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RUBBER RESEARCH INSTITUTE OF SRI LANKA

Single day smoke sheet drying system

Annual Review 2008

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Cover Story

Simple technology for significant gains: an efficient system for drying sheet rubber within a single day

Single day smoke sheet drying system which was recently introduced by the Rubber Research Institute of Sri Lanka consists of a compact and well insulated drying chamber, a trolley to hang sheets, a gravel layer, a perforated baffle plate and a bio mass fed heat source. The drying period of 4-5 days with the conventional smoke house used for over 100 years has been reduced by 80% to a single day through effective and efficient energy utilization with the newly introduced operation practices.

Contamination of ash and dirt in sheet rubber has been minimized in this system paving the way to manufacture high quality sheets. As such, negative effects on quality possible during drying process in the conventional system is reduced to near zero level with the newly introduced system. The raw rubber properties of rubber dried using the new drying system is similar to that of rubber dried using the conventional drying system.

The single day drying system was recognized as the best contribution made in the field of Development and Adaptation of Technologies for SMEs in 2008 and was presented with "The National Science and Technology Award 2008" at the national competition organized by the Ministry of Science and Technology of Sri Lanka.

Congratulations to all those involved in developing a single day drying system for sheet rubber

Photography: Mr W. Amaratunge
Miss A. Thewarapperuma

Rubber Research Institute of Sri Lanka

Annual Review – 2008

1st January 2008 to 31st December 2008

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** On no pay leave

RUBBER RESEARCH INSTITUTE OF SRI LANKA

DIRECTOR'S REVIEW

A Nugawela

The Research and Development program of the Rubber Research Institute of Sri Lanka was carried out successfully during the year. A brief summary of the major achievements made during the year are briefly discussed below.

In the crop development program for the year 3269 artificial hand pollinations were done. A significantly high success rate, *i.e.* 10.8% was recorded resulting in 354 new genotypes. Further from the 1987 and 1992 hand pollination progenies eleven new clones were selected for further testing of their performance using estate collaborative clone trials.

In order to ensure the supply of high quality planting material for the rubber growers all rubber nurseries managed by private commercial nursery owners, regional plantation management companies and the rubber development department were inspected. Around 2.5 million plants were certified as quality plants during the year. A new source bush nursery having all the recommended clones for planting were established at Dartonfield estate to issue authentic planting material for all registered nurseries on their request. The new tapping knife developed recently to ensure quality tapping even through the semiskilled latex harvesting assistants was in demand and more than 1500 knives were distributed during the year.

Collar rot (patch canker) caused by *Pythium* sp. is becoming rather common in the rubber cultivations from the recent past. Studies conducted have revealed that this could be effectively controlled by the fungicide, mancozeb. Also, the damage caused to young rubber by the rodents and mammalian pests are on the increase. In order to control such damages more effectively the retaining capacity of the animal repellents to be applied on plants was improved.

The use of *Mucuna bracteata* as a cover crop for rubber was further emphasized since it has the potential to provide 50% of the N fertilizer requirement during the immature period of rubber resulting in significant savings on chemical fertilizer. The application of 23 MT of paddy straw per hectare during the entire immature period of rubber could provide Rs.31,700 worth of K fertilizer. Weed control at the tree base of young rubber trees is essential though it is costly, labor intensive and environmentally hazardous. Power mat developed using rubber waste was found to be a cost effective, user and an environmentally friendly method of weed control. Site specific fertilizer recommendations were made for 6,700 ha of mature rubber saving around Rs.30 million for the rubber growers. Further, more than 400 ha of land were surveyed to assist growers to identify suitable land for growing rubber.

A protocol to exploit rubber at d/4 frequency with the objectives of reducing the requirement of latex harvesting assistants, tapping costs and prolonging the tapping cycle was developed. Suitable stimulation frequencies for Controlled Upward Tapping of higher panels were identified and recommended to the growers.

The Advisory Committee for the Rubber Sector of the country has identified the need to develop strategies to over come the worker shortage for rubber exploitation. With regard to this the Rubber Research Institute proposed measures to improve, a) social and financial status of harvesters b) the working environment and to c) upgrade the knowledge and skill. A curriculum was developed to be used in the training of Latex Harvesting Assistants/Officers. The Rubber Research Institute, Rubber Development Department, Tertiary and Vocational Training Institute and the Planters Association jointly implemented this programme. Two programmes, *i.e.* one in Kalutara and the other in Kegalle district were conducted during the year.

A Natural Rubber latex based adhesive to make foam blocks from crumbs and a neoprene based adhesive was developed. A total number of over 1,000 raw rubber samples were analyzed for raw rubber properties for grading and shipping purposes. Further over 500 latex samples and 150 chemicals used in the rubber industry were analyzed for their technical properties and purity respectively as per the requests from the industry.

Paper based low cost and bio-degradable latex coated bags for nurseries and other agricultural applications were developed. Further a rubber coating suitable for paper based cups was also developed. NR/particulate filler/coconut fiber based composites were made for different applications.

The single day smoke drying unit had been successfully adopted by the small and medium scale RSS manufacturing sectors. This system was awarded the National Science and Technology award in 2008 for development and adoption of technology in SMEC. Based on recent studies the currently recommended maximum levels of metal ions that can be present in processing water will be revised. Studies have shown that blending of high VFA latex concentrate with low VFA latex concentrate in appropriate ratios would give rise to an acceptable level of VFA in the blend.

In the Padiyatalawa and Mahaoya divisional secretariats in the Eastern Province awareness programs were conducted for the benefit of rubber nursery owners and smallholders. Further 40ha of rubber were planted.

Simple mathematical models were developed to estimate timber, biomass and carbon content of a rubber tree using the tree diameter.

Farmer training programmes, field demonstrations and awareness raising programmes were conducted with the aim of increasing the adoption rates of RRI recommendations in the smallholder sector. Further model rubber holdings and RSS processing units were established in the REOO ranges for the same purpose.

Rubber prices

The rubber prices remained attractive during the first three quarters of the year. During this period the monthly average price of RSS 1 ranged from Rs.258.73 to Rs.351.67 per kg at the Colombo auctions. The crepe rubber prices ranged from Rs.249.81 to Rs.398.83 per kg during this period. Nevertheless due to the global economic recession the rubber prices declined significantly during the last quarter of the year and during this period the monthly average price for a kg of RSS and Crepe were Rs.158.47 and Rs.122.00 respectively.

Trends in the natural rubber industry

The natural rubber production in the country has increased up to 129 thousand metric tones during the year. This is an unprecedented 9.7% increase over 2007 production of 117.6 thousand MT. As per the latest figure on the total rubber extent of the country, *i.e.* 122,000 hectares and assuming 80% of the extent as mature rubber the national productivity level for the year is around 1,322kg per hectare per annum. This is a 4.8% increase over the 2007 national productivity level of 1261kg of rubber per hectare per annum. The national productivity level has shown a steady increase since the increase in natural rubber prices. The poor trading conditions evident during the last quarter of the year may have had a negative impact on this trend.

The extent under rubber has increased up to 122,000 hectares in 2008 from the figure of 120,070 hectares in the previous year showing a 1.6% increase. The extent under rubber in the country too had been increasing since the increase in the natural rubber prices and this trend too could be negatively affected due to the poor prices since the last quarter of the year.

Nevertheless, it needs to be emphasized that a census on the rubber extent in the country is an urgent requirement to ensure the accuracy of the same and productivity levels.

Trends in the global rubber industry

The world natural rubber production increased up to 9,942 million tonnes from the previous year's production figure of 9,893 million tonnes. This is a 0.5% growth in the production and is very much lower than the national production increase of 9.7% for the same period. The world natural rubber consumption for the years 2007 and 2008 were 9,735 and 9,550 million tonnes respectively. Hence the world natural rubber consumption in 2008 has decreased by 1.9%. Further, the world natural rubber consumption in 2008 is 96% of the production indicating an over supply situation.

The world synthetic rubber production decreased up to 12,785 million tonnes from the previous year's production of 13,596 million tonnes. This is a 6% drop in production when comparing with the previous year and may have been due to the high crude oil prices during the first three quarters of the year. The world synthetic

rubber consumption decreased up to 12,647 million tonnes from the previous year's consumption of 13,197 million tonnes. This is a 4.2% drop in the synthetic rubber consumption from the previous year and this drop is higher than the drop recorded for natural rubber during the same period.

OVERSEAS VISITORS

Mr Henry Gaier, Kuala Lumpur, Malaysia
Dr Hidde Smit, Secretary General, IRSG

GENETICS AND PLANT BREEDING

P Seneviratne

SUMMARY

Annual hand pollination programme was carried out at Nivitigalakele Sub Station and at Malaboda division of Eladuwa estate. Due to heavy rain prevailed throughout the flowering season, the number of pollinations that could be done was about one third of the targeted number of pollinations. But, however the success rate was 10.8% which is the highest recorded value ever.

Eleven new clones were selected from 1987 and 1992 hand pollination progenies to register under a new series and further to test their performance in estate RRI collaborative clone trials. Data collection from Environment × Genotype trials was affected due to high bark consumption in most estates. Higher g/t/t values were obtained from budded plants than from seedlings except for clone PB 28/59 and PB 86 in the open pollinated seedling progenies.

Clones RRISL 203, RRISL 206, RRISL 208 and RRISL 2000 showed high g/t/t values in ECT trials proving their suitability in commercial planting.

Monthly Test Tapping data collection in most of the small scale clone trials was affected due to rain interferences and recovery tapping practices on estates. Data collection for 10-15 days continuously was possible for a few important trials.

DETAILED REVIEW

Staff

Dr (Mrs) P Seneviratne, Acting Head of the department, Assistant Geneticist and Plant Breeder Mr K K Liyanage, Research Assistant, Mr K B Karunasekera, Experimental Officers Mr K W Rupatunga, Mr L S Kariyawasam, Mr I D M J Sarath Kumara, Technical Officers Mrs A K Gamage, Mr T M S K Gunasekera, Mr H P Peiris and Mrs S D P K L Peiris, Clerk/typist were on duty throughout the year.

Geneticist and Plant Breeder Mrs S P Withanage continued her postgraduate training abroad.

Prof. N E M Jayasekara of University of Wayamba, assisted as an advisor to evaluate new clones.

Meetings and Workshops

Officer	Subject	Organization
K K Liyanage	Stakeholders Consultative Workshop on Agricultural Research Need and Priorities in Sri Lanka	CARP
	Work Shop on Intellectual Property Management in Agriculture and Benefit Sharing	Dept. of Agriculture

LABORATORY INVESTIGATIONS

Molecular biology of *Hevea* (GPB/MM/97)

Investigation on polymorphism of recommended *Hevea* clones using RAPD techniques are in progress.

FIELD EXPERIMENTS

Hand pollination (HP) programme – 2008 (GPB/BST/HP/01)

The annual hand pollination programme was carried out at RRISL sub station, Nivitigalakele and also at Malaboda division of Eladuwa estate. The parents were selected mainly to repeat the RRIC 121 cross and other promising local and selected germplasm clones. The heavy rain prevailed throughout the flowering season allowed only 3,269 pollinations which is about one third of normal figure. The crosses attempted, the number of pollinations done in each cross, number of pods harvested and seedlings obtained in each cross are given in Table 1. Despite the low number of pollinations done the success rate is 10.8% which is the highest recorded ever.

Evaluation of hand pollinated progenies

Small Scale Clone Trials

The list of the Small Scale Clone Trials monitored by the Department to-date is given in Table 2.

Table 1. *Details of 2008 hand pollination programme*

Cross	No. of pollinations	No. of fruits collected	No. of seedlings
RRIC 121 x PB 28/59	160	13	28
RRIC 121 x GP 21-163	347	21	49
RRIC 121 x GP 36-160	04	01	03
RRIC 121 x GP 21-108	09	-	
RRIC 121 x GP 22-271	82	13	17
RRIC 121 x GP 1-47	08	03	05
RRIC 121 x GP 1-4	41	02	05
RRIC 100 x PB 28/59	1016	144	120
RRIC 100 x GP 22-373	244	39	40
RRIC 100 x GP 22-271	71	09	05
RRIC 100 x GP 1-47	18	-	
RRIC 100 x GP 1-4	48	09	17
PB 28/59 x GP 36-147	46	14	28
PB 28/59 x RRIC 121	536	67	09
PB 28/59 x IAN 45/873	639	124	28
Total	**3269**	**459**	**354**

(P Seneviratne, K K Liyanage, K B Karunasekera, K W Rupatunge, T M S K Gunasekera and I D M J Sarathkumara)

Table 2. *Details of small scale clone trials*

HP year	Site	Planting date	Current status
1986	Kuruwita sub station	May 1990	10th year of tapping
1987	Clyde- Kethhena	May 1993	10th year of tapping
1988	Dartonfield	July 1993	8th year of tapping
1990	Kuruwita sub station	July 2002	Immature
1991	Pallegoda	August 2000	2nd year of tapping
	Vogan	November 2000	2nd year of tapping
1995	Sorana	June 1998	4th year of tapping
1996	Kuruwita sub station – I & II	May 1999	3rd year of tapping
1997	Clyde – I & II	June 2000	3rd year of tapping
1998	N'kele I,II & III	June 2001	1st year of tapping
	Kuruwita sub station I,II & III	July 2001	1st year of tapping
1999	Kuruwita sub station I,II & III	June 2002	Immature
2000	Arappalakande I-III	May 2003	Immature
	Delkeith I & II	June 2003	Immature
	Elston I & II	July 2003	Immature
	Nivithigalakele I & II	July 2003	Immature
2001	Paiyagala I	June 2006	Immature
	Kuruwita sub station II	July 2006	Immature
2002	Pallegoda	July 2007	Immature
2007	Kuruwita sub station (seedlings)	July 2008	Immature

Evaluation of 1986 H.P. Selections - Kuruwita Sub station (GPB/BST/HPS/86)

17th year girth measurements and yield data relevant to the 10th year of tapping based on three test tappings are given in Table 3a and 3b respectively. The highest girth and yield obtained from control clone RRIC 121 is followed by HP selection 86-87.

Table 3a. *Mean girth (17th year) of promising 1986 H.P. clones*

Clone	Mean girth (cm) and DMRT grouping
RRIC 121	93.52 [a]
86- 87	84.94 [ab]
RRIC 100	77.42 [bc]
86-22	76.46 [bc]
86-32	75.20 [bc]
86-17	69.03 [bc]
86-10	67.95[c]
86-39	64.8[c]

Table 3b. *Mean yield of promising 1986 H.P. clones*

Clone	Yield (g/t/t) and DMRT grouping
RRIC 121	48.49 [a]
86-87	47.05[a]
86-17	37.18[ab]
86-10	34.16[ab]
RRIC 100	27.65[b]
86-22	22.18[b]

(P Senaviratne, K K Liyanage, H P Pieris and K B Karunasekera).

Evaluation of 1987 H.P. selections - Clyde estate (GPB/BST/HPS/87/1)

Data collection of this trial was stopped temporarily due to high bark consumption and brown bast experienced, as a result of high intensity tapping.

Evaluation of 1988 H.P. selections - Dartonfield estate (GPB/BST/HPS/88)

The 15th year girth measurements and 8th year yield based on 6 test tappings were taken and girth and yield of clones were grouped using the Duncan's Multiple Range Test. Clones that are better than the control clones are given in Table 4a and 4b. Percentage of TPD was high in this trial.

Table 4a. *Mean girth in cm of the 1988 HP progeny*

Clone	Mean girth and DMRT grouping
88-32	86.40^{a}
88-28	85.90^{a}
88-31	83.90^{a}
88-14	80.40^{ab}
88-36	79.61^{abc}
88-16	78.80^{abcd}
88-15	73.70^{bcde}
88-40	71.60^{bcdef}
RRIC 100	71.35^{bcdef}

Table 4b. *Mean yield (g/t/t) of the 1988 HP progeny*

Clone	Mean yield and DMRT grouping
88-11	45.35^{a}
88-28	39.79^{ab}
88-31	36.13^{ab}
RRIC 121	35.43^{ab}
88-50	35.42^{ab}
88-26	34.76^{abc}
88-40	34.08^{abc}
88-38	31.82^{abcd}
88-20	31.47^{abcd}
RRIC 100	30.82^{abcd}

(P Senaviratne, K K Liyanage and L S Kariyawasam)

Evaluation of 1990 H.P. clones at Kuruwita estate (GPB/BST/HPS/90/01)

The 6th year girth measurements taken for HP entries which performed well in growth are listed in the Table 5.

Table 5. *Mean girth of selected HP entries of the 1990 HP progeny planted at Kuruwita Sub station*

Clone	Mean girth (cm) and DMRT grouping
90-10	54.62^{a}
90-20	52.37^{ab}
90-7	51.56^{abc}
90-11	50.00^{abcd}
90-21	49.68^{abcd}
90-27	48.43^{abcd}
90-1	47.93^{abcd}
RRISL 205	46.31^{bcde}
90-23	46.12^{bcde}

(P Seneviratne, K K Liyanage, H P Peris and K B Karunasekera).

Evaluation of 1991 HP clones Pallegoda and Vogan estates (GPB/BST/HPS/91/01 & 91/2)

DMRT grouping of 8th year girth and 2nd year yield based on six and five test tappings respectively are given in tables 6a and 6b.

Table 6a. *Mean girth of selected HP entries of the 1991 HP progeny planted at Pallegoda and Vogan estates*

Mean girth (cm) of 91-01 trial (Pallegoda)		Mean girth (cm) of 91-02 trial (Vogan)	
Clone	**Girth**	**Clone**	**Girth**
RRISL 205	73.23^{a}	97-62	72.11^{a}
RRIC 121	68.87^{ab}	RRISL 205	69.15^{ab}
91-29	68.73^{ab}	91-79	66.50^{abc}
91-19	66.27^{bc}	RRIC 121	65.50^{abcd}
91-1	63.27^{bcd}	91- 71	63.17^{bcde}
91-2	63.21^{bcde}	91- 63	62.40^{bcdef}
91-13	63.10^{bcde}	91- 58	60.70^{cdefg}
91-5	62.91^{cde}	97 – 58	60.50^{cdefg}
91-34	61.95^{cde}	91-57	60.19^{cdefgh}

Table 6b. *Mean yield and the results of DMRT grouping of the 1991 H.P. selections planted at Pallegoda and Vogan estate*

Mean yield (g/t/t) of 91-01 trial (Pallegoda)		Mean yield (g/t/t) of 91-02 trial (Vogan)	
Clone	**Yield**	**Clone**	**Yield**
91-21	52.98^{a}	91-73	47.80^{a}
91-19	48.82^{ab}	97-62	43.24^{ab}
91-16	46.38^{abc}	91-58	42.14^{abc}
91-24	45.58^{abc}	RRIC 121	41.98^{abc}
91-1	43.85^{abcd}	91-57	35.86^{abcd}
91-13	4307^{abcd}	91-71	35.66^{abcd}
RRISL 205	41.59^{abcde}	97-58	33.31^{bcde}
91-8	40.45^{bcdef}	RRISL 205	32.63^{bcdef}
91-4	39.40^{bcdefg}	91-89	32.08^{bcdefg}

(P Seneviratne, K K Liyanage, K W Rupatunge, L S Kariyawasam and K B Karunasekera)

Evaluation of 1995 H.P. selections Sorana estate (GPB/BST/HPS/95)

This trail had to be terminated due to high intensity tapping practiced by the estate leading to high brown bast rates (P Seneviratne, K K Liyanage, I D M J Sarathkumara and K B Karunasekera).

Evaluation of 1996 H.P. seedlings - Kuruwita estate (GPB/BST/HPS/96 -1 and 96-2)

In both trials 9th year girth measurements are grouped using Duncan's multiple range test and some of the superior genotypes are given in Table 7a. Mean yields and the DMRT grouping of some selected clones based on four test tapings in the 3rd year of tapping are given in Table 7b along with control clones.

Evaluation of 1997 H.P. clones at Clyde estate (GPB/BST/HPS/97/01 & 91/2)

Table 8a shows the 8th year girth measurements and their DMRT grouping in both trials. Mean yields and the DMRT grouping of some selected clones based on four test tapings done in the second year of tapping are given in Table 8b along with control clones.

Table 7a. *Mean girth (cm) of the 1996 HP progeny*

Mean girth (cm) from 96-1 trial		Mean girth (cm) from 96-2 trial	
Clone	**Girth**	**Clone**	**Girth**
96-59	76.53^{a}	RRIC 121	70.50^{a}
96-14	70.16^{ab}	96-37	69.73^{a}
96-15	69.28^{bc}	96-45	67.50^{ab}
RRIC 121	68.67^{bc}	96-47	67.07^{ab}
96-17	67.30^{bcd}	96-54	67.00^{ab}
96-58	64.90^{bcde}	96-44	65.80^{abc}
RRISL 205	64.21^{bcdef}	96-39	61.64^{abcd}
		96-26	61.57^{abcd}
		96-40	61.37^{abcd}
		RRISL 205	60.35^{abcde}

Table 7b. *Mean yield and the DMRT grouping of some of the HP selections*

Mean yield (g/t/t) from 96-1 trial		Mean yield (g/t/t) from 96-2 trial	
Clone	**Yield**	**Clone**	**Yield**
96-58	77.84^{a}	96-54	68.00^{a}
96-14	60.17^{b}	96-22	55.90^{ab}
96-65	57.29^{bc}	RRIC 121	54.47^{bc}
96-8	56.01^{bcd}	96-32	49.00^{bcd}
96-31	53.79^{bcd}	96-40	48.60^{bcd}
RRIC 121	51.45^{bcde}	96-45	46.34^{bcd}
96-2	47.92^{bcdef}	96-20	45.64^{bcd}
96-15	47.11^{bcdef}	96-43	45.04^{bcd}
PB 260	44.98^{bcdefg}	PB 260	44.07^{bcde}

(P Seneviratne, K K Liyanage, H P Peris and K B Karunasekera)

Table 8a. *Mean girth in cm of the 1997 HP progeny planted at Clyde estate*

Mean girth (cm) from 97-01 trial		Mean girth (cm) from 97-02 trial	
Clone	**Girth**	**Clone**	**Girth**
97-9	64.36^{a}	RRISL 205	62.41^{a}
97-2	62.93^{ab}	97-55	61.92^{ab}
RRISL 205	61.33^{abc}	97-67	61.36^{ab}
97-10	60.86^{abcd}	97-61	61.07^{abc}
97-19	59.32^{bcde}	97-79	58.92^{abcd}
97-23	58.00^{cdef}	97-60	58.26^{abcd}
97-40	57.92^{cdef}	97-64	57.93^{abcde}
97-26	57.76^{cdef}	97-66	57.71^{abcde}
RRIC 121	57.71^{cdef}	97-56	57.63^{abcde}

Table 8b. *Mean yield of the 1997 HP progeny planted at Clyde estate*

Mean yield (g/t/t) from 97-01 trial		Mean yield (g/t/t) from 97-02 trial	
Clone	**Yield**	**Clone**	**Yield**
97-25	42.60^{a}	97-74	56.95^{a}
97-9	35.26^{ab}	97-60	49.47^{ab}
97-42	34.78^{ab}	97-66	44.54^{bc}
97-26	32.69^{bc}	97-55	44.45^{bc}
97-3	32.25^{bcd}	97-70	42.124^{bcd}
97-36	31.93^{bcd}	97-56	40.15^{bcde}
97-32	31.53^{bcde}	97-67	34.70^{cdef}

(P Seneviratne, K K Liyanage, T M S K Gunasekera and K B Karunasekera).

Evaluation of 1998 H.P. clones at Nivithigalakele (GPB/BST/HPS/98/01,02,03) and Kuruwita substations (GPB/BST/HPS/98/04,05,06)

Seventh year girth measurements and first year yield data based on four test tappings were analysed using Duncan's multiple range test for each trial. Results of some of the promising HP entries and control clones are given in Tables 9a, 9b, 9c and 9d.

Table 9a. *Mean girth of selected HP entries of the 1998 HP progeny planted at Nivitigalakele Sub station*

Trial 98-01 Mean girth(cm)		Trial 98-02 Mean girth(cm)		Trial 98-03 Mean girth(cm)	
Clone	**Girth**	**Clone**	**Girth**	**Clone**	**Girth**
98-88	63.36^{a}	98-132	65.50^{a}	98-133	59.266^{a}
98-147	59.00^{b}	98-96	61.15^{b}	RRISL 205	58.56^{ab}
98-180	57.03^{bc}	RRIC 121	57.36^{bc}	RRIC 121	58.06^{ab}
98-134	56.73^{bc}	98-159	56.28^{cd}	98-280	57.63^{abc}
RRISL 205	55.86^{bcd}	98-53	55.90^{cde}	98-151	56.75^{abcd}
RRIC 121	55.82^{bcd}	98-129	55.69^{cde}	98-225	56.63^{abcd}
98-112	54.93^{bcde}	98-85	52.96^{cdef}	98-281	56.00^{abcd}
98-108	54.50^{cde}	98-259	52.65^{defg}	98- 197	55.87^{abcd}
98-115	54.32^{cdef}	RRISL 205	52.62^{defg}	98-269	54.62^{bcde}

Table 9b. *Mean girth of selected HP entries of the 1998 HP progeny planted at Kuruwita Sub station*

Trial 98-04 Mean girth (cm)		Trial 98-05 Mean girth (cm)		Trial 98-06 Mean girth (cm)	
Clone	**Girth**	**Clone**	**Girth**	**Clone**	**Girth**
98-276	63.84^{a}	98-68	63.89^{a}	98-223	64.92^{a}
98- 230	62.03^{ab}	98-58	58.96^{ab}	RRISL 205	63.26^{ab}
98- 98	61.90^{ab}	98-51	58.71^{ab}	98-154	59.54^{bc}
98- 84	61.09^{abc}	98-80	57.40^{bc}	98- 19	58.75^{bc}
RRISL 205	58.90^{abcd}	RRISL 205	56.31^{bcd}	RRIC 121	58.75^{bc}
98-11	58.50^{abcd}	RRIC 121	55.10^{bcde}	98-30	57.57^{cd}
98-219	57.96^{abcd}	98-73	54.03^{bcdef}	98-196	54.58^{cde}
98- 164	56.13^{bcde}	98-41	53.60^{bcdef}	98-278	54.45^{cde}
98- 207	56.00^{bcde}	98-07	52.60^{cdefg}	98-23	53.30^{def}

Table 9c. *Mean yield (g/t/t) of selected HP entries of the 1998 HP progeny planted at Nivitigalakele Sub station*

Trial 98-01 Mean yield(g/t/t)		Trial 98-02 Mean yield(g/t/t)		Trial 98-03 Mean yield(g/t/t)	
Clone	**Yield**	**Clone**	**Yield**	**Clone**	**Yield**
98-100	56.87^{a}	RRIC 130	54.97^{a}	RRIC 130	46.18^{a}
98-88	52.26^{a}	98-132	50.01^{ab}	98-133	39.54^{ab}
RRIC 130	49.75^{a}	96-262	49.00^{ab}	98-118	36.72^{bc}
98-168	40.23^{b}	98-259	39.09^{bc}	98-138	36.04^{bcd}
98-147	39.13^{bc}	98-86	38.29^{bc}	98-228	34.78^{bcde}
98-123	37.41^{bcd}	98-96	36.34^{cd}	98-269	33.26^{bcdef}
98-113	36.66^{bcd}	98-159	36.27^{cd}	98-225	31.80^{bcdefg}
98-112	36.47^{bcd}	98-117	33.90^{cde}	98-281	30.33^{cdefgh}
98-115	35.71^{bcde}	98-129	29.31^{cdef}	98-151	$29.56^{cdefghi}$

Table 9d. *Mean yield (g/t/t) of selected HP entries of the 1998 HP progeny planted at Kuruwita Sub station*

Trial 98-04 Mean yield (g/t/t)		Trial 98-05 Mean yield (g/t/t)		Trial 98-06 Mean yield (g/t/t)	
Clone	**Yield**	**Clone**	**Yield**	**Clone**	**Yield**
98-105	55.57^{a}	RRIC 130	52.62^{a}	98-223	58.62^{a}
98-124	48.59^{ab}	98-78	47.40^{ab}	98-257	57.10^{a}
98-98	48.48^{ab}	RRIC 121	46.60^{ab}	RRIC 130	52.82^{ab}
98-236	46.37^{abc}	98-62	46.21^{abc}	98-278	50.01^{abc}
RRIC 121	46.34^{abc}	98-68	44.74^{abc}	RRIC 121	46.68^{abcd}
98-89	44.85^{bcd}	98-51	43.30^{abcd}	98-19	41.77^{bcde}
98-237	43.25^{bcde}	98-56	43.30^{abcd}	98-30	40.17^{bcdef}
RRIC 130	42.09^{bcdef}	98-44	42.84^{abcd}	98-154	39.88^{bcdef}
98-219	41.48^{bcdef}	98-58	42.83^{abcd}	98-196	39.70^{bcdef}
98-230	40.65^{bcdef}	98-70	42.07^{abcd}	98-23	39.35^{bcdefg}

(P Seneviratne, K K Liyanage, H P Peris and K B Karunasekera).

Evaluation of 1999 H.P. clones at Kuruwita substation (GPB/BST/HPS/99/01, 02 & 03)

The sixth year girth measurements taken from each trial and results of the DMRT grouping are given in Table 10.

Table 10. *Mean girth of selected HP entries of the 1999 HP progeny planted at Kuruwita Sub station*

Trial 99-01 Mean girth (cm)		Trial 99-02 Mean girth (cm)		Trial 99-03 Mean girth (cm)	
Clone	**Girth**	**Clone**	**Girth**	**Clone**	**Girth**
99-67	51.56^{a}	99-157	61.87^{a}	99-189	60.28^{a}
99-55	51.12^{ab}	99-47	54.78^{ab}	99-216	57.00^{ab}
99-61	50.00^{abc}	99-167	53.68^{bc}	99-230	52.62^{bc}
99-73	49.00^{abcd}	99-272	50.93^{bcd}	99-166	51.93^{bcd}
99-43	48.75^{abcd}	99-265	50.62^{bcde}	99-63	49.75^{bcde}
99-139	48.68^{abcd}	99-159	50.18^{bcdef}	99-64	48.12^{cdef}
99-74	48.28^{abcd}	99-178	48.50^{bcdefg}	99-133	47.93^{cdef}
99-48	47.25^{abcd}	99-137	$47.51^{bcdefgh}$	99-192	47.71^{cdef}
99-71	46.68^{abcde}	99-204	$47.35^{bcdefghi}$	99-92	47.62^{cdefg}
99-80	46.56^{abcde}	99-194	$47.25^{bcdefghi}$	99-44	47.56^{cdefg}
99-81	46.56^{abcde}	RRISL 205	$47.18^{bcdefghi}$	RRISL 205	47.56^{cdefg}

(P Seneviratne, K K Liyanage, H P Peris and K B Karunasekera).

Evaluation of 2000 H.P. clones at Arrapalakande Estate (GPB/BST/HPS/00/01,02,03), Dalkeith estate (GPB/BST/HPS/00/04,05), Nivithigalakele substation (GPB/BST/HPS/00/06,07) at Elston Estate (GPB/BST/HPS/00/08,09)

Arrapalakande Trial I (GPB/BST/HPS/00/01)

In this trial each block contains 364 genotypes in completely randomized single tree plots, derived from 11 families. Fifth year girth measurements are given with the families in Table 11.

Arrapalakande Trial II (GPB/BST/HPS/00/02)

Total of 258 genotypes derived from ten families were tested in a completely randomized single tree plot design. Family means derived from fifth year girth measurements are given in Table 12.

Table 11. *Mean girth and DMRT grouping of families of 2000 HP progeny Trail I planted at Arrapalakande estate*

Family	Mean girth (cm) and DMRT grouping
PB 235 × PB 260	49.83[a]
RRIC 121× PB 235	49.01[a]
BPM 24 × PB 235	48.55[a]
PB 235 × RRIC 121	47.91[a]
BPM 24 × PB 260	47.60[ab]
BPM 24 × RRIC 121	44.56[bc]
PB 260 × RRIC 121	44.37[bc]
RRIC 121 × PB 260	43.28[cd]
BPM 24 × GP 36-104	42.05[cd]
RRIC 121 × GP 36-147	42.00[cd]
PB 260 × PB 260	40.34[d]

(P Seneviratne, K K Liyanage, T M S K Gunasekera and K B Karunasekera).

Table 12. *Mean girth of families of the 2000 HP progeny Trial II planted at Arrapalakande estate*

Family	Mean girth (cm)
BPM 24 × PB 235	47.37
RRIC 121 × PB 235	45.69
BPM 24 × PB 260	45.50
BPM 24 × RRIC 121	45.17
RRIC 121× PB 260	45.43
PB 235 × RRIC 121	43.91
PB 235 × PB 260	44.44
RRIC 121 × GP 36-147	41.50
PB 260 × RRIC 121	43.26
PB 260 × PB 260	40.50

(P Seneviratne, K K Liyanage, K W Rupatunge and K B Karunasekera).

Arrapalakande Trial III (GPB/BST/HPS/00/03)

This trial contains 90 genotypes derived from a single family BPM 24 × PB 235 planted in a completely randomized design with four single tree plots per clone. Fifth year girth measurements were taken and some of the genotypes and their DMRT ranking are shown in Table 13.

Table 13. *Mean girth of vigorous genotypes and their DMRT ranking in 2000 HP progeny Trial III planted at Arrapalakande estate*

Clone	Girth (cm)
2000-48	60.87^{a}
2000-103	60.00^{ab}
2000-149	57.75^{ab}
2000-42	57.00^{abcd}
2000-121	56.87^{abcd}
2000-95	56.50^{abcde}
2000-105	56.50^{abcde}
2000-192	56.37^{abcde}
2000-59	56.25^{abcde}
2000-150	56.00^{abcde}
2000-181	55.87^{abcde}

(P Seneviratne, K K Liyanage, I D M J Sarathkumara and K B Karunasekera).

Dalkeith estate Trial IV (GPB/BS/HPS/00/04)

In this trial, 112 genotypes, 56 from each family, derived from two families (RRIC 121 × PB 235 & PB 235 × RRIC 121) were planted in a completely randomized design with three single tree plots per clone. Family mean, Variance, Minimum and Maximum derived from the fifth year girth measurements are given in Table 14 (P Seneviratne, K K Liyanage, K W Rupatunge and K B Karunasekera).

Table 14. *Mean, minimum, maximum and variance of two families planted at Dalkith estate (2000 hand pollination progeny) trial IV*

	Family	
	RRIC 121 x PB 235	**PB 235 x RRIC 121**
Mean (cm)	38.30	39.86
Minimum (cm)	16.0	21.5
Maximum (cm)	58.0	57.0
Variance	57.2	54.0

Dalkeith estate Trial V, GPB/BST/HPS/00/05

In this trial, 98 genotypes from two families [BPM 24 × PB 260 (53) & RRIC 121 × PB 260 (45)] were planted in a completely randomized design with three single tree plots per clone. Family mean, Variance, Minimum and Maximum derived from the fifth year girth measurements of two families are given in Table 15.

Table 15. *Mean, minimum, maximum and variance of two families planted at Dalkith estate (2000 hand pollination progeny) trial V*

	Family	
	BPM 24 x PB 260	**RRIC 121 x PB 260**
Mean (cm)	37.96	35.64
Minimum (cm)	17.5	19.5
Maximum (cm)	53.0	52.5
Variance	63.0	56.30

(P Seneviratne, K K Liyanage, I D M J Sarathkumara and K B Karunasekera).

Nivithigalakele substation - Trial VI and Trial VII (GPB/BS/HPS/00/06, GPB/BST/HPS/00/07)

In trial VI, 46 genotypes from one family with three single tree plots are being tested in a completely randomized design. In Trial VII, 193 genotypes are tested from a single family with three single tree plots in a completely randomized design. Family mean, Variance, Minimum and Maximum derived from the fifth year girth measurements are given in Table 16.

Table 16. *Mean, minimum, maximum and variance of two families planted at Nivitigalakele (2000 hand pollination progeny) trial VI and VII*

	Results of the trial VI (BPM 24 × RRIC 121)	**Results of the trial VII (PB 260 × RRIC 121)**
Mean (cm)	44.0	46.17
Minimum (cm)	22.5	26.5
Maximum (cm)	59.5	68.5
Variance	63.0	58.1

(P Senaviratne, K K Liyanage, T M S K Gunasekera and K B Karunasekera).

Elston Estate VIII and Trial IX (GPB/BS/HPS/00/08, GPB/BST/HPS/00/09)

In trial VIII, 103 genotypes from one family (PB 235 × RRIC 121) with three single tree plots are being tested in a completely randomized design. In Trial IX, 52 genotypes have been included from 11 families with six single tree plots per genotype in a completely randomized design. Results of the fifth year girth measurements show that most of the genotypes have not achieved the tappable girth. Table 17 shows the family means calculated from the fifth year girth measurements in trial IX.

Table 17. *Mean and variance of families planted at Elston estate trial IX*

Parentage (Family)	Mean girth (cm)	Variance
BPM 24 × GP 36-104	39.70	38.31
BPM 24 × PB 235	47.26	26.30
BPM 24 × PB 260	45.54	45.00
BPM 24 × RRIC 121	45.10	21.80
PB 235 × PB 260	45.76	59.16
PB 235 × RRIC 121	42.76	33.19
PB 260 × PB 260	40.59	49.18
PB 260 × RRIC 121	43.00	47.51
RRIC 121 × GP 36-147	41.00	49.79
RRIC 121 × PB 235	45.63	40.06
RRIC 121 × PB 260	44.98	47.64

(P Seneviratne, K K Liyanage, T M S K Gunasekera and K B Karunasekera).

Evaluation of 2001 H.P. clones - Payagala estate (GPB/BST/HPS/2001/01) and Kuruwita sub-station (GPB/BST/HPS/2001/02)

The second year girth measurements were taken and the mean girth of clones were grouped using the Duncan's Multiple range test for each trial and some of the promising HP entries are given in Table 18.

Table 18. *Mean girth of selected HP entries of the 2001 HP progeny*

Payagala estate		Kuruwita sub-station	
Clone	**Girth (cm)**	**Clone**	**Girth (cm)**
2001-249	18.05^{a}	2001-179	14.86^{a}
2001-224	17.45^{ab}	2001-89	14.39^{ab}
2001-127	17.26^{abc}	RRISL 203	13.86^{abc}
2001-126	17.22^{abc}	^{200}1-207	13.52^{abc}
2001-110	17.15^{abc}	2001-183	13.47^{abc}
2001-243	17.07^{abc}	2001-159	13.15^{bc}
2001-99	17.00^{abcd}	2001-185	13.00^{bcd}

(P Seneviratne, K K Liyanage, T M S K Gunasekera and H P Peiries).

Evaluation of 2002 HP clones - Pallegoda estate (GPB/BST/HPS/2002/01)

The first year girth measurements were taken and the mean girth values of clones were grouped using the Duncan's Multiple range test. Results are given in Table 19.

Table 19. *Mean girth of selected HP entries of the 2002 HP progeny*

Clone	Girth (cm)
2002-103	9.79^{a}
2002-25	8.55^{ab}
2002-24	8.47^{abc}
2002-67	8.40^{abc}
2002-18	8.25^{abcd}
2002-14	8.21^{abcd}
2002-11	7.93^{abcd}
2002-17	7.91^{abcd}
2002-53	7.86^{abcd}

(P Seneviratne, K K Liyanage, K W Rupatunge and K B Karunasekera).

Genotype environment interaction (G × E) studies (GPB/GE/98)

Annual girth measurements (post tapping) were collected during the year. The highest mean girth at all sites was recorded for RRISL 205, RRISL 201 and RRISL 206 and GPS 1 showed the lowest girth (Table 20). It was not possible to carry out test tappings of these trials regularly due to rain interferences and high intensity tapping in most sites.

Performance of Multi-clonal stands (GPB/MCS/99/KU)

The eighth year post tapping girth measurements were taken during the year. Table 20a shows the mean girth of each treatment, *i.e.* control monoclonal plots and plots of Bi - and Tri - clonal mixtures. According to the girth data, control monoclonal plot (RRIC 121) shows a high growth rate (Table 21a). Second year yield data are given in Table 21b.

Table 20. *Post tapping mean girth (cm) and the variance of the clones in each site*

Clone	Gane palla	Muwan Kanda	Atale	Palm garden	Pelma Dulla	Badde Gama	Sorana	Clone Mean	Variance
RRISL 201	72.2	78.8	71.9	66.2	70.7	71.6	72.0	**71.6**	**13.6**
RRISL 205	74.2	80.5	74.5	71.0	65.2	75.2	76.8	**73.9**	**22.8**
RRISL 206	62.6	71.6	70.4	66.7	65.0	72.1	68.2	**68.1**	**12.4**
RRISL 210	64.9	58.7	65.2	59.5	56.7	60.4	66.1	**61.6**	**13.8**
RRISL 215	58.0	65.1	61.0	55.9	61.8	61.4	57.5	**60.1**	**9.8**
RRISL 217	60.0	59.5	62.0	55.6	59.0	60.7	62.9	**59.9**	**5.6**
RRISL 218	63.1	74.4	75.9	60.0	59.3	64.7	69.2	**66.7**	**44.5**
RRISL 220	59.3	61.1	55.0	44.3	56.3	63.1	49.4	**55.5**	**44.3**
GPS 1	47.5	44.8	39.5	46.9	39.5	42.1	48.6	**44.1**	**14.3**
RRII 105	58.6	57.5	62.0	52.8	57.5	61.3	55.7	**57.9**	**9.9**
RRIM 712	50.6	46.5	49.4	42.2	49.1	51.0	44.8	**47.6**	**10.5**
RRIC 130	58.0	54.3	56.2	54.2	62.6	56.0	54.6	**56.5**	**9.0**
Heiken 2	50.7	52.8	48.6	41.8	48.6	48.9	49.1	**48.6**	**11.4**
PB 260	55.9	56.3	64.6	59.1	58.2	56.0	54.4	**57.8**	**11.5**
Site Mean	59.7	61.5	61.2	55.4	57.8	60.3	59.2		

(P Seneviratne, K K Liyanage, K W Rupatunga, I D M J Sarathkumara, H P Peris and K B Karunasekera).

Table 21a. *Mean girth of each treatment*

Treatment	Mean girth (cm)
RRIC 121	68.67
RRIC 121/RRIC 133	67.27
RRIC 133	67.02
RRIC 102/RRIC 121	65.28
RRIC 100/RRIC 121/RRIC 133	63.79
RRIC 102/ RRIC 133	63.70
RRIC 100/ RRIC 133	63.36
RRIC 100/RRIC 102/RRIC 121	63.23
RRIC 100/RRIC 121	63.01
RRIC 102/RRIC 121/RRIC 133	62.98
RRIC 100/RRIC 102/RRIC 133	62.02
RRIC 102	60.57
RRIC 100	60.33
RRIC 100/RRIC 102	59.64

Table 21b. *Mean yield (g/t/t) of each treatment*

Treatment	Mean yield (g/t/t)
RRIC 121	30.25
RRIC 121/RRIC 133	29.67
RRIC 102/RRIC 121	29.16
RRIC 102	28.93
RRIC 100/RRIC 121	28.28
RRIC 100/RRIC 102/RRIC 121	27.60
RRIC 102/RRIC 121/RRIC 133	25.35
RRIC 100/RRIC 102	25.26
RRIC 100/RRIC 121/RRIC 133	25.06
RRIC 100	24.94
RRIC 100/RRIC 102/RRIC 133	22.23
RRIC 100/RRIC 133	20.87
RRIC 102/RRIC 133	20.80
RRIC 133	18.72

(P Seneviratne, K K Liyanage, K B Karunasekera and H P Peiris in collaboration with Plant Science Dept.)

Open pollinated seedling progenies from commercial clones (GPB/BST/SP/00)

Eighth year (post tapping) girth measurements were recorded from this trial and mean values are shown in Table 22a. Girth was measured 150 cm above the bud union in budded plants and 150 cm above the ground level in seedlings. As far as girth is concerned, there was no significant difference among selected and unselected seedlings. Higher g/t/t values were obtained from budded plants than from seedlings except for clone PB 28/59 and PB 86 (Table 22b).

Table 22a. *Eighth year girth measurements obtained from seedlings and budded plants*

Budded plants	Girth (cm)	Selected Seedlings	Girth (cm)	Unselected seedlings	Girth (cm)
PB 86	51.19	PB 86	60.51	PB 86	60.83
RRIC 121	60.65	RRIC 121	57.26	RRIC 121	61.13
PB 28/59	54.13	PB 28/59	61.54	PB 28/59	56.15
RRIC 100	56.87	RRIC 100	63.54	RRIC 100	62.97
PB 260	55.70	PB 260	63.26	PB 260	63.55

Table 22b. *Second year yield data (g/t/t) obtained from seedlings and budded plants*

Treatment	Yield (g/t/t)
PB 260 budded plants	33.15
RRIC 121 ,,	30.46
RRIC 100 ,,	30.32
RRIC 100 unselected seedlings	29.88
RRIC 121 selected seedlings	29.82
RRIC 100 selected seedlings	28.41
PB 86 selected seedlings	28.27
PB 28/59 selected seedlings	27.15
RRIC 121 unselected seedlings	26.76
PB 86 unselected seedlings	26.46
PB 260 selected seedlings	25.41
PB 28/59 budded plants	25.34
PB 260 unselected seedlings	25.07
PB 28/59 unselected seedlings	24.10
PB 86 budded plants	19.02

(P Seneviratne, K K Liyanage, K W Rupatunga and K B Karunasekera)

Estate/RRI collaborative clone trials (ECT's) GPB/BST/ECTs

Annual girth measurements were taken from all the trials. Table 23 shows the girth measurements for the year under review and for the previous two years for different planting sites.

Table 23. *Annual girth measurements of Estate/RRI collaborative clone trials*

Clone	Site	Year of planting	Girth in cm		
			2006	2007	2008
RRISL 201	Tempo	1996	68.08	70.82	71.65
	Kuruwita	1994	69.87	72.0	72.90
	Salawa	1999	64.11	68.15	73.15
RRISL 203	Galewatta	1987	72.51	73.87	75.0
RRISL 205	Pallegoda	1995	69.40	72.58	75.0
	Vogan	1997	75.60	78.30	78.5
RRISL 206	Pallegoda	1995	63.50	66.42	69.3
	Vogan	1997	65.27	66.48	66.5
	Salawa	1999	55.50	58.00	61.65
RRISL 207	Dosert division*	2004	14.50	21.86	34.4
RRISL 208	Dartonfield	1994	65.33	67.48	68.8
RRISL 210	Payagala*	2006		9.25	16.25
RRISL 211	Dartonfield	1994	64.53	65.59	66.5
RRISL 212	Kuruwita*	2006		8.6	13.7
RRISL 214	Dosert division*	2004	12.79	21.16	33.5
	Kuruwita*	2006		7.0	11.3
RRISL 215	Salawa	1999	59.80	63.5	65.90
RRISL 216	Dartonfield	1994	62.48	64.21	65.85
RRISL 217	Kuruwita	1995	58.49	59.0	60.05
	Vogan	1997	59.98	61.71	63.8
RRISL 219	Dartonfield	1994	65.16	67.20	69.1
RRISL 220	Salawa	1999	52.10	56.5	59.2
RRISL 221	Salawa	1999	56.23	59.05	62.0
RRISL 223	Galewatte	1994	64.25	64.77	66.2
RRISL 225	Nivitigalakele	2002	47.20	52.10	53.5
RRISL 226	Salawa	1999	54.46	56.45	59.20
RRISL 2000	Pallegoda	1998	62.65	65.13	70.0
	Nivitagalakele	2001	52.17	58.90	60.10
	Dosert division*	2004	15.32	24.28	38.00
RRISL 2001	Pallegoda	1995	63.10	65.34	66.3
	Nivitigalakele	2001	46.60	55.13	56.65
	Dosert division*	2004	16.25	24.31	34.4
RRISL 2002	Dosert division*	2004	13.93	20.96	57.5
RRISL 2003	Dosert division*	2004	14.71	21.70	33.4
RRISL 2004	Dosert division*	2004	15.13	23.30	34.3
RRISL 2005	Dosert division*	2004	17.46	27.40	40.23
RRISL 2006	Dosert division*	2004	16.76	24.15	35.5
RRII 105	Pallegoda	1998	52.30	54.10	59.6

* Immature fields

Yields from ECTs GPB/BST/ECT/95/01

The estate yields obtained from ECT trials are given in Table 24. Clone, year of tapping, DRC, g/t/t and yield/tree/annum are included.

Table 24. *Clone, year of tapping, number of tapping days, g/t/t and yield/tree/year of ECT trials*

Clone	Year of tapping	No. of tapping days	Average g/t/t	Yield/tree/year (Kg)
RRISL 201	5	118	30.6	3.6
RRISL 203	14	112	51.5	5.8
RRISL 205	7	94	38.5	3.6
RRISL 206	7	102	47.4	4.8
RRISL 208	6	115	54.2	6.2
RRISL 211	6	121	38.4	4.6
RRISL 216	6	113	34.3	3.9
RRISL 217	7	97	33.7	3.3
RRISL 219	6	106	27.5	2.9
RRISL 223	4	138	24.4	3.4
RRISL 2000	2	118	43.5	5.1
RRISL 2001	7	101	32.6	3.3

(P Seneviratne, K K Liyanage, K W Rupatunga, K B Karunasekera, I D M J Sarath Kumara, H P Peries, T M S K Gunasekera and L S Kariyawasam).

Smallholder/RRI collaborative clone trials - GPB/BST/SRT/01/01-03

Sixth year girth measurements were taken from these trials (Table 25). All three clones planted under this programme show vigorous growth.

Table 25. *Mean girth (cm) of the SRT trials planted in 2001*

Clone	Site/Expt. No.	Year						
		1	2	3	4	5	6	7
RRISL 201	Kegalle (SRT/01/01)	10.5	20.2	31.7	43.5	53.78	59.96	63.4
	Homagama (SRT/01/03)	10.4	20.1	31.6	43.9	53.3	59.98	62.5
RRISL 203	Kegalle (SRT/01/01)	10.8	19.4	30.03	42.45	51.73	57.0	58.6
	Homagama (SRT/01/03)	8.58	16.85	26.6	37.1	46.19	52.8	54.6
RRISL 205	Kegalle (SRT/01/01)	8.95	15.7	23.8	34.14	44.13	50.08	52.8
	Homagama (SRT/01/02)	10.3	19.9	32.50	45.60	54.79	62.41	64.8

(P Seneviratne, K K Liyanage, K B Karunasekera, H P Peries and L S Kariyawasam).

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Sixth year mean girth of the four clones obtained from three sites planted in year 2002 and fifth year girth of clones planted in year 2003 are given in Table 26.

Table 26. *Mean girth (cm) of the trials planted in 2002 and 2003*

Clone	Site/Expt. No.	Year					
		1	2	3	4	5	6
RRIC 201	Kalutara (SRT/02/02)	6.98	17.80	26.38	40.48	49.50	55.4
	Kalutara (SRT/02/03)	6.04	13.50	20.18	29.86	41.13	49.8
	Ratnapura (SRT/02/04)	6.98	11.30	17.92	33.90	40.80	49.0
	Kaburupitiya (RT/03/01)	10.00	20.70	33.75	48.55	57.6	
	Radawela (SRT/03/02)	7.30	16.00	30.12	43.67	52.6	
RRIC 205	Kalutara (SRT/02/02)	5.90	16.60	27.34	42.07	51.75	56.4
	Kalutara (SRT/02/03)	6.44	14.70	22.06	31.59	40.64	46.9
	Ratnapura (SRT/02/04)	6.17	12.30	20.90	31.21	43.75	50.8
	Kaburupitiya (RT/03/01)	8.80	18.20	30.81	44.80	52.0	
	Radawela (SRT/03/02)	7.70	15.60	29.00	43.96	53.9	
RRIC 206	Kalutara (SRT/02/02)	6.82	19.00	30.03	42.98	51.76	56.5
	Kalutara (SRT/02/03)	6.69	15.98	26.22	35.71	44.81	50.6
	Ratnapura (SRT/02/04)	6.20	12.15	20.76	33.7	41.4	47.0
	Kaburupitiya (RT/03/01)	9.18	19.75	31.86	42.30	48.0	
	Radawela (SRT/03/02)	8.51	16.90	30.37	44.17	53.0	
RRIC 121	Kalutara (SRT/02/02)	5.21	12.90	20.16	30.91	38.23	43.2
	Kalutara (SRT/02/03)	6.19	12.60	18.67	27.07	36.60	43.6
	Ratnapura (SRT/02/04)	6.18	9.60	16.70	27.12	35.00	42.0
	Kaburupitiya (RT/03/01)	9.91	17.90	27.98	41.40	50.28	
	Radawela (SRT/03/02)	8.10	17.20	29.50	42.60	51.8	

Conservation and evaluation of the IRRDB germplasm (GPB/GP/85/2)

Selected genotypes were used for annual hand pollination programme. Labelling of genotypes numbers was completed. Maintenance of the site was kept to minimum possible due to lack of funds (P Seneviratne, K K Liyanage and I D M J Sarathkumara).

New plantings

A small scale clone trial was established at Kuruwita sub station to test 2007 hand pollination progeny.

Estate/RRI collaborative clone trials were established at Kuruwita sub station with the following five clones to monitor their performances further at commercial scale.

- 87-54
- 87-101
- 87-196
- 87-203

(P Seneviratne, K B Karunasekera and H P Peries).

PLANT SCIENCE

P Seneviratne

SUMMARY

A comprehensive study on rubber seed production was carried out with 16 genotypes available at the Dartonfield group and on Estates managed by Regional Plantation Companies in wet and intermediate zones. Significant differences in seed production were observed among clones, agro climatic zones, sites etc. From the data gathered up to the year under review, the clone RRIC 100 proved to be a good seed bearer. On average RRIC 100 yields about 10,000 seeds/ha. In the year 2008 too, a sub seed fall was experienced in November-December period and the same clones which produced seeds in the main seed fall produced a substantial amount of seeds during the sub seed fall. Study conducted on wintering and flowering patterns revealed that there is a variation in wintering and flowering patterns among clones and areas which lead to a variation in the time of seed fall.

Vegetative propagation of elite materials through rooted cuttings demands re-instating juvenile characteristics by successive grafting prior to induce rooting. Planting material collected from PB 28/59 was used for this. Performance of the fibrous and the tap root systems generated by split seedlings continued to be comparable. Performance of the proprietary root trainers was poor with compared to that of normal polybags. More over, cone shape containers need additional support to keep them erect in the nursery. They are not viable ergonomically specially at transporting and planting.

The scion die back in young budding nurseries is found to be related to the use of weak seedlings; with early germinated seedlings scion die back was only 1.3% which is negligible. Young buddings continue to perform better than bare roots in the field.

Use of high yielding crowns continue to give high yield in crown budded trees.Though the g/t/t is low in trees planted at high densities, the yield per hectare is high. Similarly, in the trees planted at lower densities the g/t/t is high, but total yield per hectare is low. Growth of the clone RRIC 121 seems to be least affected by opening for tapping.

No chemical formulations tested so far to cure brown bast affected trees found effective. Efficient methods to harvest brown bast affected trees are being tested.

Perennial tree crops planted with rubber performed as expected. Rambutan flowered twice probably due to weather changes.

Sprinkler irrigation system was installed at the sub station Moneragala. Proposed agro-well for the Moneragala sub station was constructed successfully during the year under review. Authentic plants and budwood of new clones were

issued to stake holders. The improved tapping knife was supplied to Smallholder farmers as well as for Regional Plantation Companies and the knife was made available at regional level also.

DETAILED REVIEW

Staff

Dr (Mrs) Priyani Seneviratne, Head of the Department, Dr A M W K Seneviratne and Mr N M C Nayanakantha, Botanists, Mrs S A Nakandala, Assistant Botanist, Mr K A G B Amaratunga, Mr R P Karunasena, Mrs G A S Wijesekera, Mr U S Weerakoon, Mrs R K Samarasekera, Mr T U K Silva, Mr M K P Perera, and Mr D L N de Zoysa, Experimental Officers, Mrs D E Jayawardena and Mrs P D A H M A de Almeida, Clerk Typists were on duty throughout the year.

Mr P D Pathirana and Mr P K W Karunatilaka were promoted to Experimental Officer grade with effect from 03.07.2008 and 01.09.2008 respectively. Mr A Wickramaratne, Assistant Botanist continued his postgraduate studies abroad. Mr M N de Alwis, assumed duties on 11.02.2008 after completing his postgraduate studies at the University of Wolverhampton, U.K. Mr U S Weerakoon, Experimental Officer, who served the Institute for about 35 years at various capacities retired on 22.08.2008. He served the Plant Science department for 25 years continuously attending to activities related to rubber nurseries and he certainly contributed a lot to the rubber industry during his long carrier at the Institute.

Research students

- N P B N Ratnayake from University of Wayamba started his final year project on "Present Status of Tapping Panel Dryness of Rubber (*Hevea brasiliensis*) in the smallholder sector of Sri Lanka: A Case Study from Kalutara Region" under the supervision of Dr W Senevirathna.

- R M Indika Ivan, of Agriculture school of Naiwala started a project with effect from 23.6.2008 on growth and yield of rubber under the supervision of Dr (Mrs) P Seneviratne.

Seminars/Conferences/Meetings/Workshop attended

Officer	Subject	Organization
Dr (Mrs) P Seneviratne Dr W Senevirathna Mr N M C Nayanakantha	Scientific Committee Meeting	Rubber Research Institute
Dr W Senevirathna	Plant certification	Department of Agriculture, Gannoruwa
Dr W Senevirathna	Technology foresight meeting	National Science Foundation

Officer	Subject	Organization
Dr W Senevirathna	Tapping Panel Dryness	Advisory Services Department
Dr W Senevirathna	Implementation of seed act	Department of Agriculture
Mr N M C Nayanakantha	Rubber tissue culture	University of Ruhuna
Mr N M C Nayanakantha	Biotechnology	Council for Agricultural Research Policy
Mr N M C Nayanakantha	Biotechnology	Council for Agricultural Research Policy/Coconut Research Institute
Dr (Mrs) P Seneviratne Dr W Senevirathna Mr N M C Nayanakantha Mrs S A Nakandala	Plantation Crop Research Symposium	Coconut Research Institute

Training programmes

Client	Subject	No. of programmes
Regional Plantation Companies	Nursery techniques	02
Regional Plantation Companies	Bud grafting	08
Regional Plantation Companies and Thurusaviya	Tapping	06
Rubber Research Institute	Tapper skill development programmes and nursery management programmes	01
Advisory Services Dept	Awareness programme	02

Advisory visits

Client	No. of visits
Plantations	17
Smallholders	02

LABORATORY INVESTIGATIONS

Tissue culture

***Propagation of clonal* Hevea**

Embryo cultured plants were maintained for micrografting experiments (N M C Nayanakantha, P Seneviratne and G A S Wijesekera).

FIELD EXPERIMENTS

Rubber seed production

Seed fall of rubber

The seed production was studied in 16 clones viz. RRIC 100, RRIC 102, RRIC 121, RRIC 130, RRIC 133, RRISL 201, RRISL 202, RRISL 205, RRISL 208, RRISL 211, RRISL 216, RRISL 217, RRISL 219, RRISL 223, PB 260 and RRII 105 in nine plantations *viz.* Payagala, Pallegoda, Dartonfield, Kuruwita, Pussella, Nakiadeniya and Padukka estates of the Wet Zone and Pitiakande and Nottinghill estates of the Intermediate Zone. Results of the study revealed significant differences in the production of seeds between agro-climatic zones, among sites within a zone, between years and among clones. Seed production in RRIC 100 was high with compared to that of RRIC 121 in all the plantations except in Kuruwita where RRISL 201 showed the highest seed production. The seed production in RRIC 121 was almost zero in majority of the plantations except in Padukka (1,435 seeds/ha) and Nakiadeniya (30 seeds/ha) of the Wet Zone and Nottinghill (92 seeds/ha) of the Intermediate Zone (Table 1).

Apart from RRIC 100 no other clone showed a satisfactory seed production in Dartonfield, Pussella, Pallegoda and Nakiadeniya estates in the Wet Zone in the year under review. Nevertheless, RRIC 102 (31,900 seeds/ha) and PB 260 (4,880 seeds/ha) in Payagala, and RRIC 133 (5,100 seeds/ha) in Kuruwita of the Wet Zone showed a considerable seed production.

The seed production per hectare in RRIC 100 was 16,157 in wet zone while in the Intermediate Zone that was only 9,259. However, in early studies a greater seed production has been recorded from the Intermediate Zone.

Commencement of seed fall in RRIC 100 varied (from end of July to mid August) irrespective of the climatic zone and the estate (N M C Nayanakantha, P Seneviratne and P D Pathirana).

Seed germination

The germination percentage of seeds of RRIC 100 collected from all locations during early seed fall was above 70% at three weeks from seed sowing in germination beds. Therefore, sufficient amount of seeds could be collected from the areas around Payagala, Pallegoda, Kuruwita and Padukka estates in the wet zone. Moreover, the germination percentage of seeds collected during off season period also was satisfactory (N M C Nayanakantha, P Seneviratne and P D Pathirana).

Unusual seed fall

A substantial amount of seeds was seen in RRIC 100 clearings during November-December in majority of the plantations in both zones. Clones PB 260, RRISL 201, RRISL 202, RRIC 130, RRISL 217 and RRII 105 produced some off season seeds while RRIC 121 did not produce seeds during major seed fall but very little during off season (N M C Nayanakantha, P Seneviratne and P D Pathirana).

Table 1. *Seed production for two climatic zones and for 16 clones in 2008. Means with different letters in rows are significantly different ($p \leq 0.05$) according to LSD*

Clone	Mean number of seeds (thousands) per hectare								
	Wet Zone							Intermediate Zone	
	Dartonfield	Payagala	Pallegoda	Padukka	Pussella	Kuruwita	Nakiadeniya	Pitiakande	Nottinghill
RRIC 100	3.1[a]	58.91	24.18	8.56	2.9	13.56[b]	1.8	9.26	3.31
RRIC 102	0.69[b]	31.88	-	-	-	-	0.05	-	-
RRIC 121	0	-	0	1.43	0	0	0.03	-	0.09
RRIC 130	-	-	-	1.78	-	-	-	-	-
RRIC 133	-	-	-	-	-	5.18[c]	-	-	-
RRISL 201	-	-	-	-	-	4.21[b]	-	-	-
RRISL 202	-	-	-	-	-	2[c]	-	-	-
RRISL 205	-	-	0.55	-	-	-	-	-	-
RRISL 208	0.32[bc]	-	-	-	-	-	-	-	-
RRISL 211	0.15[c]	-	-	-	-	-	-	-	-
RRISL 216	0.18[c]	-	-	-	-	-	-	-	-
RRISL 217	-	-	-	-	-	2.34[c]	-	-	-
RRISL 219	0.18[c]	-	-	-	-	-	-	-	-
RRISL 223	0	-	-	-	-	-	-	-	-
RRII 105	-	-	-	-	0.2	-	-	-	-
PB 260	-	4.88	-	-	-	-	-	-	-

(N M C Nayanakantha, P Seneviratne and P D Pathirana)

Wintering and flowering of rubber

This study was conducted in eight estates *viz.* Payagala, Pallegoda, Dartonfield, Kuruwita, Pussella, Nakiadeniya and Padukka of the Wet Zone and Nottinghill estate of the Intermediate Zone with 17 clones *viz.* RRIC 100, RRIC 102, RRIC 121, RRIC 130, RRIC 133, RRISL 201, RRISL 202, RRISL 205, RRISL 208, RRISL 211, RRISL 216, RRISL 217, RRISL 219, RRISL 223, PB 260, RRII 105 and PB 217. Ten trees were selected from each clone and they were observed individually during the entire wintering and flowering period at weekly intervals.

The results of wintering and flowering analysis revealed that there is a significant variation in wintering and flowering patterns among clones and sites (Table 2 & 3).

There was no significant difference in wintering and flowering of RRIC 100 and RRIC 121 between Nottinghill (Intermediate zone) and majority of the sites of the Wet Zone. However, RRIC 121 in Payagala did not winter at all except for one tree which showed about 10% wintering. RRIC 130 in Padukka showed partial wintering. But, flowering was observed in those clones (Table 2 & 3) (N M C Nayanakantha, P Seneviratne and P D Pathirana).

Natural pollinators of rubber

Observations were made on natural floral visitors of rubber with RRIC 121 and RRIC 100 at Nivithigalakele sub station. This could not be done at Pitiyakande due to rain interferences. About 11 insect species were seen to visit rubber flowers irrespective of clones and they were trapped on to glass tubes containing Ethyl Acetate vapour. They were preserved in 70% alcohol and were sent to the Department of Zoology, University of Peradeniya, for identification (N M C Nayanakantha, P Seneviratne and P D Pathirana).

Clonal propagation

Rooting of cuttings (mist propagation) - CP/2001/1 - Dartonfield

Field planted rooted cutting of clones RRIC 100, RRIC 121 and RRIC 130 have reached an average girth of 48.5 cm in 6 years (planted at 8' × 7'). Trees of RRIC 121 and RRIC 130 have given 50.3 cm and 48.4 cm respectively while RRIC 100 has given only 39.5 cm girth (P Seneviratne and G A S Wijesekera).

Vegetative propagation of elite mature individuals - CP/2001/2 - Dartonfield

Two successive grafting passages were completed for clone PB 28/59 during the year in order to re-instate juvenile characteristics in the material prior to take cuttings (P Seneviratne and G A S Wijesekera).

Phase change of* Hevea *(CP/1991-1/DF)

All trees were cut back at 3' above the ground level to monitor characteristics related to the phase change of the trees. Number of shoots appeared, shoot length and angle between the shoot and the trunk were recorded and are given in Table 4.

Table 2. *Flowering in different clones for eight sites in Wet and Intermediate Zones of Sri Lanka*

Clone	Mean scores *							
	Wet Zone							Intermediate Zone
	Dartonfield	Payagala	Pallegoda	Padukka	Pussella	Kuruwita	Nakiadeniya	Nottinghill
RRIC 100	13.8[a]	34.7[a]	17.5[a]	18.3[a]	21.5[b]	40.8[c]	19.2[b]	11.5[a]
RRIC 102	63.9[e]	28.7[a]	-	-	-	-	10.55[a]	-
RRIC 121	57.8[d]	8.8[b]	12.9[a]	5.1[b]	8.9[a]	32.7[b]	14.1[ab]	9.5[a]
RRIC 130	-	-	-	18.2[a]	-	-	-	-
RRIC 133	-	-	-	-	-	8.7[a]	-	-
RRISL 201	-	-	-	-	-	30.0[b]	-	-
RRISL 202	-	-	-	-	-	43.5[c]	-	-
RRISL 205	-	-	16[a]	-	-	-	-	-
RRISL 208	54.9[d]	-	-	-	-	-	-	-
RRISL 211	13.8[a]	-	-	-	-	-	-	-
RRISL 216	43.5[c]	-	-	-	-	-	-	-
RRISL 217	-	-	-	-	-	27.3[b]	-	-
RRISL 219	63.9[e]	-	-	-	-	-	-	-
RRISL 223	25.7[b]	-	-	-	-	-	-	-
RRII 105	-	-	-	-	16.1[b]	-	-	-
PB 260	-	30.2[a]	-	-	-	-	-	-
PB 217	60.8[de]	-	-	-	-	-	-	-

* The higher the mean score for each clone, the higher the percentage of flowering. Means with same letters in columns are not significantly different.

Table 3. *Number of weeks taken to complete ≥75% of wintering in each clone for different regions. Means with same letter in each site are not significantly different*

Clone	Mean weeks							
	Wet Zone							Intermediate Zone
	Dartonfield	Payagala	Pallegoda	Padukka	Pussella	Kuruwita	Nakiadeniya	Nottinghill
RRIC 100	9.2^{d}	13.9^{a}	11^{a}	9^{c}	10^{a}	9.7^{b}	10.4^{b}	9.5^{a}
RRIC 102	10.3^{bc}	12.2^{b}	-	-	-	-	10.8^{ab}	-
RRIC 121	10.7^{ab}	No wintering	11.1^{a}	10.9^{b}	10.7^{b}	12^{a}	12^{a}	10.1^{a}
RRIC 130	-	-	-	17^{a}	-	-	-	-
RRIC 133	-	-	-	-	-	11.8^{a}	-	-
RRISL 201	-	-	-	-	-	10.4^{b}	-	-
RRISL 202	-	-	-	-	-	10^{b}	-	-
RRISL 205	-	-	10.6^{a}	-	-	-	-	-
RRISL 208	10.8^{ab}	-	-	-	-	-	-	-
RRISL 211	11^{a}	-	-	-	-	-	-	-
RRISL 216	9.6^{cd}	-	-	-	-	-	-	-
RRISL 217	-	-	-	-	-	9.6^{b}	-	-
RRISL 219	10.7^{ab}	-	-	-	-	-	-	-
RRISL 223	9.1^{d}	-	-	-	-	-	-	-
RRII 105	-	-	-	-	10.6^{b}	-	-	-
PB 260	-	11^{c}	-	-	-	-	-	-
PB 217	11.5^{a}	-	-	-	-	-	-	-

(N M C Nayanakantha, P Seneviratne and P D Pathirana).

Table 4. *Number of shoots, mean shot length and shoot angle to the main stem of budwood plants of different ages after cut back*

Year planted	Number of shoots	Mean shoot length	Angle
1991	4	12.1	45.8
1992	4.2	21.1	49.4
1993	3.3	15.3	48.2
1994	4.5	39.9	51.7
1995	5.2	24.2	45
1996	4.3	29.4	33.6
1997	4.5	48.8	34.6
1998	5.4	29.8	32.5
1999	3	28	21.1
2000	5.4	32.3	25
2001	4.8	11.9	33.3
2002	5.5	22.2	20.6
2003	5.6	30.1	25
2004	5.4	31.3	12.1
2005	5.5	32.2	14.5

The number of shoots and their length show an increasing trend indicating the juvenile characteristics in younger trees. The angle of the shoot to the main shoot reduces with the age of the trees confirming the higher juvenility in them (P Seneviratne and G A S Wijesekera).

Root system of* Hevea *(CP/1999/1 -NK)

Trees were opened for tapping in March 2008. Girth and yield measurements of trees with different root systems *i.e.* tap root and fibrous roots, but with same genetic make up are given in Table 5.

As far as the tree girth is concerned, in some pairs the seedling performs better and in the rest the cutting performs better. Yield data will be collected to compare the pairs (P Seneviratne and G A S Wijesekera).

Effect of the rootstock on growth and yield of rubber (YB/2005/DF)

The girth of the plants after one year of field planting are given in Table 6.

Table 5. *Girth measurements of the trees of the same genetic make up but with different root systems*

Pair No.	Girth of seedling (cm)	Girth of corresponding cuttings (cm)
1	80	58
2	65	51
3	34	60.5
4	58	21.5
5	32	21.5
6	23	60
7	36	50
8	71	86.5
9	42	20
10	50	67
11	80	44
12	54	53
Average	**52.1**	**49.4**
SEM	**5.5**	**5.8**

Table 6. *Mean girth of the plants after one year*

Number of days taken for germination	Girth (cm) at 4′	
	RRIC 100	RRIC 102
12/13	8.2	6.8
14/15	6.4	7.6
17	6.8	-
18	7	6.5
19	6.9	5.8
20/21	6.9	6.3
22	6.9	6.7
23	7.4	6.7
24	6.3	
25	-	6.75
26	7.25	-
27	-	6.35
34	5.9	-
49	-	6.9

The girth of the plants shows a decreasing trend with the increase of the number of days taken to germinate the seeds in the clone RRIC 100. However, a clear pattern is not observed with RRIC 102 (P Seneviratne and G A S Wijesekera).

Budgrafting

Successive grafting - BG/1999/1 - Dartonfield

Tenth Successive grafting passage was produced using the budwood of ninth passage and the plants obtained were planted in the budwood nursery (P Seneviratne and G A S Wijesekera).

Rejuvenation of budwood plants - Egaloya Rubber Nursery

Two more generations were produced during the year. Altogether, nine successive bud grafting passages have been completed. Ten plants of each clone from each passage were planted in a budwood nursery and the plants of 8th generation were field planted during the year.

Budwood plants of three clones were pollarded and observations were made on the sprouting percentage (Table 7), number of shoots appeared, shoot lengths and angle between the stocks and the scion shoots.

Table 7. *Sprouting percentage after two weeks in plants of different generations of the three clones*

	RRIC 100 (%)	RRIC 102 (%)	RRIC 121 (%)
G_1	5.6	2.1	2.1
G_2	6.1	3.18	2.0
G_3	6.6	3.4	3.9
G_4	5.7	5.1	5.6
G_5	4.6	5.1	4.4

Clones RRIC 102 and 121 have shown an increase in the percentage sprouting when the plants are rejuvenated.

Root trainers

The details of the experiment about the potting mixtures and the containers are given in the Annual Review for 2007. Seedlings grown in different containers using different potting mixtures were bud grafted with budwood of clone PB 260. Bud grafting success and shoot growth were monitored. Mean values of the height and diameter along with SEM are given in Tables 8a and 8b respectively. Plants were field planted at Galewatta.

Table 8a. *Mean height of the shoots after seven months (cm) SEM values are given in brackets*

Container type	Para meter	Potting mixture							
		A	B	C	D	E	F	G	H
Black polythene cone shape (32 cm × 9 cm)	n	5	7	9	11	6	3	6	-
	mean	57	96.4	85.2	74.6	62.8	62.3	77.7	-
	SEM	10.6	12.1	5.25	6.4	9.7	5.36	10.56	-
Black polythene cone shape (40 cm × 15 cm)	n	9	7	8	11	3	8	8	5
	mean	74.2	88.3	91.4	114.9	59.3	113	76.2	70.6
	SEM	7.23	6.26	8.37	9.32	7.9	7.76	7.93	10.4
Plastic proprietary root trainer	n	2	-	2	6	2	2	2	3
	mean	102.5	-	102.5	93.3	83	84	81.5	55.7
	SEM	17.5	-	17.5	13.1	7	1	12.5	11.3
Black polythene bag	n	7	7	5	7	18	9	11	-
	mean	77.8	91	82.6	78.1	78.3	65.7	69.1	-
	SEM	11.1	12.5	11.1	9.46	5.54	5.38	5.87	-

Table 8b. *Mean girth of the shoots after seven months (cm) SEM values are given in brackets*

Container type	Para meter	Potting mixture							
		A	B	C	D	E	F	G	H
Black polythene cone shape (32cm × 9cm)	n	5	7	9	11	6	3	6	-
	mean	0.98	1.28	1.33	0.995	1.0	0.783	1.1	-
	SEM	0.11	0.12	0.08	0.06	0.12	0.06	0.11	-
Black polythene cone shape (40cm × 15cm)	n	9	7	8	11	3	8	8	5
	mean	1.24	1.52	1.325	1.41	1.3	1.45	1.31	1.15
	SEM	0.11	0.11	0.14	0.09	0.06	0.1	0.12	0.15
Plastic proprietary root trainer	n	2	-	2	6	2	2	2	3
	mean	1.55	-	1.15	1.14	1.35	1.2	1.3	0.93
	SEM	0.25	-	1.5	0.07	0.05	0.2	0	0.09
Black polythene bag	n	7	7.	5	7	18	9	11	-
	mean	1.17	1.37	1.17	1.31	1.11	1.16	1.18	-
	SEM	0.071	0.11	0.162	0.103	0.05	0.107	0.052	-

Cone shape containers, have a practical difficulty in placing them in the nursery. Bags on the other hand are kept in shallow trenches which do not need additional support. Better growth in large size cone shape containers is partly due to uninterrupted tap root growth due to the presence of the opening at the base. As normal bags have not central hole at the bottom of the bag, the tap root first get

coiled at the base and then only it can penetrate to the ground. Plants grew in the proprietary containers were weak from the beginning and the number remained per treatment was low as shown in the Table 8a. As far as the potting mixture is concerned, soil mixed with sand and compost or coir pith showed good growth. Those grown in coir pith alone showed deficiency symptoms.

Irrigation systems for rubber nurseries

A new sprinkler irrigation system comprising sixty numbers of technically specified sprinklers with 15 m radius throw was designed and successfully installed at Moneragala substation covering about one hectare of the nursery. A non technical sprinkler irrigation system was designed for Kuruwita substation and installation was completed.

A design was done for Government Rubber Nursery at Gurugoda to cover 10 ha. of the nursery land. The technical evaluation report for the expansion of sprinkler irrigation system for Government Nursery at Kubukkana was submitted to the ministry (S A Nakandala, P Seneviratne and P D Pathirana).

Crown budding

RRIC 110 (1994 and 1996 replantings) - CB/1998/1 - Padukka

Details of the experiment have been given in the Annual Review for 1996. Numbering, colour banding and girth measurements were done in both clearings in Menerigama and Main Divisions. Mean girth, average yield and the brown bast percentage are given in Table 9.

Table 9. *Mean girth, yield and the brown bast percentage of RRIC 110 trees crown budded with different clones (The SEM is given within brackets)*

Clearing	Crown	No. of trees	Average girth (cm)	Average yield g/t/t	% of Brown bast trees
1995 RRIC 110	RRIC 100	98	65.64 (± 0.84)	26.41	48.1
Menerigama	RRIC 102	59	69.11 (± 1.17)	32.43	50.4
Division	RRIC 117	73	68.38 (± 1.03)	33.29	42.0
	RRIC 121	32	84.12 (± 1.34)	54.63	31.0
	RRIC 130	29	70.68 (± 1.51)	54.21	53.2
	H. spruciana	51	52.53 (± 0.89)	11.84	52.7
1993 RRIC 110	RRIC 100	111	58.23 (± 0.81)	16.5	10
Main Division	RRIC 102	58	57.87 (± 1.2)	23.72	7.9
	RRIC 117	74	59.12 (± 1.0)	20.42	10.8
	RRIC 110 (control)	47	71.19 (± 2.2)	26.73	16
	H. spruciana	10	59.24 (± 2.8)	20.18	33.3

In Menerigama Division, *Hevea spruciana* continued to show the lowest girth while RRIC 121 showing the highest. Highest yield was given by RRIC 121 whilst it was lowest with *H. spruciana*.

In the main division, RRIC 110 trees showed the highest growth but slightly lesser than the last years girth. High rate of brown bast most probably due to excessive double tapping has affected the trial (P Seneviratne, R K Samarasekera and M N de Alwis).

RRISL 224 trunk with different crowns (1992 replanting of Genetics and Plant Breeding Department) - CB/1999/1 - Gallewatta

Details of the experiment were given in the Annual Review for 1999. Numbering, colour banding and girth measurements were done during the year. Mean girth of trees with different crowns are given in Table 10.

Table 10. *Mean girth of trees with different crown clones*

Crown	Number of trees	Mean girth (cm) (SEM)
RRIC 100	41	73.4 ± (1.8)
RRIC 121	40	79.34 ± (1.83)
H. pauciflora	7	52.26 ± (3.38)
RRIC 100 + RRIC 121	5	82.04 ± (3.0)
RRIC 100 + 121 + 102	2	81.95 ± (4.95)

Trees crown budded with RRIC 100 and RRIC 121 show the best growth whilst *Hevea pauciflora* show the lowest. Yield measurements were not taken due to unfavourable weather condition prevailed in the area (P Seneviratne, R K Samarasekera and M N de Alwis).

RRIC 130, RRIC 121, RRISL 217, PB 260, BPM 24, RRIM 717 and PR 305 - CB/1998/2 - Nivithigalakale

Details of the experiment have been given in the Annual Review for 2001. Numbering, and girth measurements were done during the year. Mean girth values are given in Table 11.

Table 11. *Mean girth of trees with different crown/trunk combinations*

Treatment	Trunk	Crown	No. of trees	Mean Girth (cm)
1	PR 305	Control	28	51.85 ± 1.13
	PR 305	RRIM 717	15	42.55 ± 2.43
	PR 305	Pollarded	15	50.43 ± 1.22
2	RRIM 717	Control	28	52.54 ± 1.09
	RRIM 717	PR 305	21	40.88 ± 1.78
	RRIM 717	Pollarded	9	49.95 ± 2.49
3	BPM 24	Control	9	49.13 ± 1.89
	BPM 24	PB 260	1	48
	BPM 24	Pollarded	8	45.08 ± 1.7
4	PB 260	Control	6	57.55 ± 1.67
	PB 260	BPM 24	6	46.93 ± 2.92
	PB 260	Pollarded	1	52.7
5	RRIC 121	Control	11	63.6 ± 2.45
	RRIC 121	RRISL 217	7	49.07 ± 1.22
	RRIC 121	Pollarded	4	61.55 ± 1.38
6	RRISL 217	Control	10	57.34 ± 2.05
	RRISL 217	RRIC 121	5	50.18 ± 2.93
	RRISL 217	Pollarded	9	51.89 ± 1.25
7	RRIC 121	Control	15	59.59 ± 1.23
	RRIC 121	RRIC 130	2	52.1 ± 1.41
	RRIC 121	Pollarded	10	64.63 ± 2.66
8	RRIC 130	Control	18	56.54 ± 1.46
	RRIC 130	RRIC 121	3	44.5 ± 9.29
	RRIC 130	Pollarded	17	54.65 ± 1.37

The clone RRIC 130 showed the highest girth whilst the lowest girth was recorded for PR 305. As far as trunk and crown combinations are concerned, RRIC 130 crown on RRIC 121 trunk showed the highest girth.

The changes in girth values in T_5, T_6, T_7 and T_8 treatments as against the data for last year are due to re-identification of clones and therefore due to change in the number of trees (P Seneviratne, R K Samarasekera and L Zoysa).

RRIC 130 crown budded with RRIC 133, BPM 24 and RRII 105 - 1999 - N'kele

Details of the experiment were given in the Annual Review for 2000. Numbering and girth measurements were done during the year and are given in Table 12.

Table 12. *Girth of RRIC 130 trees crown budded with RRIC 133, BPM 24, RRII 105 and RRIC 102 control trees*

Clearing	Crown	No. of trees	Mean girth (cm)	% of BB trees
1999	RRIC 133	17	56.92 ± 2.07	-
	BPM 24	35	50.08 ± 1.67	-
	RRII 105	39	52.95 ± 1.72	-
	Control (RRIC 102)	23	63.63 ± 3.14	-

Mean girth was high in control RRIC 102 trees due to continuous growth and lowest mean girth was in BPM 24. Yield measurements could not be taken due to unfavourable weather conditions. No brown bast trees was seen up to the year under review (P Seneviratne, R K Samrasekera and M Alwis).

Budwood nurseries

BN/2000/DF, BN/2001/Olikanda, BN/2002/Olikanda, BN/2008/Dolahena

Regular visits were made to the budwood nurseries at Dartonfield, Dolahena and Olikanda. Weeding, manuaring, pollarding and application of fungicides were done according to the schedule.

Plants of the budwood nursery at Olikanda and Dartonfield were pollarded and budwood was harvested.

Authentic budwood issued for nurseries

Details of the clones and the amount of budwood issued are given in Table 13.

Table 13. *Budwood harvested from Dartonfield, Olikanda and Dolahena nurseries during the year under review*

Clone	Amount (m)	Stake holder
RRISL 203	60	Egaloya Government Nursery
PB 260	118	
RRISL 2001	105	
RRISL 217	60	
RRISL 210	25	
RRISL 215	30	

Clone	Amount (m)	Stake holder
RRISL 215	20	
RRISL 217	30	
RRISL 219	10	
RRISL 200	10	
RRISL 210	15	
PB 260	30	N'kele Division
RRISL 2004	50	
RRISL 2001	74	
RRISL 2002	15	
RRISL 2006	55	
RRISL 2000	55	
RRISL 2005	50	
RRISL 217	35	
RRISL 2004	05	
RRISL 2002	80	
RRISL 2005	35	
RRISL 2000	05	
RRISL 203	115	
PB 260	05	
RRISL 202	12	Gurugoda Government Nursery
RRISL 200	05	
RRISL 210	12	
RRISL 215	25	
RRISL 219	05	
RRISL 218	10	
RRISL 201	45	
RRISL 205	55	
RRISL 2002	05	Halwathura
RRISL 2000	112	
RRISL 203	14	Galewatta Division
RRISL 2001	78	
RRISL 217	18	
PB 260	50	Plant Science Dept.
RRISL 203	100	Moneragala Government
RRISL 2001	180	Nursery

(P Seneviratne and M K P Perera)

Authentic plants for budwood nurseries

5,070 budded plants were issued from new RRISL clones and other clones for plantation sector nurseries and private nursery owners to establish budwood nurseries. In addition, 200 plants were issued from RRISL 203 and RRISL 2001 for the Dartonfield Group. Details of the plants issued from Egaloya, Gurugoda, N'kele and Dartonfield nurseries for this purpose are given in Table 14.

Table 14. *Budded plants issued to establish budwood nurseries in estates under regional plantation companies to establish budwood nurseries*

	Balangoda	Elpitiya	Hapugastenna	Horana	Kegalle	Kelanivelly	Kotagala	Namunukula	Pussellawa	Maddagedara	Dartonfield Group	Total
RRISL 200	10									10		20
RRISL 201	75		10	20			40	9				154
RRISL 203	200	50	75	88	35	50	25	75	50	30	100	778
RRISL 202					29							29
RRISL 205	35			20	60			19				134
RRISL 206					20		50					70
RRISL 208	10				24					3		37
RRISL 210				38	20		69	25				152
RRISL 211		20	10		88					10		128
RRISL 215		25		25	20		35	25				130
RRISL 217	95		20	25	75		136	50	30	20		451
RRISL 219	95		25	25	144		22		30	10		351
RRISL 2000			10	50	245		70	31	172			678
RRISL 2001	160	25	75	50	258	25	170	31	188	10	100	992
RRISL 2002	10		50		210	25			25	11		331
RRISL 2003					40							40
RRISL 2004		16	15	20	58		65			7		181
RRISL 2005	10				49			35				94
RRISL 2006					44					6		50
PB 260		75		50	5		100	50		7		287
PB 235					27					6		33
RRIC 121		50	100									150
Total	**700**	**261**	**390**	**411**	**1451**	**100**	**782**	**350**	**495**	**130**	**200**	**5270**

Budded plants of RRISL 203 and RRISL 2001 were issued for the private nursery owners while maintaining the number of plants to be only 10% of the total number of plants in the nursery (P Seneviratne and M K P Perera).

Moneragala Substation - Budwood nursery

Land preparation was done to expand the budwood nursery. Proposed Agro-well construction was completed successfully. The total water volume was about 70 m^3/day measured in December (P Seneviratne, S A Nakandala and P D Pathirana).

Monitoring and certification of rubber plants

Nursery inspection and plant certification were done through out the year. Details of the nurseries under RPC's , government, private and in Moneragala region are stated in Tables 15,16,17 and 18 respectively.

Table 15. *RPC Nurseries (established in 2007 Aug. & 2008 January)*

Regional Plantation Company	Number of estates	Number of nurseries	No. of plants established 2008	Plants certification YB		
				2007 Aug.	2008 Jan.	Total
Agalawatta	5	7	685,000	82,800	-	82,800
Balangoda	10	19	195,600	34,300	42,600	76,900
Hapugastenna	3	4	84,500	19,000	23,000	42,000
Horana	2	3	62,000	26,000	8,000	34,000
Kahawatta	1	2	52,000	80,000	-	80,000
Kegalla	10	13	118,750	54,100	-	54,100
Kelani Valley	7	8	-	86,300	-	86,300
Kotagala	13	17	251,000	103,100	-	103,100
Lalan	1	1	109,000	120,000	-	120,000
Malwatta Valley	5	5	84,000	58,500	-	58,500
Maturata	1	1	5,000	8,500	-	8,500
Namunukula	6	6	73,000	-	-	-
Pussellawa	6	6	115,400	45,500	-	45,500
Total	**70**	**92**	**1,835,250**	**718,100**	**73,600**	**791,700**

Table 16. *Government nurseries (established in 2007 August and 2008 January)*

Name of Government Nursery	Nurseries inspected	No. of plants established
Egaloya	2007 Aug- YB	250,000
	2008 Jan - YB	202,000
Gurugoda	2007 Aug - YB	275,000
	2008 Jan - YB	203,200
Karapincha	2007 Aug - YB	-
	2008 Jan - YB	191,000
Meerigama	2007 Aug - YB	330,000
	2008 Jan - YB	250,000
Walikadamulla	2007 Aug - YB	360,000
	2007 Aug - BR	50,000
	2008 Jan - YB	300,000
Middeniya	2007 Aug - YB	29,600
	2008 Jan - YB	-
Grand Total		**2,440,200**

Table 17. *Private nurseries (established in 2007 August and 2008 January)*

Region	Season & Number of nurseries	No. of plants established	Number of plants certified
Kegalle	2007 Aug. YB (28)	516,250	297,600
	2008 Jan. YB (06)	54,500	31,500
Ratnapura	2007 Aug. YB (09)	249,400	163,250
	2008 Jan. YB (04)	100,000	66,000
Kalutara	2007 Aug. YB (09)	130,500	77,000
	2008 Jan. YB (01)	22,000	15,000
Total		**1,072,650**	**650,350**

Table 18. *Moneragala nurseries (established in 2007 August & 2008 January)*

Nursery	Nursery inspected	No. of plants established	Number of plants certified	
			YB	Total
Government Nursery	2007 Aug. YB	398,000	Not inspected	-
Moneragala	2008 Jan. YB	356,000	154,320	154,320
Private	2007 Aug. YB	387,000	181,400	181,400
	2008 Jan. YB	196,100	83,865	83,865
Wellassa	2007 Aug. YB	-	-	-
	2008 Jan. YB	300,000	152,000	152,000
Hapugastenna Pl.	2007 Aug. YB	94,000	19,000	19,000
	2008 Jan. YB	64,500	23,000	23,000
Balangoda Pl.	2007 Aug. YB	-	-	-
	2008 Jan. YB	29,000	20,500	20,500
Malwattavalley Pl.	2007 Aug. YB	9,000	3,000	3,000
	2008 Jan. YB	10,000	-	-
Total		**1,843,600**	**637,085**	**637,085**

(P Seneviratne, A M W K Senevirathna, U S Weerakoon, M N de Alwis, L Zoysa and M K P Perera)

Scion die-back in YB nurseries (YB/2008/01)

This experiment was carried out at the government rubber nursery at Moneragala to investigate the causes for the sudden die back of the young scion during dry weather conditions. Two main plots of early-planted (thick stock) and late-

planted (thin stock) seedlings that were bud-grafted almost at the same time were selected and cut-backed. Half of them were shaded with 60-65% black shade nets. In each sub plot, nearly half of the plants were re-stacked on the same place while keeping the other half undisturbed.

Results revealed that shoot die-back was severe in late-planted (thin stock), un-shaded and re-stacked plants (28%), whilst it was minimum in early planted (thick stock) plants (1.3%) irrespective to shading or re-stacking. As late planted seedlings grow into weak plants, it is advised to use only early germinating vigorous seedlings (as per the current recommendation), though shoot die-back can be minimized by sufficient watering, keeping undisturbed after cut-back and shading during dry weather conditions (A M W K Senevirathna, R S Dharmakeerthi, W Karunathilake and S N Silva).

Planting techniques

Field planting with polybags - PT/1998/1 - Nivithigalakele

Trees of this experiment are now 11 years old and are in tapping. Annual girth increment measured last year showed no significant difference among treatments. Girth measurements were not taken during the year under review (P Seneviratne and U S Weerakoon).

Selecting plants at the nursery - PT/2001/1 - Nivithigalakele

Details of the experiment were given in the Annual Review for 2001. Girth and annual girth increment for tapped and untapped trees are given in Table 19.

Table 19. *Mean girth of plants grown in three types of planting holes SEM values are given in brackets*

Soil condition	Tapped		Not tapped	
	Girth (cm)	Girth increment (cm)	Girth (cm)	Girth increment (cm)
Bad	54.42 (± 0.768)	6.07 (± 0.324)	52.98 (± 0.772)	8.23 (± 0.299)
Moderate	55.96 (± 1.139)	6.67 (± 0.409)	55.39 (± 1.063)	8.33 (± 0.61)
Good	54.49 (± 0.538)	6.16 (± 0.205)	53.57 (± 0.639)	7.57 (± 0.311)

Correlation among the initial girth of the trees and the present girth are given in Table 20. According to the data, correlation exists in all soil types and the both tapped and non tapped trees.

Table 20. *Correlation of girth and initial girth*

	Tapped			Not Tapped		
	Girth (cm)			Girth (cm)		
	Bad	**Moderate**	**Good**	**Bad**	**Moderate**	**Good**
Correlation coefficient (r)	0.374	0.510	0.349	0.386	0.336	0.346
P value	0.010	0.005	<0.0001	0.0007	0.0423	0.0005
Sample size (n)	46	29	129	74	37	99
STDEV	5.208	6.134	6.113	6.054	7.291	6.443

(P Seneviratne and L Zoysa)

Comparison of planting material-PT/Galewatta/2007

Details of the experiment were given in the Annual Review for 2007. Agro-management practices such as application of paddy straw (1 kg of paddy straw per plant) and fertilizer application were done (six times per year) according to the schedule. Mean height of the plants are given in the Table 21.

Though young buddings of RRISL 201 were planted four months later than the rest, the growth is comparable. This field is subjected to frequent lightning attacks and experiment is affected by that (P Seneviratne and M K P Perera).

Cultural practices during immature phase

Branch induction - CP/2001/1 - Pallegoda

Details of the experiment were given in the Annual Review for the year 1999. Trees of which the branch induction was done by the leaf cap method continued to give highest girth in both fields (Table 22).

Yield measurements were not taken during the year under review (P Seneviratne, U S Weerakoon, G A S Wijsesekera and L Zoysa).

Table 21. *Mean height (m) of the different planting materials measured monthly*

Clone and type of the planting material	January	February	March	April	May	June	July	August	September	October	November	December	increment
RRIC 121 young budding	1.9	2.3	2.6	2.8	3	3.3	3.7	4	4.1	4.3	4.5	4.8	2.9
RRISL 201 young budding	0.7	0.9	1	1.3	1.5	1.7	1.9	2.2	2.4	2.7	2.9	3.4	2.7
RRIC 121 bare roots	0.7	0.9	1.1	1.2	1.4	1.7	1.9	2.2	2.5	2.8	3.1	3.3	2.6
PB 260 bare roots	1.1	1.2	1.5	1.7	2.1	2.2	2.6	2.9	3.2	3.6	3.7	4	2.9

Table 22. *Mean girth and yield of the trees of the four treatments*

Treatments	Clone			
	RRIC 121		Mixed	
	No. of trees	Girth (cm)	No. of trees	Girth (cm)
T_1 - Leaf cap	27	77.1 (±1.94)	24	65.4 (±2.02)
T_2 - Leaves cut	26	74.1 (±1.65)	31	60.2 (±1.63)
T_3 - 3" long apex removed	24	76.2 (±1.7)	24	61.9 (±2.11)
T_4 – Control	30	74.4 (±1.54)	18	60.6 (±3.08)

Planting at high density (PT/1992/1/Kuruwita)

Details of the experimental layout were given in the Annual Review for 1992. Growth and yield parameters of the clones tested under four different densities are given in Table 23 a & b. Tree girth and bark thickness have decreased significantly with the increase of planting density. Also, similar trend was shown in the individual tree yield (g/t/t). Though not significant, YPH was higher in higher densities. The clone RRIC 110, affected by *Corynespora* leaf disease showed the poorest performance irrespective of the plant density. In particular, wind damage followed by *Corynespora* infection in two replicate plots resulted in low yields per hectare at the density of 700 trees per hectare in RRIC 110.

Planting at low density (PT/1996/Gallewatta & Nivitigalakele)

Details of the experiment were reported in the Annual Review for 1996. Girth measurements at 5' height, daily volume measurements and metrolac readings were recorded. Estimated yields (YPH) were calculated for the total tapping days of the year 2008. The mean girth, g/t/t and the yield per hectare (YPH) are given in Table 24.

The girth of the trees was highest in the lowest density of 350 trees/ha in all clones. The g/t/t decreases with the increase of the density in all four clones tested. The YPH is high in clones RRIC 100, RRIC 121 and RRIC 133 with 500 trees per hectare. Whereas in PB 260 YPH is highest in the density of 575 trees per hectare.

Table 23. *Effect of planting density on growth and yield parameters of rubber*

(a) Tree girth, bark thickness (BT) at 150cm height and trees in tapping per hectare

Density	RRIC 100				RRIC 110				RRIC 121			
	Girth (cm)	BT (mm)	% Trees in tapping	Tappable trees/ha	Girth (cm)	BT (mm)	% Trees in tapping	Tappable trees/ha	Girth (cm)	BT (mm)	% Trees in tapping	Tappable trees/ha
500	66.63	7.87	68.59	343	60.12	6.93	51.09	255	75.94	7.66	75.00	375
600	65.35	7.82	68.80	413	55.58	6.37	36.98	222	71.52	7.50	73.55	441
700	60.51	7.74	70.42	493	52.30	6.23	26.59	186	69.49	7.12	74.37	521
800	60.81	7.63	69.69	558	52.40	6.24	31.31	250	67.55	6.99	77.79	622

(b) Tree yield (g/t/t) and estimated yield per hectare (YPH)

Density (trees/ha)	RRIC 100		RRIC 110		RRIC 121	
	Yield (g/t/t)	YPH (kg/ha/y)	Yield (g/t/t)	YPH (kg/ha/y)	Yield (g/t/t)	YPH (kg/ha/y)
500	18.62	926	13.44	502	35.41	1870
600	19.08	1100	12.92	433	33.02	1994
700	16.67	1182	10.23	280	32.44	2441
800	16.35	1314	9.87	355	26.74	2369

(V H L Rodrigo, A Nugawela, T U K Silva in collaboration with the departments of Genetics and Plant Breeding and Plant Pathology and Microbiology)

Table 24. *Effect of planting density on growth and yield parameters of rubber*

	RRIC 100			RRIC 121			RRIC 133			PB 260		
Density	**Girth (cm)**	**g/t/t**	**YPH estimated**	**Girth (cm)**	**g/t/t**	**YPH estimated**	**Girth (cm)**	**g/t/t**	**YPH estimated**	**Girth (cm)**	**g/t/t**	**YPH estimated**
350	89.8	54.2	1965	87.3	57.7	2100	91.3	51.68	1881	82.9	48.0	1742
425	82.2	45.16	1996	78.9	49.0	2166	83.7	46.03	2034	77.3	43.6	1927
500	78.9	38.5	1871	76.5	43.33	2253	77.8	40.67	2123	69.4	39.7	2064
575	71.1	31.30	1871	76.0	37.18	2235	74.0	34.33	2053	69.0	34.8	2081

(A Nugawela, P Seneviratne and K A G B Amaratunga)

Exploitation

Girth at opening (TG/99/1) - Galewatta

Mean girth increment of two clones under same tapping system and that for the untapped trees are given in Table 25a. The girth increment of the untapped trees of clone RRIC 102 is higher though that is comparable for tapped trees of both clones.

Table 25a. *Mean girth increment of the tapped and untapped trees*

Clone	Tapping System	Mean girth increment (cm)				
		G 40	G 45	G 50	Mean for clone	Untapped
RRIC 102	½ S d/2 + 2.5 Eth.4/y	0.59	0.64	0.88	0.7	1.9
RRIC 121	½ S d/2 + 2.5 Eth.4/y	0.72	0.84	0.64	0.74	0.94

The girth of the trees tapped and untapped for the two clones are given in Table 25b. As for the girth increment, girth of the trees seems to be affected by tapping in clone RRIC 102. However, the girth difference between the tapped and untapped trees of clone RRIC 121 is low.

Table 25b. *Mean girth (cm) of the tapped and untapped trees*

	Tapped trees				
Clone	G 40	G 45	G 50	Mean for the clone	Untapped trees
RRIC 102	61.8	63.1	65.07	63.32	84.9
RRIC 121	68.04	70.66	69.4	69.34	79.94

(P Seneviratne and R P Karunasena)

Shorter replanting cycles - SRP/2007

Details of the experiment were given in the Annual Review for 2007. Numbering, colour banding, rain guarding and girth measurements were done during the year. Ethrel application was done in every 3 months through out the year. Data for a period of 15 months are given in Table 26.

Highest YPH was obtained from T1 whilst it was lowest in T3. Lowest g/t/t in T3 is due to lesser number of tapping days due to lack of rain guards (P Seneviratne and R K Samarasekera).

Table 26. *Average yield (g/t/t) for different treatments*

Treatments	No. of tapping days	No. of trees	Average g/t/t	Actual crop per year (kg)	YPH (kg)
T1-¼ S d/1+2.5% ET+RG+Fer. Double.Dose	29	19	13.5	4.6	1644
T2-½ S d/3+2.5% ET+RG+Fer. Double.Dose	9	20	27.1	2.9	1022
T3-¼ S d/1+2.5% ET- RG +Fer. Double Dose	13	20	16.9	2.63	920
T4-¼ S d/1 - ET+ RG	27	19	8.2	2.65	929

Tapping Panel Dryness

Continuous monitoring of TPD (TPD/2002/03)

Summary of the percentage TPD by the end of 2008 of ten sites monitored for the clones RRIC 100, 102, 121 and 130 are given in the Table 27. Sites AM-1995 and AR-1996 showed higher % TPD of 29.8% and 28.4%, respectively for RRIC 100 and RRIC 130 clones. The lowest % TPD of 3.9% showed in the site CY-1997 for clone RRIC 130.

Table 27. *Percentage full, partial and total dry trees. clone and site wise at the end of the year*

Clone	Site	% fully dry	% partial dry	%Total TPD
RRIC 100	CL-1998	9.2	0.3	9.5
	CL-1997	7.8	1.5	9.3
	AM-1995	25.6	4.2	29.8
RRIC 102	AM-1992	17.8	2.5	20.3
RRIC 121	CL-1997	8.0	0.3	8.3
	US-1997	14.8	2.0	16.8
	AM-1996	13.9	0.7	14.6
RRIC 130	CL-1997	13.2	0.4	13.6
	CY-1997	3.7	0.2	3.9
	AR-1996	27.2	1.2	28.4

(A M W K Senevirathna and K A G B Amaratunga)

Survey on TPD (TPD/2008/01)

A survey was done on tapping panel dryness in rubber of RRIC 100 in smallholdings of Kalutara region. Data were taken from 30 tapping blocks from the fields being tapped in BO-I, BO-II, B-I I & B-I II panels. Results revealed that, TPD incidence was low when tapping is done in virgin panels compared to that in renewed panels. On average, complete dryness was 11.7% while partial dryness was 9.3% (A M W K Senevirathna and N P B N Rathnayake, University of Wayamba).

In addition to this survey, data on TPD of all clones were gathered from estates belonged to RPCs during the year (A M W K Senevirathna).

Exploitation of TPD trees (TPD/2008/02)

In order to find a more suitable and an efficient method to harvest latex from TPD affected trees, a new experiment was started with following tapping treatments at the Dartonfield estate

T1 ½ S D/2 ↓ (continuous tapping on the same panel)
T2 ¼ S D/2 ↑ on the opposite higher panel
T3 1/8 S D/2 ↑ + 1.25 ET (3/12 mon), on the opposite higher panel
T4 ¼ S D/2 ↓ on the opposite panel
T5 ¼ S D/2 ↓ on the same panel
T6 ½ S D/2 ↓ on healthy trees

(A M W K Senevirathna and K A G B Amaratunga)

Treatments for TPD trees

Application of VITEX-PLUS (TPD/2007/01)

Details of the experiment were given in the Annual Review 2007. Results were summarized in the Table 28. The yield (g/t/t) in treated trees has initially increased for 4-5 applications and then gradually decreased to uneconomical levels both in RRIC 100 and RRIC 121 up to 23rd application and afterwards (AF).

A final report was presented to the MRP Agro Chemy Lanka Pvt. Ltd. and to the Ministry of Plantation Industries. Then the experiment was terminated (A M W K Senevirathna and A Nugawela).

Table 28. *Summary of the yield (g/t/t) in RRIC 100 and RRIC 121 clones after each application of Vitex-Plus (1-23) and afterwards (AF).*

RRIC 100

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AF	Mean
FT	19	27	36	30	29	28	26	18	15	7	4	2	5	5	8	8	6	4	3	2	1	1	0	0	11.9
FN	6	17	24	24	20	17	14	16	12	9	8	5	3	1	5	6	3	2	0	0	0	1	0	0	8.0
PT	44	44	40	20	21	13	14	12	9	8	9	10	15	15	12	4	8	12	7	8	8	13	11	8	15.2
PN	16	25	45	36	33	30	31	30	32	29	20	16	15	9	19	18	13	12	9	7	9	11	10	12	20.3
HE	57	57	58	52	51	53	49	47	39	34	25	33	23	28	30	33	39	40	35	29	61	45	49	49	42.4

RRIC 121

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	AF	Mean
FT	17	22	21	16	8	7	7	3	2	0	0	0	0	0	0	1	0	0	2	1	0	0	0	0	4.5
FN	2	4	4	5	2	3	4	3	1	1	1	4	5	3	2	2	0	0	0	0	0	0	0	0	1.9
PT	46	28	30	25	20	20	23	19	20	14	14	17	15	15	22	21	23	24	26	19	16	17	17	13	20.9
PN	12	12	11	10	7	6	6	5	5	3	3	7	9	6	8	9	5	8	6	6	5	4	3	4	6.7
HE	42	49	39	34	32	36	38	37	39	33	25	40	46	41	52	65	55	57	51	53	61	69	79	71	47.5

Fully dry-Vitex treated (FT) Partial dry-Vitex treated (PT) Fully dry-non treated (FN) Partial dry-non treated (PN) Healthy-non treated (HE)

Ethrel and Vitex-Plus (TPD/2007/02)

Details of the experiment were given in the Annual Review for 2007. Results are summarized in the Table 29.

Table 29. *Average yield per tree per tapping (g/t/t) in each treatment and % yield difference to the respective control treatment after 16 months of tapping*

Treatment code	Treatment	Mean g/t/t	% g/t/t difference to respective control
T1	FD ½ S d_2 2.5 Et.	18.7	-42.4
T2	FD ½ S d_2	32.4	-
T3	PD ½ S d_2 2.5 Et.	39.4	21.1
T4	PD ½ S d_2	32.5	-
T5	HE ½ S d_2	47.5	-
T6	HE ½ S d_2 2.5 Et.	68.8	44.8
T7	HE ½ S d_2 1g Vitex plus	51.9	9.3

FD – Fully dry trees PD – Partial dry trees HE – Healthy trees

Treatment of ethrel in healthy and partially dry trees showed an increased yield whilst fully dry trees showed a negative effect to the respective control. Application of Vitex Plus also showed a slight increase in yield (9.3%) compared to the non-treated healthy trees (A M W K Senevirathna, A Nugawela and K A G B Amaratunga).

New ethrel trial

Two tapping blocks were selected from RRIC 100 of 1997 clearing at Galewatta Division of Dartonfield Group. Each tapping block was divided in to two and following stimulation treatments were tested in each half of the tapping block.

Block 1.

T1	5% Eth. + Coconut oil (1:1)	- with x ¾ "x ½ " coconut husk brush
T2	5% Eth + hot water (1:1)	- with x ¾ "x ½ " coconut husk brush

Block 2

T3	5% Eth. + hot water (1:1)	- with ½ " x ½ " coconut husk brush
T4	5% Eth + Coconut oil (1:1)	- with ½ " x ½ " coconut husk brush

Pre-treatment daily yield data were recorded and yield data were recorded for a period of one month.

Treatment	Before stimulation g/t/t	After stimulation g/t/t
T1	37.1	37.2
T2	29.0	30.1
T3	36.7	35.7
T4	33.3	29.7

(P Seneviratne and R P Karunasena)

Rubber and oil palm (2006) – NSF/RG/2005/AG/13

Experimental details are given in the Annual Review for the year 2006. Girth and girth increment rate of rubber and leaf emergence rate of oil palm were measured regularly. Weather data were recorded hourly using the Davis Vantage-Pro Plus weather station (Davis Instruments, USA) installed at the experimental site. Soil moisture at 10 cm intervals from the ground level up to a depth of 1-1.5 metres was measured through the access tubes installed at each treatment, using a Neutron Probe. Chlorophyll florescence measurements were taken from both crops during dry weather conditions. Results revealed that the water demand is high in mature oil palm (A M W K Senevirathna, W Karunathilake and N A A S Nallaperuma).

Early selection of clones by physiology and growth (PH/2007)

Experimental details were given in the Annual Review for 2007. Growth and photosynthetic parameters were taken and correlated with yield of mature trees of the same clones while attending to the maintenance of the experiment throughout the year.

Results showed that some physiological parameters quantum efficiency, light compensation point and dark respiration of young plants were highly correlated with the yield of mature trees (A M W K Senevirathna, R H L L Chathuranga and W Karunathilake).

Tapping knives

Modified push knife which controls bark thickness as well as the depth of the cut, as explained in the Annual Review for 2007, is now manufactured by the RRISL to be issued to the stakeholders. It can now be purchased from Dartonfield and Ratmalana laboratories and also from Regional Advisory Officers.

Development of a modified tapping knife

Few models were developed with the National Engineering Research and Development (NERD) Centre and with the Mechanical Engineering Department of the University of Moratuwa and tested in the field. Further developments are in progress

(A M W K Senevirathna and K A G B Amaratunga in collaboration with the University of Moratuwa and NERD Centre).

Intercropping

Growing long term perennial crops on rubber lands - IC/S/2001/1 - Kuruwita

The objective and the experimental layout were given in the annual report for 2002. Tree density in terms of the stand per hectare and percentage trees with respect to the standard density for sole crops (rubber, tea and cinnamon) are given in Table 30. Growth of rubber with respect to the girth measured at 150 cm height was assessed and given in Table 31. In wider within raw arrangements, *i.e.*, T3 and T4, a higher girth was recorded than in other two systems. Mean tree girth of rubber planted with tea and cinnamon was comparatively higher than that of rubber grown with other intercrops, *i.e.* durian, jak, rambutan and sole rubber, probably due to increased access to nutrients as those two crops were heavily fertilized. Thickness of virgin bark of rubber was comparable among treatments (Table 32). Wider within row systems, *i.e.*, T3 and T4 recorded higher g/t/t values than the other two systems, *i.e.*, T1 and T2 (Table 33). In general, treatment 3 recorded higher YPH values due to the higher g/t/t (Table 33) and trees in tapping (Table 34). Basal girth and green fresh yield per bush of tea plants were comparable among treatments. Nevertheless, tea yield per hectare was higher in T2 and T4 systems (Table 35) due to the higher number of plants per hectare (Table 30). Growth and the establishment rates of rambutan and jak were satisfactory and better than that in bud grafted durian (bg) and seedling durian (s) (Table 36). On set of flowering was not seen in Rambutan due to the wet and cloudy weather prevailed during Feb. - March. However, a reasonable fruit set occurred towards the end of the year.

Table 30. *Trees per hectare and its percentage from sole crop density stand (SD) for rubber, tea and cinnamon in four different planting systems (main treatments)*

Main trts.	Spatial arrangement	Rubber		Tea/Cinnamon	
		Plants/ha	% trees to SD	Plants/ha	% trees to SD
T_1	(3m×3m)-15m	370	74	8333	67
T_2	(3m×3m)-18m	317	63.5	9524	76
T_3	(3.5m×3.5m)-15m	309	62	8108	65
T_4	(3.5m×3.5m)-18m	266	53	9302	74

Table 31. *Mean girth (cm tree^{-1}) of rubber in different treatments. Measurements were made at 150 cm height*

Main trts.	Sub treatments				
	Tea	Cinnamon	Durian/Jak	Rambutan	Sole rubber
T_1	54.76	55.05	54.32	53.55	56.99
T_2	57.70	56.05	52.56	52.72	52.84
T_3	60.01	58.05	57.11	54.82	55.25
T_4	60.82	58.68	56.15	55.96	59.05

Table 32. *Summary of the bark thickness of rubber (mm tree^{-1}). Measurements were made at 150 cm height*

Main trts.	Sub treatments				
	Tea	Cinnamon	Durian	Rambutan	Sole rubber
T_1	5.68	5.52	5.25	5.33	5.68
T_2	5.62	5.54	5.38	5.53	5.56
T_3	5.70	5.96	5.62	5.83	5.61
T_4	5.59	5.64	5.61	5.42	5.65

Table 33. *Mean percentage trees in tapping (%TIT) and trees in tapping per hectare (TIT_{ha}) of rubber under different planting systems*

Trt	Tea		Cinnamon		Durian		Rambutan		Sole rubber		Mean	
	%TIT	TIT_{ha}	%TIT	TIT_{ha}	%TIT	TIT_{ha}	%TIT	TIT_{ha}	%TIT	TIT_{ha}	%TIT	TIT_{ha}
T1	85.12	315	90.74	336	85.57	317	79.38	294	86.67	321	85.50	316
T2	89.40	283	80.72	256	83.76	266	84.64	268	72.49	230	82.20	261
T3	94.39	292	95.24	294	98.04	303	93.02	287	95.24	294	95.19	294
T4	86.26	229	96.25	256	97.22	259	78.89	210	71.21	189	85.97	229

Table 34. *Mean yield per tree per tapping (g/t/t) and yield per hectare (YPH) of rubber under different planting systems*

Trt	Tea		Cinnamon		Durian		Rambutan		Sole rubber		Mean	
	g/t/t	YPH	g/t/t	YPH	g/t/t	YPH	g/t/t	YPH	g/t/t	YPH	g/t/t	YPH
T1	35.65	1235	33.71	1245	29.88	1041	32.14	1038	46.28	1633	35.53	1238
T2	38.83	1210	43.75	1231	44.32	1294	39.02	1152	32.95	833	39.77	1144
T3	47.42	1201	56.15	1818	44.31	1477	55.41	1752	49.91	1616	48.64	1573
T4	45.24	1142	37.85	1066	49.33	1403	46.68	1078	56.72	1182	47.16	1174

Table 35. *Summary of the growth and yield performance of rehabilitated and unrehabilitated Tea under different planting arrangements of rubber*

Main treatment	Basal girth (cm)		Tea yield (unrehab)	
	Tea (unrehab)	Tea (rehab)	g/ bush	kg/ha.
T1	16.58	13.79	43	4261
T2	15.71	14.89	46	5200
T3	15.91	14.16	39	3824
T4	17.62	15.25	40	4502

Table 36. *Summary of the growth performance of Rambutan, Jak, budgrafted Durian (bg) and Durian seedlings (s) under different planting arrangements of rubber*

Main treatment	Basal girth (cm) at 10 cm height			
	Rambutan	Jak	Durian (bg)	Durian seedling
T1	44.53	26.29	7.10	5.88
T2	41.9	32.25	9.37	8.00
T3	41.77	19.50	15.8	6.48
T4	41.14	21.60	4.00*	8.48

* Plants were re-established in 2007 due to the damage by rabbits.

(V H L Rodrigo and T U K Silva)

Rubber - Rattan intercropping trial - IC/RR/1996 - Kuruwita Sub-station

The rubber/rattan intercropping trial was established in October 1996 and compared of three indigenous species of rattan (Annual Review 1996). The growth of rattan seems to be rapid but measurements were not be taken due to the height, sprawling of canes and inaccessibility. Some of these canes can be harvested within a period of one year (P Seneviratne and M K P Perera).

Possibilities of intercropping Cinnamon under Rubber IC/RC/1998 - Kuruwita Sub-station

The experimental details were given in Annual Review for 1998. The growth of rubber in terms of tree girth was highest in the treatment with the widest inter row spacings with single trees (Table 37).

The growth in all treatments with paired rows was comparable with the 8.4 inter row spacings and also recorded higher g/t/t Table 38. Cinnamon bark yield was higher in which planted in paired rows systems of rubber due to the higher number of plants per hectare (Table 39).

Table 37. *The growth of rubber measured as girth in the 10th year*

	Inter row spacing treatments (m)										
	7.2 S	8.4 S	9.6 S	10.8 S	12.0 S	13.2 S	13.2 P	14.4 P	15.6 P	16.8 P	18.0 P
Girth (cm)	61.6	63.0	63.6	66.5	69.3	73.2	64.4	60.7	63.1	63.3	64.3

(Values with the same letter are not significantly different)

Table 38. *Rubber yield in grams /tree/tapping under different inter row spacing*

	Inter row spacing treatments (m)										
	7.2 S	8.4 S	9.6 S	10.8 S	12.0 S	13.2 S	13.2 P	14.4 P	15.6 P	16.8 P	18.0 P
g/t/t	37.0	40.4	39.5	46.0	46.3	67.9	77.2	70.7	71.7	89.8	76.7

(Values with the same letter are not significantly different)

Table 39. *Cinnamon bark yield kg/ha under different inter row spacing*

	Inter row spacing treatments (m)										
	7.2 S	8.4 S	9.6 S	10.8 S	12.0 S	13.2 S	13.2 P	14.4 P	15.6 P	16.8 P	18.0 P
Bark yield	595.9	534.1	480.2	584.6	571.7	627.5	613.0	599.3	714.7	628.4	673.4

S- Single rubber row treatments, P- paired rubber row treatments
(Values with the same letter are not significantly different)
(CARP funded Project – Project no 12/463/349) (P Seneviratne and M K P Perera)

PLANT PATHOLOGY AND MICROBIOLOGY

C K Jayasinghe

SUMMARY

The incidence of common canopy and bark diseases were mild in all rubber growing districts. However, white root disease continued to be a threat to new clearings and mature plantations. Sporadic attacks of cockchafer grubs were reported from Avissawella, Ratnapura and Galle districts. An effective management system was introduced to control bark cracking disorder, a malady with recent origin. Several potential repellants were developed to prevent the mammalian pest attacks which became a grave threat to clearings adjoining to shrub jungles during the recent past. Screening of fungicides against Corynespora leaf fall disease (CLFD) under nursery conditions revealed that the most effective treatment to manage CLFD in nurseries was the introduction of overhead shading together with application of the fungicide, mancozeb. A positive correlation was observed between the pathogenicity levels of *Corynespora cassiicola* isolates and the production of toxic metabolite.

DETAILED REVIEW

Staff

Dr (Miss) W P K Silva, Head of the Department was on no-pay leave with effect from 28th July 2008 and Dr K E Jayasuriya, Principal Research Officer resigned from services with effect from 25th October 2008. Mrs T H P S Fernando, Assistant Plant Pathologist and Audio Visual Production Officer, Mr W Amarathunga were on duty throughout the year. Experimental Officers Mr E B Fernando, Mrs B I Tennakoon, Mrs D Wijeratne and Mr C Wijerathna continued to work in the department. Technical Officers, Mr P Pieris and Mrs N Jayawardana were promoted to Experimental Officers with effect from 2nd May 2008. Technical Officer, Mr N Nishantha was also promoted as an Experimental Officer with effect from 3rd June 2008. The Clerk Typist, Mrs P Amarasekara retired from duties on 15th August 2008.

Research students and other Temporary staff

Miss W M P Weerakkody and Mr B A C de Silva from University of Kelaniya and Miss T N Sandamali and Miss A P J Siriwardena from University of Ruhuna successfully completed their final year projects under the supervision of Dr C K Jayasinghe and Dr Miss W P K Silva respectively. Messes W M P Weerakkody, K Kulasekara, U L H S Perera and M Wijesuriya assisted the CFC funded project entitled "Improvement of Management Strategies in Combating Corynespora Rubber Leaf Fall Disease" as Temporary Technical Officers. Miss Imalka Vithanage worked as a trainee Clerk Typist with effect from September, 2008.

Seminars/Training Programmes

Dr (Ms) W P K Silva, Dr K E Jayasuriya and Mrs T H P S Fernando served as resource personnel in training Estate Managers, Assistant Superintendents, Rubber Development Officers and Field Officers. Mr E B Fernando, Mrs B I Tennakoon, Mrs D Siriwardena, Mr C Wijeratne, Mrs N Jayawardena and Mr N Nishantha covered the practical aspects of the above programmes while all the staff members extended their fullest cooperation in educating students from Universities, Technical Colleges on departmental activities.

Seminars/Conferences/Meetings/Workshops attended

Officer	Subject	Organization
T H P S Fernando	Seminar for Commodity Inspection and Quarantine for the Officials of the Developing Countries	Ministry of Commerce of the people's Republic of China.
	Symposium on Plantation Crop Research	Bandaranaike Memorial International Conference Hall Colombo, Sri Lanka.
Mrs I Tennakoon	Strategies for Management of Corynespora Leaf Fall Disease	Rubber Research Institute of India, India.
Mrs D Siriwardena	Symposium on Plantation Crop Research	Bandaranaike Memorial International Conference Hall Colombo, Sri Lanka.

GENERAL

All canopy diseases were mild throughout the year and no new clones succumbed to Corynespora leaf fall disease (CLFD). White root disease (WRD) continued to be a threat to new clearings and mature rubber plantations. Several programmes were continued with the collaboration of Advisory Services Department to educate the small holders in identification and management of WRD. Efficient and economical management strategies were introduced for CLFD under nursery conditions.

Sporadic attacks of cockchafer grubs were reported from Avissawella, Ratnapura and Galle districts. Several reports on bark cracking disorder were received and necessary advice was given to control the disease. The damage caused by mammalian pests increased tremendously and special attention was paid to research activities on the management of this threat. As a result potential repellent

was developed and presently field trials are in progress to check the efficiency of these chemicals.

Visits

The Department staff made 34 advisory, 269 experimental and 129 other visits during the year.

LABORATORY AND FIELD INVESTIGATIONS

Chemical control of *Hevea* diseases (CC/89/1)

***Screening of fungicides against* Rigidoporus microporus**

'Moncut' containing flutolanil and "fungi one" containing isoprothalin were tested in the laboratory for the efficiency. Experiments are in progress to screen them under field conditions (K E Jayasuriya, E B Fernando and B I Tennakoon).

***Management of Corynespora Leaf Fall Disease (CLFD) under nursery conditions* (CC/89/2)**

Evaluation of the selected fungicides under field conditions was successfully completed. The most effective treatment to manage CLFD in nurseries was the introduction of overhead shading together with application of the fungicide mancozeb. The fungicide mixture (carbendazim + mancozeb) applied at 5-day intervals, and carbendazim sprayed at 2-week intervals together with shade showed equally good results. Carbendazim (0.5 g/litre) sprayed at 5 or 10 - day intervals, the application of the other contact fungicides, Mancozeb, Ridomyl, Captan, Antracol, Fruvit at 3 g/litre at 5-day intervals showed similar results. Though the systemic fungicide, carbendazim efficiently controlled the disease, the other two systemics, tebuconazole and hexaconazole were found to be much less effective (Table 1). The efficacy of different shading levels is to be tested (T H P S Fernando, C K Jayasinghe, R L C Wijesundera and D Siriwardena).

Table 1. *The post assessment of the polybag plants for the incidence of foliar diseases*

Chemical Treatment	Disease incidence (%) at the end of the experiment			
Shading + Mancozeb 3 g/litre (2 week intervals)	3.083			**h**
Carbendazim 0.25 g/litre + Mancozeb 1.5 g/litre	5.9648	**g**		**h**
Shading + carbendazim 0.5 g/litre (2 week intervals)	9.715	**g**		**h**
Carbendazim 0.5 g/litre (5 d intervals)	11.3306	**g**	**f**	
Carbendazim 0.5 g/litre (10 d intervals)	11.6281	**g**	**f**	
Carbendazim 0.25 g/litre + Cobox 1.5 g/litre	11.3764	**g**	**f**	
Mancozeb 3 g/litre	13.2387	**g**	**f**	
Ridomyl 3 g/litre	13.9424	**g**	**f**	
Captan 3 g/litre	15.457	**g**	**f**	
Antracol 3 g/litre	16.412	**g**	**f**	
Fruvit 3 g/litre	16.915	**g**	**f**	
Cobox 3 g/litre	23.6159		**E**	
Tebuconazole 0.5 ml/litre (5 d intervals)	35.2205		**D**	
Tebuconazole 0.5 ml/ litre (10 d intervals)	42.0371		**D**	
Hexaconazole 0.5 ml/litre (5 d intervals)	59.9037	**C**		
Hexaconazole 0.5 ml/litre (10 d intervals)	65.6383	**c**	**b**	
Control	89.2904			**a**

Means with the same letter are not significantly different based on Duncan's Multiple Range Test

Management of secondary leaf fall diseases of the clone RRIC 121

The experiment is in progress to manage the repeated defoliation condition of the clone RRIC 121 due to Powdery mildew. Yield data and the incidence and severity of the disease are being monitored (K E Jayasuriya, C K Jayasinghe and C Wijeratne).

Management of the bark cracking disorder

A new trial was initiated at Woodend Estate, Maha Oya to manage the bark cracking dis-order. Thirty affected plants were selected; the level of damage was noted and treated with mancozeb (W P K Silva, C K Jayasinghe and N Nishantha).

Biology of pests (BP/90/1)

***Studies on cell wall degrading enzymes produced by* Cylindrocladium quinqueseptatum**

Experiment is in progress to plot the calibration curve to be used in determining the molecular weights of the pectic enzymes of *Cylindrocladium quinqueseptatum* (W P K Silva, C K Jayasinghe and N Nishantha).

***Variability of toxin production by* C. cassiicola**

The variability of toxin production by the new population of *C. cassiicola* was tested. A positive correlation was observed between the pathogenecity levels and the production of toxic metabolite (T H P S Fernando, C K Jayasinghe, D Siriwardena and T N Sandamali).

Susceptibility of different leaf stages to Corynespora Leaf Fall Disease

It was confirmed that under laboratory conditions mature leaves could not be infected by *Corynespora cassiicola.* Testing of the hypothesis under field conditions was initiated. The plants are monitored for the appearance of the lesions on mature leaves (T H P S Fernando, C K Jayasinghe, R L C Wijesundera and D Siriwardena).

Studies on the epidemiology of *Corynespora cassiicola*

The experiment at Kuruwita substation to study the epidemiology of *C. cassiicola* is in progress. The observations on spore releasing pattern, the leaf fall pattern, average disease severity index (ADSI) and the weather data are being monitored (T H P S Fernando, C K Jayasinghe, W P K Silva and D Siriwardena).

Production of toxic metabolite by the rubber isolate of *Cylindrocladium quinqueseptatum*

The production of a toxic metabolite by the rubber isolate of *Cylindrocladium quinqueseptatum* in to a liquid medium MFM (Modified Fries Medium) was tested. Further, It was shown that three new clones such as RRRISL 210, RRISL 217 and RRISL 2000 harbour *C. quinqueseptatum.* The project is in progress to differentiate the isolates using molecular based techniques (W P K Silva, C K Jayasinghe, B A C de Silva and N Nishantha).

Screening of clones for leaf and panel diseases (SC/89/1)

Maintenance of nurseries established for screening purposes

The nurseries were visited for pollarding and manuring. All the recommended clones in these nurseries were screened against Corynespora leaf fall disease and found to be disease free (W P K Silva, C K Jayasinghe, T H P S Fernando, C Wijeratne and N Nishantha).

Island-wide survey on Corynespora leaf fall disease incidence in Sri Lanka

The survey for the incidence of CLFD was conducted throughout the island. The average disease severity indices of the susceptible clones were less than those of the previous year (Table 2) (W P K Silva, T H P S Fernando and N Nishantha).

Molecular biology of pests (MBP/97/B)

Development of Molecular markers to identify Corynespora leaf fall disease resistant clones

The project was temporarily terminated due to the lack of a Research Assistant at the University of Colombo (W P K Silva, N Nishantha, A Jayakody and E H Karunanayaka. This is a collaborative project with the University of Colombo).

Studies on beneficial soil microflora (PP/SM/89)

Decorative handicrafts from partially decomposed rubber leaves

A variety of pigments with colour lasting abilities were identified. Several new designs of floral arrangements, book marks and key tags have been introduced (C K Jayasinghe and N Jayawardena).

Surveillance of potential pests and disease outbreaks (PP/SP/89)

Pathogenicity of tomato isolates of* C. cassiicola *on rubber

The cross inoculation possibilities of the isolates were tested *in vitro* and *in vivo* conditions. The final year project was successfully completed (W P K Silva and A Siriwardena).

Studies on unusual yellowing and buckling of rubber leaves

Routine observations are being recorded to confirm the predisposing factors (W P K Silva, C K Jayasinghe and N Nishantha).

Treatment for bark cracking incidence

The recovery of the plants were monitored (K E Jayasuriya, E B Fernando and B I Tennakoon).

Formulation of a repellant against rodents and mammalian pests in rubber lands

Mammalian pests have become a grave threat to rubber clearings adjoining to the shrub jungles during the recent past. With this background high priority of the department activities was given to introduce a repellent to prevent attacks of these pests. As a result several potential chemical formulations incorporating chillie powder, tobacco extract, paddy husk and thiram in rubber latex were developed and presently field evaluation of these mixtures are in progress (K E Jayasuriya, C K Jayasinghe, E B Fernando and B I Tennakoon).

Bark cracking disorder of rootstocks

Five fungicides namely copper oxychloride, hexaconazole, captan, mancozeb and thiram were screened *in vitro* against *Pythium* spp., the causative agent of bark cracking disorder. The fungicide, mancozeb was more efficient in checking the growth of the fungus (W P K Silva, C K Jayasinghe and N Nishantha).

Defense mechanisms of rubber (DM/89/1)

Variability of defence responses of* Hevea *genotypes against* Corynespora cassiicola *infections

Detached leaves from two clones of rubber: one CLFD resistant (RRIC121) and the other CLFD susceptible (RRISL 202) were artificially inoculated using a standard spore suspention, Leaf samples were tested daily for 4 days for the presence of total proteins, PAL, peroxidases and total phenols (T H P S Fernando, C K Jayasinghe, R L C Wijesundera and D Siriwardene).

MISCELLANEOUS

Improvement of management strategies in combating Corynespora leaf fall disease: Project funded by Common Funds for Commodities (CFC), the Netherlands.

Experiments on agronomic approaches to minimize the inoculum potential and to improve tree vigour were initiated under this project.

Multiclonal clearings

Two multiclonal clearings established with disease resistant and susceptible clones at Kuruwita substation, Rathnapura were generally maintained. The girth and disease severity index of CLFD was recorded (T H P S Fernando, C K Jayasinghe and D Siriwardana).

Effect of fertilizer application on the severity of Corynespora leaf fall disease

Three fertilizer levels were tested against CLFD susceptible clones, RRISL 202, RRISL 201 and RRISL 217 at RRISL Substation, Kuruwita. Girth measurements and disease severity index were monitored (C K Jayasinghe and T H P S Fernando, collaboratively with Soils and Plant Nutrition Department).

Table 2. *Average disease severity index of the clones in the RRISL recommendation list*

Clone	Average Disease Severity Index (ADSI)
RRIC 121	0
RRIC 102	0
RRIC 130	0
RRISL 203	0
PB 260	0
RRIC 133	0.67
RRISL 201	2.0
RRISL 205	0
RRISL206	0
RRISL210	NA
RRISL211	0
RRISL215	0
RRISL216	0
RRISL217	0.5
RRISL219	0
RRISL2001	NA
RRISL2003	NA
PB 235	0
BPM 24	0
PB 217	0
RRISL 208	1.25
RRISL 220	0
RRISL221	0
RRISL222	0
RRISL223	1.0
RRISL226	0
RRISL2000	NA
RRISL2002	NA
RRISL2004	NA
RRISL2005	NA
RRISL2006	NA
GPS 1	0
PB 255	0
PR 255	0
PR 305	0
RRII 105	0
RRIM 712	NA
RRISL 200	3.5
RRISL 202	2.5

N.A.- Not Available (mature clearings): ADSI, 0, free from the disease;0.01-1.0,slight infections; 1.01-2.00, moderate infections; 2.01-3.00, severe infections

SOILS AND PLANT NUTRITION

Lalani Samarappuli

SUMMARY

According to the data gathered it was observed that with the use of *Mucuna* cover crop 50% of the costly N fertilizer; urea can be cut down during the immature phase of rubber and the saving to the rubber industry as well as for the country would be around 153 Mn rupees. The "Power mat" introduced as an environmentally friendly weed control method in young rubber plantings was excellent in controlling weeds, reducing soil water evaporation and also in maintaining soil fertility around young rubber plants.

Experiments conducted in young budding nurseries indicated that replacing epsom salt in the liquid formulations with as little as 10g of dolomite as a basal dressing, could adversely affect growth of young budding plants. Studies also revealed that using a potting media of soil and coir dust with a ratio of 3:1 (by volume) could significantly improve the growth of YB plants compared to top soil only potting media.

Data suggested that application of 75g of kieserite per plant during the first year of planting can be substituted with 100g of dolomite. 50g of dolomite should be applied to the planting hole 2 weeks prior to planting and the balance 50g should be applied 7 months after planting. By substituting the costly Mg fertilizer, kieserite with locally available dolomite the saving to the rubber industry as well as for the country would be around 12 Mn rupees.

The site-specific fertilizer recommendation programme for mature rubber provided fertilizer recommendations for 5500 hectares in the estate sector. Under the routine land selection programme, 420 ha. of land were surveyed for the suitability of rubber cultivation The department also analyzed approximately 420 different samples (1600 parameters) for outside organizations during the year.

DETAILED REVIEW

Staff

The Head of the Department, Dr (Mrs) Lalani Samarappuli and Dr R S Dharmakeerthi, Soils Chemist were on duty throughout the year. Mrs R Hettiarachchi, Assistant Soils Chemist, continued her postgraduate studies while on duty throughout the year.

Experimental Officers, Messrs H D S P Perera, C Maheepala, S N Silva, P Karunadasa, U Mitrasena, A N Yakandawela, T B Dissanayake, V Edirimanne, A Thevarapperuma, P R Puhambugoda and T Gunatilleke and the English Stenographer Mrs L Rupasinghe were on duty throughout the year. Mr J A S Chandrasiri was on no pay leave since April.

Research students

Miss J A S Chaturika from the University of Peradeniya continued her BSc research work on "Growth, litter accumulation and litter decomposition of *Mucuna bracteata* cover crop under rubber" under the supervision of Dr Lalani Samarappuli.

Mr M D T W Prarthana from the University of Peradeniya continued his BSc research work on "Effect of *Mucuna bracteata* on rubber root distribution" under the supervision of Dr Lalani Samarappuli.

Miss E A D Siriwardana from the University of Peradeniya completed her final year project on "Effect of soil compaction and organic matter on *Hevea* plants raised by young budding technique" under the supervision of Dr R S Dharmakeerthi.

Seminars/Conferences/Meetings/Work-shops addressed

Officer	Subject	Organization
L Samarappuli	Prospects for Carbon Trading in Sri Lanka	Botanical Society of the Plant Science Dept. of University of Colombo
L Samarappuli	"Power Mat" for weed control in rubber plantations	Scientific Committee Meeting, RRISL
L Samarappuli	Strategies to minimize chemical fertilizer usage in rubber in view of escalating fertilizer prices	Scientific Committee Meeting, RRISL
L Samarappuli	Towards environmental sustainability: Integration of management practices with inherent characteristics of rubber plant	National Symposium, University of Ruhuna
R S Dharmakeerthi	Spatial dependency of soil properties in rubber growing soils	IRRDB NR Conference 2008, Malaysia

Seminars/Conferences/Meetings/Work-shops attended

Officer	Subject	Organization
L Samarappuli	TEC meetings for fertilizer purchasing	RDD
L Samarappuli	Meetings on fertilizer quality	MPI
L Samarappuli	Climate change/CDM	Ministry of Environment
L Samarappuli and R S Dharmakeerthi	Scientific Committee Meetings	RRISL
L Samarappuli and R S Dharmakeerthi	National Fertilizer Advisory Committee Meetings	National Fertilizer Secretariat
R S Dharmakeerthi	Annual Meetings, Soil Science Society of Sri Lanka 2008	Soil Science Society of Sri Lanka
R S Dharmakeerthi	Soil fertility management	Rubber Research Institute of Malaysia

Training programmes

Client	No. of programmes
Research Assistants	1
Estate Managers	4
Field Officers	2
Rubber Development/Extension Officers	1
University students	4
Diploma students	3
School Teachers	1

Advisory visits

Client	No. of visits
Plantations	06
Smallholdings	08

LABORATORY AND FIELD INVESTIGATIONS

Soil fertility management

Ground cover management

Performance of Mucuna bracteata under mature rubber

The experiment started to study the performance of *Mucuna bracteata* in different shade conditions under mature rubber was continued. The biomass production and litter accumulation of *Mucuna* at different shade conditions were monitored and data are being analysed (Lalani Samarappuli and P Karunadasa).

Another experiment is in progress to study the establishment and growth of *Mucuna* under mature rubber (3 years before uprooting). Data on continuous growth of *Mucuna* after replanting with rubber is presented in Table 1 (Lalani Samarappuli, U Mitrasena and T Gunathillake).

Table 1. *Growth of* Mucuna *under immature rubber*

Age of rubber plants	Growth of *Mucuna* as percentage coverage (%)	
	Mature rubber with *Mucuna*	Mature rubber without *Mucuna*
6 months	75	20
1 years	90	40

Establishment of Mucuna bracteata

In order to further improve the propagation technique of *Mucuna*, a new experiment was started to study different rooting media on the success rate of polybaged *Mucuna* cuttings. This experiment was continued (L Samarappuli, U Mitrasena and T Gunathilake).

Another experiment was initiated to study the effectiveness of poly tunnel on the success rate of *Mucuna* cuttings as a planting technique (L Samarappuli and P Perera).

Mucuna bracteata *on soil fertility*

An experiment is in progress to study the biomass production and litter accumulation of *Mucuna* under rubber and its decomposition and its contribution under different soil series and climatic conditions. Biomass production of both green matter and litter are presented in Tables 2 and 3, respectively. Contribution of N and C to the soil by growing *Mucuna* is presented in Tables 4 and 5, respectively. It was evident that decomposition of litter under *Mucuna* is less compared to open condition (Table 6) (Lalani Samarappuli, S Chathurika and P Karunadasa).

Table 2. *Dry matter production of green vegetation*

	Green matter dry weight (Mt/ha)	
Age (Years)	***Boralu* series**	***Homagama* series**
1	4.47^{a}	2.97^{a}
2	5.22^{a}	3.43^{a}
3	3.51^{a}	3.97^{a}
4	3.09^{ab}	2.29^{ab}
5	2.76^{ab}	2.15^{ab}
6	0.74^{b}	2.05^{b}
9	0.82^{b}	1.73^{b}

Means with the same letters in a column are not significantly different

Table 3. *Mean dry matter production of* Mucuna *litter*

	Litter dry weight (Mt/ha)	
Age (Years)	***Boralu* series**	***Homagama* series**
1	9.95^{a}	8.67^{a}
2	9.82^{a}	8.55^{a}
3	9.25^{a}	7.54^{a}
4	9.94^{a}	8.48^{a}
5	10.51^{a}	4.35^{a}
6	1.07^{b}	3.01^{b}
9	0.47^{b}	0.56^{b}

Means with the same letters in a column are not significantly different

Table 4. *Effect of growing* Mucuna *on soil N*

Treatment	Soil N for different ages (%)						
	1	2	3	4	5	6	9
With *Mucuna*	0.15^{a}	0.20^{b}	0.35^{a}	0.22^{a}	0.37^{a}	0.26^{a}	0.23^{a}
Without *Mucuna*	0.13^{a}	0.14^{a}	0.12^{b}	0.14^{b}	0.12^{b}	0.13^{b}	0.12^{b}

Means with the same letters in a column are not significantly different

Table 5. *Soil organic C (%) under* Mucuna *for two different soil series*

Place	***Boralu* series**	***Homagama* series**
Under *Mucuna* cover	1.36^{a}	2.01^{a}
In the weed free circle	0.92^{b}	1.34^{b}

(Means with same letter in a column are not significantly different)

Table 6. *Decomposition of* Mucuna *litter at different places*

Treatment	Decomposition (%)		
	3rd week	6th week	9th week
Open condition	33.87^{cd}	38.70^{bd}	86.33^{ad}
Under mature rubber	35.13^{ce}	27.23^{be}	53.77^{ae}
Under *Mucuna* cover	46.33^{cd}	59.77^{bd}	59.43^{ad}

(Means with same letter in a column are not significantly different)

Mucuna bracteata *on root distribution of rubber*

An experiment is in progress to study the root distribution of rubber under *Mucuna* cover in order to find out the best place to apply fertilizer to rubber tree. Root distribution of rubber at four different locations namely; weed free circle (WF), within the rubber row (ITR), inter row (IR) and between weed free circle and inter row (IB) was measured for different ages and presented in Table 7 (Lalani Samarappuli, T Prarthana and P Karunadasa).

Table 7. *Root distribution of rubber at four different locations at soil depth 0-15 cm (kg/m^3)*

Location	Root distribution of rubber (kg/m^3)						
	8th year	5th year	4th year	3rd year	2nd year	1st year	8 months
WF	1.553^b	1.711^b	1.471^b	1.322^b	2.129^a	1.650^a	0.344^a
ITR	1.021^b	5.275^a	5.275^a	4.742^a	2.626^a	1.445^a	0.047^a
IB	3.583^a	5.597^a	5.153^a	4.656^a	1.784^a	0.876^a	0.134^a
IR	1.970^b	4.485^a	5.666^a	4.727^a	1.881^a	1.135^a	0.115^a

Mucuna bracteata *in substituting N fertilizer, urea*

According to the data gathered it was observed that 50% of the costly N fertilizer; urea can be cut down during the immature phase of rubber and the saving to the rubber industry as well as for the country was around 153 Mn rupees (Table 8) (Lalani Samarappuli, P Karunadasa, U Mitrasena and T Gunathilake).

Table 8. *Savings under 50% substitution of urea with contribution from Mucuna*

Age	Savings (Rs/ha)	Savings (Mn Rs)
1	927	4.6
2	3,708	18.5
3	5,562	27.8
4	5,562	27.8
5	7,416	37.0
6	7,416	37.0
Total	31,518	152.7

Planting practices for tree legumes

Four field experiments are in progress, three in intermediate zone; at Nottinghill estate, Kahapathwela, Dammeria estate, Passara, Nalanda estate, Naula and the other experiment in wet zone; at Dorset division, Clyde estate, Tebuwana to study the performance of *Gliricidia sepium* as a successful tree legume species that can be grown between the rows of rubber plants which could provide wood material as energy for dendro power and leaf material as green manure. Growth measurements in three experiments are presented in Table 9 (Lalani Samarappuli, P Karunadasa, U Mitrasena and T Gunathilake).

Table 9. *Effect of different treatments on growth of rubber plants*

Treatments	Nottinghill 3 1/2 years girth (cm)	Dammeria 3 years girth (cm)	Nalanda 3 years girth (cm)
Control	28.8[a]	18.8[a]	13.5[a]
Gliricidia 450 sticks/ha (single row)	29.0[a]	17.4[a]	14.3[a]
Gliricidia 900 sticks /ha (Double row)	27.8[a]	18.6[a]	14.7[a]

(Means with same letter in a column are not significantly different)

Weeds and weed control

Circle weeding

Experiments to study the effect of different weedicides on efficient circle weeding during the immature period of rubber and on management of *Mucuna bracteata* around the young rubber trees were discontinued and data are being analysed (Lalani Samarappuli, A Thevarapperuma and T Gunathilake).

Weed suppression was measured in the experiment started to study the effectiveness of "power mat" as a weed control method around the rubber tree (Table 10). "Power mat" on soil temperature at 10.00am, underneath the mat was also measured (Table 11) (Lalani Samarappuli, R S Dharmakeerthi, T Gunatilleke, A Thevarapperuma and U Mitrasena).

Table 10. *"Power mat" on weed control*

Time after application	Weed suppression (%)
2 weeks	62
1 month	75
2 months	84
3 months	100
4 months	100
6 months	100
8 months	100
10 months	95
11 months	90

Table 11. *"Power mat" on soil temperature*

Place	Soil temperature (C^0)
On vegetation	32
On "Power mat"	33
Under "Power mat"	34
At 2.5cm soil depth	30

Another experiment was started to study the effectiveness of mulching of paddy straw treated with commercially available weedicides as a weed control method around the rubber plants. Data gathered on control and regeneration of weeds are presented in Table 12 (Lalani Samarappuli, T Gunatilleke, A Thevarapperuma and U Mitrasena).

Table 12. *Effect of different mulching materials on weed control*

Treatments	Regeneration at 4^{th} month after application of treatments (%)
No weeding	100
Manual weeding	95
Clean weeding + paddy straw	87
Clean weeding + Diuron + paddy straw	10
Clean weeding + Diuron sprayed paddy straw	12
Roundup	56
Roundup sprayed paddy straw	75
Clean weeding + Roundup sprayed paddy straw	78

Management of different weed species

Control and regeneration of different weed species after application of different commercially available weedicides were done. Data are being analysed (Lalani Samarappuli, T Gunatilleke, U Mitrasena and A Thevarapperuma).

Soil moisture stress management (Feasibility of growing rubber in drier areas)

Mulching

Yield measurements in the two field experiments at Bibile estate, Bibile and Nottinghill estate, Kahapathwela to study the effect of mulching on yield of *Hevea* plants are given in Table 13 (Lalani Samarappuli, P Karunadasa, U Mitrasena and T Dissanayake).

Table 13. *Effect of mulching on yield of rubber plants*

Treatment	Bibile Yield (g/t/t)	Kahapathwela Yield (g/t/t)
No mulch	38.8[a]	42.5[b]
With mulch	26.0[a]	32.6[a]

(Means with same letter in a column are not significantly different)

The effectiveness of different mulching materials on yield of *Hevea* plants grown in comparatively drier areas are being studied in a field experiment (SMC-Ag/M/99/1) at Nottinghill estate, Kahapathwela. Effect of paddy straw, coir dust, paddy husk, and green manure on yield of rubber is given in Table 14 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 14. *Effect of different mulching materials on yield of rubber*

Treatment	Yield (g/t/t)
No mulch	27.6[b]
Paddy husk	37.8[ab]
Coir Dust	42.3[a]
Green manure	30.7[ab]
Paddy straw	39.2[ab]

(Means with same letter are not significantly different)

Ground cover management

The performance of *Mucuna bracteata* in comparison with *Pueraria phaseoloides* under dry agro-climatic conditions was studied. Soil moisture content and girth of rubber plants with *Mucuna* and *Pueraria* are presented in Tables 15 and 16, respectively (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 15. *Effect of different treatments on soil moisture content*

Treatments	Nottinghill Soil moisture content (%)	Dammeria Soil moisture content (%)	Nalanda Soil moisture content (%)
Pueraria	13.1[a]	11.5[b]	14.2[a]
Mucuna	19.2[b]	15.1[a]	18.9[b]

(Means with same letter in a column are not significantly different)

Table 16. *Effect of different treatments on growth of rubber plants*

Treatments	Nottinghill 3 1/2 years girth (cm)	Dammeria 3 years girth (cm)	Nalanda 3 years girth (cm)
Pueraria	24.8[a]	18.3[b]	11.5[a]
Mucuna	29.4[b]	21.5[a]	14.8[b]

(Means with same letter in a column are not significantly different)

Fertilizer practices for overcoming moisture stress

Effectiveness of potassium and mulching to overcome moisture stress and to improve yield of *Hevea* under comparatively dry climatic conditions was studied in a field experiment at Bibile estate, Bibile. Two K levels (recommended and double the recommended level) with and without a surface mulch were applied in this experiment. Yield data are presented in Table 17 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 17. *Yield of rubber trees (g/t/t)*

	K_1 (recommended level)	K_2 (double the recommended level)
Without mulch	29.2[a]	38.5[ab]
With mulch	36.1[ab]	40.7[b]

Rubber as a system to mitigate climate change: Biomass accumulation (carbon sequestration) in rubber plantations

The objective of this study is to highlight the potential of rubber plantations to carbon trading through carbon sequestration under Sri Lankan conditions. An experiment was initiated to compare the biomass accumulation and carbon stocks among rubber, teak and mahogany. This would be helpful to growers to get information in selecting a tree species in terms of biomass and carbon stocks in their plantations (Lalani Samarappuli, and K A N A Appuhamy).

Fertilizer use and plant nutrition

Fertilizers to nursery plants

Effectiveness of dolomite as a basal dressing

Setting of P and Mg as precipitates with time at the bottom of the container after the dissolution of YB liquid fertilizer formulation requites constant stirring during application. As a solution for this the feasibility of DAP and CES from the liquid formulation and application of Mg as dolomite and P as HERP at the bag filling stage was studied. Growth of the seedling and scion (Table 18) indicates that dolomite cannot be applied as a basal dressing at the rates tested in this experiment. Visual symptoms of Mn deficiency were observed in the leaves of dolomite applied

seedlings plants which and was confirmed by subsequent leaf analysis (Table 18) (R S Dharmakeerthi, V Edirimanne and S C Chandrasiri).

Table 18. *Effect of dolomite on growth of seedlings at 12 weeks after planting*

Treatment			Seedling		Scion	
HERP as basal	Dolomite As basal	NPKMg as liquid	Diameter (mm)	Leaf Mn (ppm)	Diameter (mm)	Leaf Mn (ppm)
50g	0g	+NPKMg	7.2	26.12	5.5	42.38
50g	0g	+Nand K	7.0	32.94	6.7	46.56
50g	10g	+Nand K	6.9	13.06	5.4	23.59
50g	20g	+Nand K	6.7	7.95	5.2	26.37

Growth of young budding plants as affected by type and packing density of the potting media

The effects of potting media and the degree of compaction on shoot and root growth of YB plants were determined in this study. Soils were mixed with coir dust (C) or saw dust (S) to a ratio of either 1:1 or 3:1 and filled into polybags with two compaction levels. Feeder root density was significantly low in currently adopted top soil only treatments at both growth stages (Table 19). The level of compaction in the potting media had not exerted a considerable impact on shoot or root growth parameters measured (Table 20). This study showed that growth of young budding plants could significantly be improved by using a potting media of soil and coir dust with a ratio of 3:1 (R S Dharmakeerthi, E A D Siriwardana, V U Edirimanna and J A S Chandrasiri).

Table 19. *Shoot diameter (D) and weights (W) of tap, lateral, feeder and total root as affected by the potting media at two different growth stages of young budding plants*

Medium	D_{shoot}	W_{tap}	W_{lat}	W_{feed}	W_{tot}
	12 weeks after planting				
Soil	6.5^{b}	1.79^{ab}	0.19^{a}	0.51^{b}	2.49^{b}
SC11	7.1^{a}	1.64^{b}	0.18^{a}	0.83^{a}	2.65^{b}
SC31	7.2^{a}	2.11^{a}	0.17^{a}	1.08^{a}	3.36^{a}
SS11	6.6^{b}	1.55^{b}	0.11^{a}	0.95^{a}	2.60^{b}
SS31	6.9^{ab}	1.65^{b}	0.08^{a}	0.89^{a}	2.62^{b}
	6 weeks after cut-back				
Soil	5.0^{bc}	4.00^{b}	0.21^{b}	0.18^{b}	4.39^{b}
SC11	5.7^{ab}	5.14^{ab}	0.42^{ab}	0.49^{ab}	6.06^{b}
SC31	6.2^{a}	6.88^{a}	0.52^{a}	0.59^{a}	7.99^{a}
SS11	5.2^{bc}	3.99^{b}	0.25^{b}	0.47^{ab}	4.71^{b}
SS31	4.4^{c}	4.27^{b}	0.21^{b}	0.73^{a}	5.21^{b}

Table 20. *Shoot diameter (D) and weights (W) of tap, lateral, feeder and total root as affected by level of compaction at two different growth stages of young budding plants*

Level of compaction	D_{shoot}	W_{tap}	$W_{lateral}$	W_{feeder}	W_{total}
			12 weeks after planting		
Loose	6.8[a]	1.76[a]	0.13[a]	0.95[a]	1.08[a]
Compacted	6.9[a]	1.74[a]	0.16[a]	0.75[a]	0.91[a]
			6 weeks after cut-back		
Loose	4.5[a]	4.67[a]	0.21[b]	0.33[b]	5.21[a]
Compacted	4.8[a]	5.04[a]	0.43[a]	0.65[a]	6.13[a]

Fertilizers to immature rubber

Dolomite as a source of Mg during the first year of planting

Four field experiments were conducted to study the feasibility of using Dolomite as a substitute to kieserite during the first year of planting. These experiments were at Sapumalkanda estate (*Homagama* series), RRISL Sub station at Kuruwita (*Ratnapura* series), Pitiyakanda estate, Mawathagama and Bibile estate, Bibile. Data suggested that application of 75g of kieserite per plant during the first year of planting can be substituted with 100g of dolomite. 50g of dolomite should be applied to the planting hole 2 weeks prior to planting and the balance 50g should be applied 7 months after planting. By substituting the costly Mg fertilizer, kieserite with locally available dolomite the saving to the rubber industry as well as for the country was around 12 Mn rupees (Lalani Samarappuli, P Karunadasa, T Gunathilake and U Mitrasena).

Method of fertilizer application

Two field experiments started at Nottinghill estate and Dorset division, Clyde estate, to study the effect of cutting fertilizer pits on growth of *Hevea* under comparatively wet and dry agro-climatic conditions were in progress. Treatments consisted of two distances from the tree (1 ft. and 1½ ft), two application frequencies (4 and 2 per year) and a control. Growth measurements at 2½ years after planting are presented in Table 21 (Lalani Samarappuli, P Karunadasa, U Mitrasena and T Gunathilake).

Table 21. *Girth of rubber plants (cm)*

Treatments	Nottinghil	Dorset
Control	19.9[a]	16.2[b]
4 applications/yr & 2 ft. away	20.4[a]	18.3[ab]
4 applications/yr & 2½ ft. away	22.0[a]	19.9[b]
2 applications/yr & 2 ft. away	19.5[a]	20.4[a]
2 applications/yr & 2½ ft. away	20.3[a]	19.9[a]

(Means with same letter in a column are not significantly different)

Fertilizer use in mature rubber

Nutrient requirement of new Hevea *clones*

Simple protocol for fertilizer recommendation to immature rubber with a simulation model based on ecophysiological parameters

This experiment started in order to develop a simulation model based site-specific fertilizer recommendation program for immature rubber. Several experiments were laid down in two contracting agro ecological conditions (Sapumalkanda and Bibile) using two clones (RRIC 121 and RRISL 203) and five fertilizer levels (0, 50, 100, 150 and 200% of the currently recommended levels). Experiments were started using plants at 0, 2 and 4 years of age. Girth response to fertilizer application at 12 and 18 months after treatment initiation in experiments conducted in sites at Bibile, Sapumalkanda are given in Table 22. Preliminary analyses indicate that girth responses to fertilizer levels has shown significant differences among fertilizer levels in 2006 fields while there were no significant differences in 2002 and 2004 fields. However, in latter sites rate of girthing during the 12 and 18 month period showed a significant fertilizer effect. Lack of fertilizer effect in 2004 and 2002 sites could be due to carry-over effect of pre treatment fertilizer applications as we started the fertilizer treatments when the plants were either 2 or 4 years old. In 2006 fields however, fertilizer treatments were in place since planting. This project is funded, in part, by the National Science Foundation under the grant number RG/05/AG/08 (R S Dharmakeerthi, V H L Rodrigo, S N Silva, C K Maheepala, V Edirimanne and S C Chandrasiri).

Organic fertilizers

Planting stage

Field experiment in Pitiyakanda estate, Mawathagama to study the effect of application of different organic materials (paddy straw, poultry litter, cow dung, green manure, EM treated compost and burned paddy husk) into the planting hole was continued and the girth at 5½ after planting is presented in Table 23 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 22. *Girth (cm) at 12 and 18 months after treatment initiation in sites*

Fert. level	Bibile 2004		Sapumalkanda 2004		Bibile 2002		Bibile 2006		Sapumalkanda 2006			
	RRIC 121		RRIC 121		RRIC 121		RRIC 121	RRISL 203	RRIC 121		RRISL 203	
	12M	18M	12M	18M	12M	18M	12M	18M	12 M	18M	12M	18M
1	19.1	23.6	29.1	33.0	27.4	32.3	5.0	4.6	6.2	9.4	6.8	9.9
2	18.0	22.2	28.5	32.8	28.1	33.6	5.5	5.5	7.1	11.3	8.3	11.3
3	18.1	22.5	28.7	33.2	26.9	32.6	5.4	5.2	7.2	11.4	7.5	10.7
4	19.7	24.3	29.5	33.7	29.7	36.2	5.9	5.0	7.5	11.8	7.5	11.2
5	18.5	22.9	29.2	33.4	27.2	33.7	5.6	5.7	6.9	11.3	7.8	11.1

Table 23. *Effect of different treatments on growth of rubber plants after*

Treatment	Girth (cm)
Nil (control)	49.7[a]
Paddy straw	50.0[a]
Poultry litter	49.7[a]
Cow dung	49.3[a]
Green manure	49.3[a]
EM treated compost type 1	48.7[a]
EM treated compost type 2	48.2[a]
Burned paddy husk	49.8[a]

(Means with same letter are not significantly different)

For the experiment in 2003 replanting in Lowmont division, Payagala estate, Dodangoda applied paddy straw, poultry litter, cow dung, green manure, compost, coir dust, paddy husk, tea dust and saw dust to the planting hole. Girth at 5½ years after planting is presented in Table 24 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 24. *Effect of different treatments on growth of rubber plants*

Treatment	Girth (cm)
Nil (control)	44.1[a]
Paddy straw	48.6[a]
Poultry litter	48.9[a]
Cow dung	44.6[a]
Green manure	47.2[a]
Compost	48.9[a]
Coir dust	46.7[a]
Paddy husk	47.4[a]
Tea dust	45.1[a]
Saw dust	44.9[a]

(Means with same letter are not significantly different)

Immature stage

Two more experiments are in progress at Pitiyakanda estate, Mawathagama in a 2003 replanting and at Bibile estate, Bible in a 2004 replanting, respectively. Organic manures evaluated in these experiments are paddy straw, EM treated paddy straw, burned paddy husk, coconut husk, and green manure. Growth measurements and leaf N and K at 5½ years after planting in experiment at Pitiyakanda estate and girth at four years after planting in experiment at Bibile estate are presented in Tables 25 and 26, respectively (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 25. *Effect of different treatments on growth of rubber plants*

Treatment	Girth (cm)	Leaf N (%)	Leaf K (%)
Nil (control)	50.1[a]	3.06[a]	1.68[a]
EM treated paddy straw	53.7[a]	3.14[a]	1.74[a]
Burned paddy husk	52.2[a]	3.08[a]	1.94[a]
Coconut husk	52.5[a]	3.34[a]	1.86[a]

(Means with same letter in a column are not significantly different)

Table 26. *Effect of different treatments on growth of rubber plants*

Treatment	Girth (cm)
Nil (control)	20.4[a]
Burned paddy husk	23.0[a]
Paddy straw	23.9[a]
Green manure	21.2[a]

(Means with same letter are not significantly different)

Organic rubber

An experiment is in progress to develop a sustainable and commercially viable system for plantations as well as for smallholders to produce an environmentally friendly new grade of rubber (organic rubber) to meet the increasing demand for "bio-market". Yield data of this experiment is given in Table 27 (Lalani Samarappuli, P Karunadasa and T Dissanayake).

Table 27. *Effect of different treatments on yield of rubber*

Treatment	2006 (g/t/t)	2007 (g/t/t)
Chemical fertilizer only	23.4	32.3
Organic fertilizer only	24.8	22.8

Spatial variability of rubber growing soils and the growth of rubber

Spatial variability of some properties of rubber growing soils

If soil properties are spatially dependant, this information could be used to delineate management units for site-specific fertilizer application. Spatial dependency of soil pH, Organic C (OC), gravimetric water content (θ_g), available P (P_a), exchangeable K, Mg and Ca (K_{ex}, Mg_{ex}, and Ca_{ex}, respectively) were evaluated using geo statistical methods in a rubber field that has Red Yellow Podsolic soil, a major rubber growing soil in Sri Lanka. Soil pH, OC and θ_g showed a low variability

(CV<15%), P_a and Ca_{ex} showed a very high degree of variability (CV>50%) while K_{ex} and Mg_{ex} showed a medium variability. Variation in measured soil properties showed some spatial structure. In general, there was a high degree of randomness in plant available nutrients in this field, particularly at distances less than 5m (Fig. 1) (R S Dharmakeerthi, S P Perera, S N Silva and S C Chandrasiri).

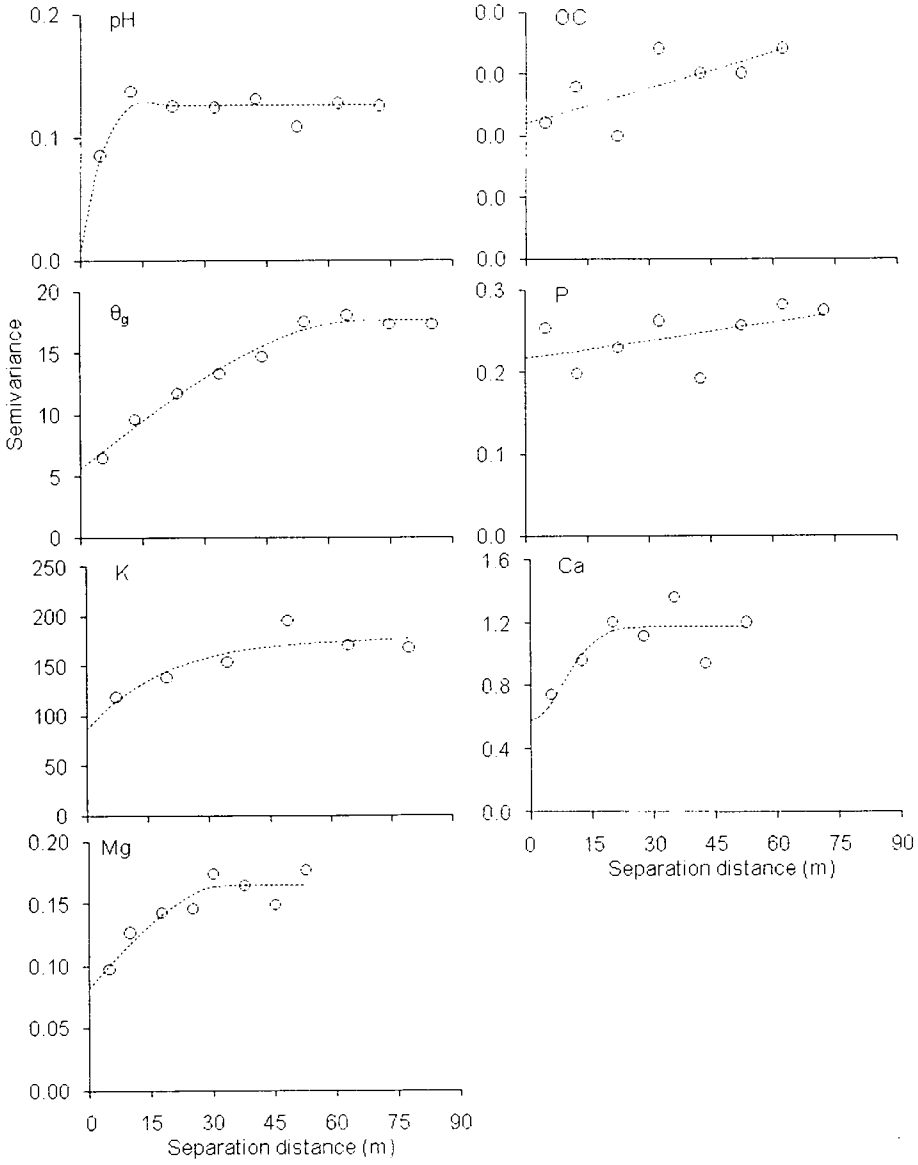


Fig. 1. Experimental (o) and model (----) semi variograms of the measured soil properties

Soil microbiology

Enhancing the effectiveness of phosphate rock fertilizers using microbiological techniques

Sparingly soluble Eppawala rock phosphate fertilizers (ERP & HERP) are the main source of P fertilizers in rubber plantations in Sri Lanka. Low solubility of these P fertilizers results very low uptake efficiencies, particularly in the initial stages of rubber growth. Efficient and effective P solubilizing bacteria and fungi may be isolated from rubber growing soils and used to increase the P availability from ERP. Few experiments were initiated in collaboration with the Plant Pathology and Microbiology Dept. to evaluate the effectiveness of this technology in rubber growing soils of Sri Lanka. Initially commercially available inoculums will be tested under nursery conditions (R P Hettiarachchi and R S Dharmakeerthi).

Soil fertility improvement through N_2 fixing microorganisms

It is well known that cover crop species in rubber plantations, once established properly, contributes tremendously to improve the N fertility of soils. The objective this study is to evaluate whether this could be further improved by introducing more effective micro-organisms to the soil-plant system. The effectiveness of commercially available N2-fixing microorganisms will be evaluated both under laboratory conditions as well as through small scale field trials. This project will be carried out in collaboration with the Plant Pathology and Microbiology Dept. (R P Hettiarachchi and R S Dharmakeerthi).

Micronutrient requirement of mature rubber plants

Under this experiment three major rubber growing soil series (*i.e.* Boralu, Parambe and Homagama) were selected to measure the micronutrient status in both soil and plants at different age categories. Leaf and soil sampling and finally measure the micronutrient level under different soil groups as sufficient or deficient. New experiment will conduct to overcome this deficiency by the application of micronutrients in required quantities (R P Hettiarachchi and L Samarappuli).

Site-specific fertilizer recommendation by soil and foliar survey program

Under this programme about 5500 hectares of mature rubber fields were surveyed and fertilizer recommendations were given for the next three years (L Samarappuli, R S Dharmakeerthi and all the staff of the department).

Land selection and suitability for rubber cultivation

Under the routine land selection programme 420 hectares of land were surveyed for the suitability of rubber cultivation (L Samarappuli, R Hettiarachchi and all the staff of the department).

An approach towards sustainable development and economics of the smallholder rubber sector

This is a collaborative study with the Biometry section and Advisory Services Department together with Ruhuna and Wyamba Universities. The soils and Plant Nutrition Department is responsible for assessing the land suitability in rubber growing areas of Moneragala and adjacent parts of Badulla and Ampara districts (L Samarappuli, P Karunadasa, U Mithrasena, Anoma Thewarapperuma and T Gunathilake).

Analytical services

Routine chemical analysis of soil, leaf and fertilizer samples collected from experimental sites, site specific fertilizer programme, land selection programme and advisory purposes were carried out.

Fertilizer samples from Plantation management companies, Rubber development department and other department of RRI were also analyzed by all the staff of the department. Details are presented in Table 28.

Table 28. *Details of the analysis done during the year 2008*

Organization	Plant	Soil	Fertilizer	Total
Experimental	1100	600	-	1700
Services done by the department				
Site specific fertilizer	1000	-	-	1000
Land selection	-	60	-	60
Outside sample analysis				
RDD	-	-	100	100
Plantation Management Companies	-	-	300	300
Other department of RRI	-	-	25	25
Research Institute	-	50	-	50
Universities	350	300	-	650
Total	2450	1010	425	3885

Analytical techniques and Lab instrumentation

Chemical analysis of plant, fertilizer and soil samples involves the use of very sophisticated instruments such as Auto Analyzer and Atomic Absorption Spectrophotometer.

A quality assurance programme was conducted to promote confidence in analytical results through achieving accurate and reliable analytical results. A good quality control programme was conducted throughout the year 2008 which includes documentation, training and implementation of good laboratory practices and procedures. Analytical values particularly of fertilizer samples were checked according to the guidelines offered by the Sri Lanka Standard Institution. Details are presented in Table 29 (R P Hettiarachchi and L Samarappuli).

Table 29. *Details of the analytical report provided during the year 2008*

Organization	Matrix	Analytical report
Rubber Development Dept.	Fertilizer	11
Rubber Development Dept. (Tender samples)	Fertilizer	02
Plantation Management Companies	Fertilizer	65
Total		**78**

BIOCHEMISTRY AND PHYSIOLOGY

V H LRodrigo

SUMMARY

Gassing frequency recommended by the agent promoting RRIMFLOW tapping technique was found to be unsuitable hence an alternative gassing frequency (*i.e.* once a month) was developed to suit the Sri Lankan conditions. A trail was set up to investigate the suitability of new gaseous stimulation system, G-Flex. Extended LFT systems, particularly the d/4 tapping provided comparable yields to those given by traditional tapping systems. Further, an experiment was set up to identify suitable Low Intensity Tapping systems particularly with short cuts and reduced frequency to minimize the bark consumption and the requirement of latex harvesters. The principle of upward thrust for measuring the density of latex in the determination of dry rubber content in latex was found to be not effective with the prototype developed to do so digitally.

DETAILED REVIEW

Staff

Dr V H L Rodrigo, Head of the Department, and Mrs K V V S Kudaligama, Assistant Biochemist, were on duty through out the year. Mrs G V L Nilmini, Assistant Biochemist was on study leave overseas to pursue her PhD programme in the University of Maine, USA. Experimental Officers, Mr P D J Rodrigo and Mr D Ramawickrama, were on duty through out the year.

Seminars/Conferences/Meetings/Workshops attended

Officer	Subject	Organization
Dr V H L Rodrigo	Scientific Committee Meetings	RRISL Colombo Office
	Project Monitoring Meetings - Monaragla, Badulla	SPEnDP
	Workshop for smallholders – Padiyatalawa	RRISL
	Workshop for smallholders- Padiyatalawa	RRISL
	2nd Plantation Crop Symposium	TRI/RRISL/CRI/SRI
	Presidential Research Award 2002	NRC
	Annual General Meeting	YSF

Officer	Subject	Organization
	Orientation Workshop for S & T Reviewers	NASTEC
	Review Workshop on Agro Research	CARP
	Research paper presentation - Social Science Conference	University of Kelaniya
K V V S Kudaligama	Annual General Meeting	YSF
	Research paper presentation – Annual Conference	IRRDB, Malaysia
	Research paper presentation – Forestry and Environmental Conference	University of Sri Jayawardhenapura

Training programmes

Subject	Client	Category/Group
Latex harvesting	ASD	REOs
	Rubber Development Dept. and VTA Centre, Horana	Unskilled latex harvesters
	RDD, Kegalle	Unskilled workers
	Opatha Estate	Semi-skilled latex harvesters
	Lalan Rubbers Pvt. Ltd.	Field Officers
	Wayamba University of Sri Lanka	Undergraduates
	Sabaragamuwa University of Sri Lanka	Undergraduates
	Elkaduwa Plantations	Asst. Superintendents and Field Officers
	Agalawatta Plantations PLC	Trainee Assistant Superintendents
	Pussellawa Plantations PLC	Field Officers
	Rubber Development Department	Rubber Developments Officer

Advisory visits

28 advisory visits were made during the year.

LABORATORY AND FIELD INVESTIGATIONS

Effect of low temperature on Metrolac reading

BCP/LT & M/2003/2

This research project aims to address the problems associated with latex weighing by Metrolac under varying temperature conditions. In order to check the accuracy of newly developed ready reckoner with temperature correction against the

existing chart, 465 latex samples were tested and deviation from the laboratory tested % DRC values were calculated (Table 1). In most clones, Metrolac under estimated % DRC values and highest deviations (above 10%) were shown by RRISL 211 and RRISL 226. The difference of % deviation due to the temperature correction was 1.6.

Table 1. *Mean % deviation in the estimated percentage of Dry Rubber Content (%DRC) in rubber latex using Metrolac from the laboratory determined %DRC for 22 clones*

Clone	Samples tested	% Deviation with standard ready reckoner reading	% Deviation with new temperature corrected ready reckoner reading
RRIC 100	38	-7.05	-5.47
RRIC 102	36	-5.03	-4.23
RRIC 121	38	-3.25	-0.56
RRIC 130	27	0.71	0.99
RRISL 201	23	-2.22	1.27
RRISL 202	23	-1.72	1.26
RRISL 203	15	-5.69	-4.57
RRISL 205	20	-4.48	-3.11
RRISL 206	23	-9.56	-6.89
RRISL 208	17	-8.99	-7.44
RRISL 211	17	-15.63	-15.18
RRISL 215	17	-0.75	0.96
RRISL 216	20	-5.33	-4.78
RRISL 217	17	-6.13	-3.55
RRISL 219	20	-6.57	-6.22
RRISL 220	17	-7.09	-5.63
RRISL 221	17	-4.15	-2.28
RRISL 222	16	-9.09	-6.03
RRISL 223	19	-6.25	-5.03
RRISL 226	15	-13.57	-13.07
RRISL 2000	15	-4.18	-3.08
RRISL 2001	15	-5.27	-3.21
Mean		-5.97	-4.36

(K V V S Kudaligama, V H L Rodrigo, G V L Nilmini, P D J Rodrigo and D Ramawickrama).

Rainguard sealant with industrial wastes
BCP/RGS/2005/1

This project aims to develop new rainguard sealants with desired characteristics such as easy application and reduced cost, particularly with industrial wastes. Three new recipes were tried out in Pitiakanda estate, Mawathagama towards the end of the year. In these recipes, tar usage was reduced from 58.1% in the standard semisolid recipe to 13.9% by incorporating waste oil as a substitute. Field observation has to be made further. The progress in this project was limited due to lack of technical staff in the department (K V V S Kudaligama, V H L Rodrigo, G V L Nilmini and P D J Rodrigo).

Low frequency tapping with gaseous stimulation
RRIMFLOW method
BCP/LFTG/2005/2

Determination of the suitable gassing interval for ethylene in Control Upward Tapping (CUT) of Sri Lankan clones was the main focus in this experiment. New trail was established with 15 and 30 days gassing intervals using the clone RRIC 100 in Gallewatta of Dartonfield estate. Two experiment blocks were set out for two gassing intervals and another block for ethephon based CUT as the control treatment. Latex volume, % DRC and scrap weight were monitored on each tapping day. RRIMFLOW experimental blocks started initially in other estates were limited to two estates, namely Dalkeith in Baduraliya and Udapola in Deraniyagala. Both fields were continuously monitored and relevant data were collected. There was no yearly change in mean % DRC in both sites. Nevertheless, mean yield per tree per tapping was higher in Dalkith than in Udapola in the year 2008 (Table 2).

Table 2. *Yield parameters of RRIMFLOW in two commercial sites. Codes %DRC and GTT refer to % dry rubber content and dry rubber yield per tree per tapping (in grams), respectively*

Experimental site	Average of 2006 - 2007			Average of 2008		
	% DRC	GTT	Tapping days	% DRC	GTT	Tapping days
Udapola	39	87.6	118	39	69	120
Dalkith	33	77	61	33	84	60

A review on experiments and commercial applications of RRIMFLOW in different sites of Sri Lanka was made. The gassing frequency recommended by the agent (10-12 days) of the RRIMFLOW tapping technique was found to be unsuitable hence alternative gassing frequency (*i.e.* once a month) was developed to suit with Sri Lankan conditions.

G-Flex method

Another trail was established in Gallewatta to test a new gaseous stimulating system, G-Flex, introduced to Sri Lanka by A. Baurs and Co. Ltd. At the same time, commercial scale testing of the system was commenced in three estates, namely Pitiyakanda in Mawathagama, Mahawela in Rathnapura and Udapola in Deraniyagala. Two gassing intervals *i.e.* 15 days and 30 days were being tested. On daily basis, % DRC and latex yield were monitored (Table 3). There was no any significant difference in % DRC among four estates, however GTT was higher with 15 days gassing.

Table 3. *Yield parameters of G-Flex in four commercial sites for five months. Codes %DRC and GTT refer to % dry rubber content and dry rubber yield per tree per tapping (in grams)*

Site	15 days gassing		30 days gassing	
	% DRC	GTT	% DRC	GTT
Gallewatta	32	93	35	74
Pitiyakanda	40	61	40	43
Mahawela	39	69	39	51
Udapola	31	74	31	57

Based on the information gathered from both RRIMFLOW and G-Flex, gaseous stimulation systems were recommended for commercial use as a method of Control Upward Tapping (CUT) after the completion of BI-1 tapping (after 'C' panel) with the gassing frequency of 30 days. Only during last two years of tapping (*i.e.* two years before uprooting), 15 days gassing frequency was allowed (V H L Rodrigo, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Portable digital system to measure the dry rubber content in latex
BCP/LT & M/2006/3

The research project was aimed to develop an electronic appliance to measure the dry rubber content of latex digitally. Using the prototype of the appliance developed by the NERD centre (Plate 1), several latex samples were measured for the density and voltage to investigate on feasibility of using variation of upward thrust with density to estimate % DRC of latex. Measurements taken revealed that upward thrust of latex dose not reflect the true density hence could not be used to estimate % DRC. Therefore, alternative approaches are to be looked into (Table 4).

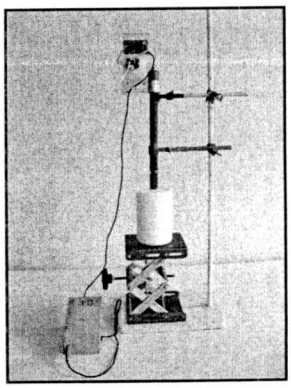


Plate 1. Electronic appliance developed by NERD centre to measure the density of latex using the principle of the upward thrust for the estimation of % DRC

Table 4. *Measurements made on % DRC with the electronic appliance developed by NERD centre*

	% DRC (lab.)	Voltage (mV)	Density (g/cm^3)
Sample 1	38.79	754	965
		749	989
		757	144
Sample 2	41.72	755	956
		755	959
		749	960

(V H L Rodrigo, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama collaboration with NERD Centre, Ekala)

Low frequency tapping with liquid stimulation

BCP/LFT(L)/2006/1

This project aims to sustain the productivity of rubber lands using Low Frequency Tapping systems with Ethephon based liquid stimulants whilst addressing the problems of tapper shortage and high tapping cost. Low frequency tapping systems with d/4 and d/6 frequencies are tested in this project.

In Dartonfield estate, four tapping blocks were selected from four major clones *i.e.* RRIC 100, RRIC 102, RRIC 121 and RRIC 130. Four tapping systems *i.e.* tapping once in two (d2), three (d3), four (d4) and six (d6) days were tested with different stimulation levels (*i.e.* no stimulation, 2.5% ET 5/y, 2.5% ET 9/y and 5% ET 12/y, respectively). However stimulation protocol differed in RRIC 130 and both d2 and d3 had no stimulation whilst the ethephon concentration used in both d4 and d6 systems was 2.5%. Daily yields and % DRC were monitored continuously whilst

girth, bark thickness, bark consumption and length of tapping cut were assessed at six month interval. Also, raw rubber properties of latex crepe were assessed on monthly basis.

Further, 15 commercial scale tapping blocks planted with RRIC 121 were selected from Notinghill estate, Mawathagama for further testing of LFT systems at large scale (*i.e.* 2,3,4 and 6 tapping blocks for d2, d3, d4 and d6 systems, respectively. Also, two tapping blocks with RRIC 121 were selected from Udapola estate to test S/2 d4 system in newly opened trees at commercial level. Daily latex yields and other yield parameters were assessed.

Yield per tree per annum (YPT) in the different experimental sites are given in Table 5. Despite if some site specific variability, the mean YPT showed a marginal decrease in d3 (4.53%) and d4 (9.14%) tapping systems. In d6, the decrease in YPT was 19.92%. Nevertheless, bark consumption was reduced considerably in LFT systems (Fig. 1) with the percentage difference of 28% for d3, 41% for d4 and 55% for d6, from the standard d2 tapping. No difference in the number of trees affected with TPD was observed (Table 6).

Table 5. *Yield per tree per year (YPT) for different tapping frequencies in each experimental site for the year 2008*

Site	d/2		d/3		d/4		d/6	
	YPT (kg)	Tapping days	YPT (kg)	Tapping days	YPT (kg)	Tapping days	YPT (kg)	Tapping days
Dartonfield (RRIC 100)	4.86	132	4.09	93	3.72	72	3.75	49
Dartonfield (RRIC 102)	4.69	139	4.32	92	4.17	74	3.82	54
Dartonfield (RRIC 121)	3.81	128	4.13	94	3.77	74	4.09	51
Dartonfield (RRIC 130)	6.01	134	5.57	96	7.28	81	5.96	53
Kuruwita (RRIC 100)	5.28	163	5.62	109	5.05	85	4.56	54
Udapola (RRIC 102)	4.53	172	3.68	113	4.90	85	3.13	56
Nottinghil (RRIC 121)	5.50	151	5.53	112	4.44	81	3.61	53
Mean	4.95	146	4.71	101	4.76	79	4.13	53

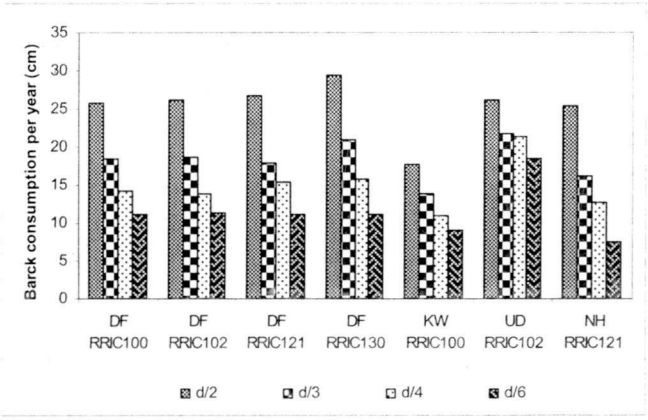


Fig. 1. Annual bark consumption rate in different tapping systems

Table 6. *% TPD trees under different tapping frequencies in each experimental site*

	D2	d3	d4	d6
Dartonfield (RRIC 100)	6	8	5	4
Dartonfield (RRIC 102)	0	8	4	5
Dartonfield (RRIC 121)	4	3	8	9
Dartonfield (RRIC 130)	10	4	4	0
Kuruwita (RRIC 100)	4	1	0	4
Udapola (RRIC 102)	4	5	4	12
Nottinghil (RRIC 121)	0	8	0	0
Average	4	5	4	5

(V H L Rodrigo, K V V S Kudaligama, P D J Rodrigo, R P S Randunu and D Ramawickrama)

Variation of non rubber constituents of latex in different *Hevea* genotypes and their impact on latex weighing with Metrolac and raw rubber properties *BCP/LD/2007/1*

This study is aimed to investigate the effect of organic and inorganic non rubber constituents of latex on raw rubber properties in different clones and their impact on latex weighing using Metrolac. In total, 22 clones in 4 estates were selected for this study and assessments were made on monthly basis. Sample collection was affected with rain. There was no clear relationship of any non rubber component with the Metrolac % dry rubber content (% DRC). Mean % DRC of clones RRIC 121, RRIC 130, RRISL 203, RRISL 205, RRISL 208, RRISL 216 and RRISL 219 was above 40%. Lovibond colour of RRISL 206 and RRISL 217 was above 3 (Table 7).

Table 7. *Raw rubber and latex properties of different* Hevea *genotypes*

	g/t/t	DRC %	TSC %	Po	PRI	Mooney viscosity	Lovibond Colour	Ash %	Acetone extractable non rubber %
RRIC 100	36.74	37.17	39.73	38	75	81	2.2	0.17	2.53
RRIC 121	30.01	36.60	37.96	48	56	84	1.6	0.15	2.26
RRIC 130	50.07	42.24	44.06	52	72	98	1.5	0.13	1.92
RRIC 102	31.29	37.93	40.60	43	68	84	2.2	0.14	2.30
RRISL 201	35.73	34.52	36.98	41	78	79	2.0	0.12	2.40
RRISL 202	22.83	29.35	32.30	39	79	73	2.0	0.14	2.56
RRISL 203	47.38	41.71	44.01	58	62	104	2.0	0.15	2.03
RRISL 205	38.44	41.27	43.55	43	75	81	2.0	0.13	2.25
RRISL 206	41.63	35.21	37.98	50	71	91	4.5	0.15	2.75
RRISL 208	61.39	44.56	47.06	46	72	81	2.5	0.14	2.63
RRISL 211	41.32	38.41	41.07	43	77	84	3.0	0.16	3.11
RRISL 215	27.73	35.08	37.68	33	75	61	1.5	0.13	2.35
RRISL 216	29.49	40.15	42.53	49	67	89	1.5	0.14	2.46
RRISL 217	56.87	37.20	40.03	39	77	75	1.5	0.25	2.41
RRISL 219	31.51	40.38	43.05	41	72	79	1.5	0.13	3.80
RRISL 220	26.15	37.21	39.91	35	69	67	1.5	0.12	2.38
RRISL 221	21.82	33.27	35.95	40	590	77	2.5	0.12	2.98
RRISL 222	34.62	30.72	33.79	40	76	75	1.5	0.13	2.75
RRISL 223	36.59	33.79	36.18	41	70	79	1.5	0.14	3.24
RRISL 226	23.63	29.51	32.71	31	76	60	2.0	0.14	2.74
RRISL 2000	40.80	39.79	42.30	43	69	85	1.5	0.12	2.61
RRISL 2001	38.43	38.49	41.16	44	72	84	2.0	0.14	2.38

(K V V S Kudaligama, V H L Rodrigo, D Ramawickrama and P D J Rodrigo)

Low intensity tapping systems
BCP/LIT/2007/3

This experiment was commenced to investigate the possibility of minimising the bark consumption with short cuts and reduced tapping frequency for sustainable latex yield with increasing the economical life span of the rubber tree. Mono clonal mature rubber field (RRIC 121) which was about to be open for tapping, was selected from Kuruwita for the study. Practically possible nine combinations of tapping frequencies, *i.e.* d2, d3, d4 and d6 (once in two, three, four and six days), stimulant concentrations (2.5% and 5% of Ethephon) and tapping cut lengths (1/2, 1/4 and 1/8 of the spiral) were setup to test their feasibility. Yield data were monitored (Table 8) for seven months and the experiment was in progress.

Table 8. *Monthly variation of the mean yield per tree per tapping (GTT)*

Ethephon %		-	**2.5%**	**2.5%**	**2.5%**	**5%**	**2.5%**	**5%**	**5%**	**5%**	**5%**
Frequency applied		-	**bimonthly**	**monthly**	**Every 2 weeks**	**monthly**	**monthly**	**monthly**	**Every 2 weeks**	**monthly**	**Every 2 weeks**
Tapping intensity		**S/2 d2**	**S/2 d3**	**S/4 d3**	**S/8 d3**	**S/8 d3**	**S/2 d4**	**S/4 d4**	**S/8 d4**	**S/2 d6**	**S/4 d6**
GTT	May	20.95	24.78	12.83	9.51	12.87	25.30	22.49	15.90	22.29	25.48
(g)	June	20.33	24.98	21.20	14.21	17.47	37.60	28.71	14.62	35.21	32.00
	July	24.54	38.59	23.07	16.52	17.83	35.35	28.49	17.71	41.82	29.36
	Aug.	24.49	32.43	20.68	15.74	12.75	33.36	17.60	11.17	38.68	13.92
	Sept.	22.55	38.61	25.53	21.54	21.67	44.78	26.76	21.04	69.18	30.96
	Oct.	29.01	38.21	29.49	23.27	21.42	43.74	25.38	19.30	57.62	46.60
	Nov.	26.82	44.56	29.92	17.98	17.97	53.14	25.81	20.08	83.09	45.30
	Dec.	26.68	39.72	25.67	16.11	17.65	51.10	25.31	24.80	64.41	45.79

(V H L Rodrigo, K V V S Kudaligama, P D J Rodrigo and R P S Randunu)

ADVISORY SERVICES

A H Kularathna and A Dissanayake

SUMMARY

Increasing the productivity and income level of rubber smallholders, through transfer of technology, promotion of selected technology packages, development of human resources and development of interactive processes among rubber smallholders to increase their bargaining power, was considered as major extension paradigms of the ASD. Several important projects were carried out at national and regional level to achieve the above objective.

Farmer training programmes were designed according to stakeholder requirements and conducted training programmes covering all rubber growing areas. Training and skill development to address the shortage of latex harvesters and to improve their productivity was conducted as a priority project.

Establishment of *Mucuna* cover crop was undertaken to improve the soil fertility management and soil moisture conservation of rubber smallholdings. Over 144.47 hectares of immature holdings were successfully introduced with *Mucuna*.

Five hundred and eighty eight demand driven advisory visits were conducted to assist rubber growers in proper adoption of agronomic and processing technologies during the period.

Four hundred and forty two model rubber holdings and 95 model processing centers were successfully established with collaboration of research staff and the industry. Rehabilitation of substandard rubber holdings also progressed well although the number of holdings rehabilitated, is low compared to the total holdings identified for the project. Introduction of rain guards and promotion of fertilizer usage were undertaken in a limited scale, as short term measures in increasing productivity.

DETAILED REVIEW

Staff

Mr A H Kularathna, Regional Advisory Officer, continued to serve as Acting Head of the Department up to 26th October, 2008. Dr Anura Dissanayaka, Head of the Department, resumed duties on 27th October, 2008. Thirty Rubber Extension Officers and two Regional Advisory Officers were on duty throughout the year

Mr P P S Perera, Assistant Training Officer and Mr D D Dasanayake, Regional Advisory Officer, retired from services. Mr L P L Gunarathna, Regional Advisory Officer (Kegalle), resigned from services with effect from 22nd December 2008.

Mr U L R A Perera, (Divisional Rubber Extension Officer - Millaniya) and Mr H H Jayasinghe (Divisional Rubber Extension Officer - Galle), were appointed to

cover up duties of posts of Regional Advisory Officers in Kalutara and Galle regions. Mr W Siriwardana was appointed to cover up duties of the post of Assistant Training Officer. Mr Nimal Gunarathna DREO was transferred to the new Aranayaka range with effect from 07.06.2008.

Training programmes/Seminars/Workshops/Meetings attended

Acting Head of the department, attended to the followings.

Officer	Subject	Organizations
A H Kularathna	Scientific Committee Meetings	RRISL
A H Kularathna	Workshop on training trainers for experiential learning programmes	Loadstar Pvt. Co.
A H Kularathna	Workshop on training rubber dealers	Loadstar Pvt. Co.
A H Kularathna	Regional and range level farmer training programmes	Advisory Services Department

In-service training for Rubber Extension Officers

Following in-service training programmes were conducted for Rubber Extension Officers.

1. A two days Outward Bound Training (OBT), an experiential learning training programme, at the Scout Training Camp in Meerigama. The programme was sponsored by the Loadstar Private Company
2. Rain guard sealant preparation and new Kisan type rain guard system conducted by the department of Bio - Chemistry and Plant Physiology of RRISL
3. Tapping Panel Dryness (TPD) of rubber trees, conducted by the Plant Science Department of the RRISL
4. Control Upward Tapping (CUT) system and tapping intensification, conducted by the Plant Physiology and Bio Chemistry Department of the RRISL

Training Centre, Nivitigalakele

ASD provided facilities for following organizations to conduct their staff and farmer training programmes at the Training Centre, Nivitigalakele.

Client	Subject	No. of programmes
Thurusaviya Fund	Farmer training	04
Department of Forest (Regional Office, Kalutara)	Staff training	02
Rubber Development Department	Staff training	03
Lalan Rubbers (Pvt.) Co. Ltd.	Staff training	03
Pusselawa Rubber Plantation Co. Ltd.	Staff training	02

SERVICES

Advisory visits

Three thousand one hundred sixty one, advisory visits were made by REOO to improve the land use efficiency and productivity of rubber smallholders and 588 special advisory visits were made on requests of rubber growers to solve their technology adoptions problems (Table 1).

Table 1. *Advisory visits conducted by REOO*

Region	Advisory visits made on requests of rubber growers to solve technology adoption problems	Advisory visits conducted by REOO to improve land use efficiency and productivity of rubber smallholders
Ratnapura	71	247
Colombo	76	394
Kegalle	221	1076
Kalutara	213	973
Galle	07	471
Total	**588**	**3161**

Farmer training programmes

Tapper training schools

ASD successfully completed two tapper training programmes in collaboration with the Rubber Development Department, Tertiary and Vocational Training Authority and Regional Plantation Companies in Kegalle and Kalutara Districts. A special training curriculum and a special publication on tapping techniques were prepared for the programme and each programme was conducted for 30 days.

Fifty one well trained new rubber tappers were introduced to the rubber industry, after successful completion of above two training programmes (Table 2).

Table 2. *Tapper training programmes*

Location	No. of new tappers introduced
1. Tertiary and Vocational Training Centre, Horana	21
2. Tertiary and Vocational Training Centre, Kegalle	30

All trainees were provided with per diem for participation and uniforms by the RDD and certificates were awarded to each participant after successful completion of programmes.

Skill development of rubber tappers

Due to the prevailing attractive high prices for RSS, many rubber smallholders were trying to maximize their production, by over exploitation, by adapting high intensity tapping systems. To control this problem, the ASD launched a series of skill development programmes to train tappers and owners of smallholdings on recommended tapping systems.

Accordingly 85 skill development programmes were successfully conducted for 1211 selected rubber tappers from model rubber holdings (Table 3).

Table 3. *Skill development programmes conducted for tappers of model rubber holdings*

Region	No. of Skill development programmes conducted	No. of tappers benefited
Kalutara	27	250
Ratnapura	16	276
Kegalle	32	484
Colombo	5	146
Galle	5	146
Total	**85**	**1211**

Quality improvement of RSS

Fifty two field training programmes (demonstrations) were conducted to train rubber growers on recommended techniques of RSS production processes. Nine hundred and two RSS producers and smoke house owners were benefited (Table 4).

Table 4. *Training programmes for quality improvement of RSS*

Region	No. of programmes conducted	No. of smoke houses owners benefited
Kalutara	03	57
Ratnapura	22	425
Kegalle	19	260
Colombo	5	111
Galle	3	49
Total	**52**	**902**

Pre-seasonal farmer training programmes

A series of pre-seasonal farmer training programmes were conducted to improve the knowledge and skills of 2007 and 2008 replanting permit holders on immature up keep, soil moistures conservation, soil fertility management and disease control thirty eight range level pre-seasonal training programmes were successfully conducted and 1348 permit holders were benefited (Table 5).

Table 5. *Pre-seasonal farer training programmes*

Region	No. of programmes conducted	No. of permit holders benefited
Kalutara	11	264
Ratnapura	08	350
Kegalle	06	414
Colombo	10	214
Galle	03	96
Total	38	1338

All above programmes were conducted in collaboration with the RDD and Heyleys Agro products Private Company.

Eradications of White root disease in the rubber smallholder sector

Eradication of white root disease, to increase the land use efficiency of rubber smallholders was continued as a priority project. Accordingly, ASD conducted a series of training programmes to educate the rubber smallholders on identification and control and prevention measures of white root disease (Table 6).

Table 6. *No. of farmer training programmes on eradication of white root disease*

Region	No. of training programmes conducted	No. of farmers benefited
Kalutara	04	60
Ratnapura	01	15
Kegalle	03	84
Colombo	01	60
Galle	02	52
Total	**11**	**271**

All above training programmes were sponsored by the Hayleys Agro Products Limited.

Meanwhile, REOO have conducted 298 individual advisory works to treat 243.34 ha. of white rood disease infected rubber smallholdings. REOO have successfully treated for 762 white root disease infected rubber trees (Table 7).

Table 7. *Eradication of white root disease*

Region	Extent of white root disease infected holdings identified by REOO	No. of Advisory Visits conducted by REOO	No. of infected trees successfully treated by REOO
Kalutara	89.70	110	338
Ratnapura	23.4	33	72
Kegalle	57.5	81	206
Colombo	57.08	55	94
Galle	15.64	19	52
Total	**243.32**	**298**	**762**

Soil fertility management and soil moisture conservation

Training programmes, Advisory visits and demonstrations together with necessary extension support services were provided to educate rubber smallholders on soil fertility management and soil moisture conservation.

Introduction and establishment of "Mucuna" cover crop in immature holdings was continued as the main extension activity of this project. Advisory and training programmes were also continued to promote other soil moisture conservation methods such introduction of other cover crops, construction of drains and terraces *etc.* REOO were able to introduce "Mucuna" in 144.67 ha. and other popular cover crops, in 108.19 ha. (Table 8).

Table 8. *Introduction of cover crops and other soil fertility and soil moisture conservation methods*

Region	Introduction of Mucuna		Introduction of other cover crops	
	Extent	No. of holdings	Extent	No. of holdings
Kalutara	24.47	67	24.64	26
Ratnapura	55.0	39	5.65	02
Kegalle	32.7	27	24.1	33
Colombo	10.5	3	15.2	04
Galle	22.0	4	38.6	19
Total	**144.67**	**140**	**108.19**	**84**

Meanwhile REOO have advised and demonstrated to construct drains and terraces for soil moisture conservation in 181.18 ha. in 168 rubber small holdings (Table 9).

Table 9. *Construction of drains and terraces for soil moisture conservation in rubber smallholdings*

Region	Introduction of drains		Construction of terraces	
	Extent (ha)	No. of holdings	Extent (ha)	No. of holdings
Kalutara	73.37	51	16.41	20
Ratnapura	19	20	7	7
Kegalle	18.8	26	15.3	22
Colombo	0	0	0	0
Galle	25.3	17	9	5
Total	**136.47**	**114**	**44.71**	**54**

Awareness raising on recommended technologies for productivity improvement

Eight awareness raising programmes were conducted in selected REOO ranges to improve the farmer knowledge on RRI recommendations in the areas of disease control, immature up keep, soil fertility management latex exploitation systems and data recording systems *etc.*, for good management of rubber holdings. Three hundred and eighty five rubber growers were benefited from these programmes.

Rehabilitation and substandard rubber holdings

REOO identified 393 substandard rubber smallholdings in the immature phase of growth and conducted 408 advisory visits to provide necessary advice and extension support to rehabilitate them. Nevertheless, the REOO could successfully rehabilitate only 41% of the identified holdings (Table 10).

Table 10. *Rehabilitation of substandard rubber holdings*

Region	No. of substandard rubber holdings identified by REOO	No. of advisory visits conducted	No. of holdings successfully rehabilitated
Kalutara	72	85	37
Ratnapura	25	25	11
Kegalle	141	145	19
Colombo	85	75	16
Galle	70	79	21
Total	**393**	**408**	**104**

Panel marking for new tapping and correction of substandard panel markings

Field demonstrations were conducted to train rubber smallholders on tapping panel marking for new tapping and correction of substandard tapping panel markings with the objective to monitoring the Quality of Tapping (QOT). Marking plates were produced by the ASD according to RRISL standards and distributed among rubber growers to encourage them to maintain their quality of tapping. REOO successfully

trained farmers to mark their tapping panels in 110.5 ha. and correction of substandard panel marking in 268.46 ha. (Table 11).

Table 11. *Marking for new tapping and correction of substandard panel markings*

Region	New tapping panel marking (ha.)	Correction of substandard panel markings (ha.)
Kalutara	41.72	76.73
Ratnapura	02	07
Kegalle	32.2	95.9
Colombo	26.56	79.26
Galle	8.00	9.3
Total	**10.48**	**268.19**

Transfer of technology for quality improvement of RSS and up grading rubber processing centers

Two types of transfer of technology programmes (TOT) were conducted by REOO to improve the processing aspects of the rubber smallholder sector.

a). Transfer of Technology for Quality Improvement of RSS.
b). Transfer of Technology for up grading RSS production centers

Transfer of technology for quality improvement of RSS

REOO conducted 52 field training and demonstration programme for 902 selected RSS produces, to educate them on recommended RSS production technologies (Table 12).

Table 12. *Field Training and demonstration programmes conducted for RSS produces*

Region	No. of field demonstrations conducted	No. of RSS producers benefited
Kalutara	03	57
Ratnapura	22	425
Kegalle	19	260
Colombo	5	111
Galle	3	49
Total	**52**	**902**

Transfer of technology for up grading RSS production centers

Apart from educating RSS producers on quality improvement of RSS, REOO provided necessary advice and extension support services, to construct and modernize their processing centers as well. Accordingly, REOO could provide technologies and extension support services to construct 73 new processing centers and modernize 61 substandard processing centers (Table 13).

Table 13. *Construction and modernization of rubber processing centers*

Region	No. of RSS processing centers constructed on REOO advice	No. of RSS processing centers modernized on REOO advice
Kalutara	18	23
Ratnapura	15	07
Kegalle	21	17
Colombo	09	06
Galle	10	08
Total	**73**	**61**

Provision of other extension services for quality improvement of the RSS

1. Introduction of the new "Single pass rubber rolling machine" produced by the Jinasena industries limited. Two rolling units were introduced in the Colombo region.
2. Promotion of "Single day sheet rubber drying system" invented by the Department of Raw Rubber Processed Development and Chemical Engineering of RRISL. REOO worked in collaboration with this Dept. to identify potential RSS producers and organizing training programmes to promote this new technology. Accordingly, REOO could successfully introduce 27 'Single day drying units' for RSS producers on trial basis.

Short - term strategies to increase the productivity in the rubber smallholder sector

As a short-term strategy to increase the productivity of mature rubber holdings, rubber stallholders were motivated to,

a) Fix rain guards to minimize the loss of tapping days due to rain interference and
b) Apply fertilizer for mature rubber holdings.

Accordingly, REOO conducted training programmes and demonstrations and provided necessary facilities to fix rain guards in 248.18 hectares and motivated rubber growers to apply fertilizer for 1837.67 ha. of mature rubber lands (Table 14).

Table 14. *Promotion of rain guard fixing and fertilizer application in mature rubber holdings*

Region	Promotion of rain guard fixing		Promotion of fertilizer application for mature rubber lands	
	Extent (ha)	No. of trees fixed with rain guards	Extent (ha)	Amount of fertilizer supplied (MT.)
Kalutara	115.03	34500	226.64	74.03
Ratnapura	10.80	5250	812.00	203.9
Kegalle	42.5	18930	140.8	49.9
Colombo	58.35	24160	180.23	44.66
Galle	21.5	8600	478.00	118.6
Total	**248.18**	**91440**	**1837.67**	**491.09**

Establishment of model rubber holdings and model processing centres

REOO continued to maintain model rubber holdings and processing centers established in year 2007. New holdings and new processing centers were selected to be up graded as model holdings in year 2008. Altogether, 216 mature and 226 immature model rubber holdings and 95 model processing centers are maintained by REOO (Table 15).

Table 15. *No. of model rubber holdings and model processing centers maintained by REOO*

Region	Model rubber holdings		Model processing centers
	Mature	Immature	
Kalutara	66	64	13
Ratnapura	21	25	01
Kegalle	77	86	45
Colombo	26	27	21
Galle	26	24	15
Total	**216**	**226**	**95**

All above mature model rubber holdings were supplied with marking plates to mark tapping panels, Plastic latex collecting cups, cup hangers, metrolac charts and yield record charts. All rubber tappers working in above model rubber holdings, were trained to improve their tapping skills.

FSC group certification for rubber growers

Five awareness programmes were conducted in collaboration with the IUCN Sri Lanka, for selected members of the FSC programme, to appraise them on current developments and future programmes of the project.

Area specific projects

Different training and institutional needs of rubber growers identified by RAOO and REOO on specific issues at regional level related to field management technology adoption and other related issues were successfully addressed.

Related training and advisory activities were carried out to address following issues and problems.

- Introduction of intercropping and mix cropping systems
- Training on yield stimulation, tapping intensification and Control Upward Tapping (CUT) techniques
- Identification and control of tapping panel dryness (TPD)
- Introduction of the new tapping knife invented by the Department of Plant Science of RRISL.

RUBBER TECHNOLOGY AND DEVELOPMENT

Dilhara Edirisinghe

SUMMARY

Combined effect of the two antioxidants Ralox and TMQ on the ageing properties of a balloon compound was evaluated. Examination gloves, using chemically treated protein free natural rubber (NR) latex were manufactured at Lalan Gloves (Pvt.) Ltd. by the existing commercial process line and the protein level of these gloves was in accordance with ASTM specifications.

A series of NR/polyvinyl alcohol latex blends was prepared and water absorption of the latex films was evaluated and compared with that of NR based latex films.

Several low cost biodegradable nursery bags were produced using different techniques with NR latex and different raw materials such as waste news papers and cement bags.

NR latex foam waste incorporated crepe rubber was produced in order to evaluate its suitability for shoe components. The shoe soles manufactured with the incorporation up to a 30% of waste foam were found to be satisfactory for the said purpose.

Magnesium silicate incorporated NR latex foam was produced in view of improving the flame resistant properties of latex foam and the results were not satisfactory in comparison with currently used graphite incorporation for the purpose.

Field trials continued for eleven months confirmed that the low cost, environmentally friendly "Power Mat", a weed control mat made out of waste rubber gloves for immature rubber trees was found to be quite durable and fully effective in controlling the growth of weeds. Several of these mats were produced for a medium scale field trial. Development of NR composites with coir for different applications was continued in collaboration with the Coconut Research Institute. Several rubberized-coir based weed control mats were too produced in order to carry out a medium scale field trial for the same purpose.

A study revealed that epoxidized soyabean oil (ESBO), epoxidized palm oil (EPO) and epoxidized sunflower oil (ESFO) could be used as alternatives for petroleum based aromatic oils, which have been reported as carcinogenic and therefore to be banned worldwide from the year 2010. It was also found that EPO could be used as an activator in dry rubber compounding.

Ageing and dynamic properties of the selected combinations of NR/SBR/BR tyre tread compounds were tested and compared.

Suitability of imported recycled rubber waste in tyre side wall compounds was evaluated to ascertain the possibility of any cost reduction. A crepe/recycled rubber blend formulation suitable for the purpose was developed.

Rubber compound and product testing services were provided to the industry and several small and medium scale entrepreneurs were given advice and assistance on setting up rubber based cottage industries. Machinery fabricated in connection with the setting up of a "Technology Incubator" in Weeraketiya in collaboration with the Ministry of Science and Technology under the "Vidatha Programme" was handed over to the Vidatha Centre, Weeraketiya. A Workshop on "Manufacture of rubberized-coir based products" was conducted in Weeraketiya for a group of entrepreneurs in collaboration with the Vidatha Centre. Further, the staff was actively involved in training students and organizing stalls at exhibitions.

DETAILED REVIEW

Staff

Mrs D G Edirisinghe, Acting Head of the Department was on duty, whilst continuing her PhD studies at the Department of Chemical and Process Engineering, University of Moratuwa, Sri Lanka. Dr (Mrs) M M Jayasuriya, Senior Research Officer (Selection Grade) resigned from the institute with effect from 25th November, 2008. Mrs G D D Seneviratne, Assistant Rubber Chemist was on study leave throughout the year continuing her MSc (by Research) Degree at the University Sains Malaysia, Penang, Malaysia.

Mrs M K Mahanama, Mrs S I Yapa, Mrs P C Wettasinghe and Mr S L G Ranjith Experimental Officers were on duty throughout the year. Mr P L Perera, Experimental Officer was on medical leave during the period from 5th June to 4th September. Mr T A A I Siriwardena, Technical Officer was promoted as an Experimental Officer with effect from 2nd May. Mrs Priyanthi Perera, Research and Development Assistant was on maternity leave commencing from 25th August.

Research students

- Mr Wasantha Punchihewa, a MSc (Polymer Science and Technology) student from the University of Sri Jayawardenapura carried out his research project under the supervision of Mrs D G Edirisinghe.

- Mr Pradeep, a MSc (Polymer Science and Technology) student from the University of Sri Jayawardenapura carried out his research project under the supervision of Dr (Mrs) M M Jayasuriya.

- Miss Ganga Chandrasekera, a BSc (Chemistry Special) undergraduate student from the University of Sri Jayewardenepura completed her final year research project.

Seminars/Lectures/Conferences/Meetings/Workshops attended

Officer	Subject	Organization
D G Edirisinghe	Young Scientists Forum – Four Steering Committee Meetings	National Science and Technology Commission
	Working Group Meeting on "Three Wheel Tyres"	Sri Lanka Standards Institution
	"Deyata Kirula" – National Development Exhibition	Ministry of Plantation Industries
	Export and Enterprise Development Forum	Export Development Board
D G Edirisinghe and Priyanthi Perera	Workshop on "Barriers to Young Scientists"	National Science and Technology Commission
D G Edirisinghe and M M Jayasuriya	Scientific Committee Meetings	Rubber Research Institute of Sri Lanka
Priyanthi Perera	Workshop on "Natural Products"	National Science and Technology Commission
M K Mahanama	Evaluation of new inventions of school children of the Matara district	Sri Lanka Inventors Commission
	Workshop on Formulating the A'Level syllabus to introduce "Rubber Technology" as a new subject	National Institute of Education
	Teacher Training Programme	Ministry of Education
	Inventor's Exhibition	Sri Lanka Inventors Commission

Lectures/Seminars/Conferences/Meetings/Workshops addressed

Officer	Subject	Organization
D G Edirisinghe	General properties of NR latex and latex technology	PRI - DPRI Course
D G Edirisinghe	Degradation and stabilization of polymers	University of Sri Jayewardenepura: MSc (Polymer Science and Technology)
D G Edirisinghe	Composition of NR latex and effect of non-rubber substances on properties	National Institute of Plantation Management: Professional course
M K Mahanama	Manufacture of RSS, Crepe and TSR	PRI - DPRI course
	Latex technology	
M K Mahanama	Compounding ingredients (dry rubber and latex)	PRI - Basic course in Rubber Technology
M K Mahanama	Processing techniques (latex)	

Training programmes

Client	Subject	No. of programmes
MSc (Polymer Science and Technology) students of the University of Sri Jayewardenepura	Practical training on "Rubber Technology"	1
Officers of the Vidatha Centre, Walallawita and small/medium scale entrepreneurs	Manufacture of rubber based products	1
Officers of the Vidatha Centre, Horana and small/medium scale entrepreneurs	Manufacture of rubber based products	1
Group of entrepreneurs in Weeraketiya	Manufacture of rubberized-coir products	1

Industrial visits

The following industries were visited during the year for collaborative research projects.

Officer	Industry
D G Edirisinghe and M K Mahanama	Carnival World, Katana
S L G Ranjith and S I Yapa	Lalan Gloves (Pvt.) Ltd.
M M Jayasuriya	Dockyard, Colombo

LABORATORY INVESTIGATIONS

Latex technology

Development of rubberized-coir products (RT/L/RC/07/3)

Development of a weed control mat out of rubberized - coir waste

Field trials were carried out using the low cost mat produced out of rubberized-coir waste, old newspapers and centrifuged/field latex and the results were satisfactory. Hence, several of these rubberized-coir based mats were produced in Dartonfield in order to carry out a medium scale field trial in an estate in Kalutara. An application for a patent was submitted.

Forty rubberized-coir based weed control mats were produced using a press at the Coconut Research Institute with the assistance of the Rubber Technology and Development Dept. and handed over to Soil and Plant Nutrition department of the RRISL to carry out field trials (W M G Seneviratne, M K Mahanama and D G Edirisinghe).

Comparison of ageing properties of NR latex compounds prepared with different types of antioxidants/antioxidant combinations at different dose levels (RT/L/AOS/06/5)

The studies of different types of antioxidants and their combinations in relation to improvements in ageing properties were continued.

Out of the antioxidants studied so far, Ralox (butylated reaction product of para cresol and dicyclo pentadiene) and TMQ (2,2,4 trimethyl 1,2 dihydro qunoline) resulted the best ageing properties and hence a trial was initiated to evaluate the effect of different combinations of the two antioxidants on the ageing properties of a balloon compound (D G Edirisinghe and P C Wettasinghe).

Protein free latex for industrial applications

A factory scale trial on production of examination gloves using protein free NR latex obtained after special chemical treatment methodology was conducted at Lalan Gloves (Pvt.) Ltd. The gloves produced were more or less comparable in physical properties to the gloves produced from commercially available centrifuged NR latex.

The protein level of leached examination gloves produced using this special, low/minimum protein centrifuged NR latex, determined by ASTM method was found to be 15.2 μg/g of rubber in powdered examination gloves (protein level of these gloves prepared using normal centrifuged latex is between 130-190 μg/g) and 10.2 μg/g of rubber in powder free (chlorinated) examination gloves (protein level of these gloves prepared using normal centrifuged latex is between 30-49 μg/g). Therefore, results clearly indicate that the protein level in powdered gloves prepared from this special latex is outstandingly lower compared to the gloves prepared from normal centrifuged latex. An application for a patent was submitted (M M Jayasuriya, S L G Ranjith and S I Yapa).

Use of hydrophilic polymers in rubber latex formulations (RT/L/HDC/07/4)

The project was initiated with a view to develop a rubber based compound suitable for the manufacture of wound dressings. As such, a series of NR latex films containing 10-30% cross-linked polyvinyl alcohol (PVA) was prepared. A control, based on NR films was also prepared and water absorption ability was assessed by determining the swelling index in water. Water absorption of the NR/PVA blend samples was not significantly different from that of the control sample, which consists of 100% NR. Strength properties too were more or less comparable to those of NR (M M Jayasuriya, S I Yapa and S LG Ranjith).

Development of cost effective nursery bags for rubber nurseries

a). Several low cost biodegradable nursery bags were produced using natural rubber latex coated waste newspapers and they were found to be suitable to replace currently used, costlier non degradable polythene bags. An application for a patent was submitted (P Seneviratne, M K Mahanama and D G Edirisinghe).

b). More than hundred and fifty, low cost nursery bags were produced out of natural rubber latex coated craft paper as it was difficult to find a large quantity of used fertilizer/cement bags, which were used to develop the nursery bags at the initial stage. The bags were handed over to the Plant Science Dept., Dartonfield, in order to carry out trials (P Seneviratne and S L G Ranjith).

Natural rubber latex foam waste for rubber product manufacture

Considerable amount of foam rubber waste is generated during manufacture of NR latex foam. Attempts were made in this project to incorporate this waste material into natural rubber through wet stage mixing. The blend of waste with virgin rubber, thus produced was processed into crepe form. The NR/waste foam blend, containing the latter at levels of 25% and 33% were used to produce shoe heels, soles, rubber strips for sandles, *etc.* by a leading shoe manufacturer. The products were satisfactory to an acceptable level. Physical tests are being carried out to investigate the effect of foam waste on product quality further (M M Jayasuriya, U N Ratnayake, S L G Ranjith and S I Yapa).

NR latex foam for fire retardance applications

A trial was carried out by replacing aluminum silicate with magnesium silicate in a NR latex foam compound in order to ascertain the suitability of the latter as a fire retardant additive. The flame resistance of this foam rubber compound was compared with that of the control compound prepared without adding any flame retardant additive and also with foam rubber incorporated with graphite. No significant difference in flame resistance between the two former foam compounds was noted from the results (D G Edirisinghe and S I Yapa).

Dry rubber technology

Development of a cost-effective weed control mat (Power Mat) out of latex dipped product waste

Field trials continued for eleven months have confirmed that the "Power Mat" is quite effective in controlling the growth of weeds and found to be durable due to its excellent tear/crack growth resistance. Some of the other advantages of this mat are retention of nutrients and soil moisture, non-toxicity, adverse impact on soil physical and chemical properties, easy handling and transportation, foldable, environmentally friendly, minimum space requirement for packaging, washability, different colour combinations for attraction, withstands extreme weather conditions and tight adherence to the soil surface whereby no space is available for blooming of even a single weed.

The results of the field trial indicated that the durability and effect of weed control of these low cost mats produced out of latex dipped product waste were superior to those of the other mats produced using different types of other low cost

raw materials such as waste papers, coir cuttings, *etc*. An application for a patent was submitted.

Several of these mats were produced in order to carry out a medium scale field trial in an estate in Kalutara district. Further arrangements were made to produce the "Power Mat" in large scale in order to meet the requests made by several Plantation Companies (A Nugawela, D G Edirisinghe and M K Mahanama).

Development of natural rubber composites with coconut coir for different applications

This project, initiated during the year 2007 was continued in collaboration with the Coconut Research Institute of Sri Lanka. Evaluation of physical/mechanical properties of the four composites prepared by varying the amounts of particulate filler (carbon black/china clay) and coir (mixed fiber) revealed that the partial replacement (50%) of carbon black with mixed fibre increases abrasion resistance and hardness. Also, partial replacement (50%) of china clay with mixed fibre increases the tear strength.

Preparation of the second series of composites for property improvements was carried out by changing the vulcanizing system. Physical property results of the five natural rubber/particulate filler/coir composites prepared by varying the amounts of the fillers carbon black, clay and coconut fibre were evaluated. It was observed that the resilience increases as the amount of (clay + coir) increases. In addition, higher amounts of (clay + coir) in the formulations increase abrasion resistance.

An experimental trial was carried with clay/coir combination replacing the reinforcing filler, carbon black in the composite in view of reducing the cost of low profile products such as floor mats, tiles for which physical properties are not stringent. However, the amount of coir in the formulation was increased instead, since one of the objectives of the project is to increase the consumption of locally available raw materials, in this case coconut fibre while maintaining the properties of the composite at a reasonably satisfactory level. 75 phr clay was used in the formulation as a diluent particulate filler. The hardness of the mat produced was 95 Shore A degrees and growth of cracks was found to appear when the edges of the mat were subjected for bending. Hence, another trial was carried out by replacing one third of the coir in the formulation with crumbs of foam waste obtained from Nippon Nature Foam (Pvt.) Ltd., Bandaragama. The mat produced showed a hardness of 20 Shore A degrees and no cracks appeared due to bending of the edges. Tensile properties and tear strength of the natural rubber composites prepared with coconut fibre, clay and foam waste were also evaluated (D G Edirisinghe, P C Wettasinghe, P L Perera and Wasantha Punchihewa - MSc student, University of Sri Jayewardenepura).

Alternative processing aids for aromatic oils used in the dry rubber products industry

Physical and mechanical property results revealed that out of the three natural oils, *i.e.* soybean, palm and sunflower oil studied, soybean oil is the best alternative for the presently used aromatic processing oils in rubber compounding for which a ban will be imposed in the year 2010. Results also showed that soybean oil acts as a co-activator during the vulcanization process. A research paper on this work was submitted to the National Science Foundation of Sri Lanka for publication in the "Journal of the National Science Foundation". An application for a patent was also submitted (L Karunanayake/Senior Lecturer, Dept. of Chemistry, University of Sri Jayewardenepura, D G Edirisinghe, Geethamala Jayawardana - BSc (Chemistry Special) student, University of Sri Jayewardenepura and Priyanthi Perera).

Epoxidized vegetable oils as processing aids and activators in carbon black filled natural rubber compounds

Suitability of epoxidized vegetable oils namely, epoxidized sun flower oil (ESFO), epoxidized palm oil (EPO) and epoxidized soybean oil (ESBO) as processing aids and activators in natural rubber based truck tyre tread compound was investigated as the second stage of the project in finding an alternative for aromatic rubber processing oils. Rice bran oil (RBO) was chosen as the reference in the case of oil selection. Processability and cure characteristics of the compounds as well as mechanical properties of the vulcanizates were compared with those of the standard vulcanizate prepared with Dutrex R, an aromatic processing oil. The epoxidation of the oils was carried out using the reaction with peracetic acid based methodology. Extent of epoxidation of oil was confirmed using ^{1}H NMR and ^{13}C NMR spectra. The results, based on tyre tread formulation revealed that ESBO, EPO and ESFO are better alternative processing aids for petroleum based aromatic oils, which have been reported as carcinogenic. EPO showed better processing properties, polymer-filler interaction, dispersion properties and the best heat resistance. It was also found that the EPO could be used even in the absence of stearic acid in rubber compounding indicating its action as an co-activator.

A research paper on this work has been completed for submission to the National Science Foundation of Sri Lanka for publication in the "Journal of the National Science Foundation" (L Karunanayake/Senior Lecturer, Dept. of Chemistry, University of Sri Jayewardenepura, D G Edirisinghe, Gayani Chandrasekera - BSc (Chemistry Special) student, University of Sri Jayewardenepura and M K Mahanama).

Development of a suitable adhesive for NR/EPDM blend compounds used in tyre curing bags

A 70:30 NR/EPDM blend compound was developed using an efficient vulcanizing (EV), system and the properties of the tyre curing bag produced out of this compound were in accordance with the requirements. However, adhesion at the valve was poor due to incompatibility of the adhesive produced using the same blend compound with the brass valve. Hence, development of a special adhesive suitable for the purpose was initiated (M M Jayasuriya, S L G Ranjith and S I Yapa).

Development of NR/SBR/BR composites for tyre treads

Ageing and dynamic properties of the selected combinations of NR/SBR/BR tyre tread compounds (NR:SBR:BR 50:40:10, 50:30:20 and 30:60:10) prepared with N330/N220 carbon black and with/without oil extension were tested (Table 1). Dynamic property testing was carried out at Loadstar (Pvt.) Ltd., Kotugoda.

Table 1. *Type, amount of carbon black and amount of oil in NR/SBR/BR tri-blend compounds*

Sample No.	NR/SBR/BR tri-blend ratio	Type of carbon black	Amount of carbon black (phr)	Amount of oil (phr)
1	50/40/10	N 330	77	15
2	50/40/10	N 220	55	5
3	50/40/10	N 330	55	5
4	50/30/20	N 330	55	5
5	30/60/10	N 330	55	5

Previous trials indicated that the tri blend composition NR:SBR:BR 50:40:10 containing 55phr of N 330 carbon black (Sample 3) is superior to the other two compositions containing the same type and amount of carbon black (Samples 4 and 5) in terms of mechanical properties, especially tear strength (Fig. 1), hardness (Fig. 2) and internal temperature (Fig. 3).

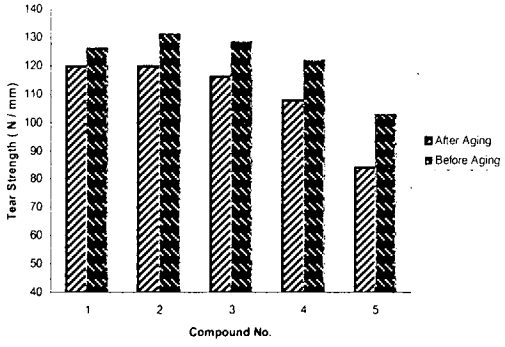


Fig. 1. Variation of tear strength of the tyre tread compounds, before and after ageing

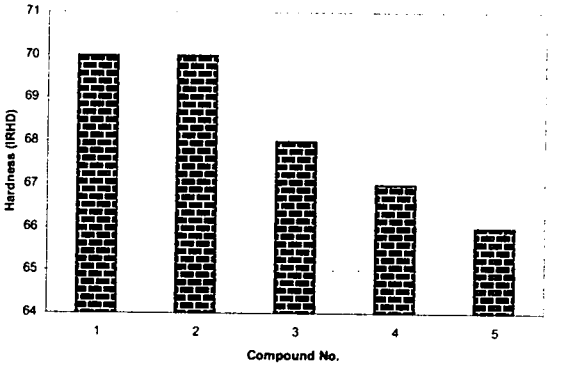


Fig. 2. Variation of hardness of the tyre tread compounds

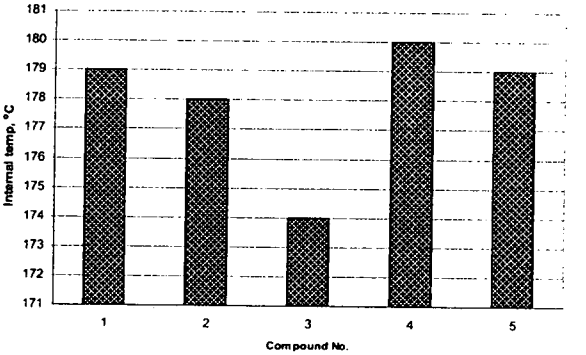


Fig. 3. Variation of internal temperature of the tyre tread compounds

However, there is no significant difference between resilience, temperature rise and dynamic properties such as elastic torque or storage modulus (E'), viscous torque or loss modulus (E") and hysteresis/Tan Delta (tan δ) of the above three compositions (Figs. 4-8).

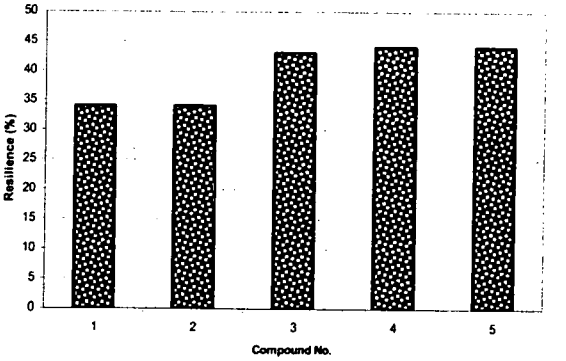


Fig. 4. Variation of resilience of the tyre tread compounds

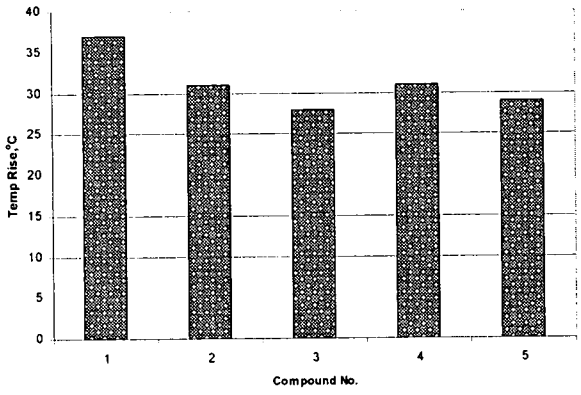


Fig. 5. Variation of temperature rise of the tyre tread compounds

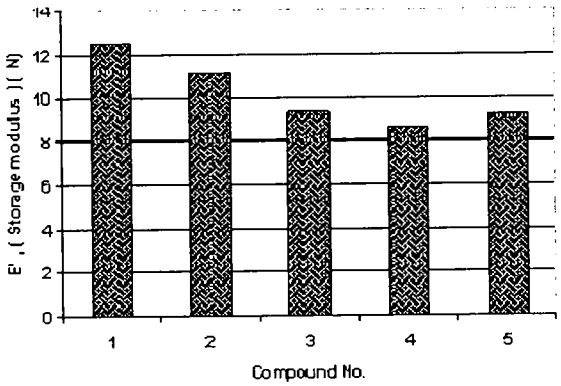


Fig.6. Variation of storage modulus of the tyre tread compounds

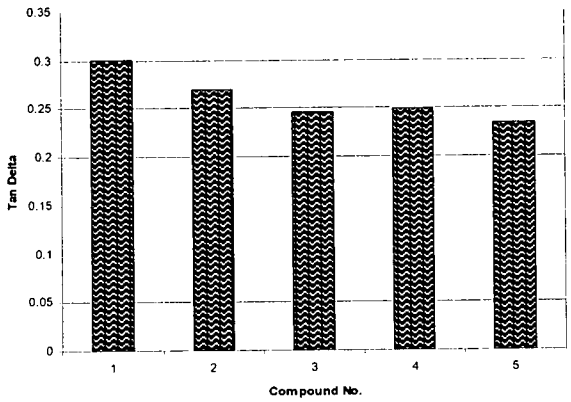


Fig. 7. Variation of Tan Delta of the tyre tread compounds

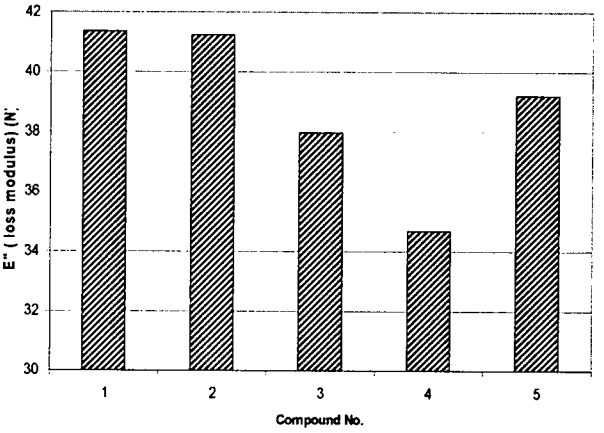


Fig. 8. Variation of loss modulus of the tyre tread compounds

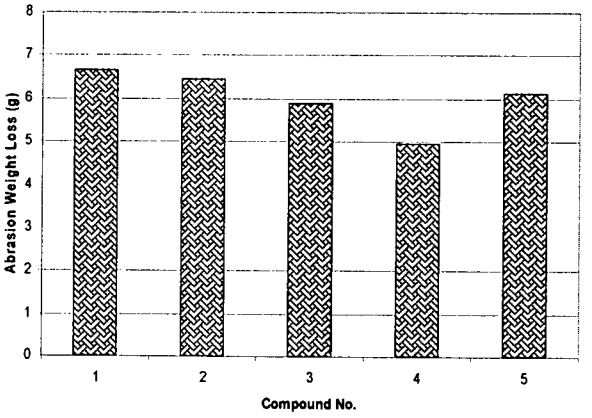


Fig. 9. Variation of abrasion weight loss of the tyre tread compounds

Further, resilience, abrasion resistance (Fig. 9), heat build-up properties (temperature rise and internal temperature) of the NR:SBR:BR 50:40:10, 55 phr N330 carbon black filled compound is superior to those of the 77phr N330 carbon black filled oil extended compound and the 55phr N 220 carbon black filled compound. However, dynamic properties of the latter compounds are greater than those of the former compound (D G Edirisinghe, G D D Seneviratne, A D J Dharmadasa/MSc (Polymer Science and Technology) Student, University of Sri Jayewardenepura and T A A I Siriwardena).

Use of recycled rubber in tyre compounds

a) **Evaluation of the suitability of incorporation of imported recycled rubber in tyre tread compounds**

This project was initiated on a request made by a leading rubber company at a time when the rubber prices were very high. The imported recycled rubber, which does not contain any fillers (a gum rubber) was evaluated for its suitability in tyre tread formulations. Preliminary experiments were carried out by varying the recycled rubber content in a tyre tread formulation based on a NR/SBR/BR tri- blend. The physical properties of the compounds were determined (M M Jayasuriya and T A A I Siriwardena).

b) **Evaluation of the suitability of imported recycled rubber made from glove waste in bicycle tyre tread compounds**

Experimental work on this short term project (carried out as a partial fulfillment of the requirements of the Diploma Course in "Rubber Technology" conducted by the Plastic and Rubber Institute of Sri Lanka (PRISL) was carried out at DSI, Mahara, Kadawatha, with the advice and assistance of the Rubber Technology and Development Department.

Incorporation of imported recycled rubber into crepe rubber compounds were carried out with the aim of reducing the cost of coloured bicycle tread compounds. Initially, three NR/reclaimed rubber blend compounds were prepared as per blend ratios 80:40, 70:60 and 60:80 NR: white reclaim. Evaluation of mechanical properties of the three compounds revealed that 70:60 NR : white reclaim blend is the best. Thereafter, compounds were prepared by varying the silica filler/antiozonant/curing ingredients. Results of the mechanical properties of the final formulation developed were in accordance with the requirements of a bicycle tyre tread compound. Hence, it was concluded that the imported white glove reclaim is suitable as a partial replacement for pale crepe to reduce the cost of coloured bicycle tread compounds. A report on this work was submitted to the Plastic and Rubber Institute of Sri Lanka (W D Sumith/DSI, Mahara, Kadawatha, D G Edirisinghe and W Upali Shantha, DSI, Mahara, Kadawatha and student/DPRI Course).

Industrial extension

The following services were provided to various rubber companies at their request.

Service	No. of Companies
Physical properties of rubber compounds	6
Physical properties of rubber products	3
Hardness of sole crepe samples	2

In addition to the services rendered to rubber industries, a large number of entrepreneurs were provided with advice and assistance on setting up of appropriate NR latex based cottage industries as well as other dry rubber based industries.

Machinery fabricated in connection with the setting up of a "Technology Incubator" in Weeraketiya in collaboration with the Ministry of Science and Technology under the "Vidatha Programme" was handed over to the Vidatha Centre, Weeraketiya. Production of rubberized-coir mattresses by an entrepreneur, using this machinery was initiated in Weeraketiya after conducting a two day workshop. Also, a group of entrepreneurs were given a training on production of other rubberized-coir based products such as pots, wall hangings, carrier bags, *etc.*

Participation/providing assistance at exhibitions

The staff of the department was actively involved in organizing the exhibition stall of the Ministry of Plantation Industries, providing advice to entrepreneurs on setting up rubber based industries and educating school children on "Rubber Technology", at the **"Deyata Kirula" National Development Exhibition** held at the BMICH, Colombo 7 from 07th to 10th February.

The staff was also involved in organizing the RRISL stall and providing advice and assistance to entrepreneurs mainly on rubber machinery required for setting up rubber based industries at the "International Machinery Exhibition and Trade Fair 2008" held at the BMICH, Colombo 7 from 14th to 18th May. This exhibition was organized by the Small and Medium Enterprise Developers (SMED) and the Ministry of Rural Industries and Self Employment Promotion.

POLYMER CHEMISTRY

Champa Wellappili

SUMMARY

Modified phenolic resins are used to increase the strength properties of chloroprene base adhesives. The peel strength of the modified adhesive for rubber to rubber and leather to leather are observed to be within the Sri Lankan standards. Latex adhesives found to be satisfactory in bonding waste foam crumbs to make pillows. A low cost sealant for rain guards was prepared by replacing considerable amount of bitumen in existing formulation by a blend of waste engine oil and rubber. This enabled the incorporation higher filler content in the sealant resulting in a marked reduction of the sealant cost. Investigations on the blends of NR and NVC showed excellent oil and other fluid resistance properties. This material was found to be a relatively cheaper raw material in applications where oil and fluid résistance is required. Processing cost reduction of tyre tread extrusion at DSI factory was investigated. Incorporation of Microcellular waste treated fatty acid derivatives in NR based compounds were found to enhance the compatibility and strength properties.

DETAILED REVIEW

Staff

Dr (Mrs) Champa Wellappili, Senior Research Officer was on duty throughout the year. Ms Nilmini Liyanage Assistant Rubber Chemist continued her postgraduate studies at the University of Cardiff in the UK.

Experimental Officers Mr H N K K Chandralal, Mrs Indra Denawaka, Mrs Chitra Kuruppu, Mr S S Warnapura and Mr Ananda Samarakoon were on duty through out the year.

Research students

- Miss Thushari, MSc student from Moratuwa University carried out a project on "Effect of resin and solvent systems of Polychloroprene/rubber based adhesives".
- Miss M P T Nilanthi and Mr Chamara Kappitiyagame, MSc students from Sri Jayawardenapura University carried out projects on "Styrene acrylate binder for weather proof paint" and "Development of a cost effective low cost rain guard sealant" respectively.

Seminars/Conference/Meetings/Workshops/Lectures attended

Officer	Subject	Organization
Champa Wellappili	Science Journalism	National Science Foundation
Champa Wellappili	Important matters connected with the rubber industry in Sri Lanka	Ceylon Chamber of Commerce
Champa Wellappili	Plantation Symposium	CRI, TRI, RRI and SRI
Champa Wellappili	Scientific Committee Meeting	RRISL, Ratmalana
H N K K Chandralal	Nano Composites	National Science Foundation

Training programmes

Client	Subject	No of Programmes
MSc (Polymer Science and Technology) students of the University of Sri Jayawardenepura.	Polymer science	01
NDT Chemical Engineering – Moratuwa University	Polymer identification	01
Small and medium scale entrepreneurs – Weeraketiya Vidata Center	Manufacture of Rubberized coir products	02
DPRI students from Plastic and Rubber Institute	Basic polymers	01
MSc (Polymer Science and Technology) students of the University of Sri Jayawardenepura	Paints and coatings	1

Exhibitions

Officers in the department participated/assisted at the following exhibitions;

- "Dayata Kirula" Exhibition at BMICH 04th February 2008
- "International Machinery and Trade Fair" exhibition at BMICH 2008

LABORATORY AND FIELD INVESTIGATIONS

Effect of modified resins on adhesive strength (PC/D/ADH/2008/02)

The project was initiated at a request of a leading plastic industry in Sri Lanka to manufacture neoprene based adhesives. Series of samples were prepared using different types of resins with varying compositions. Peel strength was measured using rubber and leather as an adherent. The results showed that the peel strength for rubber to rubber bonding can be increased by incorporating higher amounts of modified phenolic resin (Fig 1). The properties of the improved adhesive with the inclusion of the other additives (ZnO, MgO *etc.*), are within the SLS standard (Table 1).

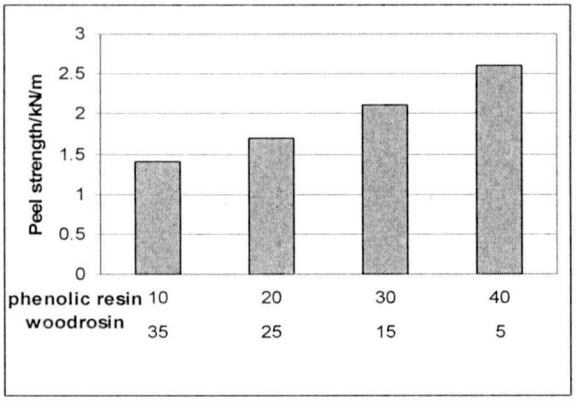


Fig.1. Effect of resin ratio on peel strength for rubber to rubber adhesion

Table 1. *Peel strength of samples with phenolic type resin*

Test/unit- Peel strength/kN/m	Test method	Peel strength/kN/m	Requirement SLS 936
Rubber - Rubber,	SLS 936		
a) Dry*		3.0	2.5 minimum
b) Wet**		3.0	2.5 minimum
c) Aged***		2.0	1.0 minimum
Leather - Leather	SLS 936		
a) Dry		4.5	4.0 minimum
b) Wet		3.8	2.5 minimum
c) Aged		4.0	3.5 minimum

* Room temperature for 48 hours

** Immersed in water for 24 hours

***Kept in an air oven 70°C for 100hours

(Champa Wellappili, Chitra Kuruppu, H N K K Chandralal and Ananda Samarakoon)

Utilization of waste rubber

Utilization of waste foam rubber in rubber compounds (PC/D/ WNRF/2008/03)

Polymer blends have become a very important subject for further scientific investigation because of their growing commercial acceptance. Therefore, effects of blending NR with foam rubber crumbs (type of waste from foam rubber industry) under different conditions were studied. It was found that all mechanical properties of NR compounds deteriorate with increasing levels of foam crumbs in blends when foam crumb is blended without any treatment (Fig. 2 and Fig. 3). 20 to 40 parts of waste foam crumbs can be incorporated with out any significant effect. Treated foam blends showed higher values when compared to untreated samples.

Pre-treatment of foam crumbs with a fatty acid derivative (FA) showed improved performances in strength properties tested. This may be due to better dispersion of foam in the presence of fatty acid in the rubber compound, giving higher attraction between rubber and foam particles (Champa Wellappili and Indra Denawaka).

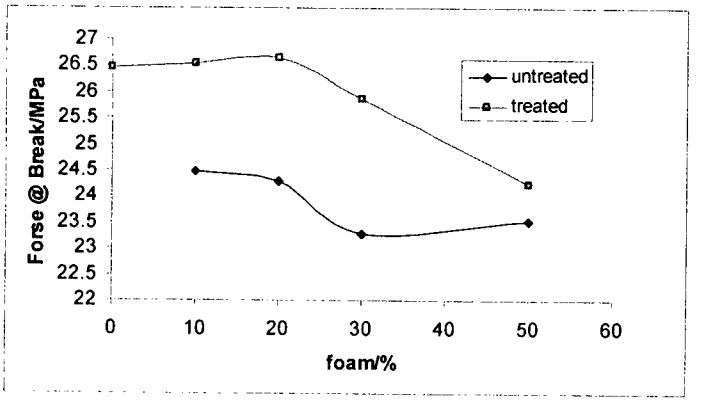


Fig. 2. Variation of force @ break as a function of foam crumbs with treated and untreated foam crumbs

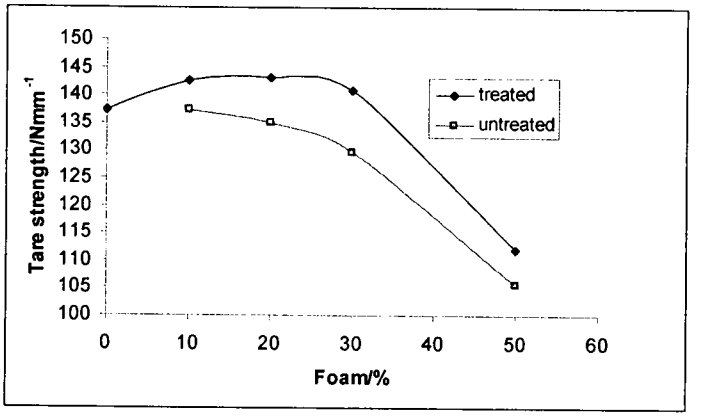


Fig 3. Variation of tare strength as a function of foam crumbs with treated and untreated fatty acid

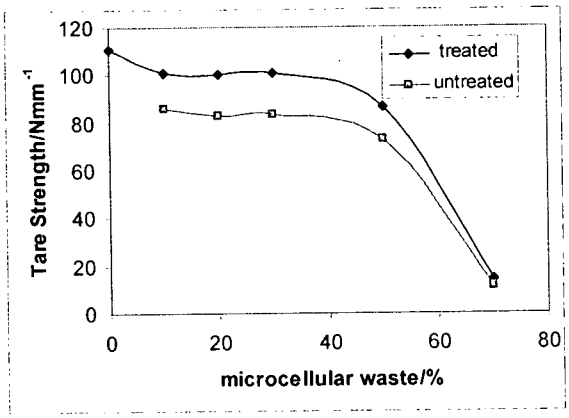


Fig 4. Variation of tare strength as a function of microcellular waste

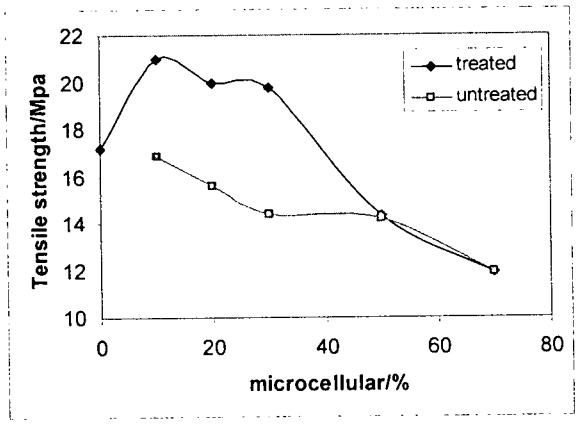


Fig 5. Variation of tensile strength as a function of microcellular waste for treated and untreated waste

In addition, waste microcellular dust (particle size 30) was also used to prepare blends with virgin rubber. Similar to that of waste crumbs FA treatment was used to improve its miscibility of the virgin rubber. It also showed improved strength properties when compared with untreated waste (Champa Wellappili, S S Warnapura, Chamila - DSI, Galle).

Therefore, the usage of preconditioned foam crumbs and microcellular waste in rubber compounds can be considered as an environmental friendly and economically viable manufacturing process to use such blends for suitable product manufacture.

Development of a latex based adhesive to make waste foam rubber blocks (PC/L/WNRF/2008/04)

NR latex based adhesive was prepared for foam crumbs and make a foam block to be used in cushion industry or to manufacture layered mattresses. This natural adhesive can be used as an alternative, in place of synthetic polyurethane based adhesives (Champa Wellappili and Chitra Kuruppu).

Preparation of low cost sealant for rain guard (PC/WBO/2008/08)

Bitumen is the main adhesive used at present for fixing of rain guards in rubber trees as the sealant. However, as the bitumen is a nonrenewable material, this project was initiated to reduce the part of bitumen with fiber waste, waste rubber and waste oil. Three different types of waste oil samples having varying viscosities were used in this project. Homogeneization of the mix becomes difficult with the addition of higher oil content. Micro fiber (cotton waste) was added to improve sealant strength. Optimum filler loading of Micro fiber and waste rubber are being investigated to reduce cost of the sealant without adverse effects on properties (Champa Wellappili, H N K Chandralal and Chamara Kappitiyagame - SJP).

Development of low cost insole material out of waste micro fiber (PC/D/WMF/2008/06)

Trials were carried out to make low cost (using waste fiber, saw dust and china clay) and fast curing rubber compound material to manufacture insoles. Project is in progress (Champa Wellappili, H N K K Chandralal and S S Warnapura).

Study of Fluid Resistance Property in Blend Compounds Based on Natural Rubber with NBR/PVC (PC/D/PVCB/2008/09)

Oil resistency of Natural Rubber for mineral oils or fuels is quite inferior. However, it is quite resistant to series of organic and inorganic chemicals such as non-mineral oil based brake fluids, silica oils and grease, glycol, alcohols, water and non oxidizing water solutions of acids, alkalis and salts.

In contrast, Acrylonitrile butadiene Rubber; NBR, possesses excellent oil resistance and aromatic solvent resistance due to the presence of polar acrylonitrile group. Oil resistance of NBR improves with higher content of acrylonitrile in the rubber.

Due to the polar nature of NBR, they are even be blended with plastic materials *e.g.* PVC and phenolic resins to improve its oil resistance with a suitable plasticizer. The use of nitrile rubbers as oil seals is quite extensive while other applications include flexible fuel tanks, oil- resistant hoses and printing rollers.

In this project few NR/NBR/PVC blends having different compositions (Table 2) were prepared with reclaimed rubber to compare the solvent resistance of the each sample.

Table 2. *Nomenclature of samples*

C1	RSS	100
C2	NBR/FAB	80/20
C3	FAB/RSS	50/50
C4	NBR/PVC	70/30
C5	FAB/RSS/Reclaim	50/50/100

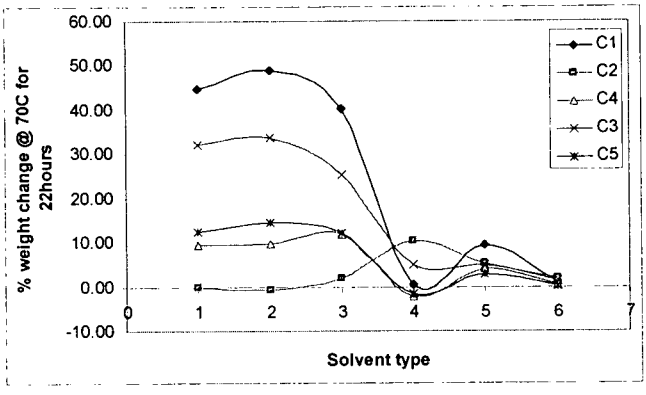


Fig 6. Variation of solvent resistance as a function of solvent system

Accelerated ageing solvent resistance tests were performed to measure changes in the rubber vulcanizate at elevated service temperatures (70°C for 22 hours) in the given fluid system.

Table 3. *Nomenclature of solvent*

Solvent	Symbol
Gear oil –SAE 90	1
Hydraulic oil	2
Grease	3
Surgical spirit (Isopropyl alcohol)	4
Betadine	5
Distilled water	6

According to the results, all samples showed better solvent resistance for 4, 5 and 6 solvents whereas poor resistance for hydraulic oil and Gear oil was observed for natural rubber based blends. However, the blend of RSS/FAB (Brown crepe rubber) with 100% Reclaimed rubber has shown poor resistance for hydraulic oil, however, it is quite superior to that of compounds prepared with 100% RSS. The blends which have shown ideal fluid resistance as per results are NBR/PVC and NBR/FAB blends (Champa Wellappili and M N F Raheesa - DPRI student).

Processing cost reduction of tread extrusion at DSI tire factory (PC/D/TE/2008/07)

In the extrusion process of any rubber compound the following primary costs are involved.

a. cost of material
b. cost of energy
c. cost of man power

A study was carried out to minimize the above cost in the rubber extrusion process (H N K KChandralal, R H Kularathna - DPRI student and N A Nandasena-DSI).

Industrial extension and testing samples

The following services were provided to the companies given below;

Company	Service
Water Board	Analysis of polymer composition of 'O' rings
Kanchana Tyre House	Polymer identification
ANSEL	Analysis of quality of rubber additives
Tas Medical Suppliers	Analysis of rubber adhesive
DSI, Galle	Polymer identification
EDNA Chocolates (Ceylon) Ltd	Quantitative analysis of plastic films for plasticizers
Crysler International	Polymer identification
Textrip Ltd	Analysis of blooming
Moratuwa University	Polymer identification
Dipped Products Ltd.	Preparation of oil emulsion
C&T Worldwide (Pvt) Ltd	Analysis of latex lace sample
Dockyard, Colombo	Production of dock fenders
Tea Research Institute	Preparation of pesticide emulsion

RAW RUBBER AND CHEMICAL ANALYSIS

Anusha Attanayake

SUMMARY

As the main function of the department analysis of rubber and related chemicals were carried out for quality assurance and certification purposes. A total number of one thousand five hundred and seventy seven rubber samples were analyzed during the year. This analysis included 337 samples of TSR, 707 samples of raw rubber of different types and 533 latex samples. The analytical reports are used for purposes such as quality certification for exports, local consumption and general quality assessments. In the area of testing chemicals used in rubber industry, 133 samples were tested for their percentage purity assessments.

Testing of rubber content in vulcanized rubber products, powder content in rubber gloves, contamination of metal ions in dipped products are among some of the other analysis carried out by the department.

In the field of research, projects on "Dependence of test conditions on Mechanical stability time variations of NR latex" and "Preliminary studies to investigate any variations in dry rubber properties of rubber from Moneragala area" was continued during the year.

DETAILED REVIEW

Staff

Ms A P Attanayake, Assistant Rubber Chemist was in Charge of overall activities of the department through out the year.

Experimental Officers, Ms H S Weeraman, L Wanigatunga, H V K Gamage, C Lokuge, L P Vitharana, M Wijesekera, B Gunasiri, N Karunatilaka, W Vithanage, and Clerk/Typist Mrs I Wijesinghe were on duty through out the year.

Instrument Technician Mr L G P Lelwela, was on duty through out the year.

Seminars/Conferences/Meetings/Workshops attended

Officer	Subject	Organization
A P Attanayake	Scientific Committee Meeting	Rubber Research Institute, Ratmalana
A P Attanayake	Workshop on Research Project Management	National Science and Technology Commission
A P Attanayake	Workshop on Barriers to Young Scientist"	National Science and Technology Commission
A P Attanayake	Lecture on Important matters connected with the rubber industry in Sri Lanka by Dr H Smit, Secretary General, IRSG	Ceylon Chamber of Commerce

Training programmes

Client	Subject
Nature Foam H M I D Herath H M B P Karunathilaka	End uses of waste rubber foam
Lalan Rubber (Pvt) Ltd Udabage Group, Deraniyagala	Laboratory DRC determination
MVPL Ltd, Moralioya Estate, Ruwanwella	Latex analysis
Lalan Rubber (Pvt) Ltd Mahaoya Group, Dehiowita Krishna Hewage Thilini Madhushika	Laboratory management, Instrumentation and Latex analysis
NDT a Group of students University of Moratuwa	Raw rubber analysis
Lalan Rubber, Dehiowita Thilini Madhushika Nirmadu Shashikala	Laboratory management, instrumentation and latex testing
University of Ruhuna K M N Chamalie Amisha Vidana Pathirana	Raw rubber testing
Universityof Sabaragamuwa B G W P Kumara	Raw rubber testing
University of Jayawardenepura MSc Polymer Students/2008/2009	Raw rubber testing and Latex testing

Advisory visits

Le-ferne Laboratory - Gataheththa, Awissawella

Two officers from the department carried out a thorough inspection of the operational procedures of TSR production at the above factory in order to compile processing data of the TSR manufactures in Sri Lanka. TSR testing laboratory too was inspected in order to ascertain the quality and accuracy of the test results (A P Attanayake and S Weeraman).

Trouble shooting activities

Contamination of flood water with rubber

On a request made by a private company, officers of the department investigated a degraded consignment of rubber reported to have affected by contamination of flood water. This was in view of making an insurance claim. Sample analysis of raw rubber properties revealed that the rubber lot was drastically affected by the water contamination and a report was issued to that effect (A P Attanayake, N Karunathilake and W Vithanage).

Low metrolac reading recorded in Millawa estate

It has been recorded by Millewa estate that the erroneous results were shown in the DRC of the latex, when DRC estimation was carried out by using metrolac in several of their divisions.

As such, number of latex samples were collected from those divisions and analyzed for important latex quality parameters to ascertain the problem. The results showed that the latex in those areas contain abnormally high content of Magnesium (Mg2+) amounting to as high as 500ppm, where as average values in most areas usually ranging from 150 -200ppm. Further studies on this subject will be continued as a short term project (A P Attanayake and C Lokuge).

Contamination of formic acid with sulphuric acid

A latex concentration/skim rubber processing factory made a complain that their waste water treatment plant was badly affected and resulted in a severe malordour generation after a new batch of formic acid was used to coagulate skim latex. Skim latex is the by-product from latex centrifuging operation and resultant skim latex is subsequently processed into crepe rubber after coagulation, using formic acid in this factory. After investigations of new and old samples of formic acids it was found that the new batch was heavily contaminated with sulphuric acid and the resultant effluent contained high levels of sulphates. As such, formation of pungent gases such as hydrogen sulphide and sulphur dioxide is quite evident resulting in an unbearable malordour from the treatment plant (A P Attanayake, S Weeraman and H V K Gamage).

LABORATORY AND FIELD INVESTIGATIONS

Study on the factors affecting the MST of NR latex with special emphasis to test conditions (RR&CA/L/MST/2006/03)

This project was initiated to study the different factors which may have certain bearing on the Mechanical Stability Time (MST) of latex. As such, MST of latex was studied in relation to the following;

- Storage temperature
- Adultration

- Level of preservatives added
- Clone
- Processing condition.

First stage of this project was focused on the study of latex stability with the storage temperature of centrifuged latex.

Centrifuged latex has to be stored for several weeks in order to achieve required level of MST for latex to become suitable for product manufacture. During the storage of latex naturally occurring lipids present in NR latex undergo decomposition to form long chain fatty acids which in turn acts as a stabilizer for NR latex. This is such slow process and takes a long time approximately 3 weeks to achieve the standard level of MST which is above 650 seconds. Therefore, the project intends to explore possibilities that could reduce the period of maturation time to attain the required level of MST.

Initial trials were conducted at four different temperatures 10°C, 20 °C, 29°C and 40°C.

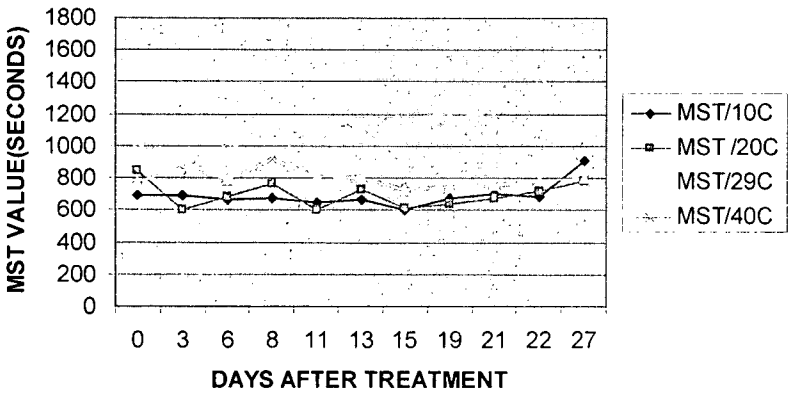


Fig. 1. Variation of MST with storage temperature

It is evident from preliminary studies that quick increase of MST could be achieved at higher storage temperatures. This project is continued with further studies (A P Attanayake, L Wanigathunga and M Wijesekera).

Investigations on dry rubber properties of latex in Moneragala region

This project was started to examine the latex and dry rubber properties of rubber from Moneragala which is classified as a dry zone and a area where number of new rubber replanting programmes are being carried out at present. The project would also help to ascertain any differences of rubber properties in Moneragala

region in comparison with the rubber from the other conventional rubber growing districts.

This project started with the samples collected from several small holders from Badalkubura, Moneragala. Four batches of RSS samples were analysed with reference to wet zone RSS samples. This project will be continued (A P Attanayake, N Karunathilake, C Lokuge, L Wanigathunga, P C Wettasinghe and P L Perera).

Services

Calibration of latex tanks

Latex tanks of the following places were calibrated for accurate measurements of the quantity of latex as requested by them.

1. Mawanella SRMC Centrifuged Latex Factory
2. Ellawala Rubber Factory, Eheliyagoda
3. Devalakanda Estate, Dehiowita,
   (L P Vitharana)

Analytical services

Samples tested during the year were as follows.

Service	No. of samples
TSR Factory	
Le-Ferne Block Rubber Factory, Getahetta	337
Miscellaneous	
Raw rubber samples	707
Latex samples	533
Chemical samples	39
Bleaching agent	94
Glove samples	19
Polythene	03
Shipping certificates	120
Testing certificates	1732

RAW RUBBER PROCESS DEVELOPMENT AND CHEMICAL ENGINEERING

S Siriwardena

SUMMARY

The new drying system (SS drying unit) developed for drying of sheet rubber in a single day was installed and successfully adapted in many places including a number of estates and Loadstar Pvt Ltd. This drying system won the annual national science and technology award in the category of development and adaptation of technologies for SMEs.

The results of the experiments carried out showed that the present maximum allowable limit for manganese (0.5 ppm) in raw rubber processing water is too low.

The results of the experiments carried out on blending of latex having two different VFA levels (high and low) indicated that high VFA concentrated latex could be safely blended with low VFA latex. Results also indicated that VFA No. tends to slowly rise after a storage period of about 6-7 weeks. A recommendation of blending of low quality latex with high quality latex will be published in the next year.

Experimental results showed that layered silicates accelerate the curing process whilst effectively reinforcing the NR tyre tread compounds. However latex compounding method for the incorporation of layered silicates is more effective in reinforcing NR, compared to the direct melt blending method.

DETAILED REVIEW

Staff

Dr Susantha Siriwardane, Head of the department, Dr Upul Rathnayake, Rubber Chemist Mr P H Sarath Kumara, Assistant Rubber Chemist were on duty throughout the year.

Messrs Chandana Senanayake, T A S Siriwardane and A K D Warnajith Prasad, Mrs Chandrika Nalini, Mrs Shirani Priyanka and Mrs C Rohanadepa, Experimental Officers, Mrs Rukmanie Liyanage, Store Keeper and Mrs Anusha Paranavithana, Typist/Clerk were on duty throughout the year.

Research students

- Mr P Jayasinghe, a final year undergraduate student of the Department of Chemical and Process Engineering, University of Moratuwa carried out his final year industrial research project on "Evaluation of the performance of a single day smoke drying unit for sheet rubber" for six months under the supervision of Dr Susantha Siriwardena starting from 30th January 2008.

- Ms T R M C D Menike a final year Chemistry student from University of Ruhuna carried out a research project titled "Investigation of VFA No. of natural rubber latex from different sources and its variation when kept under controlled and factory conditions" from April 21 to May 23 under the supervision of Mr P H Sarath Kumara.

- Ms K M N Chamalie, a final year Chemistry student from University of Ruhuna carried out a research project titled "Investigation of the performance of natural rubber/skim rubber/Carbon black composites for a tyre tread compound" from April 21 to May 23 under the supervision of Dr Susantha Siriwardena.

- Mr B G W P Kumara, a final year student from Sabaragamuwa University of Sri Lanka carried out a research project titled "Suitability of new latex coagulants for the manufacture of RSS and crepe rubber" under the supervision of Dr Upul Ratnayake from 28th April to 31st October 2008.

- Amisha Vidanapathirana, a final year student from University of Kelaniya carried out the Final year research project titled "Performance of lower grades of natural rubber in tyre tread formulations" for 3 months as partial fulfillment of BSc Special degree under the supervision of Dr W M G Seneviratne and the report was submitted.

- M G K Pushpakumari, an MSc student from University of Sri Jayewardenapura carried out a research project titled "Performances of lower grades of natural rubber in tyre tread compounds" as partial fulfillment of MSc Degree under the supervision of Dr W M G Seneviratne.

- Miss K W M D D Kumarihamy, a BSc student from University of Sabaragamuwa carried out a research project titled "Improvement of quality and Storage Stability of Prevulcanized Natural Rubber Latex concentrates" as partial fulfillment of her Special degree in Chemical Technology under the supervision of Dr W M G Seneviratne.

Lectures/Seminars/Workshops/Meetings-Attended

Officer/s	Subject	Organisation
W M G Seneviratne	NASTEC meeting on Research Project Management	NASTEC
	CRI-TRI-SRI-RRI 2nd Joint symposium held at the BMICH	BMICH
	IRC Conference held in October in Malaysia and presented a paper on Improvement of quality and storage stability of prevulcanized latex concentrates for commercial applications	IRRDB
	Seven Executive Committee Meetings of Plastics and Rubber Institute	PRISL
	Activity Plan Meeting	MPI
	Two Laboratory Accreditation Assessors' Meetings	SLAB
	Two IFAD Meetings	MPI
	Three meetings of Directors' Forum	MPI
	Cleaner Production Demonstration Project Seminar	PRISL
	Two Research project evaluations RT departments	RRISL
	Five Ceyesta Board Meetings	Ceyesta
	Plantation Sector Review Meeting with His Excellency the President at Temple Trees	MPI
	BICOST V - 2 day Seminar at Hotel Topaz, Kandy	NASTEC
	Two Meetings EDB Export Enterprises Development Forum	EDB
	Three day Workshop on Assessors' Training Programme on ISO guide 17025 held at Galle Face Hotel Colombo	SLAB and SWEDAC
	Workshop on Agricultural and Extension Policies and their Analysis	CARP
S Siriwardena	Two Steering Committee Meetings of the Young Scientists' Forum, National Science Technology Commission	NSTC
U Ratnayake	Workshop on "Research Project Management" organized by Senior Scientists' Forum of National Science and Technology Commission (NASTEC) at Industrial Technology Institute (ITI)	NASTEC and ITI

Officer/s	Subject	Organisation
Upul Ratnayake	Workshop on "Barriers to Young Scientists" organized by Young Scientists' Forum of National Science and Technology Commission (NASTEC) at Industrial Technology Institute (ITI)	NASTEC and ITI
	Workshop on "Microwave Chemistry for sample preparation in trace metal analysis" at Waters Edge	Qualitron (Pvt) Ltd.
	Three Steering Committee Meetings of Young Scientists' Forum established by NASTEC	NASTEC
	Fifth Sri Lanka Conference on Science and Technology (BICOST-V) organized by National Science and Technology Commission, from 29th May to 1st June at Hotel Topaz	NASTEC

Lectures/Seminars/Workshops/Meetings - Addressed

Officer/s	Subject	Organisation
W M G Seneviratne	Lecture on Technical aspects of crepe rubber manufacture and Chemical used in the rubber processing industry with special reference to bleaching agents at a Workshop on Introduction of new Bleaching agent	Ms. Mackwoods
	Lecture on Wastewater treatment technology for final year students in Biochemistry and Microbiology	University of Wayamba
S Siriwardena	Lecture on Newly developed single day smoke (SS) drying unit at a half day workshop organized by Advisory Service Department for small and medium scale sheet rubber manufactures in Colombo district	RRISL
	Presentation on Improved drying system for sheet rubber: Single day Smoke drying unit at the Scientific Committee Meeting	RRISL
	Presentation on Access to information at the workshop on Barriers to young scientists organized by the Young Scientists' Forum, National Science & Technology Commission	NASTEC
	The small rubber growers from Kalutara region on New SS drying system for sheet rubber drying at a workshop organized by Thurusaviya Trust Fund and held at RRISL Training Centre at Nivithigalakele	Thrusaviya Trust Fund

Officer/s	Subject	Organisation
S Siriwardena	A training programme for Rubber Development Officers of RDD on RSS manufacture and new drying technologies at RRISL Auditorium, Dartonfield	RRISL
	Three programmmes for the small rubber growers at Aravwala, Kuruwita and Kalutara region on No1. RSS manufacture and new SS drying system for sheet rubber drying organized by Thurusaviya Trust Fund	Thrusaviya Trust Fund
U Ratnayake	Two lectures on Chemicals used in rubber processing and Crepe rubber manufacture for Professional Examination in rubber manufacture and factory practice organized by National Institute of Plantation Management of Sri Lanka	NIPM, Athurugiriya
P H Sarath Kumara	Workshop for Managers, Asst. Managers, Factory and Field staff of Atale estate on 'Leadership and Teamwork' at Atale Estate, Atale	Atale Estate, Atale
	Workshop for Field staff and unskilled tappers of Atale estate on 'Correct metrolac weighing' at Atale Estate, Atale	Atale Estate, Atale
	Workshop for medium scale rubber growers from Hanwella area on "Correct method of weighing of latex" organized by Advisory Services Department of RRI	RRISL, Ratmalana
	Workshop for the small rubber growers from Kalutara region on "Quality sheet rubber manufacture" organized by Thurusaviya Trust Fund at RRISL Training Centre at Nivithigalakele	Thurusaviya Trust Fund
	Two lectures at National Institute of Plantation Management of Sri Lanka on "Latex collection and preservation" and "Metrolac Weighing" for planters for preparation of them for Rubber Manufacture and factory practice examination	NIPM, Athurugiriya
	Workshop for the small rubber growers from Bulathsinhala region on "Quality sheet rubber manufacture" organized by Thurusaviya Trust Fund, RRISL Training Centre at Nivithigalakele	Thurusaviya Trust Fund

Officer/s	Subject	Organisation
S Siriwardane and P H Sarath Kumara	An awareness programme at RRI auditorium for Factory Officers and Estate Managers of Plantation companies on "drawing & labeling of samples of scrap crepe rubber" under the project on preparation of standards for brown crepe	RRISL, Ratmalana
U Ratnayake and P H Sarath Kumara	Addressed Managers, Asst. Managers and Field staff at 9 separate workshops held at Moragalla, Diddenipotha, Udabage Group and Pitiyakande Group, Thalgaswela Estate - Elpitiya, Woodend Rubber Factory - Dehiowita, Citrus Estate - Baddegama and Rilhena Estate - Kahawatte on "Practical Aspects of Controlling VFA No. of field latex" organized, coordinated and sponsored by Lalan Latex (Pvt) Ltd.	Lalan Latex (Pvt) Ltd.
	Two Workshops for Managers, Asst. Managers and Factory staff of Watawala Plantations PLC at Homadola estate to educate them on "Quality crepe rubber manufacture", "Analysis of defects in crepe rubber", "Quality maintenance of latex in the field" and "Correct Weighing of latex using metrolac"	Watawala Plantations PLC
P H Sarath Kumara and T A S Siriwardane	Two day workshop on "important aspects of RSS manufacture" for small rubber farmers in Wellawaya organized by Industrial Development Board at Moneragala Regional Office	Pradesheeya Sabha Auditorium, Wellawaya
T A S Siriwardane	A programme to train the staff of Sanquire Estate, Pussellawa Plantations PLC on 'Manufacture of RSS and drying'	Pussellawa Plantations PLC
	Workshop for the small rubber growers from Ruwanwella region on "Quality sheet rubber manufacture" organized by Thurusaviya Trust Fund at Vidatha Centre, Ruwanwella	Thurusaviya Trust Fund
A K D Warnajith	Two workshops for the small rubber growers from Kuruwita and Ratnapura regions on "Quality sheet rubber manufacture" organized by Thurusaviya Trust Fund at Kuruwita and Ratnapura respectively	Thurusaviya Trust Fund

Advisory visits

Sample collection – Waste water

Type of industry	No. of factories/visits				
	1 Quarter	2 Quarter	3 Quarter	4 Quarter	Year Total
Rubber Industries	01	04	02	06	13
Non Rubber Industries	02	Nil	01	Nil	03

Sample collection - Experimental

Fifteen visits were made to seven estates and rubber factories in order to collect latex samples and other experimental samples.

Factory development

Table 1. *Factory development visits and services provided*

Services provided	No of factories/visits				
	1 Quarter	2 Quarter	3 Quarter	4 Quarter	Year total
Subsidy recommendations for infrastructure development from CESS fund	Nil	Nil	Nil	Nil	Nil
Advisory on process and quality improvements	3	1	2	7	13
Advisory on waste water treatment	Nil	Nil	2	6	8
Waste water treatment plant designing	Nil	Nil	Nil	3	3
Introducing SS drying system	5	4	Nil	2	11
Inspection for other purposes	1	Nil	Nil	1	02

A significant number of requests for construction/modification of existing sheet rubber drying systems were received during the year. Plans and technical advices were given and a brief summary is given below in Table 2.

Table 2. *Number of plans given for construction/modification of rubber drying units*

Purpose	Number
Plans given for construction of new SS drying system with capacity less than 100 kg	32
Plans given for modification of existing system to new SS drying system with capacity less than 250 kg	08
Plans given for construction/modification of drying units for estate sector	05

Sample testing

Table 3. *Sample testing and certificates issued*

Samples tested	Number of samples				
	1 Quarter	2 Quarter	3 Quarter	4 Quarter	Year total
Waste water	43	22	38	44	147
Processing water	07	Nil	02	09	18
Certificates issued	**Number of certificates**				
	1 Quarter	2 Quarter	3 Quarter	4 Quarter	Year total
Waste water	30	13	22	43	108
Processing water	03	Nil	01	05	09
Certificate of epidemic prevention	06	15	05	05	31

LABORATORY AND FIELD INVESTIGATIONS

Mechanization of crepe rubber manufacturing process (Project No. RRPD/D/MCM/2006/01)

No progress of this project was made during the year.

Investigation of discrepancies of DRC estimated by Metrolac and lab test (Project No. RRPD/L/DMR/2006/03)

Studies were being continued to develop a simple method to detect any deliberate dilution of fresh latex in collaboration with University of Sri Jayewardenapura. Results collected were not adequate to see the possibility of deriving a relationship between the dilution and apparent increase of DRC as estimated by metrolac (P H Sarath Kumara, A K D Warnajith Prasad, Shirani Priyanka and Laleen Karunanayake).

Effect of metal ions on quality of latex crepe (Project No. RRPD/D/EMC/2001/05)

The studies were continued to investigate the effect of metal ions such as iron, copper and manganese on quality of crepe rubber. It was reported in the literature that heavy metal ions (*e.g.* Fe, Cu and Mn) accelerate the oxidative degradation of natural rubber (NR). However, the maximum critical levels of those metal ions in crepe rubber have not been established.

Investigation of the effect of total iron on quality of crepe rubber has been completed and revised maximum allowable limits of total iron for the processing water and new maximum allowable limits of total iron in crepe rubber will be introduced in order to produce good quality crepe rubber. Studies were further continued to examine the valance state (*i.e.* Fe^{2+} and Fe^{3+}) of iron on oxidative degradation since crepe rubber can be contaminated with both these forms of iron during processing.

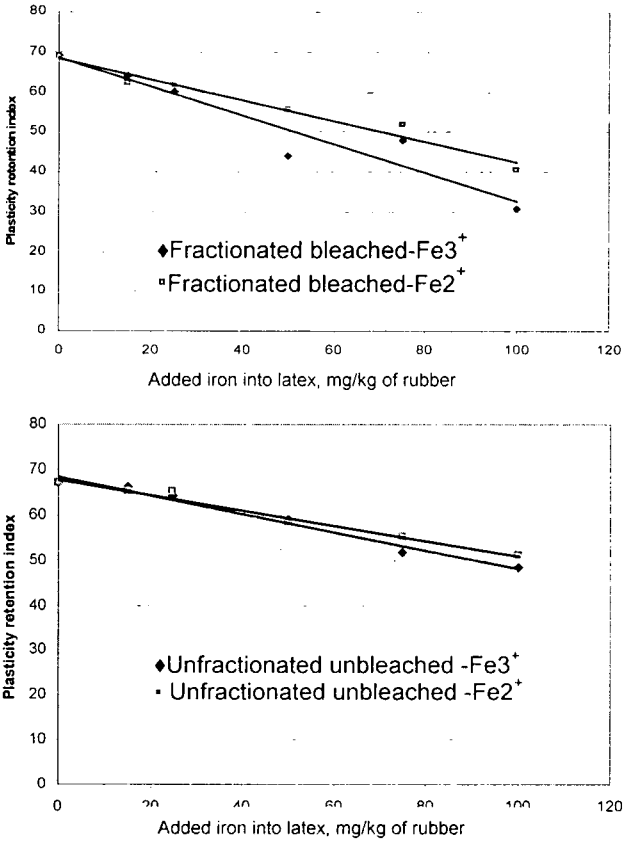


Fig. 1. Effect of valance state of iron on Plasticity retention index of FB and UFUB crepe rubber

As shown in Fig.1, effect on accelerated oxidative degradation of FB crepe rubber is more with Fe^{3+} than with Fe^{2+}. However, difference of the effect on degradation of UFUB crepe rubber was observed to be less significant.

Experimental trials to study the effect of manganese ions (Mn^{2+}) on quality of crepe rubber were completed and the results showed that the present maximum allowable limit for manganese (0.5 ppm) in processing water is too low and hence a revision of standards is required (Upul Ratnayake, P H Sarath Kumara, T A S Siriwardena A K D Warnajith Prasad and V C Rohanadeepa).

Study of quality of blends of Low VFA and High VFA centrifuged latex (Project No. RRPD/L/QLT/2006/14)

This project was continued from the previous year. Analysis were carried out to characterize third and fourth batches of blends of high VFA latex and low VFA latex for an extended period of 8 weeks and 24 weeks. The results indicated that VFA No. tends to slowly rise after a storage period of about 6-7 weeks. Results also indicated that up to 20 percentage of High VFA concentrated latex of which VFA No. of less than 0.08 could be safely blended with low VFA latex of which VFA No. is between 0.02 and 0.03. However, only 10 percentage of concentrated latex with very high VFA content as high as 0.1, could be blended with low VFA (0.03) latex. The results obtained are shown in Fig. 2 and 3.

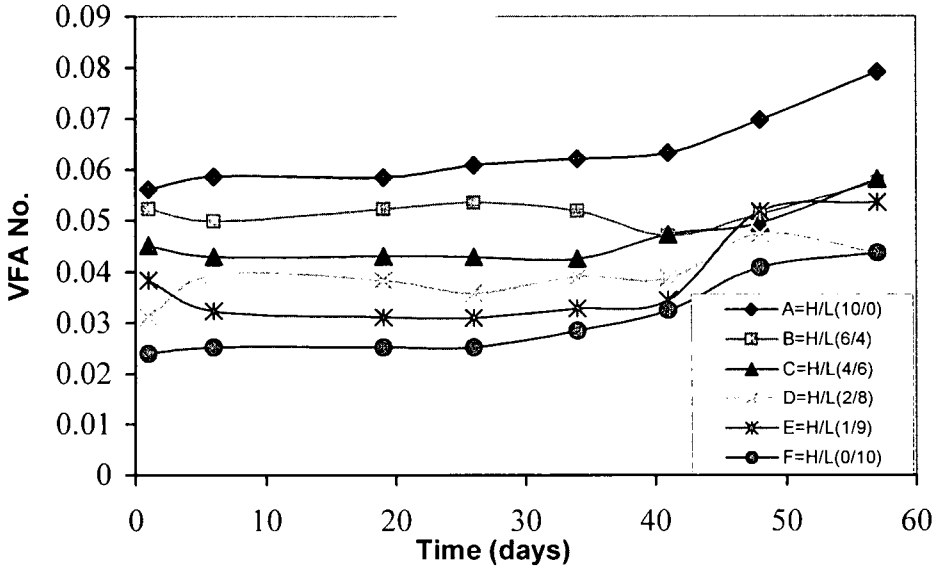


Fig. 2. Variation of VFA No. of blended latex with time (8 weeks maturation)

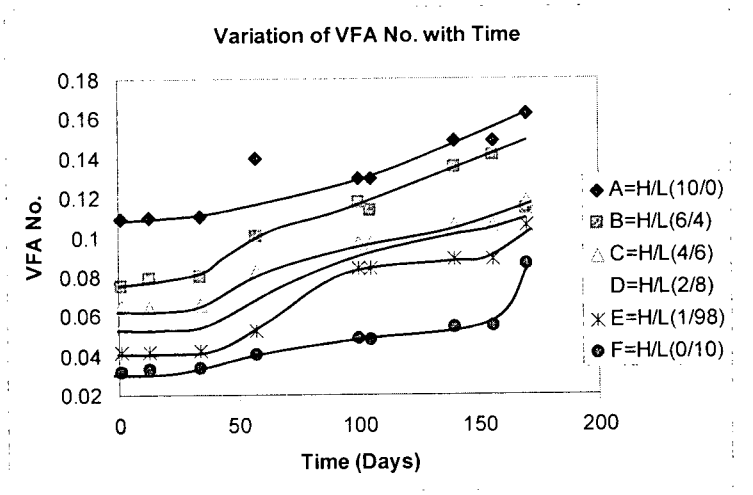


Fig. 3. Variation of VFA No. of blended latex with time (24 weeks maturation)

(P H Sarath Kumara, A K D Warnajith Prasad and V C Rohanadeepa)

Portable small scale solar assisted dryer for drying of sheets (Project No. **RRPD/D/PSD/2006/11)**

A new cost effective, user friendly and efficient smoke drying system using Single day Smoke drying units (SS drying units) which cuts down the drying period by 80% from five days to a single day was developed and introduced marking a major development in the history of sheet rubber drying. Bio gas and solar energy – two forms of renewable energy sources were also introduced in the new dryer. This drying system won the annual national science and technology award in the category of development and adaptation of technologies for SMEs organized by National Science Foundation which comes under the Ministry of Science and Technology (S Siriwardena, T A S Siriwardane and A K D Warnajith Prasad).

Development of an uninterrupted drying system for crepe rubber (Project No. RRPD/D/UDS/2007/17

Initial trials conducted at Dartonfield rubber factory did not show promising results which was supposed to be due to the heat losses and poor distribution of heat. A new heat distribution system was designed and installed in the mini drying chamber available at Dartonfield. However, significant improvement in reduction of drying period could not be achieved. Another set of experiments were carried out at Sorana rubber factory introducing continuous drying of laces in a fully loaded drying tower at 34°C (recommended temperature) until the laces were fully dried. It was

noted that the drying period was reduced from 72 hours to 33 hours. The savings on firewood consumption and labour hours are shown in Table 4.

Table 4. *Savings on firewood and labour by uninterrupted dryng of laces*

Item	Conventional drying	Continuous drying
Firewood consumption (kg/kg)	0.23	0.17
Labour requirement (hrs/kg)	0.05	0.03
Savings on firewood and labour (Rs/kg)	-	0.91

Base data: Price of firewood 2.20 Rs/kg; Labour cost 320 Rs/man-day

(Susantha Siriwardena, T A S Siriwardane and A K D Warnajith Prasad)

Rubber toughened thermoplastic nanocomposites based on layered silicates (Project No. RRPD/D/RTN/2007/05)

A research project "Rheological and mechanical properties of rubber toughened polypropylene-clay nanocomposites" submitted to National Science Foundation (NSF) was approved for funding. The funds will be released to commence the project in early 2009 (Upul Ratnayake and H N N K Chandralal).

Development of natural rubber nanocomposites based on layered silicates (Project No. RRPD/D/UDS/2007/19)

An industrial collaborative research project on "natural rubber nanocomposites based on layered silicates for tyre tread compounds" was continued with Loadstar (Pvt.) Ltd. Layered silicates (nano-clay) can be used at very low loading levels to improve material properties such as mechanical, barrier and flame retardant properties of rubber nanocomposites, in comparison to highly filled conventional micro-scale composites.

Natural Rubber nanocomposites based on layered silicates were prepared using two different techniques in order to evaluate the best method to achieve the maximum degree of exfoliation of layered silicates

- Direct melt blending method
- Latex compounding method

Experimental results showed that layered silicates accelerate the curing process whilst effectively reinforcing the NR tyre tread compounds. However latex compounding method for the incorporation of layered silicates is more effective in reinforcing of NR, compared to the direct melt blending method. Enhanced mechanical properties of NR-layered silicate nanocomposite prepared using latex

compounding method indicate a higher degree of exfoliation (Upul Ratnayake, M R N Fernando, A K D Warnajith Prasad and Asela Siriwardane).

Development of novel method to determine Mg content of natural rubber latex (Project No. RRPD/L/NMM/2007/20)

Total Mg content in NR latex from five different clones was determined using the conventional titrimetric method in which latex was coagulated and analysed for Mg content in the serum. Under this project, the latex coagulum was also analysed to ascertain whether there was any Magnesium trapped in the coagulum as well during the coagulation process. The analytical results revealed that significant percentage of total Mg ions in latex was trapped in the latex coagulum and, as such, conventional method did not reflect the total Mg ion concentration in latex.

Further experimental trials will be conducted with a series of samples collected from various regions in the country prior to introducing satisfactory correlation between Mg ions in the serum and in the latex coagulum (Upul Ratnayake, Champa Lokuge and Shirani Priyanka).

Characterization of non-conventional grades of natural rubber (Project No. RRPD/D/CNR/2006/06)

Project was extended to prepare standards for scrap crepe rubber on a request made at the Scientific Committee Meeting. An awareness programme on "Drawing and Labeling of samples" was conducted at RRISL auditorium for Estate Managers and Factory Officers. Samples were received from the month of February from 8 rubber factories and they were analysed for raw rubber properties at Raw Rubber and Chemical Analysis Department. A total number of 419 samples visually graded by respective factories into 1X, 2X, 3X and FAB were subjected to analysis. The results of raw rubber properties are being analysed statistically at the Biometry department of RRISL (Susantha Siriwardena, P H Sarath Kumara, Wasana Wijesuriya, Shirani Priyanga, L P Vitharana, Nimal Karunathilake and W D Wimaladasa).

Development of latex nanocomposites for dipped products (Project No. RRPD/L/LCN/2007/01)

A joint research project titled "Development of latex nanocomposites for dipped products" in collaboration with the Dept. of chemical Engineering, university of Moratuwa was initiated. The project proposal was approved by the University of Moratuwa and a research fund of Rs.400,000.00 was allocated by the university for a period of two years. Mr Ananda Amarasiri, a Lecturer attached to the Institute of Technology, University of Moratuwa, who was assigned to carry out the research project was registered for his MPhil degree at the same University.

The literature survey on the research project was completed. Initial set of experiments for the preparation of dispersion of layered silicates and for the characterization of raw materials were commenced (Upul Ratnayake, Shantha Walpolage and Ananada Amarasiri).

Industrial extension

Development of conductive light coloured rubber compound

Studies were initiated, on a request made by a leading rubber product manufacturing company, to develop a conductive light coloured rubber compound based on nitrile rubber (NBR).

Initial trials were carried out using nanotechnology based criteria in order to prepare functional rubber compounds (*i.e.* conductive rubber compounds). The initial experimental results showed that required resistivity for the light coloured NBR compound could be achieved with the application of nanotechnology. However, more studies are required to reduce the cost of NBR nanocomposites since the cost of such composites are found to be little more expensive due to the higher cost of nano materials (Upul Ratnayake and A K D Warnajith Prasad).

ADAPTIVE RESEARCH

V H L Rodrigo and S M M Iqbal

SUMMARY

Rubber was successfully planted in 40 hectares in 91 smallholdings in Padiyatalawa and Mahaoya regions in Eastern province. Extension programmes were strengthened to educate farmers on crop management practices of rubber in this region. The bamboo irrigation technique (*i.e.* locally adoptable development from pitcher and drip irrigation) was introduced to overcome the effects of severe dry spells in these regions. Prolonged nectar flow period was recorded in clone RRIC 100. Wax mouth infestation was found to be a major problem in the bee colonies of wooden boxes. The study on the impact of shade on anthurium grown under rubber confirmed the potential of cultivating Tropical red variety of anthurium under the shade of clone RRIC 121 and RRIC 100. A research grant was awarded by the National Science Foundation to identify suitable species and genotypes of cut foliage and flowers for cultivation on rubber lands. Seedlings of RRIC 121 and RRIC 100 outperformed the clonal plants of RRISL 2001 on vegetative growth as per data collected two years after planting. Wild boar attack on rubber trees at Polgahawela sub station was managed with repellents. One hectare of senile rubber was uprooted and arrangements were made to plant rubber with sugarcane as a demonstration plot in Monaragala sub station.

DETAILED REVIEW

Staff

Dr V H L Rodrigo coordinated the activities of this unit. Dr S M M Iqbal (Agronomist), Research Assistants Mr W A D D S Wettasinghe, Ms B M D C Balasooriya, Ms E S Munasinghe, Experimental Officer Mr E A T Senadheera (in substation Polgahawela) and Account Clerk Mrs C Weeramanthree (in substation Polgahawela) were on duty through out the year. Mr A M C P Jayawardana, a Temporary Field Assistant looked after the activities of Monaragala substation. Mr P Udayakumara and Mr J Prasanna were appointed as Temporary Technical Assistants under the grant NSF/2005/AG/14 and Nagenahira Navodaya projects, respectively.

Research students

- Miss A K D V Edirisinghe from the University of Rajarata carried out her final year research project on "Impact of shade on anthurium grown under the rubber" under the supervision of Dr V H L Rodrigo.

Seminars/Conferences/Meetings/Workshops attended

Officer	Subject	Organization
V H L Rodrigo and S M M Iqbal	A stakeholder-researcher dialogue with planters in Lalan Rubber Pvt. Ltd.	RRISL
	Conducted an awareness programme on nursery techniques and fertilizer application for the smallholders in Padiyathalawa area.	RRISL
	A Workshop conducted by International Fund for the Agricultural Development (IFAD) for designing an Integrated Holistic Extension Programme for Smallholder Plantations Entrepreneurship Development Programme (SPEnDP) at Monaragala.	SPEnDP
V H L Rodrigo, S M M Iqbal and E S Munasinghe	Presented a research paper titled "Rural livelihood of smallholder rubber farmers in Eastern Province of Sri Lanka" at the International Conference of Social Sciences Sri Lanka, 2008 held at University of Kelaniya.	University of Kelaniya
	Presented a research review on rubber in Monaragala at a meeting of Smallholder Plantations Entrepreneurship Development Programme (SPEnDP) organized by International Fund for the Agricultural Development (IFAD) held at Monaragala.	SPEnDP
	Conducted an awareness programme to smallholders on rubber planting at Divisional Secretariat Office, Padiyatalawa.	RRISL
S M M Iqbal, V H L Rodrigo, B M D C Balasooriya and E A T Senadheera	Workshop for the superintendent and field officers of Hathbawa estate, Kegalle.	Polgahawela Sub-station
S M M Iqbal	A lecture on "Rubber Multicropping Systems" in a refresher course conducted for the Rubber Development Officers of the Rubber Development Department.	RRISL
	A lecture on mixed cropping systems under rubber to the undergraduates of the Rajarata University, Sri Lanka.	RRISL
	A lecture on mixed cropping systems under rubber to the undergraduates of the Sabaragamuwa University, Sri Lanka.	RRISL
	Presented the progress of Nagenahira Navodaya programme in a meeting held at Ministry of Plantation Industries.	MPI

Officer	Subject	Organization
S M M Iqbal and K A G B Amaratunga	Workshop on planting of rubber and field demonstration to the rubber smallholders of Padiyathalawa and Mahaoya, Ampara district.	RRISL
S M M Iqbal and E A T Senadheera	Workshop on planting of rubber to smallholders in Polgahawela and Alawwa area and Extension staff of RDD/Kegalle.	Polgahawela Sub-station
V H L Rodrigo and E S Munasinghe	Presented a research paper titled "Financial viability of the rubber crop under different management options with special reference to intercropping and carbon trading" at the Thirteenth International Forestry and Environmental Symposium 2008 of the Department of Forestry and Environmental Science, University of Sri Jayawardenapura.	University of Sri Jayawardenapura
	Presented a research paper titled "Factors underpinning the intensity of banana intercropping in rubber smallholdings in Sri Lanka" at the 64th Annual Sessions of Sri Lanka Association for the Advancement of Science.	SLAAS
V H L Rodrigo, S M M Iqbal, D S Wettasinghe, B M D C Balasooriya, E S Munasinghe and E A T Senadheera	Second Symposium on Plantation Crop Research, Sri Lanka held at Colombo.	CRI

Advisory visits

120 experimental and 10 advisory visits were made.

FIELD INVESTIGATIONS

Adaptive research programme

***Beekeeping in rubber plantations* (ARU/BK/2004/1)**

Bee colonies available at Dartonfield/RRISL and Kuruwita substation were as fallows (Table 1).

Table 1. *Bee colonies available at Dartonfield and Kuruwita substation*

Site	Wooden boxes	Clay pots
Dartonfield	5	2
Kuruwita	3	3

Artificial feeding with sugar was carried out during the dearth period and around 3 liters of honey was collected during the period of April to June. Average honey yield per colony (in wooden boxes) was 1014 ml (Table 2).

Table 2. *Honey harvest from wooden boxes at Dartonfield estate and Kuruwita substation*

Site	Number of colonies harvested	Volume of honey (ml)
Dartonfield	4	4010
Kuruwita	2	2075

Two colonies were absconded due to the wax moth infestation at Dartonfield during the dearth period (May-November).

Nectar production in different rubber clones

Data collection on seasonal variation of the nectar flow of clones RRIC 100, RRIC 121 and RRIC 102 was repeated for the third year at Kuruwita substation. Volume of the nectar produced in the extra floral nectary glands of petioles was measured using micropipettes. Four trees of each clone planted in 1999 were used for the study which confined to the period of Feb 2008 to April 2008. The periods recorded with nectar flow were 46 days in RRIC 100, 10 days in RRIC 121 and one day for RRIC 102. Due to the rain interference, the volume of nectar flow was assessed only in 38 and 04 days in Clone RRIC 100 and RRIC 121, respectively (Table 3).

Table 3. *Nectar flow production period and its volume and quality in clone RRIC 100, RRIC 121 and RRIC 102 at Kuruwita sub-station*

Clone	Nectar flow period (days)	Nectar flow volume (µl/day/petiole)	Sugar concentration of nectar (%)
RRIC 100	40	6.27	7.28
RRIC 121	11	0.57	3.15
RRIC 102	01	-	-

(W A D D S Wettasinghe, S M M Iqbal, V H L Rodrigo in collaboration with Ruhuna University).

***Expansion of rubber cultivation to Eastern province* (ARU/RCEP/2004/1)**

Objectives and the initial approach taken to establish rubber in this region appeared in Annual Review 2004.

In brief, main activities of the year were,

- Assessment of photosynthetic performance of rubber leaves.
- Soil moisture measurements during dry spell.

- Leaf chlorophyll a fluorescence emission *(Fv/Fm)* of rubber leaves.
- Monthly assessments of rubber growth.
- Workshops on planting practices, nursery management and fertilizer application to smallholders in Padiyatalawa and Mahaoya area.
- Collection of leaf and soil samples for nutrient analysis.
- Installation of a new rain gauge (Casella type recommended by the Meteorological department) in Komana village at Padiyatalawa.
- Establishment of a polybag nursery with 12,000 bare root budded rubber plants in Komana and Hela Komana villages, Padiyatalawa.
- Locally adoptable system of drip and pitcher irrigation systems was developed using bamboo logs and tested with one year old rubber plants in two sites at Helakomana and one site at Komana villages.
- Rubber was planted in 40 hectares in 91 smallholdings in Padiyatalawa and Mahaoya regions.

Photosynthesis efficiency

The light response curves of photosynthesis of rubber were built up with field measurements on photosynthetic rates using a portable open system infra-red gas analyser (IRGA) (LI-6400, Li-Cor Inc., Lincoln, NE, USA). These measurements were made in a single site selected from each planting year. Two sets of measurements were made in each plant, one in morning (between 0900 and 1000h) and the next in evening (between 1500 and 1600h) during the distinct dry periods (March-April). Thereafter, light saturated rate of photosynthesis (A_{max}) and the apparent quantum yield of rubber (ϕ_{app}) were estimated by using the light response curves (Table 4). The light saturated rate of photosynthesis (A_{max}) was comparatively lower in the afternoon than in morning hours. This situation was common to all age categories and older trees showed higher values A_{max}.

Polgahawela Sub-station (ARU/RCWP/2005/1)

Expansion of rubber cultivation in Wayamba region (North western Province)

Growth of rubber

Girth of the rubber plants were measured in the clearings planted in 2005, 2006 and 2007 (Table 5). Girth values of rubber trees planted in 2005 were comparable among different densities/spatial arrangements with the mean value of 30.85cm. Seedlings of RRIC 121 and RRIC 100 outperformed over the clonal plants of RRISL 2001. Rubber planted in year 2007 showed a mean girth of 7.18 cm. Detail analyses in girth values under different girth classes in year 2007 showed in Table 6. Girth in 54% of rubber trees planted in 2007 was above 7 cm. However, only 12% trees achieved over 10cm girth in this clearing as plants were affected with unexpected dry spell during the planting season.

Table 4. *The apparent quantum yield (ϕ_{app}) and maximum light-saturated rate of photosynthetic CO2 assimilation (A_{max}) of rubber*

Year of measurement	Time of measurement	Rubber planted in 2003 November		Rubber planted in 2004 November		Rubber planted in 2005 November	
		Mean apparent quantum yield (ϕ_{app})	Mean (A_{max})($\mu molm^{-2}s^{-1}$)	Mean apparent quantum yield (ϕ_{app})	Mean (A_{max})($\mu molm^{-2}s^{-1}$)	Mean apparent quantum yield (ϕ_{app})	Mean (A_{max})($\mu molm^{-2}s^{-1}$)
2007	Morning (0900-1000h)	0.037	14.30	0.043	13.50	0.042	11.20
	Afternoon (1500-1600h)	0.031	6.880	0.033	8.70	0.017	8.49
2008	Morning (0900-1000h)	0.054	17.40	0.050	16.30	0.053	16.00
	Afternoon (1500-1600h)	0.045	16.30	0.048	15.50	0.050	15.20

Table 5. *Growth of rubber in Polgahawela substation*

Month/Year of Planting	**Clone/genotype**	**Spacing of rubber (m) with intercropping status**	**Mean girth as at December 2008 (cm)**
May/2005	RRIC 121	2.4 × 5.9 (Intercropped with banana)	30.17
May/2005	RRIC 121	2.4 × 6.9 (Intercropped with banana)	31.99
May/2005	RRIC 121	2.4 × 8.1 (Intercropped with banana)	30.73
May/2005	RRIC 121	2.4 × 8.1	31.03
May/2005	RRIC 121	2.4 × 9.6 (Intercropped with cinnamon)	30.68
May/2005	RRIC 121	2.4 × 12 (Intercropped with cinnamon)	30.51
May/2006	RRIC 121	2.4 × 8.1	14.69
May/2006	RRIC 121	2.4 × 8.1 (Intercropped with banana)	18.22
May/2006	Seedling RRIC 121	2.4 × 8.1	19.60
May/2006	Seedling RRIC 100	2.4 × 8.1	18.85
May/2006	RRISL 2001	2.4 × 8.1	17.25
May/2007	Mixed RRISL clones (bare root)	2.4 × 8.1	7.18

New planting rubber

Rubber was planted in one hectare with clone RRIC 121.

Upkeep of crops

General maintenance of rubber/banana and rubber/cinnamon intercrops and also of, cashew and pineapple were done. The first harvest of cinnamon planted 2005 clearing was made. Harvests made in subsidiary crops with the income are shown in Table 7. In total, it was possible to generate an income of Rs.727,834/- during the year.

Management of wild boar damages in rubber

Wild boar damages on rubber plants in 2005 and 2006 fields were observed with bark injuries up to 60-90cm height of tree stem. Areas bordering the jungles were more prone this problem and it appeared particularly after rains. Repellents were applied on the tree trunk with the direction of Plant Pathology & Microbiology Department (P&MD). Although no physical injuries to plants were observed thereafter, wild boars dug soil in the vicinity. Retention of the repellants after rains appeared to be weak hence new repellants were introduced by P&MD.

Awareness programmes on rubber cultivation

Three field day programmes on field establishment and immature upkeep were conducted separately to a set of smallholders, field staff of Hathbewa estate and Extension Officers of RDD/Kegalle.

Table 6. *Number of tree in different girth classes (in 2007 clearing)*

Girth Range (cm)	No of rubber trees %
<5	19
5 - 6.7	27
7 – 10	42
>10	12

Table 7. *Yield and income status of banana, pineapple and coconut in Polgahawela substation*

Crop	Yield	Income (Rs)
Banana	818 (bunches)	211,767/-
Pineapple	2414 (fruits)	72,230/-
Coconut	2305 (nuts)	48,822/-
Old rubber	Contract tapping on 600 trees	333,750/-
Cinnamon	(Supper 145.8Kg, Rough 25.8kg and Crumbles 21.9kg)	61,265/-

(V H L Rodrigo, S M M Iqbal, B M D C Balasooriya and E A T Senadeera in collaboration with all biological departments of RRISL).

Monaragala substation **(ARU/RCMR/2006/1)**

Construction activities of the office building complex in substation progressed very slowly. With the instruction of RRISL's officials, arrangements were made to correct some poor quality work done when it was under supervision of the Provincial Engineer Monaragala.

Two hectares of senile rubber were cleared and a seedling nursery was established in a hectare by the Plant science department (V H L Rodrigo, S M M Iqbal, E S Munainghe, A Nugawela in collaboration with all departments).

Anthurium culture under mature rubber **(ARU/AC/2004/1)**

Flowering of anthurium variety, "Tropical Red" was found to be successful under rubber in both Dartonfield and Kuruwita estates (Table 8).

In addition to general maintenance, the following activities were carried out.

- Quality assessments of flowers. Quality of flowers was in acceptable level (Table 9).
- Repotting of anthurium plants after six months of growth (done in December 2008).
- A slow releasing fertilizer, 'Osmocote' was incorporated to the medium at a rate of 10g per pot.
- In order to identify an effective mechanism to prevent entering of rubber roots from the bottom hole of the pots, polythene sheets were laid below the *ca.* 50% of anthurium pots.

Table 8. *Flower production in anthurium under rubber*

Site	No. of flowering plants	Total flowers harvested	Flowers damaged (physical)	Flowers damaged (by thrips)
Dartonfield	2208	5785	877	217
Kuruwita	148	450	75	116

Table 9. *Mean values for dimensions of anthurium flowers*

Site	Flower length (cm)	Flower width (cm)	Stalk length (cm)
Kuruwita	8.52	7.53	33.74
Dartonfield	7.99	7.43	28.58

(W A D D S Wettasinghe, S M M Iqbal and V H L Rodrigo)

Research project on "Impact of shade on anthurium grown under the rubber"

A separate experiment was conducted in Dartonfield estate in RRISL with an objective of quantifying the impact of shade given by the rubber canopy on the

performances of Gauthamala and Topical red anthurium varieties. Three shade levels were used as standard shade (60-75%) and shades given by the mature rubber canopies of RRIC 121 (80-85%) and RRIC 100 (90-95%). Leaf area, number of flowers, flower quality parameters and leaf chlorophyll a fluorescence were assessed in regular intervals. Leaf area of anthurium increased with the increase in shade levels. The Gauthamala variety has shown poor flowering performance and however, Tropical red was able to produce flowers successfully under three shade levels. Also among shade levels, Tropical red showed no difference in flower quality with respect to flower size, shape (asymmetry and overlapping of lobes) and straight petioles. However, the percentage of damage flowers under RRIC 121 was higher than that in the standard shade level. Leaf fluorescence indicated that there was no photoinhibition in any shade levels. Therefore, the study confirmed the feasibility of cultivating of Tropical red variety of anthurium under the shades of rubber (A K D V Edirisinghe and V H L Rodrigo).

Identification of suitable species and genotypes for cut foliage and flower production in rubber lands

A contract research project was granted by NSF for the identification of suitable species and genotypes for cut foliage and flower production in rubber lands. Due to the problems associated with disbursement of funds, most of project activities were postponed to 2009 whilst arranging only the preliminary work such as land selection within the year 2008.

Following foliage and flower plant varieties were selected for the study.

a). Under mature rubber.

1. *Dracaena massengeana*
2. *Chrylidocarpus lutescens* (Cane Palm)
3. Chinese grass (White)
4. Anthurium (Tropical red)

b). Under immature rubber.

1. *Chrylidocarpus lutescens* (Cane Palm)
2. Chroton
3. Polyscia

(S M M Iqbal, W A D D S Wettasinghe and V H L Rodrigo. This project is funded by the NSF under the grant no RG/2008/AG/02).

***Assessments of different tapping systems practiced in the smallholder sector* (ARU/TSPSH/2005/1)**

This study was commenced to assess the performance of widely planted rubber clones *i.e.* RRIC 100, RRIC 121 and PB 86, under different tapping systems practised under smallholder conditions. Twenty one sites in traditional rubber growing areas and seven sites in non traditional areas were assessed for tapping quality parameters. Also seasonal variation of latex yields was monitored for about one year and social information of smallholders was gathered through structured interviews. Arrangements were made to extend the assessment to the model farms in the Kalutara district with the collaboration of Advisory Services Department.

In all sites observed in traditional rubber growing areas, the bark consumption rate was over the expected level. Farmers only in five sites had used a stencil to mark tapping guidelines; hence, tapping cut lengths were properly maintained. Tapping angle was found to be correct in 62% sites. The depth of tapping cut was reasonably good in 90% sites. Although cup hangers were available in the majority, their placement was not properly done. Spouts were available in most of the sites; however their placement was correct only in 30% (Table 10). Except one, all others in traditional rubber growing areas had adopted the daily tapping system.

Table 10. *Summary of the tapping quality assessment in twenty one sites in traditional rubber growing areas. For each parameter, sites with over 80% trees were correct, were considered as good*

Status of the quality of tapping system	Guide line	Tapping angle	Depth of the cut	Length of cut	Bark consumption	Cup hangers	Placement of cups	Spouts	Placement of spouts
Good	5	13	19	4	0	11	5	20	6
Poor	16	8	2	17	21	10	16	1	15

(E S Munasinghe, V H L Rodrigo and S M M Iqbal)

Economical assessment of environment benefits of rubber crop under different cropping systems with special emphasis on carbon sequestration (ARU/CS/2003/1)

A yield table (Table 11a) was developed to predict the rubber in latex, total timber volume, total biomass and total carbon contents at different growth stages of the rubber tree in wet and intermediate zones. With the knowledge of average tree density of a plantation, another yield table (Table 11b) was developed to predict the same on hectare basis.

Table 11. *Estimated values of latex rubber, total timber volume, total biomass and total carbon contents (a) per tree and (b) per hectare in the rubber crop*

(a)

Age (years)	Rubber in latex (g/tree/tapping)		Timber volume (m^3/tree)		Total biomass (kg/tree)		Total carbon (kg/tree)	
	WZ	IZ	WZ	IZ	WZ	IZ	WZ	IZ
5	9.47	8.14	0.05	0.05	50.4	53.8	20.6	22.0
10	20.73	17.83	0.16	0.19	149.2	176.4	61.1	72.2
15	27.18	23.38	0.33	0.35	303.5	324.2	124.3	132.8
20	23.70	20.38	0.49	0.47	452.7	435.0	185.4	178.2
25	20.34	17.49	0.63	0.56	575.4	510.9	235.7	209.3
30	18.19	15.64	0.73	0.61	668.1	561.3	273.6	229.9

(b)

Age (years)	Latex rubber (kg/ha/yr)		Timber volume (m^3/ha)		Total biomass (MT/ha)		Total carbon (MT/ha)	
	WZ	IZ	WZ	IZ	WZ	IZ	WZ	IZ
5	554.80	519.33	19.59	21.10	20.10	21.46	8.72	9.24
10	1090.15	1020.44	56.54	67.26	53.36	63.09	53.36	63.10
15	1308.16	1224.50	107.46	114.94	99.37	106.15	41.88	44.59
20	1073.70	1005.04	151.88	145.86	139.54	134.08	58.13	55.83
25	882.05	825.65	185.29	164.32	169.77	150.74	70.34	62.49
30	763.01	714.22	208.40	174.81	190.67	160.21	78.79	66.27

(E S Munasinghe and V H L Rodrigo in collaboration with the University of Sri Jayewardenapura)

Interplanting of rubber lands with tea

Productivity in rubber/Tea systems - Gallewatta /Dartonfield **(ARU/TRIC/1990/2)**

The study was extended beyond Dartonfield in view of gathering commercial yields of tea under rubber. Collection of yield data on mono and inter-cropped tea in different estates was commenced to develop a yield profile for tea in the rubber/tea system (S M M Iqbal).

BIOMETRY

Wasana Wijesuriya

SUMMARY

Conducting research falling into the discipline of Biometry and involving in collaborative research in the rubber sector are key activities of the Biometry section. Providing research support to other research departments and maintenance of databases are among the services rendered during the year under review. Biometry section assisted other research departments in various aspects; *viz.* design of experiments, analysis and interpretation of results and construction of databases. Databases were satisfactorily maintained during the year under review on meteorological data collected at the meteorological station at Dartonfield, auction prices of rubber and information on research personnel and projects of RRISL. Analysis of questionnaire surveys and GIS applications on collected data on land suitability are among the activities carried out under the project 'Sustainability of the smallholder rubber sector in the Moneragala district'.

DETAILED REVIEW

Staff

Dr (Ms) Wasana Wijesuriya (Biometrician) and Experimental Officers; Ms Chintha Munasinghe and Mr Vidura Abeywardene were on duty throughout the year. Mr Keminda Herath (Assistant Biometrician) continued his postgraduate studies at Virginia Poly Tec University, USA.

Research students

- Ms W M M D Weerasuriya from the Faculty of Agriculture, University of Ruhuna completed her final year project on "Statistical analysis of rainfall regimes in different rubber growing areas" under the supervision of Dr (Ms) Wasana Wijesuriya.

Seminars/Conferences/Meetings/Workshops attended

Officers of the Biometry section attended the following during the year under review.

Officer	Subject	Organization
Wasana Wijesuriya	Research coordination meeting (RCM) of the Coordinated Thematic Research Programme (CTRP)	National Science Foundation (NSF)
	Scientific Committee Meetings	RRISL

Officer	Subject	Organization
Wasana Wijesuriya	Steering committee of the Senior Scientists' Forum	National Science and Technology Commission (NASTEC)
	National statistical conference	Applied Statistics Association of Sri Lanka
	Workshop on research management	NASTEC
	National Workshop on imaging and navigation from space	Geo-informatics society of Sri Lanka
	Workshop on 'Barriers to young scientists"	NASTEC
Vidura Abeywardene	Workshop on 'Observing the planet for better future'	Department of Meteorology

Services

Statistical analysis and interpretation

Biometry section provided research support to other departments in design of experiments, statistical analyses and interpretation of experimental results. This service was also extended to undergraduate and postgraduate students of different Universities attached to the research departments (W Wijesuriya).

Database management

Meteorological

The database with daily meteorological data collected in the meteorological station at Dartonfield was properly maintained. Reports were prepared from this daily database and sent to the Central Meteorological Station, Colombo and the Natural Resources Management Centre (NRMC), Peradeniya. Rainfall records of substations, *viz.* Kuruwita, Nivitigalakele and Polgahawela were also maintained in a database. These data were made available to researchers and organizations on request (W Wijesuriya, C Munasinghe and V Abeywardene).

Auction prices of rubber

The database on auction prices of different grades of rubber was updated for 2008. Some important information derived from this database is given below.

Prices of Ribbed Smoked Sheets (RSS)

The prices of RSS1 in 2008 reached the maximum of Rs.368.00 at the auction on the 29th May. The minimum was Rs.111.10 in December. Monthly averages for this grade were above Rs.250.00 except for the period October to December as shown in Fig. 1. The sharp decline in October 2008 is due to the global economic crisis as it has badly affected the automobile industry, a major consumer of rubber. As can be seen from Fig. 1, the prices have fallen to the levels of early 2005.

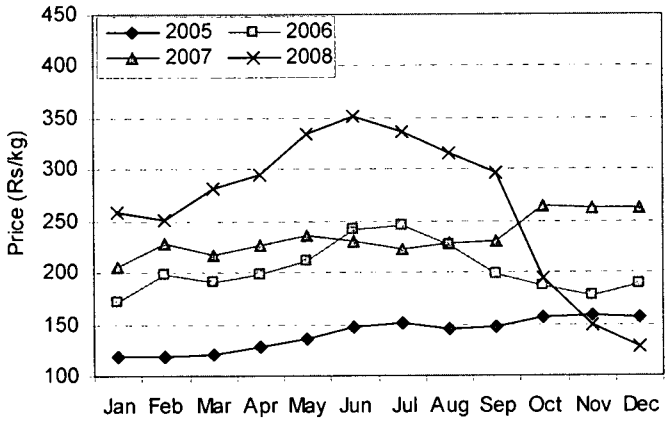


Fig. 1. Monthly variation of auction prices of RSS1 in 4 consecutive years

Prices of Latex Crepe (LC)

The prices of LC1X in 2008 ranged from Rs.103.00 in December to Rs.400.00 in June. Monthly averages of 2008 were greater than 2007 from January to September and dropped below Rs.200.00 afterwards (Fig. 2).

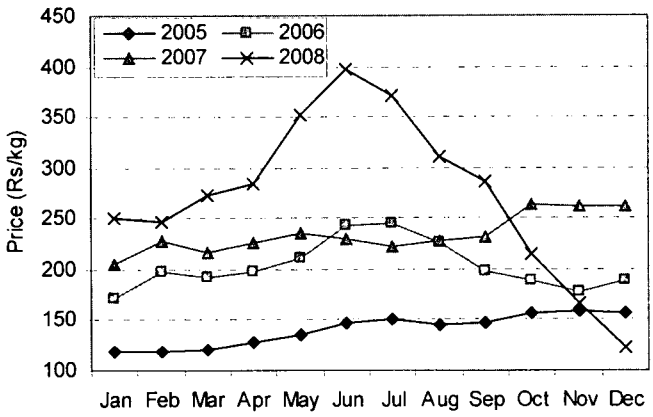


Fig. 2. Monthly variation of auction prices of LC1X in 4 consecutive years

Monthly averages of auction prices for different rubber grades; *viz.* RSS, latex crepe and scrap crepe are given in Table 1.

Table 1. *Monthly averages of auction prices for different rubber grades in 2008*

Month	RSS prices (Rs.)					Latex Crepe prices (Rs.)					Scrap Crepe prices (Rs.)			
	RSS1	RSS2	RSS3	RSS4	RSS5	LC1X	LC1	LC2	LC3	LC4	1Xbr	2Xbr	3Xbr	4Xbr
Jan	259	256	255	253	252	250	248	246	244	242	240	238	238	235
Feb	269	266	266	264	262	258	257	254	253	251	249	247	247	246
Mar	279	277	275	273	271	267	265	263	263	261	257	256	251	251
Apr	293	291	286	284	279	283	282	280	278	275	268	260	259	256
May	334	328	328	321	313	352	344	339	336	327	264	249	249	282
Jun	352	341	332	323	320	399	397	393	387	369	351	269	259	305
Jul	337	334	326	323	320	376	373	368	365	354	340	322	309	306
Aug	320	315	312	311	311	318	316	311	309	304	300	296	293	290
Sep	298	297	295	285	281	287	285	281	278	272	271	270	271	266
Oct	196	205	198	198	186	216	215	206	202	187	179	173	180	179
Nov	150	145	132	132	146	148	139	130	126	115	113	109	111	110
Dec	129	125	124	116	113	122	116	113	111	107	104	102	103	101
2008 average	268	265	261	257	255	273	269	266	263	255	245	233	231	236

The changes in annual average prices for RSS1 and LC1X are presented in Fig. 3. The difference between LC1X and RSS1 in 2008 was only Rs.5.00. Prices of LC1X were above the RSS1 prices only during May to July and observed very close to RSS1 throughout the year. There was a difference of Rs.47.00 between these two grades in July.

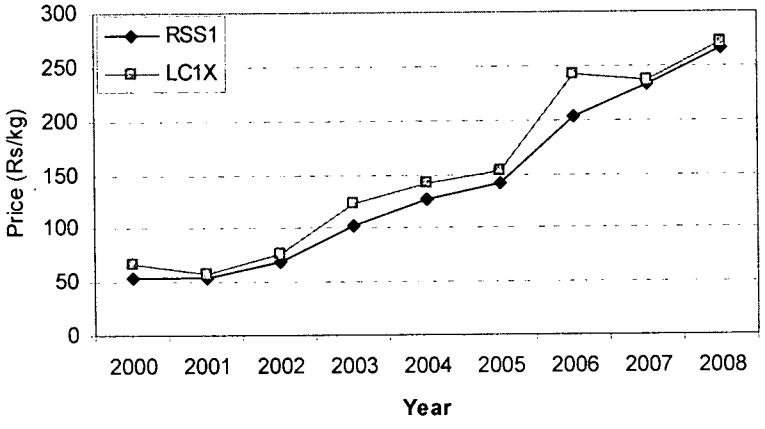


Fig. 3. Changes observed in yearly averages of auction prices for RSS1 and LC1X from 2000 to 2008

RESEARCH

Studies in progress

Tapping related activities and payment systems adopted in the smallholder sector

This study was done in all rubber-growing areas through a questionnaire survey to study tapping related activities and payment methods adopted by smallholders and how they deviate in different areas. Some results of Kegalle district were presented in the last year's review.

Examination of tapping panel and comparing with the age of the crop yielded the results depicted in Fig. 4 and Fig. 5 for clones, PB 86 and RRIC series, respectively. This analysis gives an indication of whether correct tapping is practiced as recommended. Over exploitation is more pronounced with PB86 with an average of 37% compared to 19% with RRIC series. Correct practices are adopted in 47% and 66% of the fields with clones PB 86 and RRIC series, respectively while % fields categorized as 'under exploited' was similar for both clones. These 'under exploited' fields may be a result of poor growth conditions, which resulted delay in commencement of tapping.

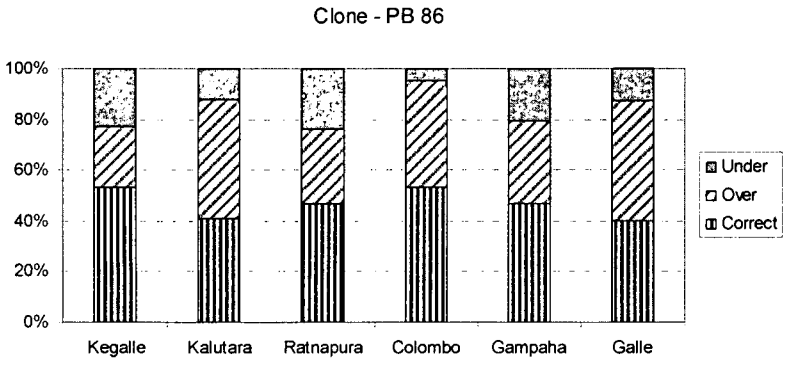


Fig.4. Status of tapping (correct, under exploited or over exploited) with age of the crop of clone, PB 86 in smallholder units in different districts

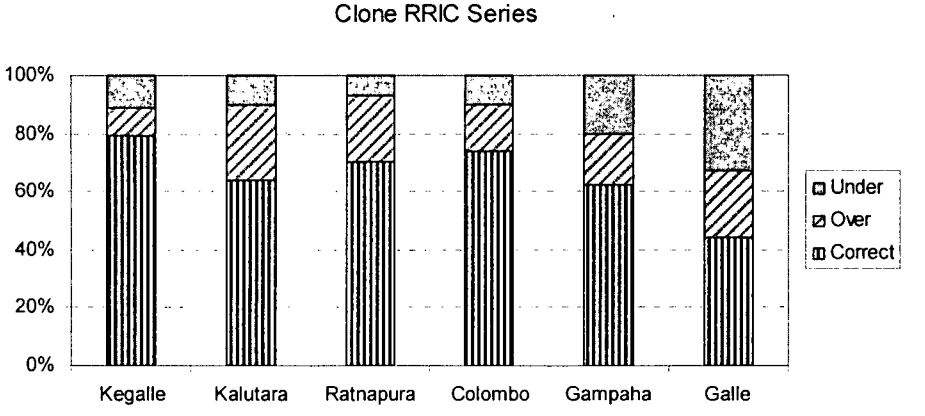


Fig. 5. Status of tapping (correct, under exploited or over exploited) with age of the crop of RRIC series clones in smallholder units in different districts

Highest involvement of family labour for tapping was observed in Kegalle district (38%) and it was above 25% in Kalutara, Ratnapura and Gampaha districts. Galle district recorded the lowest family labour involvement with 9% (Fig. 6). Involvement of family labour reduced with the extent of the holding in all districts.

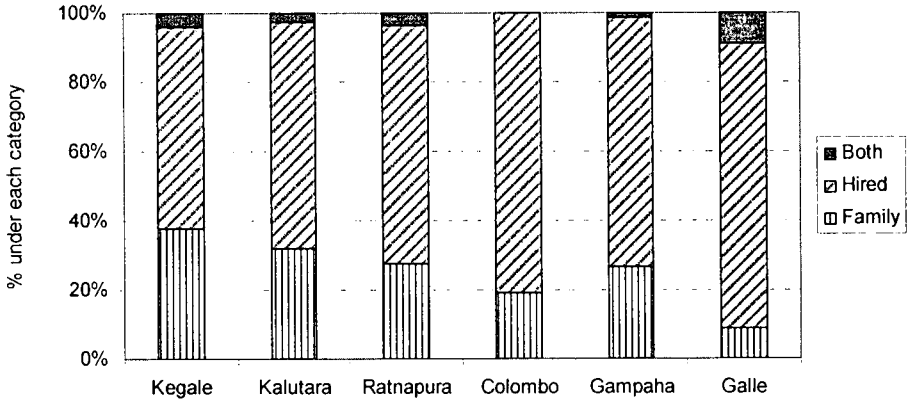


Fig. 6. Labour for tapping in different districts

Payments for tapping in terms of shares is more pronounced in Gampaha and Kegalle districts. Nearly 30% of the holdings adopted cash payments for tapping in these two districts. In other four districts, more than 75% of the holdings adopted cash payments (Fig. 7). In Kegalle district, % holdings adopting payment for tapping on a share basis decreased with increasing extent (Fig. 8) and is also common to Gampaha district (W Wijesuriya and A Dissanayake).

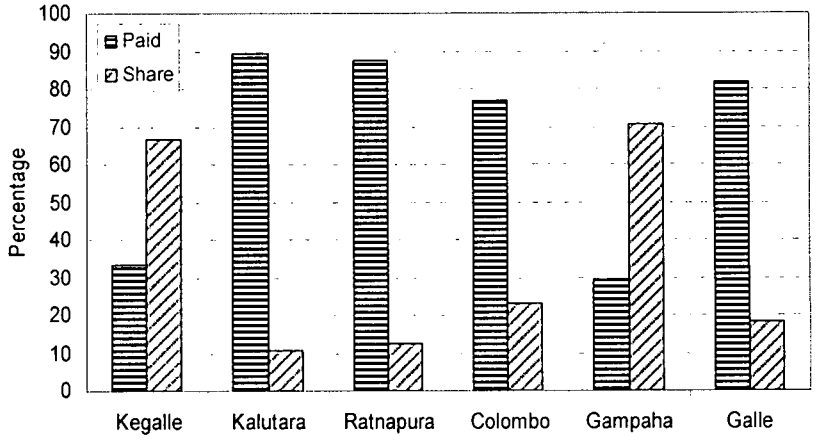


Fig. 7. Percentage under each category of payment for tapping in different districts

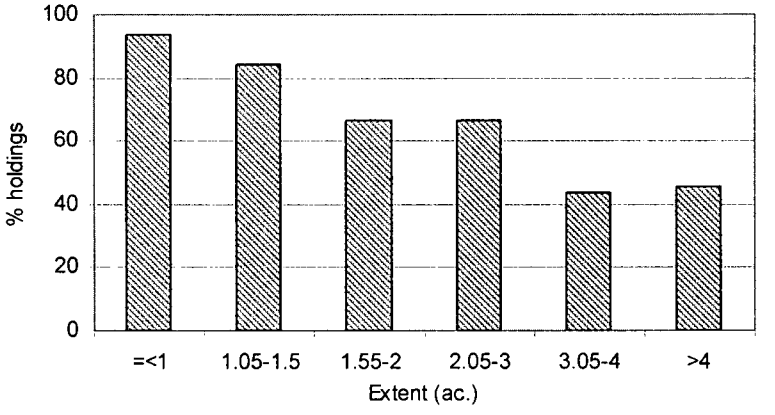


Fig. 8. Percentage holdings tapped under share basis for different extent categories in Kegalle district

Status of smallholder units in different districts

Stand per unit area

Stand per unit area is an important indicator which determines the productivity of a rubber plantation. Data for Kegalle district were observed in a narrow range when compared to other two districts (Fig. 9). The median values of trees/ha with age of the tree are depicted in Fig. 10 for different districts. Fifty percent of the holdings lie below the median boundary. The median boundaries for Kalutara and Ratnapura districts are similar and the boundary for Kegalle district lie below those districts. These fitted boundaries may be used for productivity modeling of the smallholder rubber sector.

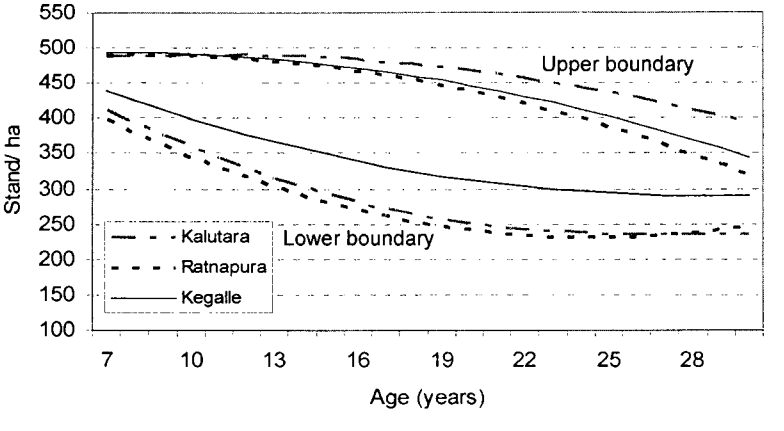


Fig. 9. Fitted upper and lower boundaries to data on stand per ha in major rubber growing districts

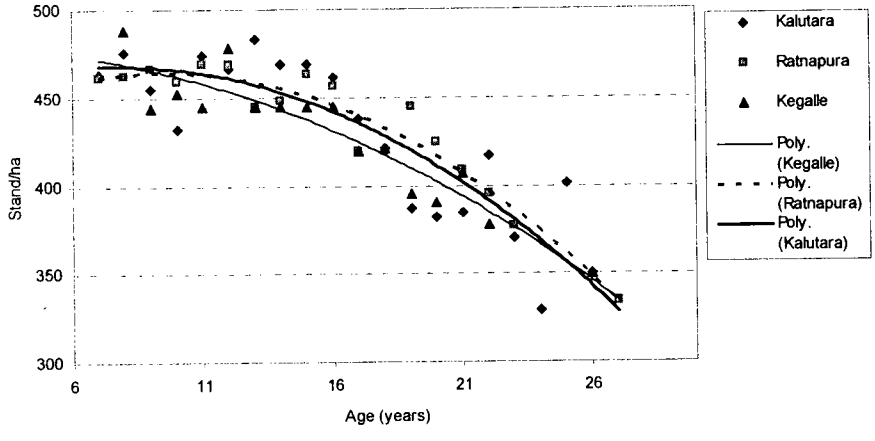


Fig. 10. Fitted median boundaries to data on stand per ha in major rubber growing districts

Yield per unit area

Yield profiles of smallholder units were plotted and from those the upper boundary points and median boundary points were selected. The fitted quadratic-by-quadratic curves for Kegalle, Ratnapura and Kalutara are depicted in Fig. 11. The upper and median boundaries of Kalurtara district were observed above the other two districts. The average yield figures for Kegalle, Kalutara and Ratnapura districts are; 1051, 1473 and 1435 kg/ha/year, respectively. This discrepancy may be due to various reasons such as clone composition, environmental factors, number of trees and adoption of agronomic practices (W Wijesuriya).

a)

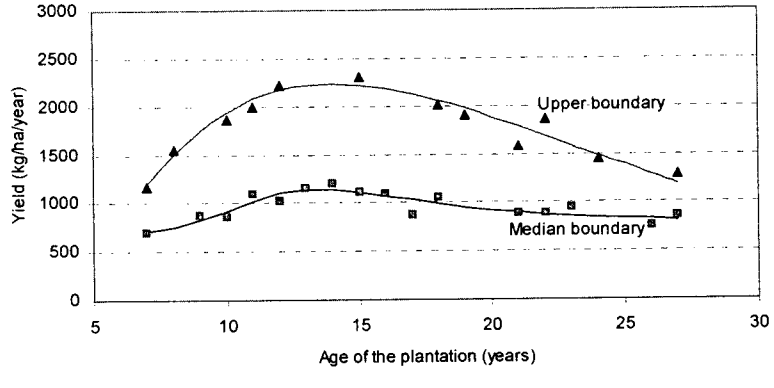
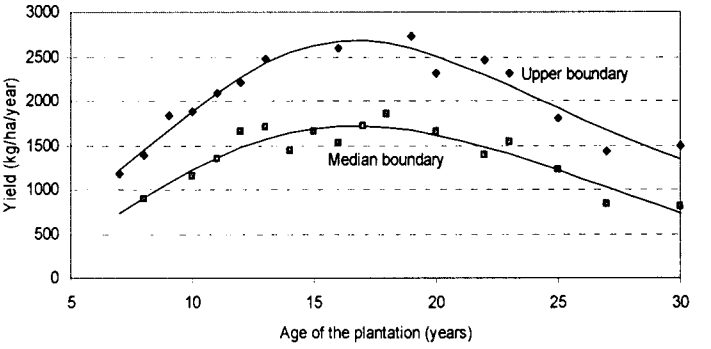


Fig. 11. Fitted upper and median boundaries to data on yield per ha in a) Kegalle

b)



c)

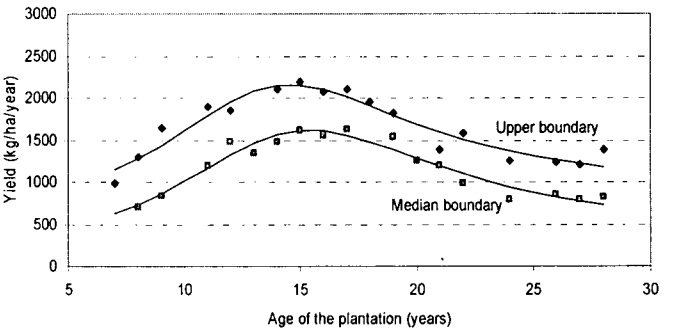


Fig. 11. Fitted upper and median boundaries to data on yield per ha in a) Kegalle b) Kalutara and c) Ratnapura

An approach towards sustainable development and economics of the smallholder rubber sector (NSF contract RG/2006/EPSD/01)

This project is funded by NSF under the theme "Environmental protection and sustainable management" of the Coordinated Thematic Research Programme (CTRP). The overall objective of this project is to improve the smallholder rubber sector in the Moneragala and adjacent parts of the Badulla and Ampara districts through sustainable management of environmental, socio-economic, technological and institutional aspects. The research departments, soils and plant nutrition and advisory services and the Biometry section are involved from RRISL together with Ruhuna and Wayamba Universities in this multidisciplinary project.

The project commenced during the 4th quarter of 2006 and the following activities were done during this year. Participatory studies were conducted in 22 sites covering 170 villages in the study area and the results were reported in previous annual reviews. This year the research team was involved in conducting awareness programmes and analysis of the questionnaire survey. During this year 6 awareness programmes were conducted in 6 sites, *viz.* Kotamuduna, Madugahapattiya,

Tanwatta, Raththanadeniya, Pallekiruwa and Radaliedda. Identification and mapping of areas suitable for rubber farming in the Moneragala district were also done during this year.

Questionnaire surveys were done separately for potential rubber farmers and those who own mature and immature rubber lands. In this process, 255 potential rubber farmers and 248 and 76 farmers who own immature and mature rubber lands, respectively were interviewed. Results on socioeconomic characteristics of potential rubber growers are presented below.

Household characteristics and educational status

The household size of the sample studied ranged from one to eight with an average household size of four. The sample had a 22% representation of female smallholders. The majority (35%) of the smallholders were found in the range 40 to 49 years of age followed by 27% and 25% in the age groups of 50-59 and 30-39 years. The proportion under 40 years was 33% compared to 17% in other traditional rubber growing areas, which is a good indication of the younger generation's preference for rubber cultivation in these areas.

The educational levels of the smallholders were categorized into (1) Primary (2) Ordinary Level (OL) qualified, (3) Advanced Level (AL) qualified and (4) Diploma/Graduate level. The majority of the farmers belonged to category (1) with 52% and 11% out of this comprised of farmers below 40 years. Only 15% had A/L or higher qualifications. Three percent of the farmers had not attended schools (Fig. 12). The higher proportion under category (1) 'primary' need to be considered as a constraint in improving the awareness and adoption of rubber farmers.

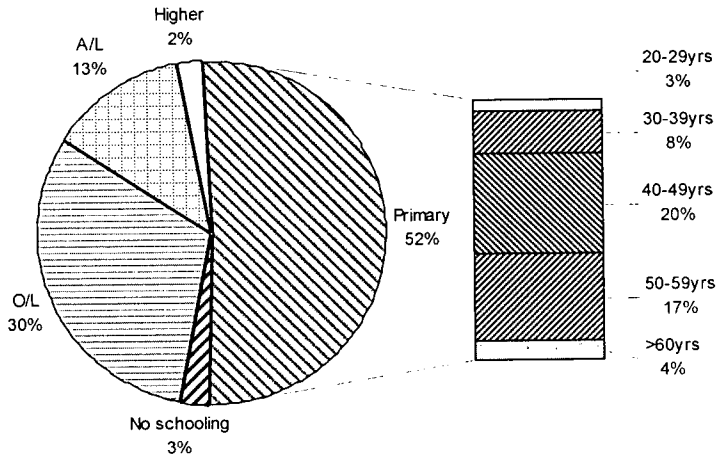


Fig. 12. Educational status of rubber farmers

Dependency on rubber

The potential rubber growers in the non-traditional rubber growing areas were involved in farming of different crops as depicted in the Fig. 13. This gives an indication that they do not solely depend on rubber cultivation as an income source. Paddy farming was done by 25% of the farmers while banana, coconut and vegetables are grown by farmers in substantial proportions. These findings may be very useful in proposing plans for cropping systems to increase the land productivity during the immature period of rubber. The farmers in Moneragala area in contrast to traditional rubber growing areas had a variety of other crops, which can be intercropped with rubber.

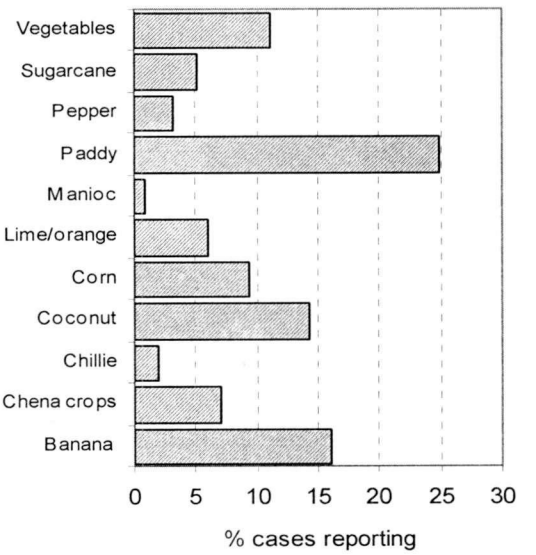


Fig. 13. Different types of crops cultivated by rubber farmers

Societal involvements

'*Thurusaviya*' is the farmer organization in operation in the Moneragala area. There is a good indication on societal involvement since 21% of the sample had already taken membership in this organization even before cultivating rubber. However, promotional campaigns on the importance of societal arrangements in different operations in rubber farming especially marketing need to be arranged to improve the membership.

Family involvement in rubber farming

Majority of the farmers (80%) believed that there will be improvement in their social status due to involvement in rubber industry. Nine percent stated there will be moderate effect and 11% were indifferent. In response to a question on what type of a conversion is expected by involving in rubber industry, 75% was confident that the involvement will create an efficient and enthusiastic environment within their families. Thirty seven percent of the sample was confident about the next generation's involvement in rubber industry while 59% was uncertain and 4% said 'no' in response to this question. Majority of the farmers (69%) were willing to use family labour for the immediate activity, *viz.* land preparation.

Income status

According to the survey, the higher percentage with a monthly income of less than Rs. 10000 (Fig. 14) should be regarded as a bottleneck in adoption of recommended technologies and proper monitoring methodologies need to be adopted in disbursement of subsidies to ensure the proper use of funds ([Wasana Wijesuriya, and Vidura Abeywardene from the Biometry section], [Lalani Samarappuli, P Karunadasa, U Mithrasena, Anoma Thewarapperuma, and T Gunathilaka from Soils and Plant Nutrition Department], Anura Dissanayake, Kapila Gunaratne, Shantha Perera, Susith Rathnayake, R A D Ranawaka, R L R U S Bandara, Manoj Nanayakkara, D R A M G Abeydissanayake, M Dharmadasa, U N Jayasuriya).

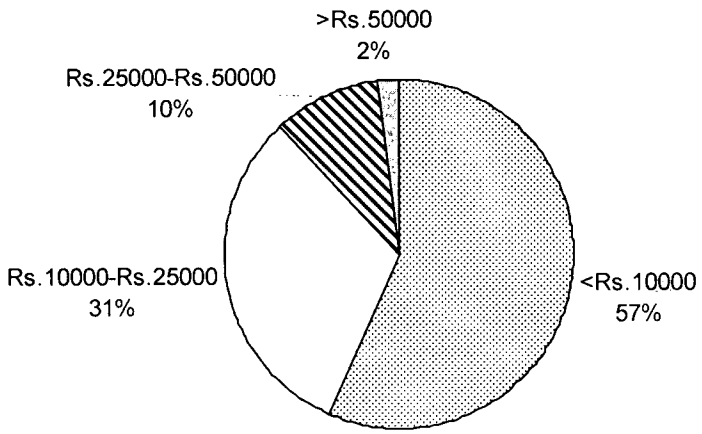


Fig. 14. Income distribution pattern of potential rubber farmers

LIBRARY AND PUBLICATIONS

S U Amarasinghe

SUMMARY

The prime objective of the Library and Publications Section is to provide promptly, appropriate documents to its clientele so as to gain knowledge to do research and development works efficiently. This section adopts various techniques such as indexing services, current awareness services, selective dissemination of information, audio-visual materials, e-mail and internet services to provide information to its clientele.

Meanwhile, they bear the responsibility of maintaining, processing and publishing of Institute's regular publications such as Annual review, Journal, Bulletin *etc.* In addition to providing these services the Library, collaborates with the Agricultural Information Network (AGRINET) in resource sharing activities since 1984 to provide a better service to their clients.

DETAILED REVIEW

Mr S U Amarasinghe, Librarian and Publications Officer, Mrs R M Amaratunga, Library Assistant and Assistant Publications Officer, Mr P M Prema Jayantha, Clerk/Typist, two Casual Library Clerks (Colombo Office) and two Library Attendants were on duty throughout the year.

Meeting/Seminars

- The AGM of the Sri Lanka Library Association at SLFI on 25th June.
- The Seminar on New developments in the fields of Information Dissemination Technologies and Management concepts at NSF on 21st August.
- Three AGRINET meetings at CARP Office on 29th February, 24th July and 24th October.

Resource development activities

Twenty two books were added to the existing Library collection bringing the total number of books to 5504. The Library subscribed to a limited number of journals due to financial constraints. Nearly twenty five journals were received on exchange basis.

Publications

The following publications were published during 2008.

- Annual Report 2007
- Annual Review 2007
- RRISL Bulletin Vol.49 (2008)
- RRISL Journal Vol.88 (2007)

The processing works of the following were done during this period.

RRISL Journal Vol.89 (2008)
RRISL Bulletin Vol.50 (2009)
RRISL Rubber Puwath Vol. 26 (2009)

SDI service

Twenty five articles were sent to various Agricultural Libraries at their request and vice versa 18 articles were requested for the benefit of RRISL Library users. Fifteen literature searches based on *Hevea*/rubber were done using CD-ROM databases available.

Information services

Computerized bibliographic data up to the year 2008 were sent to the National Library of Sri Lanka and CARP library for compilation of the National Union Catalogue and the National Agriculture Bibliography respectively.

DARTONFIELD GROUP

J Perera

SUMMARY

A total crop of 175,822 kg, have been harvested during the year. When comparing with the estimated crop it records a decline of 19.33%. 11.68% of the total crop harvested during the year was from rainguarded areas.

The YPH recorded during the year was 911 kg. When comparing with previous year it is a decrease of 225 kg.

The average intake per tapper during the year was 8.80 kg. from a tapping task of 275 trees which records a slight increase of 3.5% over the previous year. The highest intake per tapper recorded during the year was 13.50 kg. from a 285 tree tapping task tapped on ½ S d/3 tapping system.

The total number of normal, late, double, rainguard, rain interference and no tapping days recorded during the year were 184, 28, 05, 31, 02 and 118 days respectively.

The total rain fall recorded during the year was 5,244.40 mm. with 228 wet days. The total rainfall and wet days have increased compared with last year by 1,247 mm and 41 days respectively.

The COP and NSA achieved for the year ending 2008 was Rs.150.04 and Rs.232.16 respectively, giving a profit margin of Rs.82.12 per kg. and total profit of Rs.14.4 million. Further Rs.2.7 million was generated from sundry income during the year.

Even though only 80.66% of the budgeted crop was harvested total expenditure incurred was 75.19% against budget.

The No.01X grade manufactured during the year recorded as 82%.

71 % of the total revenue extent had been rainguarded during the year.

DETAILED REVIEW

Mr Jehan Perera, the Estate Superintendent, Mr K K P Gunawardena, Acting Chief Clerk, Mr D S K Ranaweera, Rubber Factory Officer, Mrs S I K Pathirage and Mrs O W Namali Udayanthie Junior Clerks, Mr B M Siriwardena, Mr K A Sarath Kumara, Mr Jagath Nakandala, Mr N L D Nihal, Mr Ajith Basil Nakandala and Mr N L D Premechandra, Junior Assistant Field Officers were on duty throughout the year.

Mr T Somaratna Field Officer and Mr W D D Senanayaka Assistant Factory Officer retired in July and August respectively.

The Group cadre stood as follows at the end of the year.

Senior staff	01
Assistant staff	10
Minor staff	03
Total	**14**

Hectarage summary - Dartonfield group

Hectarage summary of the Dartonfield Group is given in Table 1.

Table 1. *Land distribution (ha.) of Dartonfield group*

	Dartonfield division	Gallewatte division	Nivitigalakele division	Total
Mature area	39.02	138.46	15.47	192.95
Immature area	-	11.36	14.05	25.41
State land take in	0.27	-	-	0.27
Nurseries	7.27	1.00	2.00	10.27
Paddy/Deniya land		1.22	1.22	2.44
Waste land	0.19	0.18	-	0.37
Earth slipped area	3.01	1.26		4.27
Jungles	0.80	1.50	2.03	4.33
Rocky areas	2.14	5.92	1.26	9.32
Roads	2.92	6.86	0.36	10.14
Building	17.67	5.43	7.79	30.89
Abandoned areas	-	11.16	26.89	38.05
Streams	-	-	2.17	2.17
Play ground	1.00	-	-	1.00
Grand total	**74.29**	**184.35**	**73.24**	**331.88**

Rainfall

The annual rainfall recorded for the year was 5,244.4 mm. with 228 wet days.

Table 2. *Annual rainfall and wet days of the group for last five years*

	2004	2005	2006	2007	2008
Rainfall (mm)	4,349.7	4,129.0	4,260.9	3,997.4	5,244.4
Wet days	235	222	204	187	228

Crop

A total crop for 175,822 kg have been harvested against the estimated crop of 217,954 kg which is a decrease of 42,132 kg (19.33%) against the estimated crop. An additional crop of 20,551 kg (11.68%) have been harvested due to rainguards. Rainy weather prevailed during the year and was not conducive for harvesting of crop.

Table 3. *The crop and YPH (kg) Dartonfield group from 2004 to 2008*

Hect.	2004		2005		2006		2007		2008	
	184.71		196.15		187.48		195.10		192.95	
Division	**Crop**	**YPH**	**Crop**	**YPH**	**Crop**	**YPH**	**Crop**	**YPH**	**Crop**	**YPH**
Dartonfield	31394	850	33527	859	40278	1032	38025	974	27341	701
Gallewatte	119433	872	144169	997	156863	1133	163228	1179	132900	960
N'kele	8618	689	8211	656	11970	1197	11743	1174	15581	1007
Group total	159445	863	1859	948	209111	1115	212996	1136	175822	911
Group estimate	178124	964	196350	1001	184900	986	230736	1231	217954	1130

Tappers productivity

The average IPT during the last five years are given in Table 4.

Table 4. *The average IPT (kg.) of Dartonfield group from 2004 to 2008*

	2004	2005	2006	2007	2008
Dartonfield	6.4	6.8	7.1	6.6	7.7
Gallewatte	9.6	9.4	9.9	9.4	9.6
Nivitigalakele	5.9	5.7	6.3	6.3	6.5
Group average	8.7	8.9	8.9	8.5	8.8

The tapper productivity shows a slight increase of 0.3 kg over the previous year.

Tapping days

Monthly break down of Normal tapping (NT), Late tapping (LT), Double tapping (DT), Rainguard tapping (RT) and No tapping of Dartonfield estate is given in Table 5.

Table 5. *Average number of tapping days of Dartonfield group during last five years*

	2004	2005	2006	2007	2008
Normal tapping	168	190	199	212	184
Late tapping	12	06	35	22	28
Double tapping	-	(11)	(27)	(44)	(05)
No tapping	186	104	77	76	118
Rainguard tapping	-	65	54	46	31

Total number of tapping days have decreased over the previous year.

Rainguard

Total of 137.13 hectares were rainguarded during the year and an additional crop of 20551 kg (11.68% of the total annual crop) have been harvested due to rainguards. Additional tapping days done during the year were 29 and 63 days for Dartonfield and Gallewatta divisions respectively. A profit of Rs.108.39 per kilo was made from the crop harvested from rainguarded areas which yielded a total profit of Rs.2.2 million from rainguads.

Table 6. *Additional income generated by fixing rainguards (Rs./kg.)*

	Dartonfield division	Gallewatte division	Total
Hectarage	34.89	102.24	137.13
No of Rainguard fitted	102.10	31,359	41,569
Additional crop	2,906	17,645	20,551
Rainguard cost per kg	91.78	48.67	54.76
Tapping cost per kg	47.60	47.60	47.60
C.O.M. Rs./kg	21.41	21.41	21.41
Total cost Rs./kg	160.79	117.68	123.77
N.S.A. Rs./kg	232.16	232.16	232.16
Additional profit Rs./kg	71.37	114.48	108.39
Additional profit from Rainguard	207,401.22	2,019,999.60	2,227,522.89
Additional profit per hectare	5,944.43	19,757.42	16,243.87

Total profit and profitability per hectare

The total profit and profit per hectare were Rs.14,438,502.64 and Rs.74,830.28 respectively for the year under review.

Table 7. *Comparative statement of the revenue profit per kg. and profit per hectare*

	Years				
	2004	**2005**	**2006**	**2007**	**2008**
Mature area (ha.)	184.71	196.15	187.48	187.48	192.95
Total profit (Rs.)	9,000,670.79	10,777,920.74	19,556,061.30	20,268,699.36	14,438,502.64
Profit per ha. (Rs.)	48,728.66	54,947.34	104,310.12	108,111.26	74,830.28

Cost of production and productivity

COP has increased over previous year by Rs.21.92 (Table 8).

Table 8. *Labour rates and break down of cost of production from 2004 to 2008 (Rs./Kg.)*

	2004	**2005**	**2006**	**2007**	**2008**
1. Labour wages	178.75	216.25	285.50	320.00	320.00
2. Cost of production	74.50	86.84	116.24	128.12	150.04
2.1 Tapping	25.45	29.29	35.35	41.38	47.60
2.2 Manufacture	17.47	16.33	19.20	22.56	21.41
2.3 General charges	19.21	28.35	47.47	50.47	58.78
2.4 M/area upkeep	12.37	12.87	14.22	13.71	22.25
3. N.S.A.	130.95	144.34	209.76	223.28	232.16
4. Profit per kg	56.45	57.50	93.52	95.16	82.12

The impact of global recession has resulted in a drop in Rubber prices. The average price of latex crepe per kilo which stood above Rs.250/- till October fell below Rs.150/- in November, December months.

Manufacture

Out of the latex crop of 157,037 kg harvested, 120,570 kg has been sent as No.1 which is 82%. The amount of RSS manufactured was 9,712 kg out of which 9,214 kg (95%) has been graded as No.1. Details are given in Table 9.

Table 9. *Summary of grades manufactured during the year*

Grade	Quantity (kg.)	Percentage %
Latex crepe No.1	120,570	82
Latex crepe No.3	26,755	18
Total	**147,325**	**100**
Scrap crepe No. 1	13,630	73
Scrap crepe No.2	4,770	25
Scrap crepe No.3	385	02
Total	**18,785**	**100**
RSS No.1	9,214	95
RSS No.2	498	05
Total	**9,712**	**100**
Grand total	**175,822**	

KURUWITA SUB STATION

S A R Samarasekera

SUMMARY

A crop of 91,928 kg have been harvested during the year recording an increase of 9.3% on previous year's crop. The actual yield per hectare (YPH) achieved was 1,530 kg. A yield per hectare of 1,181.4 kg was achieved form the intercropped areas. The average intake per latex harvester was 8.4 kg. This is a decrease of 0.2 kg. over the previous year.

The annual rainfall was 4,624.1 mm with 135 wet days as against 3,365.2 mm with 130 wet days during the last year. The average number of normal, late, rain interference, and no tapping days were 310, 16, 11 and 29 days respectively.

The cost of production and net sale average for the year were Rs.114.27 and Rs.228.25 respectively. Hence the profit per kg was Rs.113.98 and profit made for the year was Rs.10,477,953.44. The total profit made inclusive of sundry income was Rs.11,076,344.69.

DETAILED REVIEW

The Visiting Superintendent Mr S P Dissanayake over looked the activities of the Sub - Station throughout the year.

Staff

Mr S A R Samarasekara Assistant Estate Superintendent, Mr D S Jayasinghe Clerk, Mr J R C Jayalath Assistant Field Officer and Mr V G D N Gunaseela and Mr N V U S V Kumara Junior Assistant Field Officers were on duty throughout the year.

The estate cadre stood at 05 at the end of the year made as follows.

Intermediate staff	- 01
Assistant staff	- 01
Minor staff	- 03

Hectarage

A summary of the hectarage is given in Table 1.

Table 1. *Land distribution (ha.) in Kuruwita Sub - station*

Land type	Extent (ha.)
Mature area	64.63
Immature area	18.48
Nurseries	2.25
Tea area	3.25
Fruit plantation	2.00
Paddy	1.00
Buildings, gardens and road	7.54
Water tank	0.01
Unsuitable for planting	0.84
	100.00

Crop

A total crop of 91,928kg was harvested from an extent of 64.63 hectares during the year.

When compared with the actual of the previous year this is an increase of 7,800kg.

The yield per hectare (YPH) for the past 5 years is given in the Table 2.

Table 2. *Yield per hectare for the past five years*

YPH (kg)	Year				
	2004	2005	2006	2007	2008
Estimate	1,197.7	1,200.0	1,200.0	1,200.0	1,536.7
Actual	1,393.9	1,451.2	1,610.2	1,615.3	1,530.1

The yield per hectare (YPH) recorded for different months of the year is given in Table 3.

Table 3. *Yield per hectare recorded for each month during the year*

Month	YPH (kg)	Month	YPH (kg)
January	154.0	July	144.9
February	111.2	August	140.8
March	76.5	September	135.8
April	69.0	October	135.8
May	106.5	November	148.3
June	130.1	December	177.2

Latex harvester productivity

The average intake per latex harvester for the last 5 years of the estate are given in Table 4.

Table 4. *The average intake per harvester (kg) for the last five years*

	Year				
	2004	**2005**	**2006**	**2007**	**2008**
Intake per tapper	8.5	8.7	9.4	8.6	8.4

The harvester productivity shows a slight decrease of 0.2 kg over the previous year.

Vacant blocks

The number of vacant blocks recorded for the past 3 years in the estate is given in Table 5.

It has increased during the year 2008, when compared with the previous year (Table 5).

Table 5. *Vacant blocks during past 3 years*

Year	No. of vacant blocks	Percentage %
2006	195	2.27
2007	308	3.03
2008	393	3.40

Tapping

There were 337 tapping days recorded during the year (Table 6). This was possible merely due to the use of raingurds.

Table 6. *The number of tapping days, average intake per tapper and YPH for the last five years*

	Year				
	2004	**2005**	**2006**	**2007**	**2008**
1. Total tapping days	327	336	335	334	337
1.1 Normal	306	302	306	315	310
1.2 Late	14	18	20	01	16
1.3 Rain interference	07	16	09	18	11
1.4 Rain guard	(92)	(88)	(122)	(109)	(106)
1.5 Double	(11)	(04)	(02)	(03)	(04)
2. No tapping	39	29	30	31	29
3. Average intake per tapper	8.5	8.7	9.4	8.6	8.4
4. Y.P.H.	1,393.0	1,451.2	1,610.0	1,615.3	1,530.1

The total number of tapping days have increased over the previous year.

Tapping cost

The tapping cost of the estate has increased by 15% over the last year (Table 7).

Table 7. *A break down in total tapping cost for last 5 years*

Cost item	Cost/kg (Rs.) and year				
	2004	2005	2006	2007	2008
Tapping	21.10	24.31	26.39	33.28	37.38
Double tapping	.54	.17	.09	.07	0.20
Overtime on tapping	.22	.28	.36	.27	0.31
Over kilos	.31	.33	.54	.60	0.60
Extra pay to Kangany	.03	.03	.02	.02	0.01
Scrap pay	.39	.61	.88	.86	1.47
Incentive pay to Field staff	.20	.22	.25	.23	0.12
Transportation of scrap					0.18
Cash tapping					0.31
Total tapping cost (Rs.)	22.79	25.95	28.53	35.33	40.58

Rainfall

The annual rainfall recorded for the year was 4,624.1 mm with 135 wet days. The wet weather conditions distributed evenly throughout the year were unfavourable for harvesting of crop.

Table 8. *Annual rainfall figures and the number of wet days of the estate for last five years*

	Year				
	2004	2005	2006	2007	2008
Rainfall in (mm)	4,556	3,903	4,100	3,365	4,624.1
Wet days	120	103	138	130	135

Rainguards

Due to the use of rainguards, an additional 106 tapping days were recorded in the year. This contributed to 31% of the total crop yielding an additional profit of Rs.4,657,337.27.

The performance of the use of rainguards during the last 3 years are given in Table 9.

Table 9. *Additional income generated by use of rainguards (Rs./kg)*

	Year		
	2006	**2007**	**2008**
Hectarage (ha.)	33.66	50.31	59.63
No of rain guards fitted	15,680	16,300	21,131.00
No. of kilos harvested	15,679	23,038	28,312
Cost per rain guard (Rs)	19.08	21.63	31.04
Tapping cost (Rs./Kg)	28.53	35.33	40.58
Total cost (Rs./Kg)	47.61	56.96	71.62
N.S.A. (Rs./Kg)	165.82	202.41	228.25
Profit (Rs./Kg)	118.21	145.45	164.50
Additional profit from rain guard (Rs.)	1,853,376.00	3,496,676.00	4,657,406.80
Additional profit per hectare(Rs)	55,061.67	69,502.60	78,103.92
Profit per tree (Rs)	118.20	214.52	220.40
Additional tapping days	122	109	106

Cost of production and profitability

The cost of production has increased by Rs.18.52 per kg when comparing with the previous year (Table 10).

Table 10. *Labour rate (Rs.) and the break down of the cost of production (Rs./kg) for the last five years*

	Year				
	2004	**2005**	**2006**	**2007**	**2008**
Labour rate	125.00	125.00	170.00	200.00	200.00
Total COP	55.11	60.31	78.99	95.75	114.27
Tapping	23.54	27.17	29.64	37.68	45.50
General charges	23.20	23.52	37.09	45.11	47.59
Upkeep	8.37	9.62	12.26	12.96	21.18
NSA	104.89	120.58	165.82	202.41	228.25
Profit per kg	49.78	60.27	86.83	106.66	113.98

The profit has increased by Rs.7.32 per kg when compared with the previous year.

Labour rate per day for the year was Rs.200/= plus an additional incentive of Rs:70.00 per day depending on the attendance.

Table 11. *Comparative statement of the mature extent, total profit and profit per hectare for the last 5 years*

	Year				
	2004	**2005**	**2006**	**2007**	**2008**
Mature extent (ha.)	44.25	47.61	48.61	55.31	64.63
Total profit (Rs.)	3,070,281.06	4,164,415.92	6,796,618.25	8,973,092.48	10,477,953.44
Profit/ha. (Rs.)	67,026.86	69,384.88	139,819.34	162,232.73	162,122.13

During the year 2008 a profit of Rs.113.98 on a kilogram and Rs.162,122.13 per revenue hectare were recorded.

Other crops

Tea

A crop of 19,393kg was harvested during the year. The cost of production and the net sale average for the year were Rs.43.35 and Rs.44.42 per kg respectively.

Cinnamon

642kg of cinnamon were sold during the year from the rubber/cinnamon inter crop experimental area.

Pineapple

7,778kg of pineapple and 59,052 suckers were sold during the year.

Passion fruit

1,062.75kg passion fruits were harvested during the year.

Banana

760.5kg of banana were harvested during the year from rubber/banana intercrop area.

Rubber plants

7,590 young budded plants were sold to the smallholders during the year.

Reward

The selected best harvesters were rewarded during the year in order to motivate them.

Fertilizer application

Fertilizer application for mature and immature fields were carried out as scheduled.

Meteorological Summary - 2008
Dartonfield Station

Keminda Herath

A total of 5656 mm of rain experienced during 2008. A significant increase of about 1588 mm was observed in 2008 compared to the previous year. The comparative increase with respect to the long-term average was about 39%. Fig. 1 indicates that the distribution of rainfall during this year has followed the usual bimodal pattern with above average values except for September and November. Monthly rainfall values in April, May, June and October have reached 600 mm. A maximum rainfall of 880 mm during May was observed while a minimum rainfall of 206 mm was recorded in September.

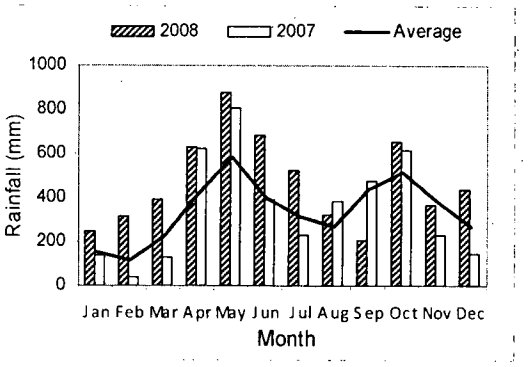


Fig.1. Monthly variation in rainfall

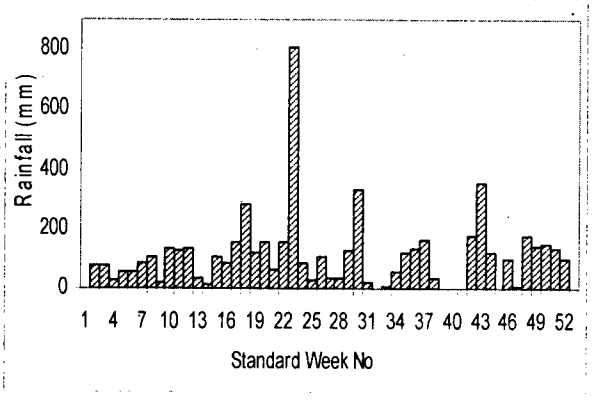


Fig. 2. Weekly variation in rainfall

The distribution of weekly rainfall is illustrated in Fig. 2. Nine dry weeks (a week having a total rainfall less than 10 mm) were observed during the year and it was 12 weeks in 2007. The highest weekly rainfall was observed during the 23rd standard week, which coincided with late May. There were four rainfall records above the hazardous limit for land slides (100 mm/day) during 2008.

Start and end of monsoon rains

The successful start of the rains occurred by 29th March and 08th September in 80% of the years for Southwest (SW) and Northeast (NE) rains, respectively when the period from 1964 to 2003 were considered. For the year under review, SW rains

commenced successfully by 01st of March, which was an early start compared to the 80% expected. However, the onset of NE rains in the year was not apparent as per the criteria for detecting start of rainy seasons.

Rains have ceased generally by 14th August and 05th January for SW and NE rainy seasons, respectively. For the year under review the date that SW rains ceased was not clear while NE rains ceased by 24th December, which is an early cease of the rainy season.

The amount of rainfall and number of rainy days under low, moderate and high rainfall categories are listed in Table 1. Number of rainy days for the year was 244, which is greater than the long-term average of 220 days. Further, the number of rainy days of each month during first seven months of the year has exceeded their long term averages while those were below their long term averages during the last five months.

Other meteorological factors

Table 2 depicts the monthly values of some important meteorological observations together with averages from 1980 to 2005. The minimum temperature dropped below 20^0C in 3 days in January, 2 days in February, 1 day in November and 3 days in December during this year.

The lowest mean minimum temperature of 21.6^0C was observed in the month of January. The highest mean maximum temperature of 33.3^0C was observed in December. The average morning RH was in the range of 86 to 95 %. For the year under review, the average morning RH was above the long term averages for every month. The monthly values of soil temperatures at four different depths are given in Table 3.

Table 1. *Monthly variation of rainfall and rainy days at Dartonfield in 2008*

Month	Total rainfall (mm)	Average** (mm)	No of rainy days *	Avg.** days	No. of days under each category			Pan evaporation (mm)
					0.3-2.5 (mm)	2.6-50 (mm)	>50 (mm)	
January	246.3	(156)	12	(11)	01	10	01	57.9
February	317.4	(114)	17	(09)	01	16	-	68.8
March	390.8	(222)	26	(13)	07	18	01	68.8
April	633.9	(415)	25	(18)	05	15	05	47.5
May	880.6	(584)	26	(24)	04	16	06	57.9
June	681.3	(398)	28	(23)	10	16	02	51.5
July	520.8	(313)	25	(22)	09	13	03	54.8
August	321.2	(268)	19	(20)	07	10	02	67.3
September	206.3	(436)	13	(22)	03	08	02	77.6
October	654.8	(513)	21	(23)	05	11	05	69.1
November	369.5	(387)	19	(20)	07	09	03	59.3
December	436.6	(266)	13	(15)	02	07	04	69.3
Total	5659.5	(4072.0)	244	(220)	61	150	33	749.8

* A rainy day is defined as a day with a rainfall ≥0.3-mm
** Average values for 1980-2005 are given in parentheses

Table 2. *Variation of observed meteorological factors at Dartonfield – 2008*

(Latitude 6° 32'; Longitude 80°. 09', E Altitude 65.50mm)									
Month	**Temperature (°C)**				**Sun shine hours**	**Relative humidity (%)**			**Wind speed mean ($kmhr^{-1}$)**
	Mean Max	**Mean Min**	**Mean**	**No. of days Min Temp <20°C**		**8.30am**	**No. of days 8.30am >90%**	**3.30pm**	
January	33.0	21.6	27.3 (26.7)	03	5.2	91 (88)	21	69 (68)	1.50
February	33.2	22.1	27.6 (27.1)	02	6.0	91 (86)	20	72 (65)	1.60
March	32.1	22.7	27.4 (27.6)	-	4.6	92 (85)	23	75 (68)	1.60
April	32.3	22.9	27.6 (27.8)	-	4.8	92 (85)	21	80 (75)	1.50
May	31.1	23.6	27.3 (27.6)	-	4.5	93 (88)	29	81 (77)	1.50
June	30.9	23.3	27.1 (26.9)	-	3.7	95 (88)	29	79 (74)	1.10
July	30.6	23.1	26.8 (26.9)	-	4.4	93 (89)	27	77 (75)	1.80
August	30.8	23.2	27.0 (26.6)	-	4.5	90 (88)	18	74 (74)	1.80
September	32.0	22.6	27.3 (26.7)	-	7.2	89 (88)	15	71 (75)	1.80
October	32.5	22.6	27.4 (26.6)	-	4.9	88 (86)	13	78 (77)	1.40
November	32.8	22.3	27.5 (26.6)	01	4.6	87 (85)	10	72 (77)	1.60
December	33.3	21.8	27.5 (26.7)	03	5.1	86 (85)	09	72 (73)	1.30

** Average values for 1980-2005 are shown in parentheses

Table 3. *Soil temperatures recorded at different depths at Dartonfield - 2008*

Month	08.30 hrs				3.30 hrs			
	5cm	**10cm**	**20cm**	**30cm**	**5cm**	**10cm**	**20cm**	**30cm**
January	26.5	25.8	27.0	28.0	33.8	31.8	30.0	28.8
February	27.3	26.6	27.7	28.8	34.6	32.4	30.8	29.5
March	27.7	27.0	27.7	28.6	33.5	32.0	30.5	29.3
April	28.0	27.1	28.0	28.8	32.7	31.2	30.1	29.3
May	28.1	27.3	27.9	28.6	31.8	30.1	29.0	28.8
June	27.4	26.4	27.1	27.8	32.8	30.9	29.4	28.5
July	27.5	26.8	27.4	28.1	32.2	30.6	29.3	28.8
August	28.4	27.4	28.1	28.7	32.4	30.5	29.6	29.2
September	28.5	27.8	28.4	29.0	35.3	32.9	31.3	30.0
October	28.6	27.2	27.8	28.7	33.7	32.3	30.8	29.4
November	28.1	26.7	27.5	28.4	34.2	32.3	30.3	29.1
December	28.2	26.2	27.0	28.4	34.8	32.4	30.4	29.2

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