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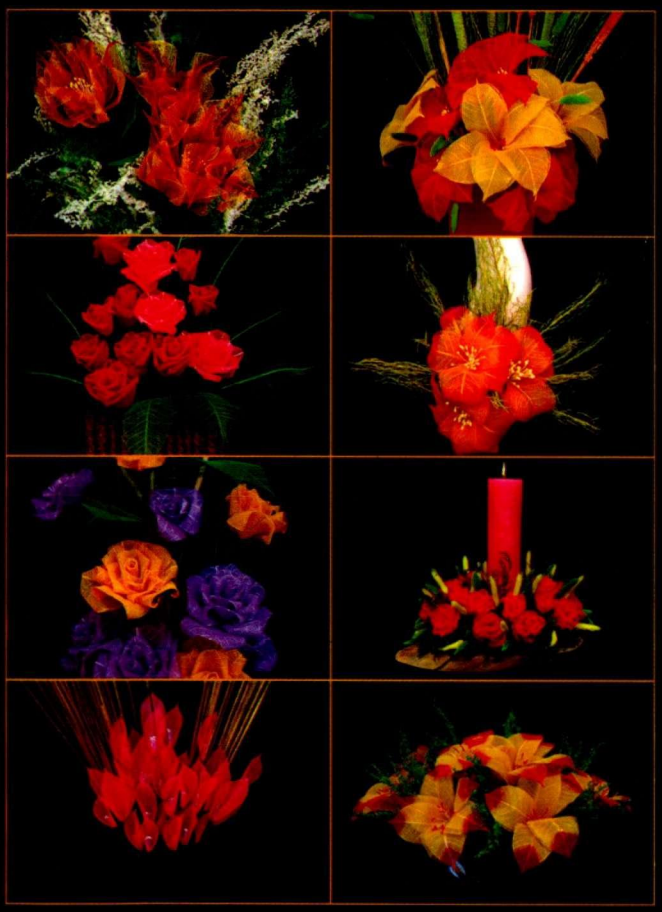
RUBBER RESEARCH INSTITUTE OF SRI LANKA



Annual Review 2005

Rubber Research Institute of Sri Lanka - Annual Review - 2005

Cover story :

Decorative handicrafts from skelitanised rubber leaves (see page 56)

Photographs by
Wimal Amaratunga

Rubber Research Institute of Sri Lanka

Annual Review – 2005

1 st January 2005 to 31 st December 2005

Editors
L M K Tillekeratne, PhD (Aston)
R C W M R A Nugawela, PhD (Essex)
W M G Seneviratne, PhD (Sussex)

Head Office & Laboratories
Dartonfield
Agalawatta

Board Office & Laboratories
Telewela Road
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CONTENTS

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Mr Vas Gunawardena, Superintendent, Opatha Estate, Kahawatta
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Mr G Gunawardena, RAO, Advisory Services Dept., Agrarian Services Centre, Paragammana, Kegalle
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Provident Fund Committee
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Mrs L J C Perera, Secretary, Provident Fund Committee
Mr W B Herath, Senior Accountant (In attendance)
Mr H H Jayasinghe, Elected Committee Member
Mr W D Wimaladasa, Elected Committee Member

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Secretary to the Board	- Mrs L J C Perera
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RUBBER RESEARCH INSTITUTE OF SRI LANKA

STAFF

DIRECTORATE

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Deputy Director - Research (Biology)	R C W M R A Nugawela, BSc (SL), MSc (Lond.), PhD (Essex)
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RESEARCH DEPARTMENTS

Genetics and Plant Breeding

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	I D M J Sarath Kumara
	L S Kariyawasam
Technical Officers	T M S K Gunasekera
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	Mrs A K Gamage, BSc (SL)
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	A M W K Senevirathna, BSc (SL), MSc (SL), PhD (Wales)
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	*N M C Nanayanakantha, BSc (SL)
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	S Wilbert
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	U S Weerakoon
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Plant Pathologists (Principal Research Officers)	K E Jayasuriya, MSc Agronomy (USSR), MPhil (Edinburgh), C Biol (SL) PhD (SL)
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	Mrs S D C K Maheepala
	S N Silva
	P Karunadasa, BSc (SL), MSc (SL), M I Biol. (SL)
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	T B Dissanayake
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	Mrs D I R Denawaka, Dip. Rubber Tech. (PRI)
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	S S Warnapura
	S L G Ranjith, Dip. Rubber Tech. (PRI)
	S M A Samarakoon, Dip. Agric. (Kundasale)
	Miss D M S Wijesekera, Dip. Rubber Tech. (PRI)
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	Mrs H V K Gamage
	Mrs C S Lokuge
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	P L Perera
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	G D N Seneviratne
	K P Jayasinghe
	W C Siriwardena
	S G G Wijesinghe
	N G Yasaratne
	D M Mahindapala
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	Mrs L Somawathi
	Mrs S M Kaluarachchi
	Miss Chitra Gunatilleke
	Mrs J N R Jayasinghe
	Mrs S K Hadunge
	Mrs S Nakandala

* On study leave overseas

RUBBER RESEARCH INSTITUTE OF SRI LANKA

DIRECTOR'S REVIEW

L M K Tillekeratne

The year under review was a good year for the rubber industry in Sri Lanka. The Natural Rubber (NR) production in the country rose by nearly 5% to 104,500 MT which is over and above the projected production figure of 98,000 MT. This can be attributed mainly to,

a) Yield increases due to the use of rainguards mainly by the PMCC
b) High yields given by the RRIC hundred series clones, population of which is now increased to 60%
c) Tapping abandoned cultivations by both the Smallholders and PMCC.

This trend would continue in the future too as the rubber prices are expected to remain high. Average rubber price rose close to Rs.200/- per Kg and this is expected to continue. The demand for crepe rubber is expected to rise further in the years to come. Many estates laid rainguards in their plantations enjoying the 50% subsidy given to the same from the rubber cess. Few PMCC got their rubber testing laboratories in the plantations for production control and quality improvement purposes through the financial support given from the cess while some companies got their poor quality or defective factory machinery replaced through cess funding.

During the year for first time since 1964, the share of world consumption of Synthetic Rubber (SR) dropped to 57.7% while the NR consumption went up to 42.3%. During the past 02 decades, SR to NR consumption ratio was almost 60 : 40 throughout. This is predicted to be due to the increase in the price of monomers used in the manufacture of SR with the increase in crude oil prices in the world market. If not, when the price of NR increased by about 45% during the year every possibility was there for the NR consumption to go down, caused by the rubber product manufacturers use of cheap SR substitutes in their production lines replacing NR.

However, still there is lot of research done in Europe, USA and in Japan to reduce the NR consumption in the tyre industry. Research is now being conducted to introduce motor cycle type spoke wheels fitted with a smaller pneumatic tyre in place of normal passenger car wheels just sufficient to give comfort to the passengers. One of the efforts taken by USA earlier to reduce NR consumption in the car industry by reducing the size of the spare wheel has been successful.

During the year, total NR and SR consumption have gone up to 20.66 M.MT from the figure of 20.20 M.MT consumed in 2004. This is expected to go up by a further 3.1% to 21.31M.MT in 2006 and also by another 6.7% to reach 22.73 M.MT in 2007. Of this 8.96 M.MT would be NR in 2006. The NR need for 2007 to reach

the total usage of 22.6 M.MT is 9.61 M.MT. The major increase in the rubber consumption in the future is expected from China where the car production is increasing quite fast. China is the main consumer of rubber in the world in the current year as well.

According to the International Rubber Study Group there are no big plans in NR producing countries all over the world to increase the NR production substantially within the next couple of years except in Vietnam and in the Ivory Coast. These two countries are planning to nearly double their NR production to 1.2 M.MT and 320,000 MT respectively in the 2006. But, that production increase in those two countries is insignificant compared to the expected demand increase.

The NR consumption in Sri Lanka has also gone up significantly during the past years. Over 15,000 MT of rubber both in dry and in latex form have been imported to the country for value addition. The latex usage in the country for the manufacture of dipped goods and foam rubber *etc.* during the year is over 32,000 MT.

Hence, based on the above global situation, it seems that there will be a severe shortage of NR in the global market by year 2010. Hence, small rubber consuming countries especially in Asia, like Sri Lanka should be concerned about this as buying NR from neighboring Asian countries by competing with giants like China to run our rubber products industry would be extremely difficult in the future.

The only way for Sri Lanka to overcome this problem is by planting rubber in the intermediate zone, dry zone and in abandoned tea lands at high elevations in the country. All the programmes planned so far to reach this goal have not yet been quite successful.

However, the role of the Rubber Research Institute in producing high yielding clones to increase productivity has been extremely successful. Under the present management, most of the company managed estates have been able to record yields above 2500 Kg/ha/year for the RRIC 100 series clones in new fields. In addition to these clones, there are RRISL 200 and 2000 series clones introduced during the past years to both smallholders and PMCC. These clones will give even higher latex yields and also higher timber yields. In order to popularize these clones specially in Moneragala area, construction of a new sub-station was commenced during the year. This sub-station at Moneragala will also be catering to the rubber plantation program of Hambantota district funded by Japanese Government.

OVERSEAS VISITORS

Mr Yoshio Kanai, Japan
Mr Mamoru Matsutani, Japan
Mr Baseey Edem, Nigeria
Mr Emmanuel Bassey, Nigeria
Mr Kassoir Konate
Mr Wadin Honest
Mr Emami Nasser, Iran

Mr Saeed Taghvae, Iran
Mr Mastota Touha, Iran
Mr D Cooper, London
Mr B Naristeean, France
Mr Sayan Kyokkong, Thailand
Mr Polchit Baukaew, Thailand
Mr Batrand Vignes, France
Mr Koffi Konan A, Ivory Coast
Mr Dock No., UK
Mr P Juinpasnt, UK
Mr Kamaruddin Mohomed Shah, Malaysia
Mr Thomas Ousepth, India
Mr Eric Penot, France

GENETICS AND PLANT BREEDING

P Seneviratne

SUMMARY

Results of the Estate Collaborative Clone trials of clones RRISL 203, RRISL 211, RRISL 216 and RRISL 2001 proved there suitability for large scale planting in Estate Sector. Use of these clones was promoted by issuing the budded plants for the establishment of budwood nurseries.

Pre-tapping girth data of open pollinated seedling progenies of commercial clones showed that, there are no significant difference between them and the budded plants for girthing ability.

RRISL 201, RRISL 203 and RRISL 205 clones reached tappable girth within a 5 year period in Smallholder clone trials in Kegalle and Colombo districts.

In molecular biology work, it was observed that the clone RRISL 2000 is genetically distinct from the other clones in RRISL 2000 series. Molecular characterization of twenty two recommended clones of RRISL 200 and RRISL 2000 series, were done with three RAPD primers selected on their polymorphism. Eleven clones were identified by two primers (OPA 20 and OPA 12), seven clones were unequally identified by the primer OPA 20 and rest of the clones were identified by OPA12.

Three primers giving consistent bands with CLS disease resistant and susceptible individuals were selected. Among them most informative six marker loci was used to build up a tree diagram by using RAPD distance computer programme.

DETAILED REVIEW

Staff

Geneticist and Plant Breeder, Mrs S P Withanage, 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 Miss 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. Mrs S Herath Assistant Geneticist and Plant Breeder resigned from the Institute with effect from 1st April. Mr K K Liyanage was appointed as an Assistant Geneticist and Plant Breeder with effect from 17th August.

Meetings and Workshops

Officer	Subject	Organization
Mrs S P Withanage	Work shop on Research Proposal Preparation and Report Writing	CARP
Mrs S P Withanage	Scientific Committee Meeting	RRI
Mrs S P Withanage and Mr K B Karunasekara	Work shop on Future Directions of Crop Improvement	CARP
Mrs S P Withanage	Work shop on Plant Genetic Resources Conservation and Management	CARP
Mrs S P Withanage	Work shop on Expert Consultation of biotechnology	CARP and Michigan Estate University

Research students

- Ms A A S Fonseka a student from the faculty of Agriculture and Plantation Management of Wayamba University carried out her research project on Molecular characterization of recommended rubber (*Hevea brasiliensis*) clones of RRISL 200 and RRISL 2000 series by using RAPD markers under the guidance of Mrs S P Withanage.

- Ms M A I Sajeevani, a student from the faculty of Agriculture and Plantation Management of Wayamba University, conducted her research project on Development of RAPD markers for *Corynespora* leaf fall disease resistance in rubber (*Hevea brasiliensis*) under the guidance of Mrs S P Withanage.

LABORATORY INVESTIGATIONS

Molecular biology of *Hevea* GPB/MM/97

Molecular characterization of twenty two recommended clones of RRISL 200 and RRISL 2000 series, were done with three RAPD primers selected on their polymorphism. Eleven clones were identified by two primers (OPA 20 and OPA 12), seven clones were unequally identified by the primer OPA 20 and rest of the clones were identified by OPA12.

Three primers giving consistent bands with CLS disease resistant and susceptible individuals were selected. Among them most informative six marker loci was used to build up a tree diagram by using RAP distance computer programme.

FIELD EXPERIMENTS

Hand pollination (HP) programme – 2005 (GPB/BST/HP/01)

The hand pollination programme for the year was carried out at RRI Sub station Nivitigalakele. The crosses were selected to study the inheritance of *Corynespora* leaf disease in RRIC 100 series clones. The crosses attempted, the number of pollinations done in each cross, the number of pods harvested and the number of seedlings obtained in each cross are given in Table 1. The final fruit set success of the pollinations done during the year was 0.521%.

Table 1. *Details of 2005 hand pollination programme*

Cross	No. of pollinations	No. of fruits collected	No. of seedlings
RRIC 100 × RRIC 100	1591	01	01
RRIC 103 × RRIC 103	9731	28	58
Total	11322	29	59

(S P Withanage, K B Karunasekera, T M S K Gunasekera and I D M J Sarathkumara)

Evaluation of hand pollinated progenies

Small scale clone trials

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

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

Results of the Duncan's Multiple Range Test for 15th year girth measurement of the promising clones are given in Table 3. Yield data relevant to the seventh year of tapping based on 9 test tappings are given in Table 4. The highest girth was obtained from clone 86-81 followed by 86-77. The highest yield was obtained from the control clone RRIC 121 followed by the new clone 86-87.

Table 2. *Details of small scale clone trials*

HP year	Site	Planting date
1986	Kuruwita	May 1990
1987	Trial I) Clyde- Kethhena	May 1993
	Trial II) Galawatta	June 1988
1988	Dartonfield	July 1993
1992	Dartonfield	May 1993
1995	Sorana	June 1998
1996	Kuruwita – Trial I & II	May 1999
1991	Pallegoda	August 2000
	Vogan	November 2000
1997	Clyde – Trial I & II	June 2000
1998	N'Kele Trial I, II & III	June 2001
	Kuruwita Trial I, II &III	July 2001
1990	Kuruwita	July 2002
1999	Kuruwita Trial I,II & III	June 2002
2000	Arappalakande Trial I- III	May 2003
2000	Dalkeith Trial I & II	June 2003
2000	Elston Trial I & II	July 2003
2000	Nivithigalakele Trial I & II	July 2003

Table 3. *Mean girth (15th year) of promising H.P. clones*

Clone	Mean girth (cm) and DMRT grouping
86-81	93.62 ^{A}
86-77	88.84 ^{A}
86-21	88.76 ^{A}
RRIC 121	86.61 ^{AB}
86-87	77.36 ^{BC}
86-76	77.13 ^{BC}
86-63	74.56 ^{CD}
86-37	74.33 ^{CD}
86-22	73.96 ^{CDE}
86-73	73.85 ^{CDE}
RRIC 110	773.26 ^{CDE}

Table 4. *Mean yield of promising 1986 H.P. clones*

Clone	Yield (g/t/t) and DMRT grouping
RRIC 121	55.63 A
86 – 87	44.02 AB
RRIC 110	41.23 A BC
86-22	40.59 ABC
86-10	38.79 ABC
86-17	38.43 ABCD
86-25	37.81 ABCDE
RRIC 100	32.80 ABCDEF

(S P Withanage, H P Pieris and K B Karunasekera).

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

Results of the Duncan's Multiple Range Test for 12th year girth are given in Table 5. Seven test tapings were done during the year. Mean yield of the high yielding test entries of this trial in the 7th year of tapping is given in Table 6. Very high bark consumption rates were observed in this field.

Table 5. *Mean girth and the results of DMRT of the 1987 H.P. selections*

Clone	Girth in cm and DMRT grouping
RRIC 121	79.60^{A}
87-370	72.57^{B}
87-364	67.46^{C}
RRIC 100	66.23^{CD}
87-372	63.46^{CDE}
RRIC102	62.56^{DEF}
87-386	60.72^{EF}
87-375	60.61^{EF}
87-382	59.88^{EF}

Evaluation of 1987 H.P. seedlings - Galewatta division Dartonfield estate (GPB/BST/HPS/87/2)

Yield data of the 6th year of BO-2 panel of each family are based on six test tapings. Progeny size, mean girth (17th year) and mean yield of the seedling families are given in Table 7.

Table 6. *Mean yield and the results of DMRT of the 1987 H.P. selections*

Clone	Yield (g/t/t) and DMRT grouping
RRIC 121	53.91^{A}
87-372	53.60^{A}
87-364	48.82^{AB}
87-370	47.48^{AB}
87-382	39.23^{BC}
87-386	33.84^{CD}
RRIC 100	33.27^{CD}

(S P Withanage, I D M J Sarathkumara and K B Karunasekera)

Table 7. *Mean girth and mean yield of the 1987 HP seedling families*

Family	Progeny size	Mean girth (cm)	Mean yield (g/t/t)
RRIM 600 × RRIC 101	07	83.25	37.43
RRIC 101 × GT 1	27	61.65	43.53
RRIC 100 × GT 1	47	85.34	54.61
RRIC 100 × RRIC 101	10	78.85	38.6
RRIC 100 × RRIC 110	08	79.87	42.68
RRIC 100 × RRIC 121	27	82.25	37.13
PB 86 × RRIC 121	14	80.76	44.00
RRIC 102 × GT 1	03	92.66	25.17
RRIC 121 × RRIC 110	24	77.96	67.41
RRIC 110 × RRIC 100	06	75.75	53.00
RRIC 110 × RRIC 121	02	66.5	21.34

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

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

The 12th year girth measurement was taken and the mean girth of clones were grouped using the Duncan's Multiple Range Test. Clones that are better than the control clones are given in Table 8. Mean yields and the DMRT grouping of some selected clones based on seven test tapings in the 5th year of tapping are given in Table 9 along with control clones.

Table 8. *Mean girth in cm of the 1988 HP progeny*

Clone	Mean girth and DMRT grouping
88-28	78.58^{A}
88-31	$76.80^{A\ B}$
88-32	$75.35^{A\ BC}$
88-36	$71.73^{\ A\ B\ C\ D}$
88-16	$69.95^{B\ CD\ E}$
88-15	$68.47^{C\ DEF}$
88-40	$68.03^{\ CDEFG}$
88-14	$67.77^{\ CDEFG}$
RRIC 100	$66.16^{\ DEFGH}$

Table 9. *Mean yield (g/t/t) of the 1988 HP progeny*

Clone	Mean yield and DMRT grouping
RRIC 102	32.97^{A}
RRIC 121	32.05^{AB}
RRIC 110	31.22^{ABC}
88-31	28.64^{ABCD}
88-14	28.24^{ABCDE}
88-32	25.80^{ABCDEF}
88-16	25.06^{ABCDEF}
88-26	24.54^{ABCDEF}

(S P Withanage and L S Kariyawasam)

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

The third year girth measurements were taken at a height of 120 cm. The HP entries better than the best control clone are shown in Table 10.

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

The sixth year girth measurements were taken at 120 cm from the two trials. Some of the best HP entries and control clones from trail 1 and trial 2 are shown in Table 11.

Table 10. *Mean girth of selected HP entries in cm of the 1990 HP progeny planted at Kuruwita Sub stations*

Clone	Mean girth and DMRT grouping
90- 29	23.06^{A}
90- 11	21.62^{AB}
90-27	21.06^{ABC}
90-10	20.62^{ABC}
90- 23	20.37^{ABC}
90- 7	19.75^{ABCD}
90-20	19.31^{ABCDE}
90-21	19.06^{ABCDE}
RRISL 205	18.62^{ABCDE}

(S P Withanage, H P Peris and K B Karunasekera).

Table 11. *Mean girth of selected HP entries in cm of the 1991 HP progeny planted at Pallegoda and Vogan estates*

Mean girth (cm) from 91-01 trial (Pallegoda)		Mean girth (cm) from 91-02 trial (Vogan)	
Clone	**Girth**	**Clone**	**Girth**
RRISL 205	57.84^{A}	97-62	55.46^{A}
91-29	54.90^{AB}	RRISL 205	52.39^{AB}
91-5	52.62^{BC}	91- 63	51.54^{ABC}
91-19	52.58^{BCD}	RRIC 121	50.36^{ABCD}
91- 13	52.34^{BCD}	91- 71	50.28^{ABCD}
91- 8	51.87^{BCDE}	97-58	49.36^{BCD}

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

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

The 6th year girth measurement (cm) and the first year yield (g/t/t) data are given in Table 12 and are grouped using Duncan's Multiple Range Test.

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

Fifth year girth measurements of the experimental clones are grouped using Duncan's multiple range test and superior genotypes are given in Table 13 (better than the control clone RRISL 205 in both trials). Girth measurements were taken at a height of 120 cm.

Table 12. *Mean girth in cm of the 1995 HP progeny*

Clone	Mean girth and DMRT grouping	Clone	Mean yield and DMRT grouping
95-55	62.90^{A}	95-55	44.84^{A}
95-50	62.64^{AB}	95-13	40.25^{AB}
RRIC 121	61.20^{ABC}	95-14	38.03^{BC}
95- 48	60.96^{ABCD}	95-47	37.76^{BC}
95- 47	59.25^{ABCDE}	95-3	35.30^{BCD}
95- 23	58.96^{ABCDE}	95-19	34.63^{BCD}
95- 51	58.69^{ABCDEF}	95-15	34.11^{BCD}
95- 45	58.64^{ABCDEF}	95-21	33.75^{CDE}
95-29	$58.37^{ABCDEFG}$	95-45	30.43^{DEF}
95-11	58.06^{BCDEFG}	95-24	30.24^{DEF}
95-33	57.38^{CDEFGH}	PB 255	29.59^{DEFG}

(S P Withanage, I D M J Sarathkumara and K B Karunasekera)

Table 13. *Mean girth at 120 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	60.66^{A}	RRIC 121	53.50^{A}
96-15	54.13^{B}	96-37	51.93^{AB}
96-3	53.84^{BC}	96-54	51.13^{AB}
96-31	53.53^{BCD}	96-44	49.42^{ABC}
96-14	52.86^{BCDE}	96-47	48.37^{ABCD}
96-17	52.13^{BCDEF}	96-45	48.33^{ABCD}
96-58	51.60^{BCDEF}	RRISL 205	47.51^{ABCD}
RRIC 121	49.89^{BCDEFG}		
RRISL 205	49.57^{BCDEFG}		

(S P Withanage, H P Peris and K B Karunasekera)

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

The fifth year girth measurements were taken at a height of 120 cm in both trials. The best HP entries of both trials are shown in Table 14 (S P Withanage, T M S K Gunasekera and K B Karunasekera).

Table 14. *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**
97-2	52.92^{A}	97-55	52.32^{A}
97-19	51.50^{AB}	RRISL 205	49.60^{AB}
97-9	51.03^{ABC}	97-61	48.32^{BC}
RRISL 205	50.46^{ABCD}	97-44	48.06^{BC}
97-26	50.36^{ABCD}	97-74	47.96^{BC}
97-22	49.80^{ABCDE}	97-48	47.76^{BC}
97-25	49.66^{ABCDEF}	97-67	47.75^{BC}

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

Forth year girth measurements taken from the above six trials were analyzed using Duncan's multiple range test. The results revealed the presence of superior HP entries than the control clones. Girth of some of the best HP entries and control clones are shown in Tables 15a and 15b.

Table 15a. *Mean girth of selected HP entries in cm of the 1998 HP progeny planted at Nivitigalakele Sub stations*

Mean girth (cm) from trial 98-01		Mean girth (cm) from trial 98-02		Mean girth (cm) from trial 98-03	
Clone	**Girth**	**Clone**	**Girth**	**Clone**	**Girth**
98-88	42.43^{A}	98-132	42.64^{A}	RRISL 205	40.75^{A}
98-147	39.15^{AB}	98-129	41.17^{AB}	RRIC 121	40.59^{A}
98-180	38.08^{BC}	98-96	40.46^{AB}	98-204	40.03^{AB}
98-134	37.46^{BCD}	98-159	40.15^{AB}	98-281	39.76^{ABC}
RRIC 130	37.30^{BCDE}	RRIC 121	39.03^{BC}	98-151	39.62^{ABC}
98-119	36.64^{BCDEF}	RRIC 130	36.40^{CD}	98-225	38.73^{ABC}
98-100	35.78^{BCDEFG}	98-53	36.03^{CDE}	98-197	38.25^{ABCD}
RRIC 121	35.76^{BCDEFG}	98-104	35.16^{DEF}	98-280	38.10^{ABCD}
98-115	35.63^{BCDEFG}	98-259	35.06^{DEF}	RRIC 130	38.06^{ABCD}
RRISL 205	35.50^{BCDEFG}	98-94	34.90^{DEF}	98-157	37.87^{ABCD}
		RRISL 205	34.78^{DEF}		

Table 15b. *Mean girth of selected HP entries in cm of the 1998 HP progeny planted at Kuruwita Sub stations*

Mean girth (cm) from trial 98-04		Mean girth (cm) from trial 98-05		Mean girth (cm) from trial 98-06	
Clone	**Girth**	**Clone**	**Girth**	**Clone**	**Girth**
98-84	36.90^{A}	98-68	36.71^{A}	98-223	34.91^{A}
98-98	35.62^{AB}	98-58	36.00^{AB}	98-19	33.92^{AB}
98-230	34.90^{AB}	98-51	34.43^{ABC}	RRISL 205	33.57^{ABC}
98-219	34.53^{ABC}	98-80	34.37^{ABC}	98-154	33.50^{ABCD}
98-11	34.50^{ABCD}	98-41	33.50^{ABCD}	RRIC 121	32.77^{ABCD}
98-276	34.46^{ABCD}	98-62	32.68^{BCDE}	98-30	32.17^{ABCDE}
98-89	33.81^{ABCDE}	98-07	32.63^{BCDE}	98-278	31.62^{ABCDEF}
98-153	33.40^{ABCDE}	98-73	32.26^{CDE}	RRIC 130	31.57^{ABCDEF}
98-25	33.18^{ABCDE}	RRIC 121	30.93^{CDEF}	98-15	$31.00^{ABCDEFG}$
98-124	33.09^{ABCDE}				
RRISL 205	32.31^{ABCDE}				

(S P Withanage, H P Peris and K B Karunasekera).

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

This experiment was planned to test the HP entries derived from 1999 HP programme. Three trials were planted using complete randomized design including three control clones RRIC 121, RRIC 130 and RRISL 205. Each clone was replicated 8 times. The trials 99/01, 99/02, 99/03 have 39, 39 and 38 HP entries respectively.

Results of the third year girth measurements were taken from each trial and the HP entries better than the best control clone is shown in Table 16.

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 division (GPB/BST/HPS/00/06,07) at Eleston Estate (GPB/BST /HPS/00/08, 09)

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

In this trial, progenies derived from 11 families are being tested in three blocks. Each block contains 364 genotypes in completely randomized single tree plots. Results of the second year girth measurements are given with the families (Table 17a).

Table 16. *Mean girth of selected HP entries in cm of the 1999 HP progeny planted at Kuruwita Sub stations*

Mean girth (cm) from trial 99-01		Mean girth (cm) from trial 99-02		Mean girth (cm) from Trial 99-03	
Clone	**Girth**	**Clone**	**Girth**	**Clone**	**Girth**
99-55	19.93^{A}	99-157	21.75^{A}	99-230	21.18^{A}
99-61	19.00^{AB}	99-265	20.18^{AB}	99-78	21.07^{AB}
99-71	18.81^{ABC}	99-167	20.00^{ABC}	99-195	20.31^{ABC}
99-73	18.00^{ABCD}	99-236	19.71^{ABCD}	99-44	20.18^{ABC}
99-43	17.75^{ABCD}	99-159	19.16^{ABCDE}	99-120	20.00^{ABC}
99-48	17.68^{ABCD}	RRISL 205	18.92^{ABCDE}	99-166	19.68^{ABCD}
99-81	17.43^{ABCD}	99-47	18.56^{ABCDEF}	99-64	19.56^{ABCD}
99-42	17.37^{ABCD}	99-210	$18.37^{ABCDEFG}$	99-189	19.50^{ABCD}
99-139	17.37^{ABCD}	99-137	$18.07^{ABCDEFG}$	99-216	19.37^{ABCD}
99-80	17.06^{ABCD}	99-178	$18.00^{ABCDEFG}$	99-63	19.31^{ABCD}
99-67	16.93^{ABCDE}	99-242	$17.81^{ABCDEFG}$	RRIC 121	19.21^{ABCD}
99-94	16.92^{ABCDE}	99-161	$17.78^{ABCDEFG}$		
99-69	16.81^{ABCDEF}	99-206	$17.06^{BCDEFGH}$		
99-58	16.68^{ABCDEF}	99-135	$16.93^{BCDEFGH}$		
99-72	16.62^{ABCDEF}	99-197	$16.75^{BCDEFGH}$		
RRIC 121	16.62^{ABCDEF}	99-246	$16.68^{BCDEFGH}$		

(S P Withanage, H P Peris and K B Karunasekera).

Table 17a. *Mean girth in cm and DMRT grouping of families of the 2000 HP progeny Trail I. planted at Arappalakande estate*

Family	Mean girth and DMRT grouping
RRIC 121 × PB 235	17.64^{A}
PB 235 × RRIC 121	17.06^{AB}
BPM 24 × PB 260	16.87^{AB}
PB 235 × PB 260	16.83^{ABC}
BPM 24 × PB 260	16.73^{ABC}
RRIC 121 × PB 260	16.59^{ABC}
BPM 24 × RRIC 121	16.23^{BDC}
BPM 24 × GP 36-104	16.05^{BDC}
PB 260 × RRIC 121	15.58^{CDE}
RRIC 121 × GP 36-147	15.36^{DE}
PB 260 × PB 262	14.85^{E}

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

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

In this trial a total of 258 genotypes derived from 10 families are tested in a completely randomized single tree plot experiment. Results of the second year girth measurements are given with the families (Table 17b).

Table 17b. *Mean girth of families in cm of the 2000 HP progeny Trail II. planted at Arrapalakande estate*

Family	Mean girth
BPM 24 × PB 235	17.5
BPM 24 × PB 260	16.7
BPM 24 × RRIC 121	17.2
PB 235 × PB 260	16.2
PB 235 × RRIC 121	16.5
PB 260 × PB 260	15.2
PB 260 × RRIC 121	16.9
RRIC 121 × GP 36-147	17.0
RRIC 121 × PB 235	17.4
RRIC 121 × PB 260	17.1

(S P Withanage, K W Rupatunge and K B Karunasekera).

***Arappalakande Trial III* (GPB/BST/HPS/00/03)**

This trial contains 90 genotypes derived from a single family BPM 24 × PB 235 in a completely randomized design with four single tree plots per clone. Second year girth measurements (cm) of some the genotypes and their DMRT ranking are shown in Table 18.

Table 18. *Girth in cm and their DMRT ranking*

Clone	Girth
2000-59	20.55^{A}
2000-130	19.62^{AB}
2000-64	19.50^{AB}
2000-121	19.25^{AB}
2000-192	18.90^{ABC}
2000-54	18.87^{ABC}
2000-149	18.75^{ABC}
2000-101	18.62^{ABCD}
2000-103	18.60^{ABCD}
2000-106	18.27^{ABCDE}
2000-190	18.20^{ABCDE}

(S P Withanage, I D M J Sarathkumara and K B Karunasekera).

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

In this trial, 112 genotypes derived from two families (RRIC 121 × PB 235 and PB 235 × RRIC 121), 56 from each family, were planted in a completely randomized design with three single tree plots per clone. Results of the second year girth measurements show that about 52 genotypes have achieved over 15.0 cm (S P Withanage, K W Rupatunge and K B Karunasekera).

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

In this trial, 98 genotypes from two families [BPM 24 × PB 260 (53) and RRIC 121 × PB 260 (45)] were planted in a completely randomized design with three single tree plots per clone. DMRT grouping from the second year girth measurements is shown in Table 19.

Table 19. *Mean girth (cm) of some of the good genotypes and DMRT ranking*

Clone	Girth
2000-1199	19.5^{A}
2000-292	17.5^{AB}
2000-208	16.50^{ABC}
2000-274	16.25^{ABCD}
2000-198	16.00^{ABCD}
2000-1222	16.00^{ABCD}
2000-254	15.93^{ABCD}
2000-1286	15.60^{ABCDE}
2000-275	15.50^{ABCDE}
2000-1198	18.27^{ABCDE}

(S P Withanage, I D M J Sarathkumara and K B Karunasekera).

Nivithigalakele division 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 in a completely randomized design are being tested. In Trial VII 193 genotypes have been included from a single family with three single tree plots in a completely randomized design. Family mean, Variance, Minimum and Maximum for the second year girth measurements (cm) are given in Table 19.

Table 19. *Details of the girth (cm) measurements of the two trials*

	Results of the trial VI (BPM 24 × RRIC 121)	Results of the trial VII (PB 260 × RRIC 121)
Mean	15.38	16.83
Minium	12.33	11.50
Maximum	22.00	24.50
Variance	4.31	4.47

(S P Withanage, 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 in a completely randomized design are being tested. 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 second year girth measurements in trial VIII shows that most of the genotypes have good girthing ability. Table 20 shows the family means calculated from the second year girth measurements in trial IX.

Table 20. *Families and their mean girth*

Parentage (Family)	Mean girth in cm
BPM 24 × GP 36-104	13.76
BPM 24 × PB 235	14.91
BPM 24 × PB 260	14.33
BPM 24 × RRIC 121	14.32
PB 235 × PB 260	14.59
PB 235 × RRIC 121	14.32
PB 260 × PB 260	13.13
PB 260 × RRIC 121	13.89
RRIC 121 × GP 36-147	13.48
RRIC 121 × PB 235	14.80
RRIC 121× PB 260	13.90

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

Analysis of variance of the seventh year girth showed the presence of highly significant differences in growth between clones, sites and the presence of significant genotype × environment interaction effect (Table 21). Table 22 shows the mean girth measurements and the variance amongst the clones in the eight sites under study. The highest mean girth, over all sites were recorded for RRISL 201, RRISL 205 and RRISL 206 whilst GPS 1 showed the lowest girth.

Table 21. *The results of the analysis of variances*

Source	DF	Mean square	Significance
Clones	13	4780.29	***
Sites	7	1743.54	***
Clone × Sites	91	151.82	***

*** 0.1%

Table 22. *Mean girth (cm) and the variance of the clones in each site*

Clone	Ganepalla	Muwan Kanda	Atale	Palm Garden	Pelma dulla	Badde Gama	Bibile	Sorana	Clone Mean	Variance
RRISL 201	59.6	63.5	58.6	54.7	59.8	61.3	55.0	58.6	58.9	8.7
RRISL 205	62.0	66.8	60.4	56.7	55.3	60.9	55.9	66.9	60.6	20.8
RRISL 206	52.8	62.3	59.1	55.6	54.6	59.4	57.2	59.5	57.6	9.6
RRISL 210	54.7	50.8	54.0	48.5	51.7	53.3	46.8	52.0	51.4	7.3
RRISL 215	51.9	55.0	49.3	48.3	54.0	53.8	46.2	52.3	51.4	9.5
RRISL 217	50.7	52.8	52.4	47.6	52.3	51.5	50.1	55.5	51.6	5.2
RRISL 218	48.9	59.8	59.4	44.6	51.7	56.7	49.5	59.4	53.7	34.1
RRISL 220	50.6	54.2	47.4	37.0	48.9	54.6	41.4	38.8	46.6	46.2
GPS 1	38.5	41.6	35.7	33.2	32.7	38.1	36.2	37.4	36.7	8.4
RRII 105	51.2	54.5	54.0	43.6	51.8	54.0	47.0	50.6	50.8	14.6
RRIM 712	44.5	46.1	44.5	34.9	45.7	47.4	41.7	34.5	42.5	25.9
RRIC 130	49.2	49.5	47.6	48.4	55.1	50.3	43.3	47.6	48.9	10.8
Heiken 2	41.0	50.1	45.4	36.1	44.9	43.3	46.5	38.8	43.3	20.0
PB 260	46.2	50.9	52.4	50.2	52.0	51.8	43.8	50.5	49.7	9.5
Site Mean	50.1	54.1	51.5	45.7	50.7	52.6	47.2	50.2		

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

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

The 5th year girth measurements were taken. Table 23 shows the mean girth of each treatment, *i.e.* control monoclone plots and plots of Bi – and Tri - clonal mixtures.

Table 23. *Mean girth of each treatment*

Treatment	Mean girth (cm)
RRIC 121	57.94
RRIC 100/RRIC121/RRIC 133	55.20
RRIC 121/RRIC 133	52.46
RRIC 133	52.21
RRIC 102/RRIC 133	51.10
RRIC 100/RRIC 133	50.44
RRIC 100/RRIC 102	50.30
RRIC 102/RRIC 121	49.96
RRIC 100/RRIC 121	49.90
RRIC 102	49.86
RRIC 100/RRIC 102/RRIC 133	49.43
RRIC 100/RRIC 102/RRIC 121	48.90
RRIC 102/RRIC 121/RRIC 133	48.79
RRIC 100	48.32

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

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

Fifth year girth measurements were recorded for this trial and are shown in Table 24. It shows that girthing ability of seedlings is as good as budded stumps.

Table 24. *Fifth year girth measurements obtained from seedlings and budded plants*

Budded plants	Girth (cm)	Selected seedlings	Girth (cm)	Unselected seedlings	Girth (cm)
PB 86	42.67	PB 86	49.81	PB 86	48.42
RRIC 121	48.35	RRIC 121	45.62	RRIC 121	50.40
PB 28/59	46.13	PB 28/59	44.29	PB 28/59	43.69
RRIC 100	45.85	RRIC 100	52.19	RRIC 100	51.95
PB 260	48.41	PB 260	54.13	PB 260	52.08

(S P Withanage, 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 25 shows the girth data for the current year along with the data for previous two years.

Table 25. *Annual girth measurements (cm) of ECTs and year of planting*

Clone	Site	Year of planting	Girth in cm		
			2003	2004	2005
RRISL 201	Tempo	1996	57.6	62.8	65.5
	Moralioya	1996	58.5	63.7	69.4
	Kuruwita	1994	62.02	64.0	67.0
	Salawa	1999	34.78	50.5	58.8
RRISL 202	Moralioya	1996	55.6	58.1	61.7
	Kuruwita	1994	55.47	56.5	59.8
RRISL 203	Galewatta	1987	68.32	69.3	71.2
RRISL 205	Pallegoda	1995	61.9	64.2	67.9
	Vogan	1997	62.0	68.5	73.5
RRISL 206	Pallegoda	1995	55.5	57.7	61.8
	Vogan	1997	53.1	59.2	62.7
	Salawa	1999	40.06	49.7	53.9
RRISL 211	Dartonfield	1994	61.2	62.8	63.7
	Siriniwasa	2001	17.35	28.46	38.76
RRISL 208	Dartonfield	1994	60.55	62.7	64.16
RRISL 215	Salawa	1999	44.1	52.0	57.9
RRISL 216	Dartonfield	1994	57.2	59.6	60.8
RRISL 217	Kuruwita	1995	50.95	53.4	56.7
	Vogan	1997	49.9	54.1	58.6
RRISL 219	Dartonfield	1994	NA	62.0	63.5
RRISL 220	Salawa	1999	36.8	45.10	49.37
RRISL 221	Salawa	1999	34.0	45.9	52.6
RRISL 223	Galewatte	1994	61.4	61.44	63.1
RRISL 225	Nivitigalakele	2002	12.5	21.65	34.5
RRISL 226	Salawa	1999	36.6	47.5	52.5
	Siriniwasa	2001	16.7	26.0	37.2
RRISL 2000	Pallegoda	1998	46.28	54.25	60.5
	Nivitagalakele	2001	18.8	30.6	43.6
RRISL 2001	Pallegoda	1995	56.5	58.7	61.0
	Nivitigalakele	2001	15.6	24.7	36.9
GPS 1	Pallegoda	1998	27.9	33.4	39.0
RRII 105	Pallegoda	1998	39.5	47.2	52.3

Yields from ECTs

GPB/BST/ECT/95/01

The estate yields obtained from ECT trials are given in Table 26. Clone, year of tapping, DRC, g/t/t and yield/tree/annum are reported for the year.

Table 26. *Commercial yields obtained from ECT trials*

Clone	Year of tapping	No. of tapping days	Average DRC (gm/l)	g/t/t	Yield/tree/annum (Kg)
RRISL 201	5	159	330	22.28	3.54
RRISL 202	5	164	280	23.10	3.78
RRISL 203	11	96	380	49.64	4.76
RRISL 205	4	106	349	29.00	2.63
RRISL 206	4	132	343	26.50	3.46
RRISL 208	4	92	390	43.89	4.08
RRISL 211	4	75	320	39.55	2.99
RRISL 216	4	92	360	40.07	3.58
RRISL 217	5	103	310	27.03	3.43
RRISL 219	4	92	320	36.66	3.47
RRISL 223	2	87	290	27.96	2.43
RRISL 2001	4	145	298	29.75	4.34
GPS 1	4	73	272	24.55	2.00

(S P Withanage, 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

Fourth year girth measurements were taken from these trials (Table 27). All three clones planted under this programme showed vigorous growth.

Table 27. *Mean girth of the SRT trials planted in 2001*

Clone	Site/Expt. No.	Year 1	Year 2	Year 3	Year 4
RRISL 201	Kegalle (SRT/01/01)	10.5	20.2	31.7	43.5
	Homagama (SRT/01/03)	10.4	20.1	31.6	43.9
RRISL 203	Kegalle (SRT/01/01)	10.8	19.4	30.03	42.45
	Homagama (SRT/01/03)	8.58	16.85	26.6	37.1
RRISL 205	Kegalle (SRT/01/01)	8.95	15.7	23.8	34.14
	Homagama (SRT/01/03)	10.3	19.9	32.50	45.60

(S P Withanage, K B Karunasekera, L S Kariyawasam and E A T Senadeera)

CARP Project 12/478/973 - Testing of new *Hevea* clones for rubber smallholders

Third year mean girth for the four clones obtained from three sites planted in year 2002 and second year girth of clones planted in year 2003 are given in Table 28. The site planted by Mr K C Gunathilaka is frequently affected by the floods resulting a set back on plant growth. Required fertilizer applications for the period was completed.

Table 28. *Mean girth of the trials planted in 2002 and 2003*

Clone	Site/Expt. No.	Year 1	Year 2	Year 3
RRIC 201	Kalutara (SRT/02/02)	6.98	17.8	26.38
	Kalutara (SRT/02/03)	6.04	13.5	20.18
	Ratnapura (SRT/02/04)	6.98	11.3	17.92
	Kaburupitiya (SRT/03/01)	10.0	20.7	
	Radawela (SRT/03/01)	7.3	16.0	
RRIC 205	Kalutara (SRT/02/02)	5.9	16.6	27.34
	Kalutara (SRT/02/03)	6.44	14.7	22.06
	Ratnapura (SRT/02/04)	6.17	12.3	20.9
	Kaburupitiya (SRT/03/01)	8.8	18.2	
	Radawela (SRT/03/01)	7.7	15.6	
RRIC 206	Kalutara (SRT/02/02)	6.82	19.0	30.03
	Kalutara (SRT/02/03)	6.69	15.98	26.22
	Ratnapura (SRT/02/04)	6.2	12.15	20.76
	Kaburupitiya (SRT/03/01)	9.18	19.75	
	Radawela (SRT/03/01)	8.51	16.9	
RRIC 121	Kalutara (SRT/02/02)	5.21	12.9	20.16
	Kalutara (SRT/02/03)	6.19	12.6	18.67
	Ratnapura (SRT/02/04)	6.18	9.6	
	Kaburupitiya (SRT/03/01)	9.91	17.9	
	Radawela (SRT/03/01)	8.1	17.2	

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

Three selected genotypes 12-93, 22-137 and 44-24 were bud grafted to establish ECT trials to monitor their performance. Nursery fence was renewed. The genotype numbers were repainted while maintaining the trial with minimum expenditure (S P Withanage, K K Liyanage and I D M J Sarathkumara).

New plantings

Estate/RRI collaborative clone trials

An ECT trial was established at Kuruwita Sub-station to test the performance of RRISL 2000, GPS II and selected seedlings of RRIC 100.

PLANT SCIENCE

P Seneviratne

SUMMARY

Experiments on the quality improvement of the planting material continued with a little success. Girthing ability of plants with different root systems, *i.e.* tap root and fibrous root, but with the same genetic make up were comparable. Successive grafting experiments were continued in order to reinstate the juvenility in mature budded plants.

In crown budding trials done on RRIC 110 trunks, trees with RRIC 121 as the crown showed the highest girth in both trial tested. *H. spruciana* crowns showed the lowest girth. In another trial with a number of trunk crown combinations, RRIC 121 crown on RRISL 217 trunk showed the highest girth.

Nursery inspection for the quality improvement of plants was carried out throughout the year. The number of plants certified for RPC, government and private nurseries were 0.8, 1.6 and 0.17 million respectively for the year under review. Budwood nurseries were also monitored for the authenticity. The main problems with regard to budwood nurseries were the lack of sufficient budwood points and nurseries in large enough the very poor quality condition of them.

The growth parameters of rubber have significantly decreased with the increase of planting density from 500 to 800. The overall performance of RRIC 121 was superior to that of other clones, whilst it was lowest in RRIC 110, the clone affected by *Corynespora* leaf disease.

Among the low frequency tapping systems tested, d/6 tapping system showed the highest g/t/t, but the YPH low. The highest YPH was given by d/4 tapping system and particularly in the clone RRIC 130. Stimulation showed no adverse effect on DRC. According to the results of the survey done on the tapping panel dryness, % TPD has increased generally with the advancement of the tapping panel from BO-1 to BI-2.

With the use of biomass and organic carbon contents in the above and below ground components, total biomass and organic carbon content of the whole tree was estimated and two models were established as a function of the diameter at 1.5m height of the tree.

In the trial conducted to see the possibilities of intercropping rubber with cinnamon, treatments with widest inter row spacings and paired rows of rubber gave the highest cinnamon bark yields. Those treatments with narrow inter row spacings gave low yields. In the trial conducted with perennial fruit crops performance of durian was poor as far as establishment and the growth were concerned.

DETAILED REVIEW

Staff

Dr (Mrs) Priyani Seneviratne, Head of the Department, Dr V H L Rodrigo, Principal Research Officer in Intercropping, Mr L S S Pathiratna and Dr A M W K Seneviratne, Botanists, Mr K A G B Amaratunga, Mr R P Karunasena, Mrs G A S Wijesekera, Mr S Wilbert, Mr U S Weerakoon, Mrs R K Samarasekera, Mr T U K Silva, Mr M N de Alwis and Mr M K P Perera, Experimental Officers, Mr D L N de Zoysa, Mr P D Pathirana, and Mr P K W Karunatilaka, Technical Officers, Mrs D E Jayawardena and Mrs P D A H M A de Almeida, Clerk/Typists were on duty throughout the year.

Mr A Wickramaratne, Assistant Botanist continued his postgraduate studies at University of Alberta, Canada. Mr N M C Nayanakantha, Assistant Botanist, left for his postgraduate studies on 06.01.2005. However, he was in department during his semester break, from 09.06.2005 to 22 07. 2005.

Miss D S A de Silva, joined the department as an Assistant Botanist with effect from the 17th August. Mr J Chaminda, Graduate trainee was recruited as a Development Assistant under the graduate training programme. Dr V H L Rodrigo, Principal Research Officer assumed duties as the Acting Head, Biochemistry and Physiology Department with effect from 13th October.

Research students

- Mrs E S Munasinghe, Research Assistant, continued her project on "Economic Assessment of rubber plantations of Sri Lanka with special emphasis on carbon sequestering capability and timber production" under the supervision of Dr V H L Rodrigo.

- Miss U K D K Deepika, University of Wayamba conducted her final year project on "Studies on the somatic embryogenesis from immature inflorescence of improved cultivars of *Hevea brasiliensis*" under the supervision of Dr (Mrs) P Seneviratne.

- Miss L U S Sandamali Jayawardana from University of Wayamba conducted her final year project on "The effect of media on in vitro propagation of *Paulownia spp.*" under the supervision of Dr (Mrs) P Seneviratne.

- Mr M S Mangala from University of Wayamba, conducted his final year project on "Feeder root distribution of component crops in the rubber/tea intercropping system" under the supervision of Dr V H L Rodrigo, Dr S M M Iqbal and Dr S Dharmakeerthi.

- Mr H M L Niran from University of Wayamba, started his final year project on "Influence of the establishment of cover crops on the floral distribution under mature rubber plantation" under the supervision of Dr V H L Rodrigo and Mr C Nayanakantha.

- Mr H S Priyantha, from Advanced Technical Institute, Naiwala started his 4 month training from 2nd August and studied the factors governing the quality of the plants

Seminars/Conferences/Meetings/Workshop attended

Officer	Subject	Organization
Dr (Mrs) P Seneviratne and Dr V H L Rodrigo	Scientific Committee Meeting	RRISL
Dr (Mrs) P Seneviratne	Biotechnology Meeting	NSF
Dr (Mrs) P Seneviratne	Rubber Cluster Meeting	MPI
Dr (Mrs) P Seneviratne	Cess Committee Meeting	MPI
Dr (Mrs) P Seneviratne	Meetings on Moneragala Rubber Project	MPI
Dr V H L Rodrigo	Meetings on Moneragala Rubber Project	MPI
Ms D S A de Silva	Short course on Crop Experimentation	CARP and Post Graduate Institute of Agriculture

Training programmes

Client	Subject	No. of programmes
Plantation Sector	Tapping	04
Plantation Sector	Rainguards	02
RDD	Planting, Tapping and Rainguards	02

Advisory visits

Client	No. of visits
Plantations	27
Smallholders	04

LABORATORY INVESTIGATIONS

Tissue culture

***Propagation of clonal* Hevea**

New experiments were not conducted as the Research Assistant who conducted research on tissue culture, had to leave the country for his post graduate studies.

Existing cultures of *Hevea* were subcultured regularly to maintain them in culture (N M C Nayanakantha, P Seneviratne and C P Edussuriya).

FIELD EXPERIMENTS

Clonal propagation

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

Plants of clones RRIC 130 and 100, produced through rooted cuttings and plants produced from rooted cuttings RRIC 121 subjected to several generations of successive grafting were maintained in the field. These rooted cuttings were planted in the field in 2002 and the trees have reached an average girth of 30 cm after 03 years (P Seneviratne and G A S Wijesekera).

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

Plants of five high yielding individuals were maintained in a budwood nursery. Propagation of these plants through rooted cuttings was not successful, due to failures of the mist propagator as well as maturity factor associated with them (P Seneviratne, G A S Wijesekera and R K Samarasekara).

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

Wintering and flowering were observed in seedlings trees in the field consecutively planted from the year 1991. Wintering was observed in seedlings planted from the year 1991 to 2001 and flowering occurred in seedlings, planted from the year 1991 to 1997 (P Seneviratne and G A S Wijesekera).

Variation in budded plants (BG/2003/DF)

As mentioned in annual review 2004, all the uniform plants of this experiment were cut back to obtain rooted cuttings of similar age to repeat budgrafting experiments. But as the rooting percentage was very low (4%) in the mist propagator, obtaining plants of same age in large quantities was unsuccessful (P Seneviratne, B T J Perera and G A S Wijesekera).

Root system of* Hevea *(CP/1994/1 -NK)

Girth measurements of the plants with different root systems, *i.e.* tap root and fibrous root, but with the same genetic make up are given in the Table 1.

Table 1. *Girth measurements of the plants of the same genetic makeup but with different root systems*

Plant number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Average**	**SEM**
Girth of the seedling (cm)	61.5	54.5	32	49	21.5	21.5	35	47.5	37	40	64	43	42.5	3.86
Girth of the corresponding cutting (cm)	53	43	54	20	19.5	53	44	68.5	20.5	48	38	47.5	42.4	4.46

50% of the cuttings have girthed better than their seedling counterparts whilst in the balance the seedlings have shown a higher girth (P Seneviratne and G A S Wijesekera).

The effect of the rootstock on growth and yield of budded plants (BG/2005/DF)

A new experiment was initiated with the seedlings of August seed fall, to see the effect of rootstock of budded plant on growth and yield. Seedlings were raised from the seeds of clone RRIC 102 and RRIC 100.

Germination time and the growth of seedlings were monitored and the germination percentage is shown in Fig. 1.

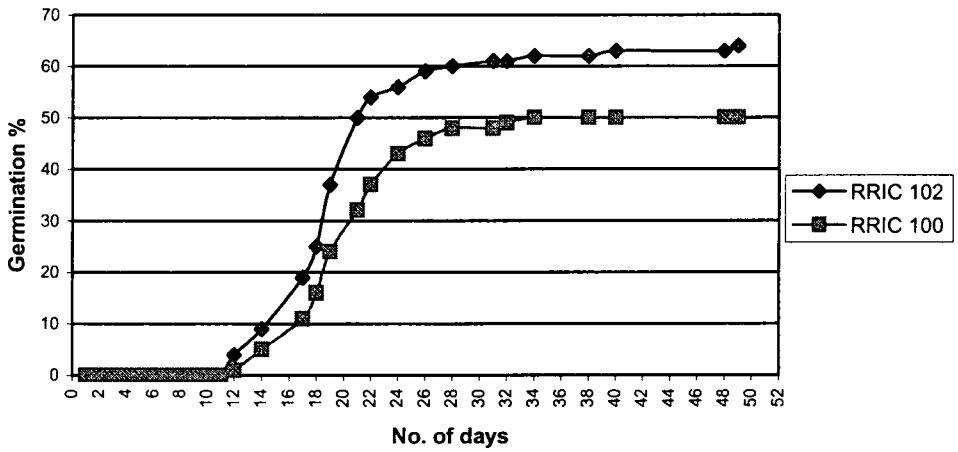


Fig. 1. Germination percentage of RRIC 102 and RRIC 100 seeds

It has taken 20 and 28 days for RRIC 121 and RRIC 100 seeds to complete 50% germination respectively (P Seneviratne and G A S Wijesekera).

Budgrafting

Successive grafting - BG/1999/1 - Dartonfield

Only one budgrafting passage was completed during the year. Seven successive grafting passages have been completed up to now (P Seneviratne and G A S Wijesekera).

Rejuvenation of budwood plants

Three budgrafting passages have been completed by the end of 2005 and 10 plants of the first two passages of each clone were field planted at Eagaloya nursery (P Seneviratne and G A S Wijesekera).

Crown budding

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

Mean girth of RRIC 110 trees crown budded in 1997 with RRIC 100, 102, 117, 130 and *H. spruciana* at Padukka estate are given in Table 2. As shown in Table 2, RRIC 121 shows a significantly higher girth in both clearings. *H. spruciana* crown budded trunks shows the lowest girth.

Table 2. *Mean girth of RRIC 110 plants crown budded with different clones (The SEM is given within brackets)*

Clearing	Crown	Girth (cm)
1996 RRIC 110	RRIC 100	62.93 (±) 0.91
Menerigama Division	RRIC 102	63.35 (±) 1.17
	RRIC 117	63.64 (±) 1.053
	RRIC 121	81.65 (±) 1.43
	RRIC 130	62.1 (±)1.18
	H. spruciana	52.83 (±) 1.18
1994 RRIC 110	RRIC 100	57.48 (±) 1.008
Main Division	RRIC 102	58.49 (±) 1.42
	RRIC 110 (control)	81.06 (±) 2.56
	RRIC 117	58.24 (±) 0.92
	H. spruciana	***51.28*** (±) 2.6

Trees of both clearings show comparable growth irrespective of their age difference. Girthing is relatively better when the crown is RRIC 121 and it is as good as continuous growth of RRIC 110 trees which are two years older than crown budded trees in the Menerigama division. Yield data of the two trials are given in Table 3. Yield of *H.spruciana* is unexpectedly low.

Table 3. *Average yield of RRIC 110 plants crown budded with different clones*

Division	Clone	Average yield (g/t/t)
Menerigama	RRIC 130	31.07
	RRIC 100	27.95
	RRIC 102	25.48
	RRIC 117	14.53
	RRIC 121	20.48
	H. spruciana	7.92
Main	RRIC 100	16.44
	RRIC 102	11.9
	RRIC 117	12.65
	RRIC 110 (control)	13.09
	H. spruciana	6.0

(P Seneviratne and M N de Alwis).

RRIC 121 trunks with RRIC 100 crowns – CB/1992/1 – Dartonfield

Average yield for a period of one month during 2005 is given in Table 4. The girth of crown budded trees is less when compared with trees not crown budded owing to the set back after cut back crown budding. The higher yields in trees, which were not crown budded is attributed to the higher girth.

Table 4. *Average yield (volume) and girth (number of test tappings done is given in brackets)*

Treatment	Mean girth in cm	Yield ml/t/t
1. Trunk – RRIC 121 Crown – RRIC 100	66.42	145.9 (10)
2. RRIC 121 (Not crown budded)	91.46	352.9 (10)
3. RRIC 100 (Not crown budded)	88.41	348.7 (10)
4. RRIC 121 (Control)	63.90	132.5 (12)
5. RRIC 100 (Control)	64.63	152.0 (12)

(P Seneviratne and S Wilbert).

RRIC 130 trunks with H. spruciana crown - CB/1992/2 - Galewatta

Average yield and girth of RRIC 130 trees and crown budded trees with *H. spruciana* are given in Table 5. The girth of *H. spruciana* crown is slightly low when compared to the girth of RRIC 130. The yields of trees with *H. spruciana* crowns are very poor.

Table 5. *Average yields (volume) and girth (Number of tappings are given in brackets)*

Crown	Tree No.	Girth in cm	Average yield ml/t/t
Hevea spruciana	1	70.0	52.3 (10)
	2	69.5	66.4 (10)
Mean		69.7	53.3
RRIC 130	4	50.0	58.6 (10)
	9	89.0	584.0 (10)
	11	76.5	366.8 (10)
	13	86.5	368.6 (10)
Mean		75.5	344.5

(P Seneviratne and S Wilbert).

RRISL 224 trunk with different crowns (1992 replanting of G & PB Dept) - CB/1999/1 – Galewatta

Mean girth of trees with different crowns are given in Table 6.

Trees crown budded with RRIC 100 have given the highest growth, where as those budgrafted with *H. pauciflora* shows the lowest. RRISL 224 trees which failed crown budding eventually died due to repeated attacks of *Corynespora.*

Table 6. *Mean girth of trees with different crown clones*

Crown	Mean girth cm (± SEM)
RRIC 100	74.20 (±) 13.25
RRIC 121	56.97 (±) 3.11
H. pauciflora	51.34 (±) 3.43
RRIC 100 + *pauciflora*	68.68 (±) 4.35
RRIC 100 + RRIC 121	66.98 (±) 4.89
RRIC 121 + *pauciflora*	60.73 (±) 13.6
RRIC 100 + 121 + *pauciflora*	62.13 (±) 3.70

(P Seneviratne 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 were published in the Annual Review for 2001. The clone RRIC 121 shows the highest girth whilst it is lowest in clone PR 305. As far as trunk and crown combinations are concerned, RRIC 121 crown on RRISL 217 trunk shows the highest girth (Table 7).

Budwood nurseries

Budwood availability

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

Above budwood nurseries were established with new RRISL clones in order to provide authentic material for the establishment of budwood nurseries in private and regional plantation company nurseries. The number of plants of each clone in these nurseries have been reported in Annual Review for 2002.

Budwood was harvested when necessary to budgraft rootstocks in order to issue authentic planting material for establishing budwood nurseries (P Seneviratne, U S Weerakoon, M N de Alwis and L Zoysa).

Plant certification programme

The following nurseries which are given in Tables 8, 9 and 10 were inspected, each nursery at least 3-4 times during the year, in order to improve the quality of the plants produced.

Table 7. *Mean girth of trees with different crown/trunk combinations*

Treatment	Trunk	Crown	Mean girth (cm)	
1	PR 305	Control	45.18	± 1.02
	PR 305	RRIM 717	34.90	± 1.72
	PR 305	Pollarded	45.57	± 1.15
2	RRIM 717	Control	47.33	± 0.89
	RRIM 717	PR 305	34.31	± 0.88
	RRIM 717	Pollarded	43.63	± 2.67
3	BPM 24	Control	45.75	± 2.02
	BPM 24	PB 260	33.50	± -
	BPM 24	Pollarded	40.13	± 2.41
4	PB 260	Control	51.14	± 2.01
	PB 260	BPM 24	38.17	± 2.35
	PB 260	Pollarded	47.00	± 2
5	RRIC 121	Control	55.14	± 1.89
	RRIC 121	RRISL 217	39.83	± 2.58
	RRIC 121	Pollarded	50.67	± 1.33
6	RRISL 217	Control	49.38	± 1.29
	RRISL 217	RRIC 121	40.75	± 0.95
	RRISL 217	Pollarded	45.00	± 1.07
7	RRIC 121	Control	54.17	± 1.43
	RRIC 121	RRIC 130	34.50	± 4.65
	RRIC 121	Pollarded	54.64	± 1.63
8	RRIC 130	Control	52.43	± 1.22
	RRIC 130	RRIC 121	38.50	± 3.75
	RRIC 130	Pollarded	51.58	± 1.39

(P Seneviratne and L Zoysa).

Table 8. *RPC Nurseries (established in 2004 January, 2004 August and 2005 January)*

RPC	Estate/s	No. of nurseries	No. of plants certified		*Total*
			YB	BR	
Agalawatta	8	18	-	132,035	132,035
Balangoda	5	11	1,300	32,365	33,665
Elpitiya	2	8	-	48,760	48,760
Hapugastenna	2	3	-	-	-
Horana	4	8	4,100	41,000	45,100
Kahawatta	1	5	40,000	45,200	85,200
Kegalla	11	50	66,386	27,255	93,641
Kelani Velly	12	15	-	-	-
Kotagala	9	35	50,854	99,696	150,550
Lalan	1	3	155,484	-	155,484
Malwatta Velly	5	11	90,629	7,500	98,129
Maturata	1	1	-	-	-
Namunukula	1	1	-	-	-
Pussellawa	7	20	4,000	51,000	55,000
Watawala	2	4	-	-	-
Total	71	193	412,753	484,811	897,564

Table 9. *Government nurseries (established in 2004 January, 2004 August and 2005 January)*

Name of Government Nursery	Nurseries inspected	Number of plants certified		Total
		YB	BR	
Egaloya	2004/Aug/YB, 2005/Jan./YB	328,000	-	328,000
Gurugoda	2004/Aug/YB, 2005/Jan./YB	248,000	-	248,000
Karapinche	2004/Aug/YB, 2005/Jan./YB	175,000	-	175,000
Meerigama	2004/Jan/YB, 2004/Aug./YB, 2005/Jan./YB	345,700		345,700
Monaragala	2004/Aug/YB, 2004/Aug./GN, 2005/Jan./YB	200,000	5,000	205,000
Welikadamulla	2004/Aug/YB, 2004/Aug./GN, 2005/Jan./YB	315,000	63,000	378,000
Total		1,611,700	68,000	1,679,700

Nursery monitoring for quality improvement was done throughout the year. The main problem in most of the nurseries was the use of seedlings collected from mature fields to establish rootstock nurseries. The second most important factor that affected the quality of budded plants was the lack of budwood nurseries and therefore harvesting buds from field trees for grafting (P Seneviratne, A M W K Seneviratne, U S Weerakoon, M N de Alwis, L Zoysa, D Pathirana and J Chaminda).

Table 10. *Private nurseries*

Region	Number of nursery holders	Number of nurseries inspected	Number of plants certified		Total
			YB	BR	
Kalutara	3	8		27,000	27,000
Kegalla	18	36	9,225	89,385	98,610
Monaragala	3	10	6,000	-	6,000
Ratnapura	8	20	-	49,000	49,000
Total	32	74	15,225	165,385	180,610

Consistency of the Porous pipes

The objectives of this study were to compare the consistency of the locally produced porous pipe with that of imported porous pipes and to measure the mean discharge rates. 2.5 m long porous pipes were connected to the main line under a pressure of 1.5 bar.

According to the results, there was a variation in the consistency of locally produced porous pipes. The average discharge rate of the locally produced porous pipe was 19.0 l/m/hr while in the imported porous tube it was 2.2 l/m/hr (P Seneviratne, D S A de Silva and G A S Wijesekera).

Micro-Porous Irrigation System for Rubber Nurseries

A field experiment was carried out at Gurugoda Government Rubber Nursery to assess the performance of porous pipe micro–irrigation system on growth of rubber plants during prolonged dry spells as a cost effective method.

Main objective of the experiment was to assess the performance of sub surface irrigation system on the growth of rubber plants, while comparing locally produced porous pipes with imported porous pipes, over manual watering.

Installation of porous-pipes was completed in December 2005. The system is to be operated until the nursery plants are ready to distribute to the growers. The experiment comprised of three main treatments and replicated four times.

T1 - with imported porous pipes (Aqua Spa)
T2 - trial with locally produced porous pipes (Leaky pipe)
T3 - normal manual watering (control)

Plants were arranged in double rows and porous tubes were installed 10 cm below the ground level and perforated poly bags were placed on porous pipes with 60 cm spacing between double rows (P Seneviratne, D S A de Silva and G A S Wijesekera).

Planting techniques

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

Mean girth and girth increment for different treatments are shown in the Table 11. Girth increment is comparable in all treatments but the mean girth is highest in the control treatment in both types of planting material tested. However, the treatment differences are not significant with young buddings.

Table 11. *Mean girth, girth increment and SEM of the plants (RRIC 121 and PB 260) of different treatments*

Treatment	Young budding RRIC 121 1999 N/E		Poly bag PB 260 1999 S/W	
	Mean girth (cm)	Girth increment (cm)	Mean girth (cm)	Girth increment (cm)
T1 - With poly bag	51.545 (±1.086)	5.485(± 0.406)	49.974 (±1.171)	5.340 (±0.485)
T2 – Base removed	51.730 (±1.396)	6.306(± 1.324)	53.450 (± 1.457)	4.540 (±0.380)
T3 – Base removed + four slits	52.985 (±1.303)	6.46 (± 0.339)	54.411 (± 1.839)	6.022 (±0.742)
T4 – Four slits only	53.694 (±1.375)	7.705(± 1.811)	53.175 (± 1.228)	5.375 (±0.639)
T5 –Bag removed as Recommended	54.017 (±1.361)	5.788(± 0.370)	57.720 (± 1.942)	5.855 (±0.586)

(P Seneviratne and U S Weerakoon)

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

Details of the experiment are given in Annual Review for 2001. A correlation exists between the initial girth and the girth measured up to the year under review. The average girth of the plants grown in three types of planting holes are not significantly different (Table 12 and 13).

Table 12. *Girth of plants grown in three types of planting holes*

Soil condition	Girth (cm)	Girth increment
Bad	39.286 (± 0.109)	7.236
Moderate	39.553 (± 0.603)	7.273
Good	40.872 (± 0.322)	7.832

Table 13. *Correlation of girth increment and initial girth*

	Girth (cm)		
	Bad	**Moderate**	**Good**
Correlation coefficient (r)	0.31727	0.35365	0.26375
P value	< 0.0001	< 0.0001	< 0.0001
Sample size (n)	139	84	253
STDEV	5.0184	5.523	5.123
SEM	0.109	0.603	0.322

(P Seneviratne and L Zoysa).

Coppicing (CP/2002/1-N'Kele)

Shoot regeneration capacity of mature trees was tested by pollarding some RRIC 52 trees planted in 1972 at a height of 6" form union. The sprouting time varied from tree to tree and also the girth and the number of shoots produced showed a big variation. Further, the success rate was only 15% owing to the trees being very old. However, the trials conducted at Dartonfield and Gallewatta in 2003 showed some positive results as for as the success rate and the girthing are concerned. When 5-6 years old trees were cut at 12" and 18" above the union an average girth of 25cm per annum was observed (P Seneviratne and M N de Alwis).

Cultural practices during immature phase

Branch induction – CP/2001/1 – Pallegoda

The girth of the trees of different branch induction treatments are shown in Table 14. With the clone RRIC 121, the leaf cap method and removing a 3" long part of apex have given almost the same effect while in the other two treatments the girthing is not significantly different. With mixed clones, leaf cap method shows the highest girthing capability.

Table 14. *Girth values of different branch induction treatments on RRIC 100 and mixed clones*

Treatment	**Girth (cm)**	
	RRIC 121	**Mixed clones**
T1 – Leaf cap	69.73 (± 1.52)	63.73 (± 1.59)
T2 - Leaves cut	67.82 (± 1.27)	58.38 (± 2.05)
T3 – 3" long apex removed	69.75 (± 1.38)	60.93 (± 1.96)
T4 – Control	68.50 (± 1.02)	56.12 (± 2.22)

(P Seneviratne and U S Weerakoon).

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

Details of the experimental layout are given in the Annual Review for 1992. Growth and yield parameters of the clones tested under four different densities are given in Table 15 (a). The growth parameters of rubber as indicated in Table 15 (a) have significantly decreased with the increase of planting density and subsequently the individual tree yield (g/t/t) also shows a similar trend. Table 15(b). Although not significant in all four planting densities, comparatively higher YPH values were recorded this year than previous years. Some possible reasons are bringing in new trees in the experiment for tapping and tapping on 334 days during the year. The overall performance of RRIC 121 was superior to that of other clones, whilst it was lowest in RRIC 110, the clone affected by *Corynespora* leaf disease.

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

Details of the experiment have been reported in the Annual Review for 2003. Effective trees in each block at Nivitigalakele division were remarked and arrangements were made to record yield data. Girth measurements at 5' height from grafted union were taken at the end of the year. Girth decreased with increasing planting density irrespective of the clone. Latex yield of individual clone (g/t/t) was highest in the trees planted with the lowest density. Among the clones tested, PB 260 has given the highest g/t/t whilst it was lowest in RRIC 100 (Table 16).

The possibility of expanding cultivation of rubber to areas, above 300m in the mid country wet zone

Details of the experiment have been reported in the Annual Review for 2003. RRIC 100 and RRIC 102 were tapped on 1/2S d/2 system while RRIC 130 and PB260 were on 1/2S d/3 system as done in previous year. During each tapping dry rubber yield and latex volumes were measured. At monthly intervals yield determining parameters, *i.e.* Plugging index, Dry rubber content and Initial flow rate were measured as given in Tables 17 and 18. Tapping days were recorded and climatic parameters, *i.e.* Minimum temperature, Maximum temperature and Relative humidity were monitored. Girth measurements were taken quarterly.

Trends in yield/tree/tapping continues to be the same whilst it is high in all four clones tested. Anyhow, the two d/2 clones, *i.e.* RRIC 100 and 102 have given the highest yield per tree per annum among the four clones tested (Table 17).

The number of normal tappings recorded during the second year of tapping is 308, which is significantly higher than what is recorded in traditional areas (Table 19).

Table 15. *Effect of planting density on growth and yield parameters of rubber. In (a) plant girth (cm) and bark thickness (mm) at 150cm height, % trees in tapping and tappable trees/ha (b) tree yield (g/t/t) and estimated YPH (kg/ha/year)*

(a)

Density	RRIC 100				RRIC 110				RRIC 121			
	Girth (cm)	Bark thickness (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	61.99	7.34	92.52	463	57.86	6.96	75.62	378	69.95	7.21	94.14	471
600	61.21	7.33	94.14	565	54.13	6.42	69.04	414	66.12	7.13	91.64	550
700	57.51	7.17	90.50	634	51.86	6.47	60.16	421	64.92	6.69	89.02	623
800	57.16	7.06	88.96	712	51.21	6.28	56.78	454	62.82	6.50	91.73	734

(b)

Density (tree/ha)	RRIC 100		RRIC 110		RRIC 121	
	Yield (g/t/t)	Yield (kg/ha/yr)	Yield (g/t/t)	Yield (kg/ha/yr)	Yield (g/t/t)	Yield (kg/ha/yr)
500	23.80	1688	24.15	1390	38.55	2767
600	23.58	2035	21.81	1393	31.76	2666
700	19.06	1829	20.12	1290	31.07	2982
800	18.96	2086	18.99	1324	26.60	3001

(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 16. *Effect of planting density on growth and yield parameters of rubber*

	RRIC 100			RRIC 121			RRIC 133			PB 260		
Density l/ha	Girth (cm)	g/t/t	Yield kg/ha/yr.	Girth (cm)	g/t/t	Yield kg/ha/yr.	Girth (cm)	g/t/t	Yield kg/ha/yr.	Girth (cm)	g/t/t	Yield kg/ha/yr.
350	77.1	32.12	809.42	78.9	35.54	895.61	79.4	33.67	848.48	74.1	38.22	963.14
425	75.1	31.90	976.14	75.9	34.32	1045.25	75.9	32.59	997.25	72.2	35.44	1084.46
500	66.4	31.64	1139.04	68.9	33.91	1220.76	70.5	31.84	1146.24	63.2	35.16	1260.00
575	64.6	27.91	1155.47	66.5	30.18	1249.45	62.2	30.08	1245.31	64.5	32.23	1334.32

* No of tappings per year (2005) - 72

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

Table 17. *Yield and growth performance of different* Hevea *clones*

Parameter	Clone			
	PB 260	RRIC 102	RRIC 100	RRIC 130
Yield (g/t/t)	32.72	33.22	36.97	42.66
Latex volume (ml/tree/tapping)	98.69	91.82	104.25	103.41
Dry rubber content (%)	33.15	36.12	35.42	32.70
Trunk girth (cm)	49.17	57.09	59.66	61.73

Table 18. *Clonal mean in Plugging Index and Initial flow rate at two different girth levels*

Genotype	Initial flow rate (ml/min)		Plugging index	
	45cm girth	50cm girth	45cm girth	50cm girth
RRIC 100	0.076	0.070	2.184	2.156
RRIC 102	0.063	0.067	2.114	1.915
RRIC 130	0.096	0.592	2.505	2.226
PB 260	0.057	0.068	1.646	1.707

Table 19. *Tapping days in Second year of tapping (January 2005 – June 2005)*

	Total
I. Normal Tapping	308
II. Double Tapping	-
III. Late Tapping	-
IV. Slight Rain Interference	-
V. Heavy Rain Interference	-
VI. No Tapping due to rain	24
VII. No Tapping due to other	33
Total	365

(A Nugawela, V H L Rodrigo and G P Wijesinghe)

Exploitation

Low frequency tapping

Dartonfield 1988 replanting (LFT/2003-/1)

This experiment was started in July 2003 at Dartonfield estate to test the effectiveness of low frequency tapping systems in clone RRIC 130 and RRIC 100. Details of the experiment are given in the Annual Review for 2003.

Low frequency tapping systems and the stimulation schedule are given in Table 20.

Table 20. *Tapping systems and the stimulation schedule for the treatments*

Treatment	Tapping system	Schedule of stimulation (ET 2.5% Ba.)
T_1	½ S d/4	Monthly application except in February, March, April
T_2	½ S d/6	Monthly application
T_3	½ S d/2	No stimulation

Table 21. *Summary of the latex yield, number of tapping days, average DRC and the estimated YPH for different tapping systems*

Treatment	Clone	g/t/t	Tapping days/y	Estimated YPH/Y	Average DRC (%)
T_1 - ½ S d/4	RRIC 130	67.4	61	1644.5	42
	RRIC 100	54.0	61	1317.6	34
T_2 - ½ S d/6	RRIC 130	80.2	25	1122.8	46
	RRIC 100	72.6	41	1190.6	36
T_3 - ½ S d/2	RRIC 130	26.0	136	1414.0	36
	RRIC 100	25.8	128	1320.0	32

According to the Table 21, d/6 tapping system showed the highest g/t/t, however YPH was lowest in this system. The highest YPH was given by d/4, particularly by the clone RRIC 130. Stimulation showed no adverse effect on DRC. Although rainguards had been fixed, number of tapping days were rather low (V H L Rodrigo, A Wickramarathne and R K Samarasekera).

Galewatta Replatings 1987, 1989, 1990 - LFT/2005/1

This experiment was commenced in February 2005 at Gallewatta to test the effectiveness of low frequency tapping systems d/4 and d/6 in clones RRIC 100, RRIC 102, RRIC 121 and RRIC 130.

Detatils of the LFT systems together with stimulation schedule are given in Table 22.

Table 22. *Tapping systems and the stimulation schedule for the treatments*

Treatment	Tapping system	Schedule of stimulation (ET 2.5% Ba.)
T_1	½ S d/4	Monthly application except February, March, April
T_2	½ S d/6	Monthly application

One tapping block from each clone was allocated for the experiment. In each block 25 trees were allocated to T_2 treatment and the rest of the trees in the block were tapped according to the T_1 treatment.

Daily latex yields were monitored using volumetric measurements of latex and metrolac measurement for DRC%. For three clones (*i.e.* RRIC 100, RRIC 121 and RRIC 130), yield records on d/3 tapping were obtained from estate records (No. additional tapping block was available for RRIC 102).

Table 23. *Summary of the yield parameters of low frequency tapping systems*

Treatment	Clone	g/t/t	Tapping days (11months)	Stand/Ha.	YPH(Kg)	Average DRC (%)
T_1 - ½ S d/4	RRIC 100	47.7	57	400	1087.0	34
	RRIC 102	51.7	69	400	1426.0	34
	RRIC 121	46.9	60	400	1125.6	38
	RRIC 130	42.0	55	400	924.0	40
T_2 - ½ S d/6	RRIC 100	75.9	40	400	1214.4	36
	RRIC 102	74.8	41	400	1226.7	36
	RRIC 121	74.1	40	400	1185.6	36
	RRIC 130	60.1	39	400	937.5	40
T_3 - ½ S d/2	RRIC 100	35.0	97	400	1358	34
	RRIC 102	48.9	101	400	1975.5	38
	RRIC 121	47.3	98	400	1854.0	38

Although g/t/t was higher in d/6 tapping YPH was comparable between the tapping systems (Table 23). Stimulation showed no adverse effect on DRC, which was generally over 30% (V H L Rodrigo, A Wickramarathne and R K Samarasekera).

Tapping Panel Drynes

Survey on Tapping Panel Dryness (TPD/2002/01)

Survey on Tapping Panel Dryness of presently grown four clones was completed. Collection of data from 85 tapping blocks has been done (Table 24). Summary of total and partial tapping panel dryness (% TPD), clone and panel wise, is given in the Table 24. According to the results, % TPD has increased generally with the advancement of the tapping panel from BO-1 to B1-2 (Table 24 and Fig. 2).

Table 24. *Summary on the survey of TPD in different clones under different tapping panels*

Clone	Tapping Panel	No. of Tapping blocks	% TPD	
			Total	Partial
RRIC 100	BO-1	9	7.1	5.1
	BO-2	10	16.9	11.9
	B1-1	7	17.7	8.7
	B1-2	1	17.4	6
RRIC 102	BO-1	4	3.8	3.1
	BO-2	7	14.2	8.1
	B1-1	4	12.1	7.7
	B1-2	-		
RRIC 121	BO-1	10	1.7	2.3
	BO-2	11	10.6	6.2
	B1-1	7	11.9	7.3
	B1-2	2	16.2	15.4
RRIC 130	BO-1	6	5.9	4.2
	BO-2	2	14.9	7.4
	B1-1	5	15.1	9.7
	B1-2	-		
Total		**85**		

* Total TPD – Entire tapping panel is dry Partial TPD – Part of the panel is dry

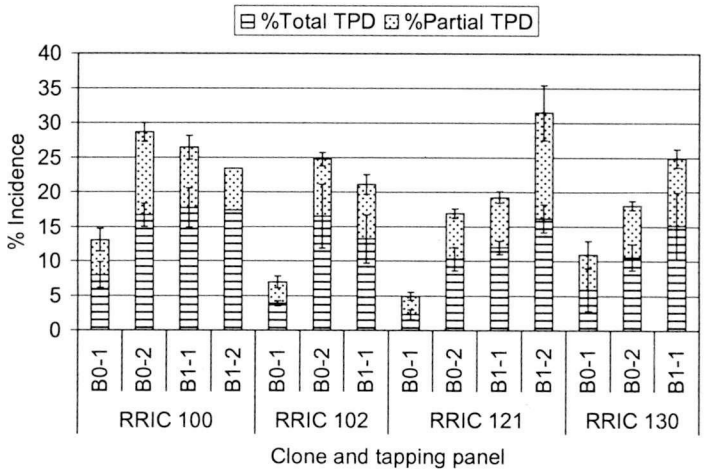


Fig. 2. Incidence of TPD in different tapping panels (BO-1 - B1-2) of some clones. % totally dry trees (Total TPD) and % partially dry trees (Partial TPD) are shown for total of 85 tapping blocks in Table 24 (A M W K Senevirathna, S Wilbert and S Wijesinghe).

Resting and continuous shaving on TPD trees (TPD/2002/02)

Selected tapping blocks at the Dartonfield estate are being monitored. No significant changes have been recorded to date (A M W K Senevirathna, S Wilbert and S Wijesinghe).

Continuous monitoring of TPD (TPD/2002/03)

Ten tapping blocks from each of the clones RRIC 100, 102, 121 and RRIC 130 and from five estates were monitored at three monthly intervals for the incidence of TPD (Table 25). According to the results, TPD percentages are comparatively high in clearings of RRIC 100 (1995) and RRIC 130 (1996) of Ambetenna and Arappolakanda estates, respectively. 'Total TPD' percentage of 23.88% for RRIC 130 at Arappolakanda estate was extremely high probably due to the high intensity of tapping over the recommendation (Table 25). Continuous monitoring also showed that TPD first appears as a partial dryness. The % dry trees increases gradually with period of tapping.

Table 25. *Percentage total and partial TPD trees of a tapping block of rubber being tapped in the first virgin panel, BO-1*

Clone	Estate	Planting Year	% TPD	
			Total	Partial
RRIC 100	Ambetenna	1995	12.06	4.31
	Culloden	1997	1.39	1.16
	Culloden	1998	0.95	0.63
RRIC 102	Ambetenna	1992	3.87	2.9
RRIC 121	Ambetenna	1996	1.41	2.47
	Culloden	1997	1.55	1.24
	Uskvalley	1996	2.38	0.95
RRIC 130	Arappalakanda	1996	23.88	10.82
	Culloden	1997	3.06	2.45
	Clyde	1997	1.3	0.78

* Total TPD – Entire tapping panel is dry Partial TPD – Part of the panel is dry

In addition to above data, tappers involved in the survey are being interviewed for the collection of local knowledge incorporated in TPD. Most of tappers pointed out that tapping on wet panels due to rainy weather causes TPD (A M W K Senevirathna, S Wilbert and S Wijesinghe).

Biochemical analyses (TPD/2002/04)

Analysis of sugars showed that glucose and sucrose content of TPD affected trees are high compared with healthy trees. Further investigations on clonal

differences are being carried out (A M W K Senevirathna in collaboration with Biochemistry Department CARP funded project – 12/478/358).

Rainguards 2004

Five training programmes were conducted on rainguarding and manufacturing of the sealant (V H L Rodrigo, R P Karunasena and W Karunatilaka).

Intercropping

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

Details of experimental layout were reported in the Annual Review 2002. Out of the three replicates, grafted Durian plants in replicate 1 and 2 were replaced with grafted Jak plants and Durian seedlings respectively because of the poor establishment of grafted Durian plants. Growth measurements of all crops except Durian and Cinnamon were made at six month intervals. Harvesting of Cinnamon was continued throughout the year and this activity interrupted growth measurements of this crop. Rambutan flowered in May and assessments of fruit sets were made. Tea was harvested throughout the year and high yields were recorded in the treatments with wider alleys (Table 27). Growth of rubber with respect to the girth measured at 150 cm height was comparable among treatments (Table 26). Also growth of Rambutan and rubber was comparable.

Table 26. *Summary on the growth performance of rubber. Values for girth increment are given for a period of 12 months and measurements were made at 150cm height*

Treatments	Rubber			
	Planted in 2001		Planted in 2000	
	Girth (cm)	Girth increment (cm)	Girth (cm)	Girth increment (cm)
T1- (3m×3m) ×15m	36.48	3.78	36.09	4.34
T2- (3m×3m) ×18m	36.20	3.60	36.61	4.49
T3- (3.5m×3.5m) ×15m	32.82	2.69	42.07	4.19
T4- (3.5m×3.5m) ×18m	37.18	4.31	40.92	6.17

Table 27. *Summary of the growth performance of Rambutan and yield performance of tea* under *different planting arrangements of rubber. Yield of tea is given as the mean fresh weight per hectare per month.*

Treatments	Rambutan	Tea
	Girth (cm)	Crop (kg/month)
(3m × 3m) -15m	20.22	70
(3m × 3m) -18m	17.46	122
(3.5m × 3.5m) -15m	19.39	111
(3.5m × 3.5m) -18m	18.7	120

(V H L Rodrigo, T U K Silva and P D Pathirana)

Economic assessment of rubber plantations of Sri Lanka with special emphasis on carbon sequestering capability and timber production

Model development to assess the biomass and carbon contents in the rubber trees

With the use of biomass and organic carbon contents in the above and below ground components, total biomass and organic carbon content of the whole tree was estimated and two models were established as a function of the diameter at 1.5m height of the tree (Model 1 & 2), (Fig 3).

Total biomass (kg) = $-136.09 + 8874.4\ D^2$ ------Model 1

Total organic carbon (kg) = $-55.75 + 3636.8\ D^2$ ------Model 2

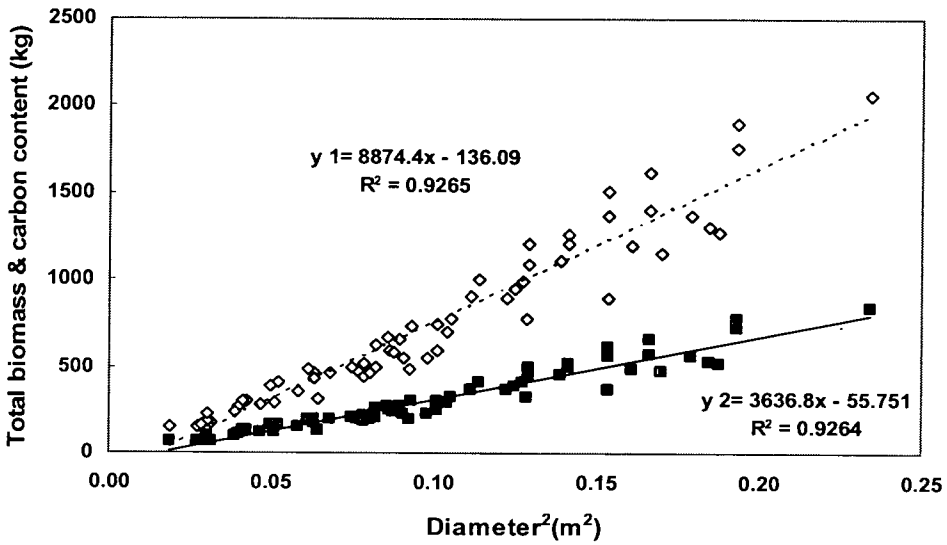


Fig. 3. Relationship of total biomass and total organic carbon content (per tree) with the tree diameter (at 150 cm height). y1 and y2 show the fitted lines to the values of total biomass (symbol -◊) and the organic carbon of whole tree (symbol - ■), respectively.

Financial evaluation of major rubber based intercropping systems under smallholder level

A field survey was commenced to investigate the socio economic conditions of rubber based intercropping systems. A financial evaluation at the smallholder farmer level on three widely used intercropping systems such as banana, tea and pineapple was the focus in this survey. Thirty two farmers were interviewed by end of the year under review (V H L Rodrigo, E S Munasinghe and P K W Karunatilake in collaboration with the University of Sri Jayawardenapura. - This project was initially

funded by Climate Change Enabling Activity (Phase II) Project of the Ministry of Environment & Natural Resources and subsequently by CARP).

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

This rubber/rattan intercropping trial was established in October 1996 and comprised of three indigenous species of rattan (Annual Review 1996). The growth of rattan seems to be rapid but measurements could not be taken due to the height, sprawling of canes and inaccessibility. Some of these canes can be harvested in about a year (L S S Pathiratna and M K P Perera).

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

The experimental details are given in Annual Review 1998. The growth of rubber trees was highest in the treatment with the widest inter row spacings with single rows of rubber. The growth in all treatments with paired rows was comparable with the 8.4m inter row spacing treatment (Table 28).

Treatments with widest inter row spacings and paired rows of rubber gave the highest cinnamon bark yields. Those treatments with narrow inter row spacings gave low yields (Table 29).

Tapping of rubber commenced in January 2005 and taping in the first three months were on a d_3 frequency and was later increased to d_2. The g/t/t yield of rubber was highest in wider inter row spacing treatments with single rows of rubber. Paired row treatments and the treatment with the 7.2m inter row spacing had the lowest yield but was comparable with the 8.4m inter row spacing treatment (Table 30).

Table 28. *The growth of rubber measured as girth in the 6th 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) *	55.2^{C}	57.0^{BC}	57.7^{BC}	58.5^{ABC}	60.4^{AB}	61.5^{A}	56.3^{C}	55.7^{C}	55.1^{C}	54.5^{C}	55.7^{C}

(Values with the same letter are not significantly different)

Table 29. *Cinnamon bark yield kg/ha under different interrow 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	305.7	285.3	356.7	364.0	392.9	487.9	329.3	391.9	451.5	517.7	541.1

S- Single rubber row treatments, P- paired rubber row treatments

Table 30. *Rubber yield in grams /tree/tapping under different interrow 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**
Rubber yield g/t/t	33.4^{CDE}	36.4^{CDE}	38.3^{BCD}	40.2^{ABC}	45.2^{A}	42.6^{AB}	31.2^{DE}	31.4^{DE}	34.8^{CDE}	33.6^{CDE}	29.6^{E}

(Values with the same letter are not significantly different)

(CARP funded Project – Project no 12/463/349) (L S S Pathiratna and M K P Perera)

PLANT PATHOLOGY AND MICROBIOLOGY

C K Jayasinghe

SUMMARY

The incidence of *Oidium* leaf fall during the refoliation period was mild in all rubber growing districts. Although there was a heavy pod set, *Phytophthora* leaf fall and bark rot were moderate. The severity of the *Corynespora* leaf fall in susceptible clones was extremely low through out the year. Sudden outbreak of cockchafer grub attack was reported from Avissawella region during the second quarter and reached the epidemic proportions towards the end of the year. The chemical, chloropyrifos was recommended after screening the insecticides available in the market. Abnormal condition of oozing out of latex below the collar region of rubber trees were noticed in estates managed by Lalan Group of Companies in Avissawella region and investigations have been commenced to confirm the causative agent.

Synergetic effect of inherent phenolic substances in rubber leaves along with increments of peroxidases and/or phenylalanine ammonialyase activity was earmarked as a criteria to distinguish tolerance levels of new rubber clones against *Colletotrichum* leaf disease infection. An island-wide campaign has been launched to assist in eradicating the white root disease in infected patches of young and mature clearings of smallholdings and company owned estates. budwood nursery comprising 44 recommended clones was established at Kuruwita sub-station for the screening purposes. Amplified fragment length polymorphism (AFLP) technique was developed for the early detection of *Corynespora* leaf fall disease susceptibility. Protocol involving anaerobic microbial decaying process was developed to obtain skelitanised rubber leaves to be used in the production of decorative handicrafts such as flower arrangements, book marks, greeting cards and other miscellaneous souvenirs.

DETAILED REVIEW

Dr C K Jayasinghe, continued to be the Acting Deputy Director Biology while covering the duties of the Head of Plant Pathology and Microbiology Department. Dr (Miss) W P K Silva, Principal Research Officer, Dr K E Jayasuriya, Principal Research Officer and Mr W Amaratunge, Audio Visual Production Officer were on duty throughout the year. Experimental Officer Mrs T H P S Fernando was promoted to the post of Assistant Plant Pathologist with effect from 17th August.

Experimental Officers Mr E B Fernando, Mrs B I Tennakoon and Mrs D Wijeratlne, Technical Officers Mr C Wijeratne, Mr P Pieris, Mrs N Jayawardene and Mr E A D N Nishantha, Clerk/Typist, Mrs P Amarasekera continued to work in the Department. Mrs M Kulatunge, Graduate Trainee assumed duties as a Development Assistant with effect from 13th October 2005.

Seminars/Conferences/Meetings/Workshops attended

Officer	Subject	Organization
Dr C K Jayasinghe	Pesticide Technical Advisory Committee	Dept. of Agriculture
Dr C K Jayasinghe	Specialist Committee on Plant Protection	CARP
Dr C K Jayasinghe	Research Committee meeting at CRI to review the progress of research programmes	CRI
Dr C K Jayasinghe	Meetings organized by IRRDB in Malaysia	IRRDB

Seminars/Training programmes conducted

Dr C K Jayasinghe, Dr (Miss) W P K Silva and Dr K E Jayasuriya served as resource personnel in training Estate Managers, Trainee Asst. Managers, Asst. Managers and Field Officers. Mr E B Fernando, Mrs T H P S Fernando, Mrs B I Tennakoon and Mrs D Siriwardene covered the practical aspects of above programmes while all the staff members extended their fullest cooperation in educating students from universities, technical colleges and schools on department activities.

Visits

The Department staff made 24 Advisory, 252 Experimental and 113 other visits during the year.

GENERAL

The wintering was uniform. The weather conditions during the refoliation period were not conducive for the propagation of *Oidium hevea*, the causative agent of Oidium leaf fall. The incidence of *Phytophthora* leaf fall was moderate during this year except in highly susceptible clones. However, an interim circular was sent to all Plantation Companies, Rubber Development Dept. and Advisory Services Dept. requesting them to be vigilant of the bark rot incidences. Island-wide survey on *Corynespora* leaf disease situation was undertaken. No clone recommended for large sale planting was found to be affected with the disease. The incidence of CLF disease was very mild during this year. A project on the management of the white root disease in rubber smallholdings as well as in company-owned estates was initiated. This project is funded by the Sri Lanka Council of Agricultural Research Policy and expected to cover selected infected sites in all rubber growing areas. A new project was also initiated to make use of partially decayed rubber leaf in preparation of decorative handicrafts. Dr C K Jayasinghe was invited by the IRRDB to participate the following events in Kuala Lumpur, Malaysia.

a. Expert consultation meeting on enhancing income of rubber smallholdings in Africa (7^{th} – 8^{th} April 2005)
b. Present a paper on *Corynespora* leaf fall disease (CLFD) at the Transfer of Technology Workshop (4^{th} – 5^{th} April 2005)
c. Attend the meeting of the subject experts of the technical programme on the combating CLF disease (5^{th} – 6^{th} April 2005).

LABORATORY AND FIELD INVESTIGATIONS

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

Screening of fungicides against bark rot caused by* Phytophthora *spp.

A series of experiments was conducted in Dartonfield estate to find the efficacy of fungicides available in Sri Lankan market against bark rot. The technique developed by Satchuthananthavale and others (1974) was used with slight modifications in the screening process. The chemicals tested were Captan, (captan 80%), Dithane M 45, (mancozeb 80%), Ridomil (mancozeb 64%), (metalaxyl 8%), Folicur (tebuconazole), Brunolinum plantarium (xylenols 7.12%), Coal tar oil 30%, Contaf (hexaconazole), Antracol (propineb 70% w.p.), Previcur N (propamocarb hydrochloride 60.7%).

The lesion length above the tapping cut was recorded three weeks after the inoculation with 1×10^4 spore/ml zoospore suspension. The observations indicated that propineb, mancozeb and metalaxyl are the best fungicides to manage bark rot. This experiment will be repeated during the SW monsoon period of the year 2006 (C K Jayasinghe and N Jayawardene).

In vitro *screening of fungicides against* Rigidoporus microporus

Experimental work connected to this project has been in progress (K E Jayasuriya, C K Jayasinghe and D Siriwardene).

Biology of common pathogens (BCP/90/1)

Island-wide survey on *Cylindrocladium quinqueseptatum*

Several leaf samples having symptoms similar to *Cylindrocladium* infection were collected from different agroclimatic regions. Fungal colonies were isolated in the laboratory. The colonies resembling *Cylindrocladium quinqueseptatum* were obtained only from the RRISL 206 leaf samples collected from Baduraliya area (C K Jayasinghe, W P K Silva and N Nishantha).

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

The peak days of Pectic enzyme (PG & PL) production after inoculation were confirmed and the molecular weight determination of PG and PL is underway (C K Jayasinghe, W P K Silva and N Nishantha).

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

Possibility of the use of 'Cassicolin' in screening clones against* Corynespora *leaf fall

Preliminary investigations were done on the production of cassicolin by different isolates of *Corynespora cassiicola* (W P K Silva, C K Jayasinghe, N Nishantha and T H P S Fernando).

Development of molecular markers to identify* Corynespora *leaf fall resistant clones

Experiments are underway to detect resistant gene analog (RGA) markers for the early detection of *Corynespora* resistant clones (This is a collaborative project with University of Colombo and partly funded by CARP) (W P K Silva, C K Jayasinghe, N Nishantha, A Jayakody and E H Karunanayake).

Maintenance of nurseries established for screening purposes

Regular visits were made to the new nursery established at Kuruwita sub-station (C K Jayasinghe, W P K Silva, T H P S Fernando and N Nishantha).

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

The above survey was carried out through out the island covering recommended and potential clones in Group 1, Group 2 and Group 3 (Table 1,2,3). Ranking given based on the disease severity index revealed that no clone recommended for large scale planting was found to be infected with the disease. Slight infections were found in three clones in Group 2 and 3, *viz*. RRIC 133, RRISL 217 and RRISL 208. The clone RRISL 201 showed moderate infections.

Table 1. *Disease severity score of the clones recommended in Group 1*

Clone	Average Disease Severity Index
RRIC 100	0
RRIC 102	0
RRIC 121	0
RRIC 130	0
PB 217	0
PB 28/59	0

Table 2. *Disease severity score of the clones recommended in Group 2*

Clone	Average Disease Severity Index
RRIC 117	0
RRIC 133	0.33
RRISL 203	0
RRISL 205	0
RRISL 206	0
RRISL 211	0
RRISL 215	0
PB235	0
PB 260	0
BPM 24	0

Table 3. *Disease severity index of the clones recommended in Group 3*

Clone	Average Disease Severity Index
RRISL 201	1.19
RRISL 217	0.55
RRISL 204	0
RRISL 208	1.00
RRISL 218	0
RRISL 220	0
RRISL 221	0
RRISL 222	0
RRISL 226	0
GPS 1	0
PB 255	0
PR 255	0
RRII 105	0
RRISL 2000	0
RRISL 2001	0
RRISL 219	0

0, highly tolerant; 0.01 – 1.00, slight infections; 1.01 – 2.00 moderate infections; 2.01 – 3.00 severe infections.

Biological control of *Hevea* diseases (BC/89/1)

Biological control of white root disease

The final field experiment was completed and data were obtained. A patent application has been forwarded to the Commissioner of the Intellectual Property to obtain the patent right to the biological control formula T310 (K E Jayasuriya and B I Tennakoon).

Biological control of rubber nursery diseases

Screening of T21 was abandoned due to its inability to establish on the young rubber leaf surface. Experiments were in progress using an alternative *T. harzianum* isolate (T23) (K E Jayasuriya and C Wijeratne).

Biological control of bark and stem diseases

T. harzianum isolate (T23) was successfully established on rubber bark surface in laboratory conditions. Studies are in progress to improve the retaining ability of the biocontrol formula on the bark surface (K E Jayasuriya and D Siriwardene).

Defence mechanisms of rubber (DM/89/1)

Defence mechanism of rubber

The relationship of PR-protein, PAL enzyme and Peroxidase activities in RRIC100 and RRIC121 rubber leaves infected with *C. gloeosporioides* was studied. Findings were presented in the Symposium held at the University of Wayamba (K E Jayasuriya, B I Tennakoon and W M N Hulugalla).

MISCELLANEOUS

Poisoning of stumps to improve the methods of removing old stand during replanting

The field trial at Galewatta division was in progress and assessments were taken during this period. Organisms responsible for decaying the treated logs were obtained for further studies. They were isolated and a trial to investigate their decaying potentials had been carried out and completed (K E Jayasuriya, C K Jayasinghe, E B Fernando and P Pieris).

Eradication of White root disease in patches of immature, young and old mature rubber lands to increase the land use efficiency and productivity

During this period, several white root disease infected fields selected from Plantation company-owned estates and smallholdings were treated according to the project design. Immature plants including adjoining plants were treated with 1 liter of 1% Contaf while mature trees including adjoining trees were treated with 4 liters of 1% Contaf. Treatments were repeated whenever necessary. Decaying logs including surrounding soils were fumigated with metham sodium and 100 g sulfur was added thereafter 1 month. Vacant points were also treated with 100 g sulfur and the presence of the pathogen was checked using 4 indicator poles in each point. Assessments were taken from previously treated fields (K E Jayasuriya, C K Jayasinghe, E B Fernando and P Pieris).

A repellant against rodents in rubber lands

Formulations containing chillie and tobacco powder were initially tested against household animals and field applications were carried out to test against wild-boars and porcupines. A significant decline of rodents' damage on young plants has been observed in smallholdings and experiments are in progress to minimize the cost and increase the efficacy of the formula using various stickers. Integration of other traditional methods are taken into consideration (K E Jayasuriya, C K Jayasinghe and K M M E K Kulathunga).

Decorative handicrafts from partially decomposed rubber leaf

Rubber tree is known for more than a century for its latex production and timber value. However, the value of the rubber leaf as a source of decorative handicrafts was realized only during the recent past. Rubber producing countries such as Thailand and Malaysia have already developed the ideal technology for converting partially decayed rubber leaves to flower arrangements, book marks, greeting cards and other miscellaneous souvenirs.

With this background Plant Pathology and Microbiology Department initiated the above project during the 2nd quarter of the year with the view of developing economical and efficient technology to obtain the raw material. Presently we are successful in producing skelitanised rubber leaves in large scale using an anaerobic microbial decaying process. Experiments to improve the quality of raw material, labour productivity and colour lasting of ornamental handicrafts are in progress (C K Jayasinghe and N Jayawardene).

Improving Management Strategies in Combating* Corynespora *Leaf Fall Disease: Project Funded by Common Fund for Commodities (CFC)

Collaborative project entitled "Improvement of management strategy in combating *Corynespora* leaf fall disease has been approved to be financed by the Common Fund for Commodities (CFC) for a period of three years. The project will be carried out with the collaboration of Indonesian Rubber Research Institute (IRRI), Malaysian Rubber Board and Rubber Research Institute of India. IRRI will be the Project Executing Agency while International Rubber Research and Development Board will act as the Technical Coordinator. The experiments under the following project components will be carried out with the broad objective of minimizing the losses in natural rubber production due to *Corynespora* leaf fall disease.

- Agronomic approaches to minimize the inoculum potential in the field and thus preventing the incidence of CLFD.

(a) Establishment of multiclonal clearings with disease resistant and susceptible clones.
(b) Experiments with modified dozes of fertilizer on the susceptible clones.
(c) Screening of new-generation fungicides to develop an integrated disease management system.

- Utilization of disease resistance as a tool in the management of CLFD.

(a) Screening of clones under field conditions based on natural inoculum present in the environment.
(b) Laboratory screening of the clones using detached leaf techniques.
(c) Detection of pathogenesis – related proteins in disease resistance of *Hevea brasiliensis* to *Corynespora cassiicola.*
(d) Induction of resistance in different clones against *Corynespora* leaf disease by biological and chemical inducers
(C K Jayasinghe and T H P S Fernando).

Exudation of latex below the collar region due to bark cracking

The attention of the Plant Pathology & Microbiology Department was drawn to an abnormal condition of oozing out of latex below the collar region in mature and immature clearings in estates managed by Lalan Group of Companies in Avissawella region. The preliminary investigations revealed that there is no direct involvement of a fungal pathogen. However, common secondary invaders were isolated from the samples brought to the laboratory. Though there are evidence to categorize this malady under physiological disorders, further investigations are in progress to confirm the causative factor (C K Jayasinghe, W P K Silva and T H P S Fernando).

Cockchafer grub epidemic

Sudden outbreak of cockchafer grub attack was reported from Avissawella region during the second quarter and reached the epidemic proportions towards the end of the year. The affected area had one to two year old clearings and the total area damaged was around 160 ha. More than 20% of the plants in the affected fields were subjected to severe defoliation resulting in a die-back. Immediate steps were taken to screen the chemicals available in the market since the insecticide (Carbofuran) recommended for the management of grub attack was found to be not effective. Chloropyrifos was recommended based on the results of the initial experiments and presently grub attack is under control. Research is in progress in order to develop an integrated pest management system, since pesticide application needs to be repeated for effective control (C K Jayasinghe and M Kulatunga).

SOILS AND PLANT NUTRITION

Lalani Samarappuli

SUMMARY

Incorporation of 5kg rice straw per tree per annum would contribute about 1/3 of N and 2/3 of K recommended as chemical fertilizer for rubber during the mature period. Accordingly an integrated fertilizer programme was formulated combining reduced quantity of chemical fertilizer and rice straw for both virgin and renewed panels. An effective method to control *Wedelia trilobata* (Arunadevi) is recommended; that is to spray with MCPA 60 or its cocktails. *Mucuna* very effectively covered a thickly grown *Wedelia* field and completely controlled the growth of *Wedelia*a in about 4-6 months period. It is concluded that establishment of *Mucuna* is the most efficient control measure of *Wedelia* in rubber cultivations. The effect of various agronomic practices on growth performance and productivity of rubber was investigated in the Moneragala district and a management plan is recommended with special reference to soil moisture conservation.

A commercially available controlled-release fertilizer, Agroblen, was found agronomically effective when a single application of 9 g per plant was applied in young budding nurseries. Because of the high cost, at present Agroblen could be used when there is an absolute labour shortage in young budding nurseries. The current fertilizer recommendation for young budding nurseries was revised by recommending continuous application of currently recommended fertilizer mixtures at 4-week intervals by doubling the rate of application.

Leaf N, P, K and Mg contents of mature rubber leaves collected during the soil and foliar survey in the year 2005 indicated that fertilizer application should be continued uninterruptedly during the initial period of tapping. The site-specific fertilizer recommendation programme for mature rubber provided fertilizer recommendations for 2500 hectares in the estate sector. Under the land selection programme for planting rubber 100 hectares were surveyed. The Department analyzed approximately 450 samples (2000 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. Assistant Soils Chemist, Mr D N P Wickramasinghe continued his postgraduate studies in USA. Experimental Officer, Mrs R Hettiarachchi assumed duties as an Assistant Soils Chemist in August.

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 and A Thevarapperuma and Technical Officers, Messrs P R Puhambugoda, J A S Chandrasiri and T Gunatilleke and the English Stenographer Mrs L Rupasinghe were on duty throughout the year.

Research students

- Miss S de Silva, an undergraduate student from the University of Peradeniya, completed her final year project on "An investigation on the phosphorous availability in rubber growing soils of Sri Lanka when locally available P sources are used as a P fertilizer" under the supervision of Dr R S Dharmakeerthi.
- Mr R Ranasinghe, an undergraduate student from the University of Wayamba, completed his third year project on "Agronomic effectiveness of locally available phosphate sources as a basal application in young budding nurseries of rubber" under the supervision of Dr R S Dharmakeerthi.

Seminars/Conferences/Meetings/Work-shops addressed

Officer	Subject	Organization
Lalani Samarappuli	*Wedelia trilobata* (Arunadevi): Is it a threat to rubber plantations?	Scientific Committee Meeting, RRISL
S Dharmakeerthi	Fertilizer application to rubber	Bogawantalawa Plantations Ltd.

Seminars/Conferences/Meetings/Work-shops attended

Officer	Subject	Organization
Lalani Samarappuli	Formulation of policies and strategies for the long-term sustainability of the plantation sector	Ministry of Plantation Industries
Lalani Samarappuli	Revision of the curriculum of Faculty of Agriculture	Faculty of Agriculture, University of Peradeniya
Lalani Samarappuli S Dharmakeerthi	Ceremonial opening of the Soil Survey Laboratory and SRICANSOL Resource Center	Soil Science Society of Sri Lanka
Lalani Samarappuli S Dharmakeerthi	Scientific Committee Meeting	Rubber Research Institute
S Dharmakeerthi	Water Professionals' Day Symposium 2005	PGIA
S Dharmakeerthi	Geo-Informatics 2005	PGIA

Training programmes

Client	No of programmes
Plantation Executives	01
Estate Managers	04
Field Officers	03
Estate Workers	01
Rubber Development Officers	00
Smallholders	01
University Students	03
NDT Students	01

Advisory visits

Client	No of visits
Plantations	13
Smallholdings	12

LABORATORY AND FIELD INVESTIGATIONS

Soil fertility management

Mulching

The incorporation of 5kg rice straw per tree would contribute about 1/3 of N and 2/3 of K, recommended as chemical fertilizer for rubber per year during the mature period. An integrated fertilizer programme was formulated combining reduced quantity of chemical fertilizer and rice straw for both virgin and renewed panels (Table 1). Application of rice straw was continued with and without chemical fertilizer during mature phase. Test tapping was done to assess the latex yield (Table 2) (Lalani Samarappuli, U Mitrasena and T Gunathilake).

Table 1. *An integrated fertilizer programme for both virgin and renewed panels of mature rubber*

Panel	Amount of straw (kg/tree/yr)	Amount of urea (g/tree/yr)	Amount of Muriate of Potash (g/tree/yr)
Virgin	05	125	50
Renewed	05	75	25

Table 2. *Effect of mulching on yield of rubber*

Species	Yield (g/t/t)
No fertilizer, no mulching	35.1^{A}
Fertilizer only, no mulching	41.3^{B}
Mulching without fertilizer	41.0^{B}
Mulching with fertilizer	45.2^{B}

(Means with same letter are not significantly different)

Ground cover management

New cover crop species

An experiment was started to study the performance of *Mucuna bracteata* in different shade conditions under mature rubber. Field experiments are in progress at Payagala estate, Dodangoda, Dartonfield estate, Agalawatta, Salawa estate, Avissawella, Weniwella estate, Kegalle and RRI sub station, Kuruwita to study the performance of *Mucuna* under mature rubber in different soil series; *Boralu, Agalawatta, Homagama, Parambe* and *Ratnapura,* respectively. Another experiment is also in progress to study the same under soil moisture stress conditions at Kumarawatta estate, Moneragala (Lalani Samarappuli, P Karunadasa, and U Mitrasena).

Another experiment is in progress to study the establishment and growth of *Mucuna* under mature rubber (3 years before uprooting). Data on establishment success and growth are presented in (Table 3) (Lalani Samarappuli, U Mitrasena and T Gunathilake).

Table 3. *Establishment and growth of* Mucuna *under mature rubber*

Age of *Mucuna*	Establishment success (%)	Growth as coverage (%)
6 months after planting	78	20
12 months after planting	-	30
18 months after planting	-	50

At Sapumalkanda estate, Deraniyagala an experiment (SMC-GC/C/97/1)) was started in a 1997 replanting to study the influence of *Wedelia trilobeta* (Arunadevi), on growth, nutrient enrichment and other desirable characteristics in comparison with *Pueraria*. The effect of *Wedelia* and *Pueraria* as ground covers on the growth of rubber plants at two different slope classes is presented in Table 4 (Lalani Samarappuli, P Karunadasa, U Mitrasena and T Gunathilake).

Table 4. *The effect of* Wedelia *and* Pueraria *on the growth of rubber plants*

Ground cover	Girth (cm) (6 yrs a. p.)	
	At 10% slope	At 40% slope
Pueraria phaseolides	49.7	43.4
Wedelia trilobata	40.3	39.8
Wedelia + extra N	43.6	42.2

Phosphate fertilizers for cover crops

The field experiment, (SMC-GC/P/97/1) in Weniwella estate, Kegalle to study the effectiveness of Eppawela rock phosphate (ERP) as a source of P for leguminous ground covers, both creeping and bush/tree types was discontinued. Data on effects of treatments on different parameters are being analysed (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Planting practices for tree legumes

Field experiment (SMC-GC/TL/96/1), started to compare the efficiency of 3 systems of planting *Crotolaria micans* and *Flemingia macrophylla* as successful tree legume species that can be grown between the rows of rubber plants which could provide enough material for mulching, was terminated and the data are being analysed (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Another four field experiments were started, 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 (Lalani Samarappuli, P Karunadasa, U Mitrasena and T Gunathilake).

Weeds and weed control

Circle weeding

An experiment is in progress to study the effect of different weedicides on efficient circle weeding during the immature period of rubber. Performance of these weedicides on circle weeding is presented in Table 5 (Lalani Samarappuli, A Thevarapperuma and T Gunathilake).

Another experiment was started to study the performance of different weedicides on management of *Mucuna bracteata* around the young rubber trees. Treatments consisted of seven weedicides/weedicide combinations and a control (manual weeding). Data on control of *Mucuna* are presented in Table 6 (Lalani Samarappuli, A Thevarapperuma and T Gunathilake).

Table 5. *Effect of different weedicides on management of weed free circle*

Treatments	Regeneration of weeds after application of treatments (%)		
	1st month	2nd month	3rd month
Manual weeding	41	89	100
Manual weeding + Diuron	00	11	35
Glyphosate only	04	26	52
Paraquat only	02	21	48
Glyphosate +Diuron	02	07	32
Paraquat + Diuron	02	13	33

Table 6. *Effect of different weedicides on management of* Mucuna *in the weed free circle*

Treatments	Regeneration of *Mucuna* at 10th week after application of treatments (%)
Manual weeding	74
Paraquat only	43
Glyphosate only	41
Paraquat + 2.4.D Amine	20
2.4.D Amine (level 1)	36
2.4.D Amine (level 2)	36
Rapid only	46
MCPA only	36

Integrated management of different weed species

A field experiment was in progress at Dorset division, Clyde estate, Thebuwana to study the effect of growing *Mucuna* as a cover crop on management of *Wedelia trilobata* (Arunadevi) under immature rubber. *Mucuna* very effectively covered a thickly grown *Wedelia* field and completely controlled the growth of *Wedelia*a in about 4-6 months period (Table 7). It is observed that establishment of *Mucuna* is the most efficient control measure of *Wedelia* in rubber cultivations.

Table 7. *Effect of growing* Mucuna *on control of* Wedelia

Weeks after planting of *Mucuna*	Control of *Wedelia* (%)
04	16
08	38
12	62
16	80
20	96

An experiment was in progress at Dartonfield estate, Agalawatta to study the effect of different weedicides on management of *Wedelia trilobata* (Arunadevi) under

rubber. An effective method to control *Wedelia trilobata* (Arunadevi) is recommended; that is to spray with MCPA 60 or its cocktails.

Effect of weedicides such as MCPA, 24D and Paraquat on control of *Wedelia* is given in Table 8. It is observed that MCPA is more efficient than 24D and paraquat. Effects of MCPA 60 and its cocktails on control and regeneration of *Wedelia* are given in Tables 9 and 10, respectively (Lalani Samarappuli, A Thevarapperuma and T Gunathilake).

Table 8. *Effect of MCPA, 24D and Paraquat on control of* Wedelia

Weedicides	Weeks after application of weedicides	
	100% Control	50% Regeneration
MCPA 60	4	12
24D	4	8
Paraquat	1	4

Table 9. *Effect of MCPA and its cocktails on control of* Wedelia

Weedicides	Control (%)			
	1st week	2nd week	3rd week	4th week
MCPA 60 only	20	43	75	98
MCPA 60 + Glyphosate	38	62	82	98
MCPA 60 + Diuron	27	60	80	98

Table 10. *Effect of MCPA and its cocktails on regeneration of* Wedelia

Weedicides	Regeneration (%)			
	1st week	2nd week	3rd week	4th week
MCPA 60 only	5	11	22	48
MCPA 60 + Glyphosate	5	10	20	53
MCPA 60 + Diuron	4	6	14	40

An Experiment was started to study the effect of different weedicides on the management of *Gleichenia linearis* (kekeilla) and the performance of these weedicides is presented in Table 11 (Lalani Samarappuli, A Thevarapperuma and T Gunathilake).

Table 11. *Effect of different weedicides on management of* Gleichenia linearis *(kekeilla)*

Treatments	Control at 5 weeks after application of treatments (%)	Regeneration at 8th month after application of treatments (%)
MCPA + Surpass	98	28
Rounder only	93	13
Rounder + Surpass	98	10
Diuron only	95	01
Glyphosate + MCPA	100	03

Another field experiment was started to study the control of *Wormia triquetra (*Diyapara*)* and *Thanbargia spp.* It was found that young plants of *Wormia triquetra (*Diyapara*)* can be controlled by application of concentrated paraquat. This experiment was continued with several other weedicides/weedicide combinations. Similarly, it was observed that *Thanbargia spp* can be controlled by application of Surpass (Glyphosate) to under ground parts (Lalani Samarappuli, A Thevarapperuma and T Gunatilake).

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

Mulching

Two field experiments at Bibile estate, Bibile and Nottinghill estate, Kahapathwela are in progress to study the effect of mulching on growth of *Hevea* plants. Girth at seven years after planting in Bibile and girth at six years after planting in Kahapathwela are given in Table 12 (Lalani Samarappuli, P Karunadasa, U Mitrasena and T Dissanayake).

Table 12. *Effect of mulching on girth of rubber plants*

Treatment	Girth (cm) in Bibile	Girth (cm) in Kahapathwela
No mulch	48.2^{A}	54.3^{A}
With mulch	53.3^{B}	56.1^{B}

(Means with same letter are not significantly different)

Field experiment (SMC-Ag/M/99/1) is in progress at Nottinghill estate, Kahapathwela to study the effect of different mulching materials on growth of *Hevea* plants in a comparatively drier area. Treatments consisted of four mulching materials and a control; no mulching (M0), paddy straw (M1), coir dust (M2), paddy husk (M3) and green manure (M4). Girth at six and a half years after planting of rubber is given in Table 13 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 13. *Effect of different mulching materials on girth of rubber plants*

Treatment	Girth (cm)
No mulch	52.3^{A}
Paddy husk	56.3^{B}
Coir dust	55.3^{BC}
Green manure	57.7^{BC}
Paddy straw	57.0^{C}

(Means with same letter are not significantly different)

Ground cover management

At Kumarawatta estate, Monaragala an experiment was started in a 1998 replanting to study the performance of *Mucuna bracteata* in comparison with *Pueraria phaseoloides* under dry agro-climatic conditions. In the same experiment the effect of different planting practices of *Crotolaria micans* and *Flemingia macrophylla* as successful tree legumes under dry agro-climatic condition was also studied. Data on girth at seven years after planting under two situations are given in Tables 14 and 15, respectively (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 14. *Effect of growing* Mucuna *on girth of rubber at six years after planting*

Species	Girth (cm)
Pueraria phaseoloides	50.3^{A}
Mucuna bracteata	53.9^{B}

(Means with same letter are not significantly different)

Table 15. *Effect of different planting systems of tree legumes on girth of rubber plants at six years after planting*

Treatment	Girth (cm)
Crotolaria micans	51.8^{A}
Flemingia macrophylla	52.8^{A}
Flemingia + Crotolaria	53.8^{A}

(Means with same letter are not significantly different)

Fertilizer practices for overcoming moisture stress

A field experiment (SMC-Ag/F/88/3) that was in progress at Nalanda estate, Ulpotha to study the effect of different levels of potassium on growth and yield of *Hevea* plants in comparatively dry conditions was terminated. The data are being analyzed (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Two field experiments SMC-Ag/F/99/1 and SMC-Ag/F/98/1 are in progress at Nottinghill estate, Kahapathwela and Bibile estate, Bibile respectively, to study the effect of both potassium and mulching on moisture stress and growth of *Hevea* under two different agro-climatic conditions; comparatively intermediate and dry. Treatments consisted of two mulching techniques; no mulch (M_0) and surface mulching (M_1) and two potassium levels; recommended level (K_1) and double the recommended level (K_2). Test tapping was continued (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Another two field experiments are in progress at Keppitigala estate, Keppitigala and Pillassa division, Pitiyakanda estate, Mawathagama to study the effect of both potassium and paddy straw on yield of rubber under comparatively dry agro-climatic conditions. Treatments consisted of recommended level of K, recommended level of K + 100g of MOP and recommended level of K + paddy straw. Test tapping was continued (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Soil moisture requirement of rubber under different densities

The experiment (SMC-Ag/D/97/1), started at Dorset division, Clyde estate to study the soil moisture requirement of rubber under different densities was discontinued (Lalani Samarappuli, P Karunadasa and U Mitrasena in collaboration with the Plant Science Department).

Silt pitting for soil moisture conservation

The field experiment started to study the effect of silt pits on the moisture conservation at Bibile estate, Bibile was discontinued. The data are being analyzed (Lalani Samarappuli, P Karunadasa and U Mitrasena).

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

The study started to estimate the biomass accumulation (carbon sequestration) in rubber plantations under Sri Lankan conditions to highlight it's potential in relation to carbon trading through carbon sequestration for purposes of sustaining rubber cultivation in the country was continued. Different ages of rubber trees were uprooted to estimate the biomass accumulation of rubber. The data are being analyzed (Lalani Samarappuli, Wasana Wijesuriya, T Dissanayake, U Mitrasena and T Gunathilake).

Fertilizer use and plant nutrition

Fertilizers to nursery plants

Improvements to the fertilizer application and use efficiency in young budding nurseries

Slow-release fertilizers for young budding nurseries

A commercially available slow-release fertilizer, Agroblen, was evaluated for its agronomic effectiveness in young budding nurseries in collaboration with the Lalan Rubbers Pvt. Ltd. at Sapumalkanda Group, Awissawella. Application of 12 g of Agroblen or more in one application has significantly increased scion death percentages (Table 16). The current liquid based fertilizer recommendation is agronomically superior to Agroblen, from levels tested in this experiment.

Table 16. *Effect of different levels of Agroblen on the growth and grafting success young budding plants*

Treatment	Seedling diameter (mm) at 8 wk after planting	Grafting success %	Scion diameter (mm) at 8 wk after cut-back	Scion death %
Current recommendation	5.8^{A}	99^{A}	5.3^{A}	8^{E}
Agroblen 12g (1 application)	5.4^{BC}	99^{A}	5.0^{AB}	28^{C}
Agroblen 18g (1 application)	5.3^{C}	98^{A}	4.7^{BC}	4^{A}
Agroblen 12g + 12g (2 applications)	5.7^{AB}	94^{A}	4.9^{AB}	34^{B}
Agroblen 6g + 12g (2 applications)	5.3^{C}	98^{A}	4.5^{C}	18^{D}
Agroblen 6g + 6g (2 applications)	5.7^{A}	100^{A}	4.8^{BC}	9^{E}

(values in a column with the same superscript are not significantly different at $p<0.05$)

Based on the results of the above experiment, another experiment was initiated on the same site to further evaluate the effectiveness of Agroblen using different levels. Application of 9g of Agroblen in one application appears to be as agronomically effective as the current liquid based fertilizer recommendation, until 8 weeks after cut-back and under the conditions of this experiment (Table 17). Among the main advantages of an agronomically effective slow-release fertilizer are the low fertilizer application cost and assurance on plant nutrient requirements are being met in correct proportions and quantities at correct time. Even though, agroblen could be used in absolute labor shortage situations, the cost effectiveness of Agroblen in young budding nurseries under different agro-management conditions is yet to be evaluated (R S Dharmakeerthi, A Nugawela, S Chandrasiri and V Edirimanne).

Table 17. *Effect of different levels of Agroblen on the growth and grafting success young budding plants*

Treatment	Seedling diameter (mm) at 12 wks after planting	Grafting success %	Scion diameter (mm) at 8 wks after cut-back	Scion death %
Agroblen 3g + 3g (2 application)	6.8^{C}	88^{A}	5.9^{B}	0.0^{A}
Agroblen 6g (1 application)	6.9^{C}	78^{A}	5.9^{B}	2.6^{A}
Agroblen 6g + 6g (2 applications)	7.2^{B}	87^{A}	6.1^{AB}	2.0^{A}
Agroblen 9g (1 application)	7.6^{A}	84^{A}	6.1^{AB}	2.5^{A}
Current recommendation	7.7^{A}	92^{A}	6.2^{A}	0.0^{A}
No fertilizer control	6.4^{D}	96^{A}	4.5^{C}	2.7^{A}

(values in a column with the same superscript are not significantly different)

Frequency of fertilizer application and urea as a N source in young budding fertilizer mixtures

Two experiments were initiated to determine the agronomic effectiveness of urea as a N source in young budding fertilizer mixtures. Another objective of these experiments was to evaluate the possibility of reducing the current fertilizer application frequency by increasing the rate of application. One experiment was established at Dartonfield group, while the other one at the Sapumalkanda group. Application of urea did not have any significant negative effect on seedling growth, percentage of buddable plants, grafting success and scion die-back. However, effect of urea on the growth of scion was not consistent in the two experiments. In the Sapumalkanda experiment, urea has slightly, but significantly, retarded the growth of scion at the levels tested in this experiment (Table 18).

In both experiments, reducing the application frequency to 4-week intervals was as effective as the currently recommended 2-week intervals in all parameters tested (Table 18). Therefore, the labour cost for fertilizer application in young budding nurseries could be cut down by half when the liquid based fertilizer mixture is applied at 4-week intervals by doubling the rate of application. Our previous experiments have revealed that resuming fertilizer application at cut back or fertilizer application during the bud grafting and cut back periods do not have any negative effects on plant growth. Therefore, the recommendation for fertilizer application in young budding nurseries could be revised to continuous application of the currently recommended mixtures at 4-week intervals (R S Dharmakeerthi, S Chandrasiri and V Edirimanne).

Table 18. *Effect of N source and the application frequency on growth and grafting success of young budding plants*

Treatment	Experiment 1[§] (Sapumalkanda)					Experiment 2[§] (Dartonfield)				
	SLD (mm)	**BB (%)**	**BS (%)**	**SCD (mm)**	**DB (%)**	**SLD (mm)**	**BB (%)**	**BS (%)**	**SCD (mm)**	**DB (%)**
No fertilizer control	6.4^{C}	67^{B}	96^{A}	4.5^{C}	3^{A}	5.6^{B}	70^{A}	100^{A}	4.9^{B}	0^{A}
SA based (2-week intervals)	7.7^{A}	90^{A}	92^{A}	6.2^{A}	0^{A}	6.4^{A}	83^{A}	$81b^{C}$	6.0^{A}	8^{A}
Urea based (2-week intervals)	7.4^{B}	92^{A}	85^{A}	5.7^{B}	3^{A}	6.5^{A}	84^{A}	71^{C}	6.4^{A}	5^{A}
SA based (4-week intervals)	7.4^{AB}	87^{A}	83^{A}	6.1^{A}	1^{A}	6.5^{A}	84^{A}	89^{B}	6.4^{A}	0^{A}
Urea based (4-week intervals)	7.5^{AB}	97^{A}	95^{A}	5.7^{B}	4^{A}	6.6^{A}	88^{A}	$82b^{C}$	6.1^{A}	6^{A}

Values in a column with the same superscript are not significantly different at $p<0.05$.

[§] SLD – seedling diameter at 12 wks; BB – budability; BS – bud grafting success; SCD – scion diameter at 8 wks after cut back; DB – scion die-back.

Effectiveness of different basal P sources in young budding nurseries

An experiment was initiated at the Dartonfield group to evaluate the effectiveness of different basal P sources in young budding nurseries. This study was prompted as a result of practical difficulties encountered in large scale government rubber nurseries for the application of phosphate rock fertilizers as the basal dressing due to scarcity of labor. Different levels of diammonium phosphate (DAP), in liquid from, were evaluated against with or without IRP in an experiment established at the Dartonfield group in 2005 (Table 19). The use of a basal P source in young budding nurseries (either IRP or DAP) could not effectively be substantiated under the conditions of this study.

Table 19. *Effect of different basal P sources on grafting success and scion growth of young budding plants*

Treatment	Parameter[§]			
	BB (%)	**BS (%)**	**SCD (mm)**	**DB (%)**
No fertilizer control	13^{C}	100^{A}	4.6^{C}	10^{A}
Only 50g IRP at bag filling	38^{B}	98^{A}	4.9^{C}	11^{A}
Only NPKMg liquid formulation as recommended	61^{A}	90^{B}	5.7^{AB}	12^{A}
50g IRP at bag filling + NPKMg liquid formulation as recommended	63^{A}	99^{A}	5.4^{B}	13^{A}
2g DAP 1 wk after planting + NPKMg liquid formulation as recommended	53^{AB}	90^{B}	5.7^{AB}	2^{A}
2g DAP 1 wk after planting + 2g DAP 3 wks after planting + NPKMg liquid formulation as recommended	39^{B}	94^{AB}	5.9^{A}	10^{A}

Values in a column with the same superscript are not significantly different at $p<0.05$.
[§] BB – budability; BS – bud grafting success; SCD – scion diameter at 8 wks after cut back; DB – scion die-back.

Therefore another study was started at Dartonfield estate in 2005 to determine whether this could be due to the application of P in soluble form at every 2-week intervals in young budding nurseries or high available P contents in these soils. Data given in Table 20 indicates that application of P may not be required for the seedling growth at least during the first 3 months in these soils (R S Dharmakeerthi, V Edirimanne and S Chandrasiri).

Table 20. *Effect of P on growth and grafting success of young budding plants*

Treatment	Seedling diameter (mm)		Grafting success (%)
	8 wks after planting	12 wks after planting	
50g IRP as basal dressing + DAP in liquid formulation	5.4^{B}	6.8^{A}	77^{B}
50g IRP as basal dressing + No DAP in liquid formulation	5.7^{A}	7.1^{A}	82^{B}
No IRP as basal dressing + DAP in liquid formulation	5.6^{AB}	6.9^{A}	89^{B}
No IRP as basal dressing + no DAP in liquid formulation	5.8^{A}	6.9^{A}	85^{B}
No fertilizer control	5.1^{C}	5.7^{B}	96^{A}

(Values in a column with the same superscript are not significantly different at $p<0.05$)

Fertilizers to immature rubber

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

Two field experiments were started to study the feasibility of using Dolomite as a substitute to kieserite during the first year of planting in 2005 replantings at Sapumalkanda estate, Deraniyagala (*Homagama* series) and RRISL Sub station at Kuruwita (*Ratnapura* series). Another two experiments were started to study the same under soil moisture stress conditions at Pitiyakanda estate, Mawathagama and Bibile estate, Bibile. Residual effect of treatments on girth of rubber plants at the end of 2 years and four months after planting at Pitiyakanda estate is presented in Table 21. From 2nd year onwards the Mg source and rate are same for all treatments as per the RRISL recommendations (Lalani Samarappuli, P Karunadasa, T Gunathilake and U Mitrasena).

Table 21. *Effect of different treatments on girth of rubber plants*

Fertilizer treatments	Girth (cm)
75g kieserite in 2 applications (Control)	24.1^{A}
25g kieserite + 75g dolomite	24.7^{A}
50g dolomite + 75g dolomite	24.4^{A}
75g dolomite only (planting hole)	25.0^{A}
75g dolomite (planting hole) + 25g kieserite	24.7^{A}
100g dolomite (planting hole) + 25g kieserite	24.5^{A}
50g dolomite (planting hole) + 75g dolomite	24.3^{A}
75g dolomite (planting hole) + 25g kieserite	23.1^{A}
100g dolomite only (planting hole)	25.4^{A}
150g dolomite only (planting hole)	24.9^{A}

(Means with same letter are not significantly different)

Method of fertilizer application

Two field experiments were started at Nottinghill estate, Kahapathwela and Dorset division, Clyde estate, Tebuwana to study the effect of cutting fertilizer pits on growth of *Hevea* under two different agro-climatic conditions; comparatively wet and dry. Treatments consisted of two distances from the tree; 1 ft. and 1½ ft.and two application frequencies; 4/year and 2/year (Lalani Samarappuli, P Karunadasa, U Mitrasena and T Gunathilake).

Fertilizer requirement of rubber under different densities

An experiment (SMC-Ag/D/96/1) was in progress at Mucalana division, Sirikandura estate to study the fertilizer requirement of rubber under different densities. Treatments consisted of (a) Four different densities; (i) 500 trees/ha [4.5m × 4.5m], (ii) 600 trees/ha [4.2m × 4.2m], (iii) 700 trees/ha [3.8m × 3.8m] and (iv) 800 trees/ha [3.5m × 3.5m] (b) Three fertilizer treatments; (i) recommended level (F1), (ii) reduced level (F2) and (iii) 1st three years recommended level and thereafter reduced level (F3). Residual effect of different fertilizer treatments on yield of rubber was monitored (Lalani Samarappuli, P Karunadasa and T Dissanayake in collaboration with the Plant Science Department).

Another experiment (SMC-Ag/D/97/1) was also in progress at Dorset division, Clyde estate to study the fertilizer requirement of rubber under different densities with same treatments. Residual effect of different fertilizer treatments was monitored (Lalani Samarappuli, P Karunadasa and U Mitrasena in collaboration with the Plant Science Department).

Fertilizer use in mature rubber

Fertilizer application during mature stage on yield

An experiment started at Hillcroft division, Mirishena estate to study the effect of fertilizer application during mature stage on yield was continued (Lalani Samarappuli and P Karunadasa).

Site specific fertilizer recommendation by soil and foliar survey programme

Improvements to soil and foliar survey programme

Estate sector

Leaf N, P, K and Mg contents of mature rubber leaves collected during the soil and foliar survey in the year 2005 indicated that fertilizer application should be continued uninterruptedly during the initial period of tapping, at least in the virgin panels (Table 22) (Lalani Samarappuli, V Edirimanne and A Thevarapperuma).

Smallholder sector

The fertilizer programme introduced to mature smallholdings in different rubber growing districts using leaf nutrient values of both smallholdings and

surrounding estates was popularized by several training programmes conducted to both smallholders and extension officers (Lalani Samarappuli, V Edirimanne and T Gunatillaka).

Soil and foliar survey programme - Fertilizer recommendation

The site-specific fertilizer recommendation programme for mature rubber provided fertilizer recommendations for 2500 hectares in the estate sector.

Table 22. *Leaf nutrient contents of mature rubber leaves in different rubber growing districts*

District	Status	Leaf nutrients (%)			
		N	P	K	Mg
Kalutara	Immature*	2.6	0.20	1.2	0.28
	BO-1	2.8	0.24	1.1	0.30
Kegalle	Immature	2.9	0.21	1.0	0.27
	BO-1	3.0	0.22	1.1	0.31
Avissawella	Immature	2.9	0.20	0.9	0.27
	BO-1	2.7	0.21	0.8	0.28
Ratnapura	Immature	2.9	0.24	0.9	0.28
	BO-1	3.0	0.25	0.8	0.31

* $5^{th}/6^{th}$ year

Nutrient requirement of new* Hevea *clones

Several experiments have been established using different clones and different fertilizer treatments to determine the fertilizer requirement of new vigorously growing, high yielding clones.

Trials conducted in group III soils

A trial had been initiated in RRISL substation, Kuruwita in a clearing established in 1997, to determine the fertilizer requirement of some new clones after they were brought into tapping. Fertilizer treatments were initiated in the year 2003. The girth increment of the RRISL 217 was significantly affected by the fertilizer level during the 2nd year of fertilizer application (Table 23) (R S Dharmakeerthi, S N Silva and C K Maheepala).

Table 23. *Effect of fertilizer level on girth increment (cm) of some new clones during the 8th year after planting*

Fertilizer Level	Girth increment (cm)		
	RRISL 201	RRISL 202	RRISL 217
No fertilizer	1.5 ^{A}	3.1 ^{A}	1.3 ^{B}
100% Current recommendation	1.6 ^{A}	2.2 ^{A}	2.0 ^{A}
200% Current recommendation	2.0 ^{A}	2.6 ^{A}	1.1 ^{C}

values with the same superscript in a column are not significantly different

Trials conducted in Moneragala

An experiment was started in 2004 at Muppanavalley division, Kumarawatta estate, Moneragala to determine the effectiveness of fertilizer mixtures R/U/12:14:14 and R/U/15:15:7, with and without a Mg source on the growth of RRIC 121 and RRISL 203 clones at three different fertilizer levels (0, 1 and 2 times the currently recommended levels for traditional rubber growing areas). Experimental plots were arranged according to a split-split-plot design. Growth measurements made one year after planting did not show any statistically significant difference ($p<0.05$) among main effects (fertilizer mixture, level and clone) or their interactions (R S Dharmakeerthi, S N Silva and C K Maheepala).

Management of diseases through fertilizer application

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

Three fertilizer levels (*i.e.*, no fertilizer, current recommendation based on leaf analysis, and double the current recommendation) have been imposed on RRISL 201, 202 and 217 clones in the 1997 clearing at RRISL substation, Kuruwita since June 2003. CLF incidence during the year was low and therefore differences among treatments could not be observed (R S Dharmakeerthi, C K Jayasinghe, S N Silva and E A D N Nishantha).

Secondary and micro nutrition

The experiment started at Pallegoda estate to study the effect of three different sources of Sulphur on the performance of young rubber was discontinued (L Samarappuli and P Perera).

Organic fertilizers

Planting stage

A field experiment was started in Pitiyakanda estate, Mawathagama in a 2003 replanting to study the effect of application of different organic materials into the planting hole. Treatments consisted of; no organic manure (control), paddy straw,

poultry litter, cow dung, green manure, EM treated compost type 1, EM treated compost type 2 and burned paddy husk. Girth at two years and four months 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)	21.9^{AB}
Paddy straw	23.8^{A}
Poultry litter	22.6^{AB}
Cow dung	22.9^{AB}
Green manure	20.6^{B}
EM treated compost type 1	23.0^{AB}
EM treated compost type 2	23.8^{A}
Burned paddy husk	20.2^{B}

Another field experiment was started in Lowmont division, Payagala estate, Dodangoda in a 2003 replanting to study the effect of application of different organic materials into the planting hole. Treatments consisted of; no organic manure (control), paddy straw, poultry litter, cow dung, green manure, compost, coir dust, paddy husk, tea dust and saw dust. Girth at two and a half years after planting is presented in Table 25 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

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

Treatment	Girth (cm)
Nil (control)	15.5^{AB}
Paddy straw	16.7^{A}
Poultry litter	17.7^{A}
Cow dung	14.1^{AB}
Green manure	16.8^{AB}
Compost	17.4^{A}
Coir dust	17.7^{A}
Paddy husk	16.2^{AB}
Tea dust	13.6^{B}
Saw dust	14.1^{B}

Immature stage

A field experiment (FPN-Org/An/01/1), is in progress at Pembroke division, Payagala estate to study the effect of poultry litter as an organic manure for rubber. Treatments consisted of (T1) No organic manure (control), (T2) Organic manure to planting hole + 1st to 6th year, (T3) Organic manure to planting hole + 2nd year + 4th year + 6th year (Level 1), (T4) Organic manure to planting hole + 2nd year + 4th year + 6th year (Level 2), (T5) Organic manure to planting hole + 3rd year + 6th year

(T6) Organic manure to 3rd year + 5th year. Effect of treatments on girth at the end of four and a half years is given in Table 26 (Lalani Samarappuli, P Karunadasa, U Mitrasena and T Dissanayake).

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

Treatment	Girth (cm)
T1	38.8^{A}
T2	42.1^{B}
T3	42.9^{B}
T4	42.4^{B}
T5	41.7^{B}
T6	42.1^{B}

(Means with same letter are not significantly different)

Another two experiments are in progress at Pitiyakanda estate, Mawathagama in a 2003 replanting and at Bibile estate, Bible in a 2004 replanting, respectively. In experiment 1, treatments consisted of; no organic manure (control), EM treated paddy straw, burned paddy husk and coconut husk and in experiment 2, treatments consisted of; no organic manure (control), paddy straw, burned paddy husk and green manure. Growth measurements at two years and four months after planting in experiment 1 and girth at one year after planting in experiment 2 are presented in Tables 27 and 28, respectively (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 27. *Effect of different treatments on growth of rubber plants*

Treatment	Girth (cm)
Nil (control)	22.1^{A}
EM treated paddy straw	24.7^{B}
Burned paddy husk	23.7^{AB}
Coconut husk	23.5^{AB}

Table 28. *Effect of different treatments on growth of rubber plants*

Treatment	Girth (cm)
Nil (control)	3.7^{A}
Burned paddy husk	3.9^{AB}
Paddy straw	4.4^{AB}
Green manure	4.8^{B}

Field experiment, (FPN-Org/Gm/97/2) at Dorset division, Clyde estate, started to study the effect of plant materials as organic manure for rubber was terminated. Data on effects of treatments on different parameters are being analyzed (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Field experiment (SMC-Ag/M/97/1) at Sapumalkanda estate, Deraniyagala, started to study the effect of different quantities of refused tea and wood ash on growth of *Hevea* plants was terminated. Data colleted during the immature period of rubber are being analyzed (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Experiment started at Payagala estate to evaluate sludge as an organic fertilizer for immature rubber was terminated. Data colleted during the immature period of rubber are being analyzed (Lalani Samarappuli, U Mitrasena, T Gunatilleke and S Chandrasiri).

The field experiment started at Eladuwa estate to study the possibility of using rubber factory effluent as a fertilizer was discontinued (Lalani Samarappuli, and R Puhambugoda).

Organic rubber

An experiment is in progress to develop a sustainable and a 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". Data on effects of different treatments are being analyzed (Lalani Samarappuli, P Karunadasa and T Dissanayake).

Spatial variability of rubber growing soils and the growth of rubber

Spatial variability of some properties of rubber growing soils

An experiment was initiated to gather preliminary information on the spatial structure of some important soil properties in rubber growing soils. Sites with different slope classes were selected. Soil samples collected according to a geostatistical design was analyzed for OC, clay, gravimetric water content, pH, and nutrient availability. Data generated from this study will be analyzed using geostatitical software (R S Dharmakeerthi, S P Perera, S N Silva and S Chandrasiri).

Land selection and suitability for rubber cultivation

Under this programme about 100 hectares of land was surveyed to find out the suitability for planting rubber (Lalani Samarappuli and all the staff of the department).

Analytical services and techniques

Analytical service

The Department analyzed approximately 450 samples (2000 parameters) for outside organizations.

Analytical techniques

Work on preparation of a Laboratory Manual for the Soils and Plant Nutrition Department was continued.

BIOCHEMISTRY AND PHYSIOLOGY

V H L Rodrigo

SUMMARY

Emphasis was given to develop a ready-recknor chart to correct the error in metrolac dry rubber determination associated with temperature variation and to develop cost effective semi solid rainguard sealants with industrial wastes.

Studies on biochemical changes associated with tapping panel dryness were continued for the purpose of identifying the mechanism for this physiological disorder. Further, attention was paid to identify the seasonal variations of non-rubber constituents in latex, particularly with recently developed rubber genotypes.

Experiments were also continued to develop an economically feasible method to extract "Quebrachitol", a valuable biochemical in rubber serum, during the process of raw rubber manufacture.

In order to improve the productivity of rubber lands whilst addressing the problems of tapper shortage and high tapping cost, emphasis was also given to test low frequency tapping system with gaseous stimulations.

DETAILED REVIEW

Staff

Dr V H L Rodrigo, Acting Head, and Mrs G V L Nilmini, Assistant Biochemist, were on duty through out the year. Dr Rodrigo was appointed as the Head of the Department with effect from 13th October, 2005. Experimental Officer, Mrs K V V S Kudaligama, was promoted to the post of Assistant Biochemist with effect from 17th of August 2005. 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
V H L Rodrigo and G V L Nilmini	Scientific Committee Meetings	Rubber Research Institute
V H L Rodrigo, P D J Rodrigo and G V L Nilmini	Developments in the manufacture of rainguard sealant	Reucastle Estate
P D J Rodrigo and G V L Nilmini	Effective proposal writing, conducting and publishing research	General Research Committee of the Sri Lanka Association for the Advancement of Science

Officer	Subject	Organization
P D J Rodrigo and G V L Nilmini	Proposal writing in biotechnology	National science Foundation
P D J Rodrigo and G V L Nilmini	Safety against chemical hazards and biological threats	Esco Micro PTE LTD together with Analytical Instruments (Pvt) Ltd.
	Annual General meeting and workshop on effective communication for survival in the market economy	National Science and Technological Commission
G V L Nilmini and K V V S Kudaligama	Sampling, Statistics and Standardization in Chemical Analysis and Environmental Management	College of Chemical Sciences, Institute of Chemistry Ceylon
K V V S Kudaligama	Seminar and demonstration on HPLC applications	National Dangerous Drugs Control Board

Training programmes

Client	Subject	No. of programmes
Students from universities, agriculture schools and schools	Rubber manufacturing and wastewater treatment	50

Advisory visits

Client	No. of visits
Plantation Sector	05

LABORATORY AND FIELD INVESTIGATIONS

Extraction of Quebrachitol from rubber serum BCP/Q and RS/2002/1

Finding a suitable method for the extraction of Quebrachitol from rubber serum was continued and the non availability of required instruments within the department has been a constraint for this study (G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Biochemical studies of Tapping Panel Dryness (TPD) BCP/TPD/2002/2

This project attempts to identity possible causes for the TPD which is considered to be a physiological disorder. Bark samples taken from affected trees were processed and sent to for the analysis of sugar content using HPLC in

University of Peradeniya. Gel electrophoresis of latex samples was commenced to identify protein patterns of the healthy and TPD affected trees of clones RRIC 100, 121, 130 and 102 (G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama in collaboration with the Plant Science Department - This project is funded by the Council for Agricultural Research Policy).

Studies on non-rubber constituents present in latex
BCP/NRL/2003/1

Seasonal variation of non-rubber constituents present in latex was investigated in 4 clones, *i.e.* RRIC 100, RRIC 121, RRIC 130 and RRIC 102. Latex samples were collected from two tapping blocks of each clone and were analysed for dry rubber, total solid, acetone extractable non rubber and ash (G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Effect of low temperature on metrolac reading
BCP/LT and M/2003/2

This research project aims to solve the temperature associated problem in measuring dry rubber content of latex with the metrolac commonly reported in high elevation areas. Initial studies on metrolac readings at low temperatures showed a high level of deviation from the values determined through laboratory methods (Fig. I). A ready recknor chart based on both metrolac reading and temperature was developed to correct the problem and data collection is continued to test the same under varying conditions.

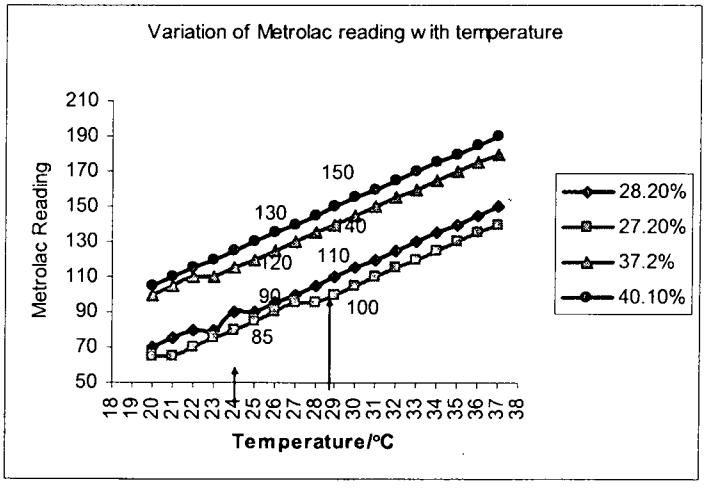


Fig. 1. Variation of metrolac reading with temperature under different levels of dry rubber content (DRC) (G V Lakmali Nilmini, V H L Rodrigo, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama)

Cost effective Semi Solid Rainguard Sealant
BCP/RGS/2005/1

This project was designed to develop new rainguard sealants with desired characteristics such as easy application and reduced cost, particularly with industrial wastes. About 65 latex and waste oil based recipes were tested and seven were selected to test under field conditions. Rainguards were fixed in seven experimental blocks (30 trees in each) at Nivitigalakele and Gallewatta divisions using the selected mixtures for field scale testing. Finally two recipes with ideal characteristics were selected for further testing (K V V S Kudaligama, V H L Rodrigo, G V L Nilmini, P D J Rodrigo and D Ramawickrama).

Low frequency tapping with gaseous stimulation
Patch and Tap method (BCP/LFTG/2005/1)

Patch and tap experiment was commenced in October at Dartonfield and Sorana estates. In Dartonfield estate gas jackets were fixed in 125 trees. 1/8S↓ d3 tapping system was employed with once in ten days ethylene gassing. At the same time, 116 trees with 1/2S↓ d3 tapping were monitored for comparison. In Sorana estate 25 trees were selected for patch and tap exploitation method with 1/4S↑ d3 tapping and two control blocks were monitored (each with 25 trees) with 1/4S↑ d/2 and 1/2S↓ d2 tapping. DRC%, latex volume and scrap weight were monitored. Latex DRC% and g/t/t of the patch and tap and control are given in Figs.2 and 3.

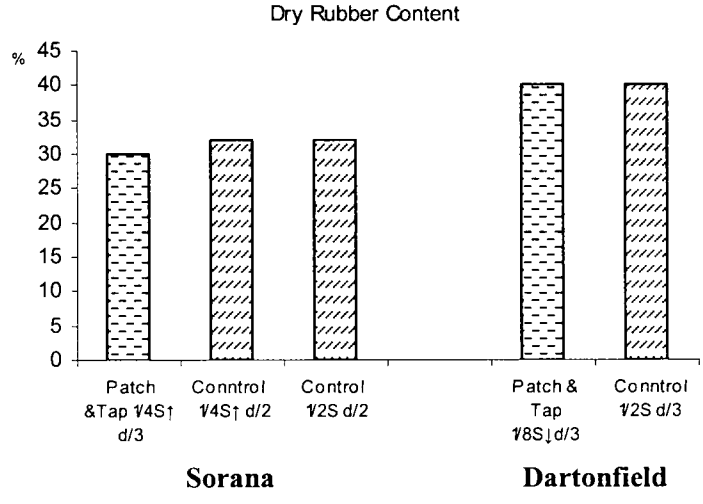


Fig. 2. Mean dry rubber content (DRC%) of Patch and Tap and control blocks in Dartonfield and Sorana estates

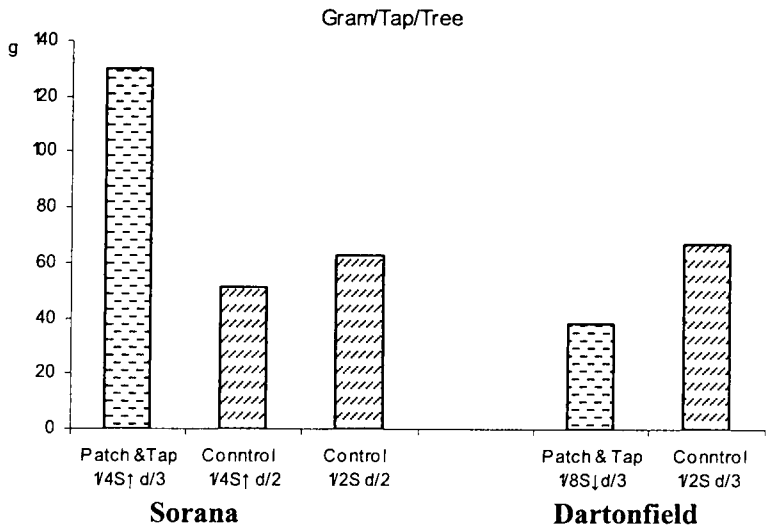


Fig. 3. Mean g/t/t of Patch & Tap and control blocks in Dartonfield and Sorana estates (V H L Rodrigo, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama in collaboration with the Plant Science Department)

RRIMFLOW method (BCP/LFTG/2005/2)

Six tapping blocks, three from each of the clones RRIC 100 and RRIC 121 (1986 clearing) were selected for the RRIMFLOW exploitation trials. Gas jackets and other accessories were fixed and gassing began in mid December. Further, two control blocks from each clone were selected. DRC%, latex volume and scrap weight were monitored daily for evaluation of the systems. Time taken for tapping and latex collection was also monitored to see the possibility of increasing the size of the tapping task. RRIMFLOW experimental blocks in eight other estates were also monitored (V H L Rodrigo, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama in collaboration with the Plant Science Department).

ADVISORY SERVICES

A Dissanayake

SUMMARY

Increasing the productivity and income levels of rubber growers through transfer of technologies by Extension and Advisory activities, were identified as a 'Thrust' area, during the period, and several important projects were carried out at national and regional levels to achieve these objectives.

Rainguard fixing and distribution of fertilizer for mature rubber holdings were identified as priority projects. Four thousand five hundreds and seventy one acres (4571) of rubber lands were fixed with rainguards, while eight hundred and nineteen metric tons (819) of fertilizer was distributed for 9649 acres, among 1813 farmers.

The ASD staff also carried out farmer training programmes to improve the quality of RSS, tapper productivity, and knowledge on rubber cultivation aspects.

Special advisory, extension, and skill development programmes were conducted to train rubber growers in the Moneragala district, in all aspects of rubber cultivation and processing.

DETAILED REVIEW

Staff

The Head of Department, 02 Regional Advisory Officers, Assistant Training Officer, and 31 REOO were on duty. Three new Regional Advisory Officers were appointed with effect from 17th August, to fill the vacancies in Kegalle, Ratnapura and Galle/Matara regions.

The Head of Department resigned from the post of Chairman of the Thurusaviya Fund with effect from 01st December.

Seminars/Conference/Meetings/Works shops attended

Officer	Subject	Organization
A Dissanayake	Meetings of the Board of Thurusaviya Fund	MPI
A Dissanayake	Tender Board Meetings for the selection of fertilizer and rainguard sealant suppliers	MPI
A Dissanayake	Rubber Sector Review Meetings	MPI
A Dissanayake	Cess Fund Committee Meetings	MPI
A Dissanayake	Study tour in Thailand, Vietnam and India from 05.06.2005 to 23.06.2005	Sri Lanka Society of Rubber Industries

Officer	Subject	Organization
A Dissanayake	Scientific Committee Meetings	RRISL
A Dissanayake	Progress Review Meetings of the ASD	RRISL

RAOO and REOO attended the followings

- Monthly regional progress review meetings of the ASD
- Special meetings organized by the Thurusaviya Fund
- Regional and range level farmer meetings to create awareness, and organize and implement programmes of rainguard fixing and fertilizer distribution for mature rubber under the subsidy schemes funded by the "cess" and managed by the Thurusawiya Fund
- Advisory visits on requests of medium scale rubber growers
- Committee meetings of the 'National Rubber Small Holder Federation' of Sri Lanka
- Committee meetings of the Medium Scale Rubber Growers Associations in Rathnapura, Kegalle, Kalutara, Colombo/Gampaha and Galle/Matara regions.

SERVICES

National level projects

Rainguard fixing project

In collaboration with the Thurusaviya Fund of the Ministry of Plantation Industries, the ASD launched a rainguard-fixing project under a subsidy scheme (subsidy component = 50% of total cost), funded by the "Cess" fund.

The project was successfully completed, fixing rain guards in 4571.03.21 Ac. and achieving 77% of the target (Table 1).

Table 1. *Progress of rain guard fixing Project*

Region	Extent fixed with rainguards (Ac. R. P)	No. of trees fixed with rainguards	No. of farmers benefited
Kegalle	1,719.0.00	295,230	258
Ratnapura	1,182.0.00	211,070	188
Kalutara	830.1.00	154,452	123
Galle/Matara	152.2.00	28,000	27
Colombo/Gampaha	688.0.21	107,270	127
Total	**4,571.3.21**	**796,022**	**723**

Total value of the project was Rs.6.7 million.

Motivation of private sector rubber industries in the participation of smallholder development projects of the ASD

The ASD could successfully motivate several private sector rubber industries and other agricultural service organizations to participate in the rain guard-fixing project as follows.

- Loadstar rubber products private (Ltd), made a grant of Rs.01 million to meet the cost of polythene in rainguard fixing of selected group of farmers. 184 farmers were selected from all rubber growing areas through selection criteria developed in collaboration with the Loadstar Rubber Products Ltd. and disbursed the granted money among selected farmers, in farmer meetings organized in district-levels.

- Associated Specialty Rubber Products Ltd, Yatidariya, Kegalle, supplied polythene for 35 selected farmers to encourage the fixing of rain guards, in the Yatiyantota range. The total cost of the programme was Rs.200, 000/-.

- Lanka Phosphate Limited granted Rs.100,000/- through the Thurusawiya Fund to prepare 10 roadside hoardings, to demonstrate the value of the rainguard technology. These hoardings were fixed in selected places covering rubber-growing regions.

Collection of data on the performance of rainguards

A special field survey to collect data on yield performance of rubber trees, after fixing rainguards was carried out in collaboration with the Biometry section of the Rubber Research Institute. Data were collected from selected farmers and the analysis is in progress.

Promotion of fertilizer usage in mature rubber holdings

In collaboration, with the Thurusawiya Fund of the Ministry of Plantation Industries, the ASD carried out a fertilizer distribution project to supply fertilizer for mature rubber holdings in the country, under a subsidy scheme (subsidy component = 25% of fertilizer cost) funded by the "Cess" fund of the Ministry of Plantation Industries. 819.675 Metric Tons of fertilizer for the value of Rs.13.39 million was distributed among farmers (Table 2).

Table 2. *Distribution of fertilizer for mature rubber holdings*

Region	Amount of fertilizer distributed for mature holdings (MT)	Extent (Ac)	No. of Farmers benefited	Value of fertilizer Rs. Million
Kegalle	282.925	3877	698	4.23
Ratnapura	120.625	1089	180	2.04
Kalutara	174.725	1997	465	3.12
Colombo/Gampaha	144.925	1667	272	2.4
Galle/Matara	85.625	957	171	1.5
Moneragala	5.850	62	27	0.1
Total	819.675	9649	1813	13.39

Improvement of RSS production

Rubber producers were encouraged to repair their processing centers to improve the efficiency of the production process and to improve the quality of the produce and the ASD provided the necessary technical support. Technical support was also provided to construct new processing centers too.

Following achievements were made during the period

- Providing of technical advices and extension support to construct 80 new processing centers and repair of 77 existing processing centers,
- Providing of technical assistance to repair 44 pairs of rubber rolling units,
- Up graded the Pandeniya GPC in the Kegalle district as a model processing center,
- Completed the data collection and estimation of repair works of processing centers to be upgraded in the year 2006.

Improvement of knowledge on rubber cultivation and tapping

Farmer training was identified as a priority project of the ASD and following national and regional level training programmes were successfully completed during the year (Tables 3 and 4).

Table 3. *National level training programmes*

Name of the training programme	Region	Duration	Venue	No of trainees successfully completed the programme
1. Productivity improvement of medium level rubber growers	Rathnapura	02 full days From 20-09-2005 To 21-09-2005	Training center Nivitigalakele	39
2. Mobile Tapper training School	Kalutara	15 full days From10-03- 2006 To 19-03-2006	Training center Nivitigalakele	35
3. Mobile Tapper training School	Kalutara	15 full days From 22-09-2005 To 18-10-2005	Training center Nivitigalakele	29
4. Skill development of rubber tappers	Colombo/ Gampaha	03 half days From 19-09-2005 To 21-09-2005	Ambanawatta, Meerigama.	114
5. Work shop on the identification of training and extension needs	Kandy/ Matale	01 full day On 14-11-2005	Kirigalpotta, Palapathwela Matale	102
6. Work shop on productivity improvement of rubber growers	Kegalle	01 full day On 06-03-2005	Yatiyantota Vidyalaya Yatiyantota	170
7. Training program on all aspects of rubber cultivation and processing	Monaragala	03 full days From 15.12.2005 To 18.12.05	Training Centre, Nivitigalakele, Matugama	75

Table 4. *Regional level farmer training programmes*

Name of the programmes	No. of programmes conducted	No. of trainees successfully completed the programmes
1. Maintenance of rainguards	03	77
2. Identification and control of diseases	07	95
3. Up keep of immature rubber holdings	12	168
4 Preparation of fertilizer mixtures and application of fertilizer	02	41
5. Skill development on Rubber processing aspects	08	101
6. Soil conservation techniques	18	114
7. Marking for tapping, correction of tapping panel markings and tapper training	25	180
8. Rubber related aspects for G.C.E.O/L students	01	300
9. Regional level workshops to create awareness on rubber growing, processing ad related aspects	03	350

Introduction of* Mucuna *as a cover crop

Planting *Mucuna* as a cover crop was popularized among rubber growers and *Mucuna* cover crop was introduced to 749. 958 ha. during the period (Table5).

Table 5. *Introduction of Mucuna as a cover crop*

Region	Extent of rubber holdings introduced with *Mucuna* (Ha)
Kalutara	62.358
Rathnapura	536.222
Kegalle	135.1
Colombo/Gampaha	5.378
Galle /Matara	10.9
Total	**749.958**

Control of diseases

Eradication of White root disease

REOO identified 669.705 ha of rubber holdings where there were 1 to 10 white root disease infected plants. Smallholders were advised on recommended treatment methods. In addition, farmer-training programmes on identification, control and preventive measures of white root disease were conducted.

Area specific projects

RAOO and REOO identified different projects on specific issues at regional and range levels, covering a full range of field management practices, processing, marketing and other related aspects of rubber cultivation and processing, and were conducted successfully. Related activities were carried out to address following issues/problems.

1. Introduction of alternate fire wood sources,
2. Training programmes on yield stimulation practices,
3. Introduction of suitable soil conservation practices,
4. Introduction of intercropping and multi cropping systems.

Advisory, extension and farmer training programmes conducted in the Moneragala district

ASD conducted several advisory, extension and skill development programmes in collaboration with other resource organizations, to create awareness on rubber growing, and to identify technological and extension requirements of farmers who are participating in the new rubber-growing project in the Moneragala district.

Following programmes were conducted successfully to achieve above objectives.

- Identification of Technological, Extension and other development needs of farmers using "Participatory Rural Appraisal" (PRA) methodologies in collaboration with the Biometry section of the Rubber Research Institute,
- Conducting a SWOT analysis,
- Preparing a survey report on the present agronomic, economic and operational conditions of rubber lands and processing centers,
- 400 selected farmers were successfully trained on all aspects of rubber cultivation and processing, in four (04) farmer training programmes conducted in four selected locations in the Moneragala district,
- 07 farmer organizations were established to enhance the resource mobilization and access to resources by farmers and to uplift the social and economic conditions of rubber growers in the district.

RUBBER TECHNOLOGY AND DEVELOPMENT

Dilhara Edirisinghe

SUMMARY

The developed NR/CR latex blend compounds consisting of 5-15% polycholroprene exhibit good strength properties combined with non polar oil resistance. Projects on development of NR/PVAc latex blends for manufacture of dipped products and NR/SBR/reclaimed rubber tri blends suitable for tyre retreads were almost completed during the year. Work on the development of NR/NBR latex blends suitable for dipped products manufacture was continued. Radiation vulcanization of two NR/synthetic rubber latex blend systems was initiated. Four latex based product developments and four dry rubber based product developments were carried out for rubber industries. A cationic rubberized bitumen emulsion with improved properties was developed using modified latex for road applications. The detailed study on incorporation of scrap crepe into tyre retread compounds was continued in the laboratory. The research work on interpenetrating polymer networks (IPN's) was almost completed. Nineteen industries obtained services in testing rubber compounds/products, measurements of hardness of the sole crepe samples and ball milling of rubber chemicals. Further, the staff was actively involved in training students, entrepreneurs, etc. and organizing stalls at national exhibitions and conducting workshops organized by several ministries.

DETAILED REVIEW

Staff

Mrs D G Edirisinghe, Rubber Chemist was on duty throughout the year. She was appointed as the Acting Head of the department with effect from 13th October. Mrs M M Jayasuriya, Rubber Chemist continued her studies at the RRISL during the year as a partial fulfillment of her postgraduate studies leading to a PhD degree at the Loughborough University, UK. Miss G D Dilini Galpaya, a graduate trainee from the graduate scheme was appointed as an Assistant Rubber Chemist of the department with effect from 17th August.

Mrs M K Mahanama, Mrs S I Yapa, Mrs P C Wettasinghe, Mr S L G Ranjith and Mr P L Perera, Experimental Officers were on duty throughout the year. Mrs Priyanthi Perera, Research and Development Assistant and Mr A I Siriwardena, Technical Officer was also on duty throughout the year.

Research students

- Miss Pradeepa Gunaratnam and Mr Thushara Samaraweera, MSc (Polymer Science and Technology) students of the University of Sri Jayawardenepura conducted their research work at the department.
- The staff of the department assisted N.D.T. (Polymer Technology) students from the University of Moratuwa on preparation and physical testing of rubber compounds.
- Miss Prasanthi Deepthika De Silva, a BSc (Chemistry Special) undergraduate student from the University of Kelaniya, Sri Lanka carried out a one month research project titled "Some Developments on Natural Rubber/ Polychloroprene Rubber Latex blends"
- Mrs Gayanthi Alahapperuma, a MSc (Polymer Technology) student from the University of Moratuwa continued her research work at the Department.
- Mr Karunaratne, a NDT student from the University of Moratuwa commenced his in-plant training.

Seminars/Conferences/Meetings/Workshops

Officer	Subject	Organization
Mrs D G Edirisinghe Mrs M M Jayasuriya	Seminar on Radiation Vulcanisation	Atomic Energy Authority of Sri Lanka
Mrs D G Edirisinghe	Sectoral Committee Meeting on "Chemical and Polymer Technology"	Sri Lanka Standards Institution
Mrs D G Edirisinghe	Workshop on "Research Management"	National Science Foundation
Mrs DG Edirisinghe	Workshop on "Drafting of Patent Documents"	Sri Lanka Inventors Commission
Mrs D G Edirisinghe Mrs M M Jayasuriya	Scientific Committee Meetings	Rubber Research Institute of Sri Lanka

Training programmes

Client	Subject	No. of programmes
Students of the Plastics and Rubber Institute	(i) General properties of NR latex and latex technology (ii) Manufacture of RSS, crepe and TSR (iii) Manufacture of foam rubber *DPRI in Rubber Technology*	1

Client	Subject	No. of programmes
Students of the Plastics and Rubber Institute	(i) Structure and property relationship of polymers (ii) Compounding ingredients (dry rubber and latex) (iii) Processing techniques (latex) *Basic Course in Rubber Technology*	1
NDT (Polymer Technology) students of the Institute of Technology, University of Moratuwa.	Rubber technology	1
BSc (Polymer) and MSc (Polymer Science and Technology) students of the University of Sri Jayewardenepura.	Degradation and stabilization of polymers	1
MSc (Polymer Technology) Students of the University of Moratuwa	Latex technology	1
An executive officer from Sinwa Holdings (Pvt.) Ltd.	Rubber compound development, physical testing *etc.*	1
Two technical officers from Quality Latex Products (Pvt.) Ltd.	Latex technology	1
A group of school teachers (organized by the National Institute of Education)	Polymer technology	1
Students – at the Technical College, Ratnapura and Kegalle (Sabaragamuwa Schools Inventions Exhibition - organized by the Sri Lanka Inventors Commission)	Inventions	1

Industrial visits

- Mrs D G Edirisinghe, Mrs M K Mahanama, Mrs S I Yapa and Mr A I Siriwardena accompanied two officers from the Cambodian Rubber Research Institute on the following industrial visits.
  - Lalan gloves (Pvt.) Ltd.
  - Suyamas (Pvt.) Ltd.,
  - Loadstar (Pvt.) Ltd.

- Miss G D D Galpaya, Mrs M K Mahanama and Mr H N K K Chandralal visited Volanka Exports Ltd. Kotugoda in order to introduce the bonding agent developed by them for cotton shoddy based mats.

Visits made by the officers of the task groups

The following industries were visited during the year in order to look into the problems encountered during manufacture of products and to identify new research areas relevant to the industries.

Officers	Industry	Month
Dr W M G Seneviratne Mrs D G Edirisinghe Miss G D D Galpaya and Mr Sarath Kumara	Industrial Clothings (Pvt.) Ltd. Seethawaka, Avissawella	October
Dr W M G Seneviratne Mrs DG Edirisinghe Mrs M M Jayasuriya and Miss G D D Galpaya	Richard Peiris Natural Foams Ltd., Seethawaka, Avissawella and Biyagama	November
Mrs M M Jayasuriya Dr S Siriwardena Dr (Mrs) C J Wellappili	Toyo Cushion (Pvt.) Ltd. Kotugoda	December

LABORATORY INVESTIGATIONS

Latex technology

Latex blends

Natural rubber (NR)/polychloroprene rubber (CR) latex blends

NR/CR blend compounds were prepared by varying the technique of blending and cast films were produced thereafter for testing. Properties such as tensile strength, tear strength and resistance to non – polar oils were evaluated. The results revealed that the films produced by incorporation of curing ingredients after blending the two rubber latices (technique A) yield better properties than those produced by adding curing agents proportionately to the two latices prior to blending the same (technique B).

Further, it was found that dilution of one of the blend components does not exert a significant effect on properties, but improves the surface texture of the films.

Films of NR/CR latex blends consisting of 5-15% polychloroprene latex produced as per technique A, exhibit good tensile strength, tear strength (Fig. 1) and non-polar oil resistance (Fig. 2) and hence these blend compounds are suitable for manufacture of products requiring the same [W M G Seneviratne, D G Edirisinghe,

Priyanthi Perera and Deepthika de Silva – BSc (Chemistry Special) student from the University of Kelaniya].

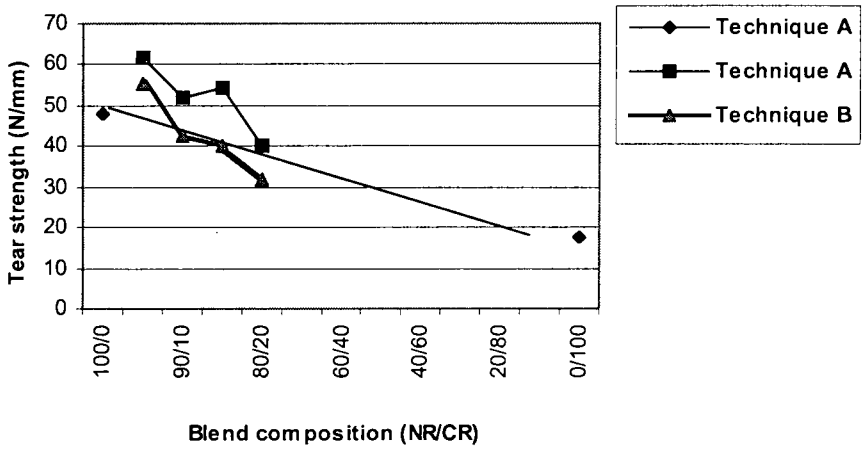


Fig. 1. Variation of tear strength of NR/CR latex blend compounds according to blend composition and the technique of blending

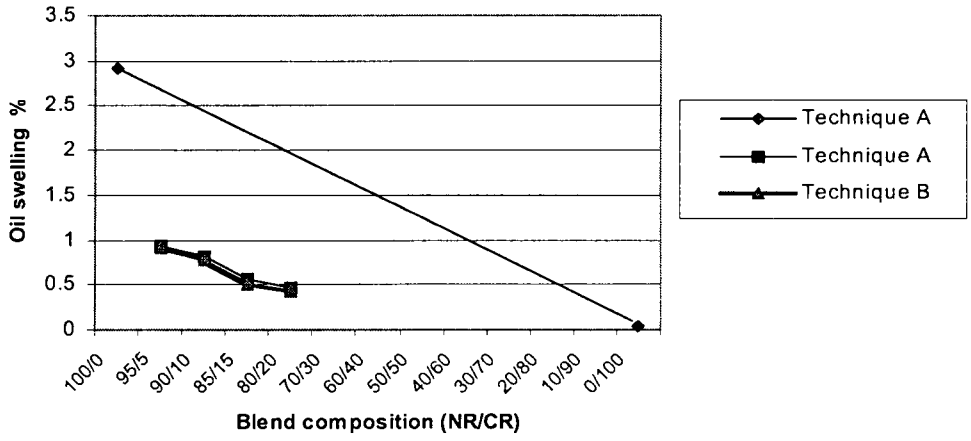


Fig. 2. Variation of oil swelling of NR/CR latex blend compounds according to blend comparison and the technique of blending

Development of NR/NBR blends for dipped products

This project was continued in collaboration with Prime Polymers (Pvt.) Ltd., Seethawaka, Avissawella. Properties of cast films prepared by varying the NR/ NBR blend ratio, blending conditions, technique of blending and the level of ingredients in the curing system used were evaluated and compared with those of the gloves being produced in the factory. Some property improvements were noted. Gloves produced as per the formulation were subjected to physical property analysis. Some trials were repeated for confirmation of the results (D G Edirisinghe, S Siriwardena, Thushara Samaraweera - MSc student, University of Sri Jayawardenapura and Priyanthi Perera).

Development of NR/polyvinyl acetate (PVAc) blends for dipped products

Trials were initiated to produce gloves out of the developed NR/PVAc blends (D G Edirisinghe, Poson Wettasinghe and Priyanthi Perera).

Radiation vulcanization of NR/CR and NR/NBR latex blends

A project was initiated in collaboration with the Atomic Energy Authority of Sri Lanka to study the effect of radiation vulcanization on the film properties of blends of natural and synthetic latices. Sets of NR/CR and NR/NBR cast films were produced out of blends prepared at different blend ratios and irradiation doses. The tensile properties and tear strength of the films were evaluated. Further work is in progress (D G Edirisinghe, S Kulatunge - AEA, Sri Lanka, S L G Ranjith, A I Siriwardena and P L Perera).

NR latex foam

Development of a latex foam compound suitable to produce

Key tags as souvenirs

Initial trials were carried out to produce key tags out of NR latex foam. The density of the foam produced was suitable for the purpose. Further work is in progress to get the desired colours and shapes of the product (S Siriwardena, D G Edirisinghe and S I Yapa).

Masks

Development of NR latex foam suitable to produce Halloween rubber masks was initiated at the request of a latex based mask manufacturing company (W M G Seneviratne, D G Edirisinghe, G D D Galpaya and S I Yapa).

Development of a latex compound suitable as a coating for canvas material used in auto-mobile applications

Work was initiated to develop a NR latex based compound suitable as a coating in order to produce a water resistance canvas material, on a request made by an industrialist. This material which is being produced out of synthetic latex at present is used by auto-mobile manufacturers in Japan. As commercially available

material made by using synthetic latex is costly, trials were carried out to produce the material out of NR latex. The developed NR latex compound was found to be suitable for the above purpose (M M Jayasuriya, S L G Ranjith and S I Yapa).

Development of NR latex based moulds suitable to produce vases

Few NR latex based moulds suitable to produce high quality clay vases of different shapes and colours were developed and handed over to Art Decorations (Pvt.) Ltd. on request (D G Edirisinghe and M K Mahanama).

Development of a centrifuged latex with special properties

Trials were carried out on the development of a centrifuged latex produced using a vegetable oil. The cast films prepared out of this special centrifuged latex exhibit a glossy surface and hence the latex compound would be ideal for production of cast and dipped products.

In the case of dipped articles the glossy nature is an advantage as it will ease the donning effect or in other words removal of dipped articles from the formers. Further the special ingredient added into the latex acts as an excellent stabilizer as well as a thickening agent (W M G Seneviratne, D G Edirisinghe and M K Mahanama).

Rubberized bitumen emulsions in road construction

Modified latex was prepared in order to produce a cationic rubberized bitumen emulsion on a request made by Senok Trade Combine Ltd., a reputed company in manufacturing bitumen emulsions for road construction work. The developed rubberized bitumen emulsion showed an improvement in properties.

Therefore, a series of cationic natural rubber latices was prepared using a novel cationic surfactant which was then incorporated into the cationic bitumen emulsions. In this process, different percentages of rubber were incorporated to different types of bitumen emulsions.

The rubberized bitumen emulsions, most suitable for road construction work was identified from these trials. These trials were carried on laboratory scale and a large scale plant trial will be carried out in the near future with the collaboration of the company (M M Jayasuriya, S L G Ranjith and S I Yapa).

Dry rubber technology

NR/SBR/reclaimed rubber blends for tyre retreads

Work on this project was continued to improve specially the abrasion resistance of tyre tread compounds containing reclaimed rubber as one of the triblend components. Steps were taken to modify some of the compound formulations on the advice of Loadstar (Pvt.) Ltd. A combination of carbon black types was introduced into the formulations and the accelerator used was also varied. Abrasion volume loss

of the tyre retread compounds prepared by combining two grades of carbon black was higher than those prepared with the higher particle size grade alone. This effect may be attributed to the poor distribution of the blend of blacks in the rubber phases. The type of accelerator used was found to have a significant effect on the abrasion resistance.

Akron abrasion test pieces of the triblend compounds were prepared according to British Standards with the aim of analyzing the abrasion patterns using a Scanning Electron Microscope (SEM). Work had to be postponed as the SEM at MRI was under repairs (W M G Seneviratne, D G Edirisinghe, Pradeepa Gunaratnam - MSc student, University of Sri Jayawardenapura, P C Wettasinghe and M K Mahanama).

Development of an EPDM rubber compound

An EPDM rubber compound suitable for an engineering application was developed at the request of J S Enterprises, Panadura. The physical properties were in accordance with the required values. The developed formulation was forwarded to the company (D G Edirisinghe, S L G Ranjith and Dinesh Krishantha - postgraduate student).

Development of a micro-cellular rubber strip

A trial was carried out to develop a NR compound suitable for the production of highly resilient micro-cellular strips, at the request of an industrialist. The aim of this work is to develop a micro-cellular strip out of NR, which can be used as a replacement for the synthetic polymer strip currently being used in a cutting machine (S Siriwardena, D G Edirisinghe, P C Wettasinghe and P L Perera).

Development of a formulation to produce small rubber balls as souvenirs

Trials were carried out with NR initially and the rubber balls produced showed high resilience and the required hardness. However, work with synthetic rubbers in order to get the glossy appearance of the surface of the product is in progress (D G Edirisinghe, P C Wettasinghe, A I Siriwardena and M K Mahanama).

Development of tyres for three-wheeler models

Few tyres suitable for the above purpose were produced out of NR and handed over to David Peiris Motor Company (Pvt.) Ltd. on request (D G Edirisinghe, M K Mahanama and A I Siriwardena).

Use of scrap crepe in tyre retread compounds

The above work initiated at the University of Moratuwa as a MSc project was continued. Part of the RSS in the compounds was replaced by scrap crepe 1X and 2X grades and the physical properties were evaluated and compared with the control samples. It was found that 20% of the RSS in the tyre tread compounds could be replaced by scrap crepe without a significant reduction in the tensile properties and

resistance to flex-cracking. However, the compression set, abrasion volume loss and hardness change markedly (D G Edirisinghe, Shantha Maduluwage – Lecturer, Dept. of Chemical Engineering, University of Moratuwa, Gayanthi – MSc student, University of Moratuwa and Priyanthi Perera).

Industrial designs

Mrs D G Edirisinghe and Mrs M K Mahanama obtained registration under "Industrial Designs" for the shoe soles produced out of dipped products waste/ rejects. An application was forwarded to the Sri Lanka Inventors Commission for the "Presidential Awards 2005/2006".

Industrial extension

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

Service	No. of companies
Physical properties of rubber compounds	11
Abrasion resistance of rubber compounds	1
Physical properties of latex strips	1
Hardness of rubber products	1
Hardness of sole crepe samples	3
Ball-milling of rubber chemicals	2
Testing of latex based adhesives	1

In addition to the services provided to the above listed industries, about twenty entrepreneurs were provided with advice and assistance on setting up NR latex based cottage industries.

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

- Mrs Manel Mahanama assisted the RRISL stall by conducting demonstrations at the exhibition held at St. Thomas College, Matale on 17th May.

- Mrs M K Mahanama and Mr P L Perera, assisted the RRISL stall by conducting demonstrations at the "Shrama Udana" held at the Coconut Nursery Centre, Coconut Cultivation Board, Medamulana, Middeniya, Hambantota from 8th to 10th July. This exhibition was organized by the Coconut Cultivation Board in collaboration with the Ministry of Plantation Industries.

- The department was involved in organizing the RRISL stall of the "Kapruka Navodaya" exhibition held at the Walpita Estate of the Coconut Cultivation Board on 3rd and 4th November.

- Mrs D G Edirisinghe, Miss G D D Galpaya and Mrs G M P Perera assisted the RRISL stall by conducting demonstrations at the "Science and Technology Exhibition" held at the Industrial Technology Institute from 5th to 9th November, organized jointly by the Ministry of Science and Technology, National Science Foundation and Industrial Technology Institute.

- Mrs D G Edirisinghe, Miss G D D Galpaya and Mr H N K K Chandralal conducted a workshop on "Rubber based Products Manufacture", held at the Divisional Secretarial Office, Weeraketiya, Hambantota on 16th December. The workshop was organized by the Vidatha Center, Ministry of Science and Technology.

POLYMER CHEMISTRY

Nilmini Liyanage

SUMMARY

A general purpose adhesive using a chemically modified grade of NR to compete with the synthetic neoprene rubber based adhesives has been satisfactorily developed and commercially implemented.

Modified rubber latex and bitumen based waterproof coating made for application in pruned tea bushes have shown promising results as per the trials carried out by the TRI. When this coating was applied, it has been observed that the growth of tea bushes are better when compared to the growth after application of fungicides incorporated sealants.

Large scale master batches of NR and carbon black made by using NR latex with a new dispersing agent have been handed over to Loadstar Ltd., to evaluate the physical properties for application in solid tyres. This department was also involved in developing herbal based fungicides for bark rot and oil emulsion to protect the whole tea plant against bacterial attack after pruning.

DETAILED REVIEW

Staff

Ms Champa Wellappilli, Assistant Rubber Chemist completed her PhD from University Cardiff, UK and assumed duties on the 1st of August. Mrs Nilmini Liyanage, Assistant Rubber Chemist was on duty throughout the year.

Mr R Wijesundara Experimental officer resigned with effect from 31st August.

Experimental Officers Mr H N K K Chandralal, Mr S S Warnapura, Mr S L G Ranjith, Mr Ananda Samarakoon, Mrs Chitra Kuruppu and Mrs Indra Denawaka, and Mrs Renuka Wijeratne, Clerk/Typist, were on duty through out the year.

Research students

- Mrs Ganga Ilanchelian and Miss Jeyadarshana, MSc (Polymer Science and Technology) students of the University of Sri Jayawardenapura commenced work on their MSc research projects on "Conductivity measurements for NR latex characterization" and "Latex Carbon black master batches" respectively.

- The staff of the department was involved in conducting practical classes for the students following the MSc degree course in Polymer Science and Technology at the University of Sri Jayawardenapura.

Officers from the industry

Miss Niranjala, an Officer from SINWA Holidings (Pvt.) Ltd. was given a training on Special grades of NR, Adhesive testing *etc.* at the request of the Company.

Seminars/Conferences/Workshops/ Visits

Officer	Subject	Organization
Ms Nilmini Liyanage	Three day work shop on Patent drafting	Sri Lanka Inventors Commission
Ms Nilmini Liyanage, H N K K Chandralal Ms Chitra Kuruppu	To inspect the machinery available and provide the technical advice on manufacture of RRI developed general purpose adhesive system	EDNA group of companies
Mr H N K K Chandralal	Valuation on machinery	SRMC factory at Millewa
Mr H N K K Chandralal	workshop on "Rubberized coir" for small scale entrepreneurs at Weeraketiya	Organized by the Ministry of Science and Technology at Weeraketiya

Task groups

Rubberized coir task group made an industrial visit to the Toyo Cushion Lanka, a leading rubberized coir mattresses manufacturer in the country. Several trouble shootings areas were identified which need technological improvements. Two projects were initiated to solve some of the defects in the processing line to improve the quality of the mattresses (Champa Wellappili, S Siriwardane, M Jayasooriya, H N K K Chandralal and P H Sarth Kumara).

Exhibitions

Officers of the department participated in the Mahapola Exhibition held at Paduwasnuwara, "KAPRUKA" programme conducted by the Coconut Cultivation Board (CCB) at Walpita and Mulkirigala and Science and Technology exhibition conducted by the ITI in Colombo.

LABORATORY INVESTIGATIONS

Latex/Carbon black master batches

The industrial research project on the above subject as requested by a tyre manufacturing industry was continued during the year. A series of NR latex Carbon Black master batches were prepared with the incorporation of chemicals such as ZnO and stearic acid. A novel dispersing agent was used in this study. Some of the properties of the master batch compounds are given in Table 1.

Table 1. *Properties of the masterbatch compounds*

		Before aging				After aging		
Sample	**Hardness (shore A)**	**Abrasion Resistance (mm3)**	**Modulus @100% MPa**	**Tensile Strength MPa**	**EB%**	**Modulus @ 100% MPa**	**Tensile Strength MPa**	**EB%**
Open mill mixed compound (control)	53	226.13	1.064	22.27	649.75	1.911	15.25	425
Carbon black master batch compound	53	166.99	1.080	20.34	652.80	2.107	18.96	454

The results show that the hardness has not been affected by the use of novel dispersing agent while abrasion and tensile properties shows an improvement. Hence, these NR-carbon black master batches prepared from latex would be suitable to be used in tyre treads compounds (Nilmini Liyanage, H N K K Chandralal and Indra Denawaka).

Rainguard sealant

An improved sealant was prepared by incorporating compounded latex with oil mixed hot bitumen mixture. A filler material China Clay is subsequently added after agitation of the mixture for a reasonable period of time. Trial samples have been tested at an estate in the Kalutara district.

As per the trial, sealant possesses good chemical, physical and user friendly properties such as elimination of Kerosene oil for dissolution of rubber, easy handling, improved adhesion properties and required flow properties *etc.* Flow properties of the sealant were found to be increasing with the incorporation of NR latex (Nilmini Liyanage, H N K K Chandralal and Ananda Samarakoon).

Cyclised rubber

Trials were conducted to prepare cyclised rubber using deprotenized and depolymerized lattices. FTIR studies proved that the efficiency of cyclisation is better with deprotenized – depolymerised latex and to solve the problems encountered previously with the cyclisation reaction and the solubility of the final product (Nilmini Liyanage, H N K K Chandralal and Ananda Samarakoon).

Bitumen and used plastic mixture in waterproof application

A waterproofing material was prepared using bitumen and plastic waste. Needle penetration and ductility tests were conducted to test the quality of the material prepared. Main target of this product is to be used as a roofing material because of its rigidity and durability (Nilmini liyanage, H N K K Chandralal and S S Waranapura).

Solid Tyre Tread Compound

Project was initiated upon a request made by an industrialist. Main goal of the project is to replace certain quantity of SBR rubber with Natural rubber from the currently used tyre tread formulation without affecting the major physical properties, in particular the abrasion properties of the product. Trials were initiated to achieve this goal using natural rubber and various grades of carbon blacks. According to preliminary results, it was observed that replacing of SBR by 20 – 30 parts of natural rubber is feasible without affecting compression set, abrasion and tensile strength properties.

Series of further trials were conducted to achieve better properties with the incorporation of different grades of carbon blacks as blends such as mixtures of N

330, N 220 and N 375 carbon blacks in different proportions. Project is in progress (N Liyanage and C Kuruppu).

Rubber based Adhesive

General purpose adhesive system

Project was initiated on request made by an industry. Trials were successfully completed as per their specifications. Technical know how, fabrication of stirrers and the safety measures need to be taken were already transferred to the company. Studies on viability of commercialization of the product too was carried out and submitted to the company (NIlmini Liyanage and Chitra Kuruppu).

Special Adhesive System

Request was made by an industrialist to prepare a low cost adhesive for bonding of long sticks (poles) of specially made crepe rubber form to the wood surface as the imported adhesive currently being used is expensive. An adhesive was prepared using Natural rubber, Toluene and Rubinid (rubber to Cellulose bonding promoter) which exhibits superior bond strength and half the cost of the imported adhesive. Details of the manufacturing process of this product was passed onto the requested party (Nilmini Liyanage and H N K K Chandralal).

Development of Gum Boot using natural rubber latex

Request was made by an industrialist to develop a textile – coated gum boot using NR latex. Major targets to be achieved in this request were, to prevent the penetration of latex to interior of the product and to obtain a fine texture. Expected results were achieved using a cationic surfactant and other suitable latex compounding ingredients. Technical details of the process were passed to the industry and commercial scale production of the product is in progress (Nilmini Liyanage, H N K K Chandralal and Ananda Samarakoon).

Development of a cellular beading out of EPDM

A study was undertaken as requested by the IDB. A formulation was designed for oven curing at 140°C. Different types of blowing agents were tested to improve the cellular structure of the product. Evaluations of results are in progress (Champa Wellappili, H N K K Chandralal and Indra Denawaka).

NR/modified EPDM blends

Different types of modifying agents were used to improve compatibility of NR with EPDM. New mixing methods of blending were tested in order to improve the performance of the blends. The experiments were continued with different types of EPDM. Evaluations of the results are in progress (Champa Wellappili and Indra Denawaka).

Development of an oil emulsion

Having experimented on different types of surfactants, an oil emulsion was developed to protect the tea plant against pathogens after pruning as requested by the TRI to use on a commercial scale. The main purpose of this preparation of an oil emulsion as against previously applied pesticides is to enhance the coverage of application in a larger extent.

Comparison of this emulsion was made with several the other pesticides. Results of the application of the oil emulsion were found to be successful and the layer of oil retained for about 3 months (Champa Wellappili and H N K K Chandralal).

Industrial extension and testing samples

The following services to the companies/Organizations were provided at their request.

Company	Analytical service
Edna Group	Analysis of the composition
Malindu Timber	Testing of timber for density and moisture
Water Board	Analysis of polymer composition of O rings
Sinwa Holdings	Analysis of adhesive for bonding properties
Fire Wall Company Ltd., Australia	Analysis of fire proof partitioning board

RAW RUBBER AND CHEMICAL ANALYSIS

Anusha Attanayake

SUMMARY

Summary of the activities performed during the year are as follows;

a. Testing, grading and issuing shipping certificates for all TSR produced in the country.
b. Testing and issuing quality certificates for different grades of raw rubber produced in the country for local industries and for shippers.
c. Analysis of chemicals used for processing raw rubber in the rubber products manufacturing industry in view of ascertaining the purity.
d. Analysis of skim rubber adulteration in scrap grades of crepe rubber.
e. Recommendation of chemicals for the industry and analyzing them for percentage purity.
f. Testing of finished products such as ;
    1. Rubber gloves for Sodium Pentachlorophenate and powder content.
    2. Rubber content in vulcanized product.
    3. Contamination of metal ions in dipped products.
g. The following research projects were in progress.
    1. Quality assessment of latex by monitoring the volatile fatty acid number and mechanical stability parameters
    2. Determination of average technical parameters for low grades of Natural Rubbers.

DETAILED REVIEW

Staff

Miss A P Attanayake, a trainee assigned to RRISL under graduate trainee scheme by the Ministry of Plantation Industries was made permanent as an Assistant Rubber Chemist with effect from 17th August.

Experimental Officer, Mrs H S Weeraman was in charge of overall activities of the department until Miss A P Attanayake was appointed.

Experimental Officers Mrs L Wanigatunga, Mrs H V K Gamage, Mrs C Lokuge, Mr L P Vitharana, Miss M Wijesekera, Mr B Gunasiri, Mr N Karunatilaka, Mr 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.

Research students

- Mrs Ganga Illenchelvah, a postgraduate student from University of Sri Jayawardanapura continued the laboratory analysis on the project on Property Variations of Centrifuged Latex with maturation and with different soap (Surfactant) concentrations under the supervision of Dr Shantha Walpolage, University of Moratuwa.

- Miss Jayatharshana Jesudawson, a postgraduate student from University of Sri Jayawardanapura continued the laboratory analysis of the project on "Depolymerization of NR latex masterbatches" under the supervision of Dr Kalyani Liyanage of University of Moratuwa.

- Mrs M K P Chithrangi, a student of University of Kelaniya carried out a statistical analysis of quality parameters of Lankaprene under the supervision of Dr Gamini Seneviratne and submitted a report.

Seminars/Conferences/Meetings/Workshops

Officer	Subject	Organization
Mrs H V K Gamage	Seminar on sampling statistics and standardization in chemical Analysis and Environment Management	Institute of Chemistry.
Miss Medavi Wijesekara	Seminar on safety protectors	Safety equipments (Pvt) Ltd.
Mrs H S Weeraman	Seminar on safety against Chemical Hazards and Biological threats	Esco Micro (Pvt.) Ltd. and Analytical Instruments (Pvt.) Ltd.

Training Programmes

Client	Subject	No. of programmes
NDT polymer Students, University of Moratuwa	Latex and raw rubber testing	1
MSc (Polymer) students of the University of Sri Jayawardenapura	Latex testing and dry rubber testing	10
Glenross Rubber Factory	Latex testing	1
Priyanga Dulmini, Quality latex (Pvt.) Ltd. Hanwella,	Latex testing	1
G D A Gunasekara, Institute of Chemistry	Latex testing	1
H Illapperuma, Richard Pieris & Co. Ltd.	Latex testing	1
B M N Rathnayake, Texas Rubber Industry, Horana	Latex testing	1

Client	Subject	No. of programmes
G A V Perera, Suyamas International (Pvt) Ltd.	Latex testing	1
P N J Fernando, University of Jayawardenapura	Latex and raw rubber testing	1
L A W K Dahanayaka, University of Ruhana,	Latex and raw rubber testing	1
Sinwa Holdings, Dehiwela	Raw rubber testing	1

Industrial visits

Miss Anusha Attanayake, Mrs C Lokuge, Mr P L Perera visited Culodden estate, Matugama to assist setting up of the new testing laboratory at their rubber factory.

LABORATORY INVESTIGATIONS

Services

Fixing of rainguards

Assistance was given on the preparation and fixing of rainguards for the above project initiated by Advisory Services Department in all rubber growing districts (A Dissanayake, Nimal Karunatilaka and Wimaladasa Vithanage).

Calibration of latex tanks

Calibration of bulking and storage tanks were carried out at Sapumalkanda group, Deraniyagala, Atale estate, Kegalle, Waulugala estate, Horana and Pitiyakanda estate, Mawathagama, on their requests (L P Vitharana).

Trouble shooting activities

- The problem of precoagulation of latex was solved by analyzing samples of liquid ammonia as per the request of small holders (A P Attanayake, L Wanigatunga, M Wijesekarara, N Karunathika, C Lokuge and V Gamage).

- Poor coagulation of latex with the use of formic acid in several estates was solved by analyzing a series of samples issued by several distributors in the Kalutara district (A P Attanayake, C Lokuge and V Gamage).

- In addition Miss Anusha Attanayake assisted the RRISL exhibition stall held at ITI, organized by National Science Foundation by way of conducting demonstrations.

Analytical services

Samples tested from each TSR factory during the year are as follows:

TSR Factory	No. of samples
Le-Ferne Block Rubber Factory, Getahetta	321
Nathupana	24
Total	345

Miscellaneous samples tested during the year are given below:

Samples	No. of samples
Raw rubber samples	354
Latex samples	1411
Chemical samples	69
Bleaching agent	129
Glove samples	36
Total	1999

RAW RUBBER PROCESS DEVELOPMENT AND CHEMICAL ENGINEERING

S Siriwardena

SUMMARY

Advisory and consultancy services were provided as main function of the department for factory development, waste water disposal and other related problems in raw rubber processing. Number of factories and industries visited for these purposes were 53. A total number of 64 and 05 analysis reports were issued for waste and processing water respectively along with 186 number of 'certificate of epidemic prevention' for latex crepe.

Two protein digestive enzymes were tried in order to reducing extractable proteins in NR latex. Although the laboratory trials gave promising results, semi-industrial scale trials were yet to yield satisfactory results. Several problems were encountered in the preparation of sheets from NR/EPDM blends in order to be irradiated to introduce direct crosslinks instead of sulphur crosslinks as it is not possible to obtain evenly crosslinked product with sulphur vulcanization. Several methods were attempted to overcome the problems and a composite of carbon black with the blend is currently being investigated.

An investigation was initiated to establish the most accurate and effective test method out of the two test methods currently being employed for determination of iron, and also to establish the maximum allowable iron content in the bleaching agent, which can be incorporated safely into latex without any adverse effect on the raw rubber properties of crepe rubber produced.

A comprehensive report was prepared with proposals suggesting how the ISO 9000 quality system at Dartonfield rubber factory can be reestablished and improved.

A study is being carried out to establish the quality standards and the minimum and maximum limits for some selected properties of low grades of NR.

Centrifuging operation at Lalan Latex Centrifuging factory at Bulathsinhala was thoroughly studied and a comprehensive report was submitted with proposals for improvement.

DETAILED REVIEW

Staff

Dr Susantha Siriwardane, Principal Research Officer was appointed the Actg. Head of the department with effect from 13th October. Mr Upul Rathnayake, Assistant Rubber Chemist continued his postgraduate studies at University of

Loughborough, UK. Mr P H Sarath Kumara, Assistant Rubber Chemist returned to the island and reported for duty on 17th October, after completing his research project on "Modification of Biodegradable Polymer by Radiation Cross-linking" at Japan Atomic Energy Agency at Takasaki, Japan. Mr P P Jayasinghe, Research Assistant was on duty throughout the year.

Mrs Chandrika Nalini, Mr T A S Siriwardane, Chandana Senanayake and Mrs U M S Priyanka, Experimental Officers, Miss V C Rohanadepa, Mr A K D Warnajith Prasad, Technical Officers, Mrs L Rukmanie, Store Keeper and Mrs S A Paranavithana, Clerk/Typist, were on duty throughout the year.

Research students

- Mr Lal Ranatunga, a MSc student from University of Sri Jayawardenapura continued his research project titled "Effect of different processing conditions on the mechanical properties of Natural rubber/Ground tyre composites" under the supervision of Dr Susantha Siriwardena.

- Miss L A W K Dahanayake, an undergraduate from University of Ruhuna, completed her industrial training project titled "Preparation and characterization of NR latex/ground rubber tyre masterbatch" under the supervision of Dr Susantha Siriwardena.

Lectures/Seminars/Workshops/Meetings

Officer	Subject	Organization
Susantha Siriwardane	Continued to serve as a visiting lecturer for the NCT (Polymer) course	Institute of Technology, University of Moratuwa
Susantha Siriwardane	Continued to serve as a visiting lecturer for the BSc General Degree course	Department of Chemistry, University of Sri Jayawardenepura.
Susantha Siriwardane	Attended a workshop on "Project report writing"	Council for Agricultural Research Project (CARP)
Susantha Siriwardane	Delivered lectures on raw rubber processing for the induction course for planter trainees	National Institute of Plantation Management

Officer	Subject	Organization
Susantha Siriwardane	Delivered a lecture on important aspects of raw rubber processing at the workshop organized by the Advisory Services Department for the medium scale rubber growers in the Ratnapura district	RRISL
Officers of the Dept.	One-day training program on process development of crepe rubber manufacture for Asst. Managers and factory staff	Kotagala Plantations Ltd.
Officers of the Dept.	Participated in organizing the rubber sector exhibition stalls at the Mahapola trade exhibition organized by the Ministry of Plantation Industries, in collaboration with other departments and affiliated institutes under the ministry	S W R D Bandaranayake National School, Paduwasnuwara, Kuliyapitiya
T A S Siriwardena and A K D W Prasad	Delivered lectures for the factory staff and field staff of Woodend Estate, Sapumalkande Estate, Udabage estate and Mahaoya Estate on correct estimation of DRC by metrolac measurements	Lalan Rubbers (Pvt) Limited
W M G Seneviratne, Susantha Siriwardena, T A S Siriwardena and U M S Priyanka	Addressed the factory staff of Nakiadeniya and Homadola estates, and all planting executives of the company on quality raw rubber manufacturing practices	Watawala plantations Ltd.
T A S Siriwardena	Attended a seminar on 'Environmental pollution' organized by the Industrial Institute of Technology (IIT)	ITI
A K D W Prasad and V C Rohanadeepa	Attended a seminar on the use of analytical instruments in water analysis conducted by Analytical scientific services (Pvt) Ltd	Analytical Scientific Services (Pvt) Ltd

Advisory visits

Sample collection for testing and advisory visits on waste water treatment and disposal

Type of industry	Service	No of Factories
Rubber Industries	Sample collection	15
	Modifications, Repairs	4
	New designs & Installations	3
	Monitoring of treatment efficiency	2
Non Rubber Industries	Sample collection	5
	New designs and Installations	1

Factory development

Service	No of factories
Inspection for subsidy recommendations for Infrastructure development from Cess funds	08
Process and quality development	08

Experimental visits

Client	Experiment/service
Lalan Glove Factory, Warakapola	Reduction of leachable proteins in Latex/gloves
Ellekanda Rubber Factory, Horana	Mechanization of fractionation process

Sample testing and certificates issued

Sample tested	Number of samples				
	1 Quarter	2 Quarter	3 Quarter	4 Quarter	Year Total
Waste water	45	37	42	32	156
Processing water	02	02	nil	01	05

Certificates issued	Number of certificates				
	1 Quarter	2 Quarter	3 Quarter	4 Quarter	Year Total
Waste water	09	18	23	14	64
Processing water	02	02	nil	01	05
"Certificate of epidemic prevention"	40	58	55	33	186

LABORATORY AND FIELD INVESTIGATIONS

Reduction of allergenic extractable proteins (EP) - rubber and rubber products

Laboratory investigations were carried out to evaluate the performance of two enzymes namely PARE 36 and PARE 37 received from Malaysia, in the reduction of extractable proteins in NR latex dipped products.

Cast films were prepared from centrifuged latex. The treatments were as follows;

1. Maturation of enzyme treated field latex for different periods of time followed by centrifuging
2. Heating of the cast films prepared from centrifuged latex, at different temperatures.

The cast films prepared from enzyme treated field latex were air dried for 2-3 days and tested for extractable protein (EP) according to ASTM D 5712. Irrespective of the maturity period of field latex and heat treatment of cast films, enzyme treatment of latex showed a reduction in EP level.

Similarly, gloves were prepared using compounded centrifuged latex having a maturity of 12 days produced from enzyme treated field latex. The gloves were subjected to different heat treatments. Results showed that EP levels in gloves had reduced significantly with enzyme treated latex.

A semi commercial trial conducted at Lalan Gloves (Pvt) Ltd. at Warakapola using latex treated with enzymes did not show a significant difference compared to that in gloves made from untreated latex. The project will be continued (W M G Seneviratne, U M S Priyanka and D S A de Silva).

Development of irradiated natural rubber (NR) and Ethylene - Propylene - diene ter polymer (EPDM) based composite materials for outdoor applications

The above project funded by National Science Foundation was continued throughout the year. NR/EPDM blends of 70:30 (by weight) were prepared and four samples were exposed to different doses of gamma radiation at Atomic Energy Authority of Sri Lanka. Irradiated samples were tested for Mooney viscosity and its variation with time. It was found that initial Mooney viscosity increases as the radiation dose increases up to a certain level and after which it drops again.

NR/EPDM blends were vulcanized with very low concentrations of sulphur before irradiation to obtain a defect free moulded sheet. However, formation of tiny air bubbles in the sheets after vulcanization at very low sulphur concentrations was a problem encountered here. Various attempts were made to overcome this drawback. Calendaring technology was also used to obtain bubble free sheets with even thickness. The minimum sulphur concentration for partial vulcanization to obtain

defects free sheets was determined and NR/EPDM/Carbon black (CB) composites were prepared accordingly. They were tested for their mechanical and ageing properties to select the best compositions for radiation vulcanization (Susantha Siriwardena, Dilhara Edirisinghe, Priyanthi Perera, Laleen Karunanayake, Samantha Sooriaarchchi and Dinesh Krishantha).

Estimation of iron levels in water-soluble rubber bleaching agent

Sodium salt of tolyl mercaptan is a water-soluble bleaching agent widely used in the crepe rubber industry to bleach the caratenoid pigments present in NR latex to get a water white colour for crepe rubber. However, contamination of the bleaching agent with metal ions such as Ferrous and Ferric causes discoloration of crepe rubber. Therefore, determination of iron level in bleaching agent is of paramount importance before incorporation into latex in the manufacture of crepe rubber.

Two different test methods are used to determine the iron content in the bleaching agent. In one method, bleaching agent is incinerated after evaporation to dryness and iron content in the resulting ash is determined. In the other method, crystallized thiol is separated by decantation and filtering. The iron content in the decanted solution is estimated by using UV spectrophotometer. Studies have so far not been done to compare the results of these two test methods.

Therefore, an investigation was initiated to establish the most accurate and effective test method out of the two. Also, another investigation has been planned to establish the maximum allowable iron content in the bleaching agent, which can be incorporated safely into latex without any adverse effect on the raw rubber properties of crepe rubber produced (Susantha Siriwardena and W Prasad).

ISO 9000 quality system at Dartonfield factory

Surveillance audit carried out at the end of the second quarter revealed that management of the quality system at the Dartonfield crepe rubber manufacturing factory, which was accredited under ISO 9000 quality system few years back, is not satisfactory. The investigation revealed that the competency of factory personnel is not adequate to maintain the system properly. A comprehensive report was prepared with proposals suggesting how the system could be re-established and improved (Susantha Siriwardena and W Prasad).

Lalan centrifuged latex manufacturing factory - Bulathsinhala

An investigation was carried out at Lalan centrifuged latex manufacturing factory at Bulathsinhala with the following objectives;

1. To study the current centrifuging operations at the factory
2. To identify the areas where further improvements could be made
3. To make appropriate recommendations for remedial and corrective actions to be taken

Procedural aspects on the following areas were investigated.

1. quality inspection at receiving latex
2. bulking of latex
3. centrifuging process
4. primary storage of centrifuged latex
5. final storage of centrifuged latex
6. preparation of chemical dispersions
7. quality assurance procedures in the factory

Having studied the above, a comprehensive report was submitted to the management of Lalan Group with suggestions and proposals for improvement (Susantha Siriwardena, U M S Priyanka and A K D Warnajith).

Studies on raw rubber properties of different grades of dry NR of low quality

Standards have not been established for raw rubber specifications for low grades of rubber such as scrap crepe and skim rubber. Wide variations are observed in raw rubber properties of these grades which contain higher levels of non-rubber substances. Therefore, a study was undertaken to investigate the raw rubber properties of low grades of rubber with a view to establish the quality standards and the minimum and maximum limits for some selected raw rubber properties. Rubber samples are being collected and testing has already been initiated (Susantha Siriwardena, Shriyanthi Weeraman, U M S Priyanka, Chandrika Nalinee and Wimaladasa Vithanage).

ADAPTIVE RESEARCH

V H L Rodrigo and S M M Iqbal

SUMMARY

A workshop on management practices of rubber was conducted for the rubber smallholders in the regions coming under the intermediate zone of Eastern province and in total, 48 acres of rubber were planted in 40 smallholdings. Research activities were geared towards enhancing the land use efficiency of rubber through a free range poultry system, Anthurium culture and bee keeping. Adaptive research on low and high density planting systems of rubber together with rubber/cinnamon and rubber/banana intercropping was set up in the RRISL sub-station at Polgahawela. Also, necessary steps were taken to popularize rubber cultivation in the Wayamba region of the country through the activities at Polgahawela substation.

DETAILED REVIEW

Staff

Dr V H L Rodrigo coordinated the activities of this unit. Dr S M M Iqbal (Agronomist), Mr W A D D S Wettasinghe (Research Assistant) and Mr E A T Senadeera (Experimental Officer) were on duty throughout the year. Dr Iqbal was promoted to the selection grade of the Senior Research Officer with effect from 27th October. Research Assistants, Ms B M D C Balasooriya and Ms E S Munasinghe assumed duties on 17th August and Development Assistant, Mr R Handapangoda assumed duties on 10th October.

Seminars/Conferences/Meetings/Workshops attended

Officer	Subject	Organization
Dr S M M Iqbal	Meeting with IRSG Chairman	RRISL
	Seminar on 5S system	Labour Department
	AGM of Soil Science Society of Sri Lanka (SSSL)	Soil Science Society of Sri Lanka
	Short course on crop experimentation	CARP/PGIA University of Peradeniya
Mr W A D D S Wettasinghe	Short course on identification of common bees in Sri Lanka	Dept. of Zoology, University of Peradeniya
Dr V H L Rodrigo and Dr S M M Iqbal	Scientific Committee Meetings	RRISL
	Project Meeting on Rubber Cultivation at Moneragala	RDD/MPI

Seminars/Conferences/Meetings/Workshops conducted

Officer	Subject	Organization
Dr S M M Iqbal	Lecture on intercropping of rubber with tea to the students of Wayamba University	RRISL
	Lecture on intercropping of rubber with tea to the trainees of NIPM	RRISL
	Workshop on agronomic practices on rubber for smallholders at Polgahawela region	RRISL Sub station, Polgahawela
	Project proposal presentation on rubber cultivation in the Eastern Province to the National Science	NSF

Support services

Staff of the Adaptive Research Unit assisted in implementation of RRISL's recommendations pertaining to the agronomic activities at Kuruwita sub-station of RRISL (W A D D S Wettasinghe).

Advisory visits

78 experimental and 16 advisory visits were made.

FIELD INVESTIGATIONS

Adaptive Research Programme

***Beekeeping in Rubber Plantations* (ARU/BK/2004/1)**

This project aims to increase the income of the rubber grown through the production of bee honey. Based on the initial observations made during the period of 1999 to 2004, two apiaries were set up in 2004 in both Kuruwita and Dartonfield estates. In Kuruwita, 4 colonies were set up and maintained whilst in Dartonfield, the apiary was started with six colonies and then expanded to nine colonies. In addition honey from four harvests each at Dartonfield and Kuruwita were collected (Table 1).

Table 1. *Performance of bee hives/colonies*

Site	Number of colonies available	Number of colonies harvested	Volume of honey collected (l)
Kuruwita	4	4	3.5
Dartonfield	9	4	2.9

Clay pots were installed on trees (25 in each estate) to enable the new swarming colonies to settle down. Artificial feeding was carried out during the dearth period (June to December) by using sweeping sugar solution at the rate of 200 ml/ hive/week. (W A D D S Wettasinghe and L M K Tillekeratne in collaboration with Training and Extension Division, Department of Agriculture, Peradeniya and Dr R W K Punchihewa, University of Ruhuna).

***Expansion of rubber cultivation in the eastern province* (ARU/RCEP/2004/1**

Details of this experiment are given in Annual Review 2004. Additional 48 acres of rubber were planted in 40 smallholdings.

National Science Foundation (NSF) awarded a grant for this project to identify the eco-physiological limitations to productivity of rubber in Eastern Province. Following are being investigated in this study.

1) Determination of the growth pattern of rubber in the intermediate zone of Eastern province of Sri Lanka

2) Assessment on the influence of dry spells on growth and photosynthetic capacity.

3) Assessment of the social acceptability for rubber in this region.

(V H L Rodrigo, S M M Iqbal, R S Dharmakeerthi, K B A Karunasekera and A Nugawela).

***Expansion of Rubber cultivation in Wayamba region (North western province)* (ARU/RCWP/2005/1)**

In order to facilitate the rubber cultivation in the Wayamba region, a sub station of RRISL was established in Narampola estate at Polgahawela. Construction of the office building progressed. An adaptive research trial on low and high density planting systems of rubber together with rubber/cinnamon and rubber/banana intercropping was established in an area of 03ha with the onset of SW monsoon (see Table 2).

Table 2. *Rubber and intercropping systems at RRISL sub-station Polgahawela.*

Extent (ha)	Rubber spacing	Cropping system	Density (plants/ha)
0.6	8ft × 19.5ft	Mono crop	High density (700)
0.6	8ft × 23 ft	Mono crop	High density (600)
0.6	8ft × 27ft	Intercrop with banana	Normal density (500)
0.6	8ft × 34ft	Intercrop with cinnamon	Low density (400)
0.6	8ft × 45ft	Intercrop with cinnamon	Low density (300)

(V H L Rodrigo, S M M Iqbal, and E A T Senadeera in collaboration with all biological departments of RRISL).

Mixed clonal systems **(ARU/MCS/2004/1)**

Experimental details appeared in the Annual Review 2004. Field trials established in Moneragala (dry) and Kegalle (wet) regions were maintained with the estate/smallholder collaboration. However, the experimental site at Kumarawatta estate was terminated as the management of the estate was unable to do the planting in accordance with the experimental design (S M M Iqbal, V H L Rodrigo and K B A Karunasekara).

Anthurium Culture under Mature rubber **(ARU/AC/2004/1)**

Details of the experiment appeared in Annual Review 2004.

Anthurium under mature rubber at two locations, namely RRISL Dartonfield, Agalawatta and RRISL substation Kuruwita was maintained. In each site 150 plants from both Gauthamala and Tropical red varieties were established between rows of mature rubber. At the age of six months, Tropical Red variety began to produce flowers suitable for sale. However, Gauthamala variety showed a poor performance in flowering probably due to the growth performance associated with the quality of planting material used. Plants of Tropical red were obtained through tissue culture whilst plants of Gauthamala variety were collected from smallholdings in Kalutara district (Table 3).

Table 3. *Performance of Anthurium under mature rubber*

Site	Variety	Number of plants established	Time taken to produce flowers (months)	Number of flowers sold (July – December)
Kuruwita	Tropical red	150	07	338
	Gauthamala	150	06	18
Dartonfield	Tropical red	150	07	356
	Tropical red	2500	Established November 2005	-
	Gauthamala	150	06	25

(W A D D S Wettasinghe, S M M Iqbal and V H L Rodrigo)

***Rubber with Poultry system* (ARU/PS/2005/1)**

A study was initiated to develop a sustainable system for free range poultry production under rubber in two locations at Dartonfield estate. Initially 30 birds [F1 of CPRS Brown strain (Central Poultry Research Station) and Indigenous backcrossed with Indigenous] were introduced in April. Birds were fed fully with formulated rations at the beginning and then amount of feed given was gradually reduced up to ca. 40% of the initial level (50g/bird/day) allowing them live on natural habitat. Cages were provided for the birds to rest in the night and during unfavorable weather conditions. Egg production and assessments of floral distribution in the sites were recorded.

Monthly egg production during the year is presented in the Table 4.

Table 4. *Monthly egg production during the year*

Month	No. of hens	No. of eggs
April	24	19
May	23	260
June	22	67
July	22	190
August	19	55
September	19	266
October	17	228
November	16	222
December	15	134

Birds were introduced on 19th April. On average, each hen layed 8 eggs per month. Egg production was low during the period of 19th to 30th April due to the stress in traveling and change of environmental conditions. Also, during the months of June and August, egg production was low due to the moulting of birds (Table 4).

Table 5. *Density of weed species. This represents the mean density of a species of the area where the particular species was present*

	Botanical name	Family	Density (no of plants/m^2)				
			June	Sept.	Oct.	Nov.	Dece.
1.	*Hedyotis auricularia*	Rubiaceae	3	0	0	17	15
2.	*Paspalam conjugatum*	Poaceae	12	5	8	3	3
3.	*Commelina indehiscens*	Commelinaceae	3	0	1	6	4
4.	*Adiantum latifolium*	Pteridaceae	18	16	15	24	26
5.	*Syngonium podophyllum*	Araceae	12	6	5	7	6
6.	*Pueraria phaseoloides*	Leguminosae	6	3	5	4	2
7.	*Symplocos cochinchinensis*	Symplocaceae	2	0	0	0	0
8.	*Mikania micrantha*	Asteraceae	2	0	1	1	2
9.	*Desmodium ovalifolium*	Leguminosae	13	3	2	2	3
10.	*Pathos scandens*	Araceae	1	0	0	0	0
11.	*Unidentified small seedlings*		0	5	7	14	15
12.	*Cyperus rotundus*	Cyperaceae	0	0	1	1	1
13.	*Grass*		0	0	8	0	0

Weed species found in the experimental area and their respective densities are given in Table 5. Accordingly, density of individual species changed with time. Grasses were very rarely found at the beginning and then, their density has increased indicating the beneficial effect of poultry on them. *Paspalam conjugatum, Adiantum latifolium, Syngonium podophyllum* and *Hedyotis auricularia* were dominant throughout the study period. The density of *Paspalam conjugatum* and *Syngonium podophyllum* decreased with time and it clearly indicated that the birds were feeding on these weeds. Further investigations are in progress to study the effect on soil erosion and to quantify the carrying capacity of the poultry system (B M D C Balasooriya, S M M Iqbal and V H L Rodrigo in collaboration with VRI).

***Assessments of different tapping systems practiced in the smallholder sector* (ARU/TSSH/2005/1)**

A study was commenced to assess the performance of recommended clones under different tapping systems practiced under smallholder conditions. Ten sites from Kalutara district were selected and six sites were assessed for the quality of tapping systems (Table 6). In all sites, the rate of bark consumption was reasonably acceptable but length of the tapping cut and placement of latex collecting cups were not in order. Farmers only in three sites had used a stencil to mark tapping guidelines and had placed the cup hangers properly. Tapping angle was found correct in four sites.

Table 6. *Tapping quality in six sites in the Kalutara district (Sites with a minimum of 80% trees be in order, were considered as good)*

Status of the quality of tapping system	Guide line	Tapping angle	Depth of the cut	Length of the cut	Bark consump -tion	Cup hangers	Placement of cups
Good	3	4	5	0	6	3	1
Poor	3	2	1	6	0	3	5

(E S Munasinghe, S M M Iqbal, V H L Rodrigo and R Handapangoda)

Interplanting of rubber lands with Tea

Productivity in Rubber/Tea systems (ARU/TRIC/1990/1)

Details of the experiment were given in the Annual Review 1990. Tea yield in each treatment plot was monitored through out the year. In the sole tea crop it showed a significantly higher value than that in the intercropped tea. Between intercrop treatments there were no significant difference in tea yield (Table 7).

Table 7. *Made tea yield (MTY) in tea rubber system*

System	Mean Made Tea Yield (kg/bush)
1. Tea only (100%)	0.1707^{A}
2. Rubber (8'×27') + Tea (Non rehabilitated soil)	0.0761^{B}
3. Rubber (8'×27') + Tea (Rehabilitated soil)	0.0674^{B}
4. Rubber (8'×40') + Tea (Non rehabilitated soil)	0.0596^{B}
5. Rubber (8'×40') + Tea (Rehabilitated soil)	0.0496^{B}

(Means with the same letter are not significantly different)
(S M M Iqbal, S Wettasinghe and R Handapangoda)

***Productivity in Rubber/Tea systems* (ARU/TRIC/1990/2)**

Treatment details of the experiment were given in the Annual Review 1990. Tea plants were pruned in May. Among the intercrop treatments, the yield of sole crop tea was significantly greater than that in intercropped tea during both before (January to April) and after pruning (September to December) (Table 8 and 9). Among intercrop treatments, there was no statistical difference in tea yields. Also, no significant difference was found in rubber yields between treatments (Table 10).

Table 8. *Made tea yield (MTY) in rubber/ tea system (Before pruning) (Agalawatta)*

System	Mean MTY Kg/bush
1 Tea only (100%)	0.0314^{A}
2. Rubber 8' × 27' (100%) + Tea	0.0211^{B}
3. Rubber 8' × 32' (85%) + Tea	0.0215^{B}
4. Rubber 8' × 36' (75%) + Tea	0.0117^{B}
5. Rubber 8' × 40 (70%) + Tea	0.0163^{B}
6. Rubber 8' × 44' (65%) + Tea	0.0184^{B}

(Values with the same letter are not significantly different)

Table 9. *Made tea yield (MTY) in tea rubber system (After pruning) (Agalawatta)*

System	Mean MTY Kg/bush
1. Tea only (100%)	0.2279^{A}
2. Rubber 8' × 27' (100%) + Tea	0.1138^{B}
3. Rubber 8' × 32' (85%) + Tea	0.1007^{B}
4. Rubber 8' × 36' (75%) + Tea	0.1050^{B}
5. Rubber 8' × 40 (70%) + Tea	0.1181^{B}
6. Rubber 8' × 44' (65%) + Tea	0.1064^{B}

(Values with the same letter are not significantly different)

Table 10. *Rubber yield (RY) in rubber/ tea system (Agalawatta)*

System	Mean RY g/t/t
1. Rubber only (100%)	61.445[A]
2. Rubber 8'× 27' (100%) + Tea	57.708[A]
3. Rubber 8'× 32' (85%) + Tea	56.816[A]
4. Rubber 8'× 36' (75%) + Tea	59.232[A]
5. Rubber 8'× 40 (70%) + Tea	55.412[A]
6. Rubber 8'× 44' (65%) + Tea	61.250[A]

(Values with the same letter are not significantly different)
(S M M Iqbal and R Handapangoda)

Productivity in rubber/tea system - Vogan estate **(ARU/TRIC/1998/1)**

Details of the experiment were given in the Annual Review 1998. Field assessments had to be suspended as RRI was unable to settle labour payments due to the estate (S M M Iqbal and R Handapangoda).

AGRICULTURAL ECONOMICS

J C Edirisinghe and Wasana Wijesuriya

SUMMARY

Agricultural economics unit continued its assistance to other research departments through economic analyses in various forms. Several studies were conducted during this year focusing on technical efficiency of smallholder rubber farmers in Kalutara district, leading indicators as an aid to forecast rubber prices and income, inequality and poverty in the smallholder sector. New projects are in progress on profit inefficiency of smallholder rubber producers and resulting health costs and abatements through water pollution from rubber industry. In addition the Agricultural Economics Unit was involved in collaborative studies with the Biometry Section and Advisory Services Department.

DETAILED REVIEW

Staff

Mr J C Edirisinghe was on duty as an Assistant Agricultural Economist till his resignation on the 01st of December.

Research students

- Ms P K C Priyadarshani from the Faculty of Agriculture, University of Ruhuna conducted her project on "Technical efficiency of the medium scale rubber plantations" for the partial fulfillment of the BSc degree in Agriculture under the supervision of the Assistant Agricultural Economist.

Seminars/Conferences/Meetings/Workshops attended

Officer	Activity	Organization
J C Edirisinghe	Scientific committee meetings	Rubber Research Institute
J C Edirisinghe	Proposal presentation – "Water pollution from rubber industry: Health costs and abatement"	South Asian Network for Development and Environmental Economics (SANDEE), Bangalore, India
J C Edirisinghe	2nd partner meeting of the project "Role of institutions in global environmental change" funded by the START secretariat APN	Rubber Research Institute of Sri Lanka

Services

Research support

The Agricultural Economics unit continued the support to other research departments through various cost-benefit analyses and sensitivity analyses.

Database management

The database on auction prices was continuously updated since 2000. Changes in key economic indicators derived through this database are given below.

Prices of Ribbed Smoked Sheets (RSS)

The prices of RSS showed a steady increase during the year as depicted in Fig. 1. Monthly averages were above than that of 2004 in most instances. The gap in prices has been broadened towards the end of the year. The prices of RSS grades increased by 10 -12% from 2004 to 2005 compared to 25 – 27% from 2003 to 2004. The behaviour of prices of RSS from 2000 to 2005 showed a rapid increase from 2002 to 2004 and started to level off after 2005 as shown in Fig. 2.

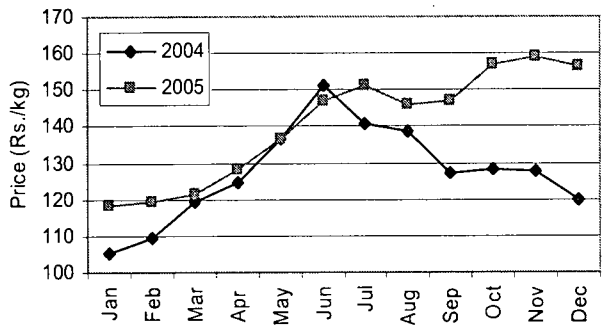


Fig. 1. Monthly averages of nominal RSS1 prices in years 2004 and 2005

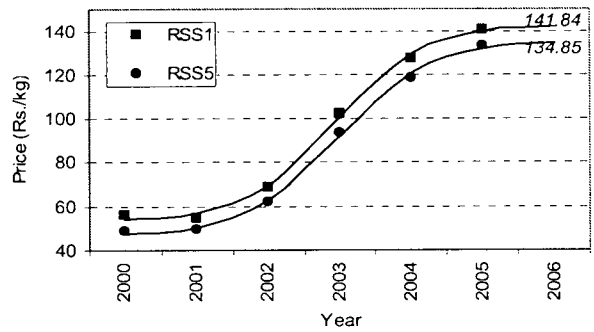


Fig. 2. Observed and fitted RSS prices using the logistic function

Prices of Latex Crepe (LC)

The gap in prices was more prominent in the early months of the year when compared to the previous year in contrast to the RSS prices (Fig. 3). The prices of LC grades increased by 5 - 7% from 2004 to 2005, which was marginal when compared to 18 – 31% from 2003 to 2004 (Fig. 4).

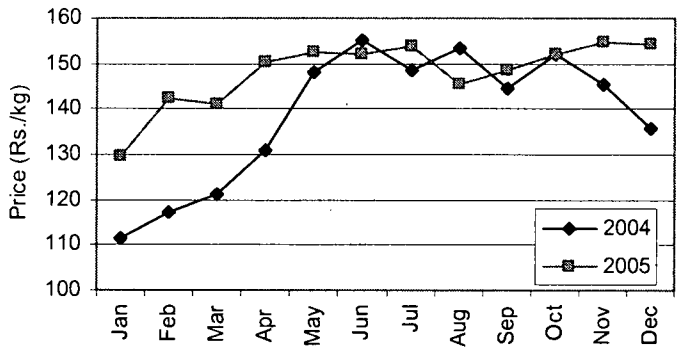


Fig. 3. Monthly averages of nominal LC prices in years 2004 and 2005

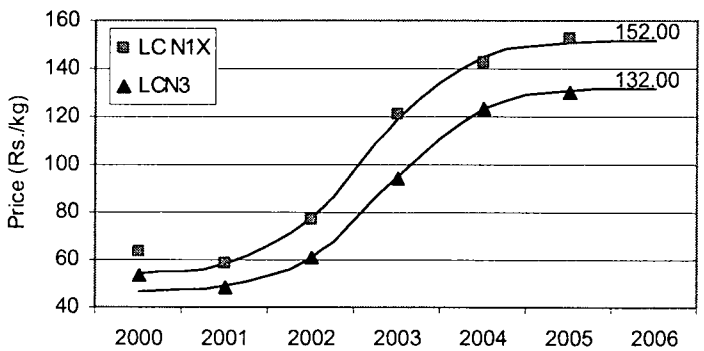


Fig. 4. Observed and fitted LC prices using the Logistic function

Changes in real prices for the rubber grades

The real prices were in an upward trend since 2001 till 2004 for rubber as shown in Fig.5. However, the real prices had never reached the values observed in the year 1996, which is equal to Rs.75/kg of latex crepe in nominal terms. A slight decrease was observed in real prices in 2005 as depicted in Fig.5.

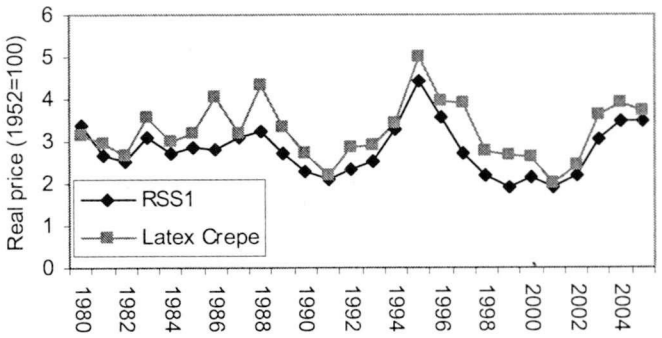


Fig. 5. Changes in real prices for RSS1 and Latex Crepe

Quantities of rubber grades traded through auction during 2005

There has been no marked departure in percentage quantities traded through Colombo auction in years 2004 and 2005 (Fig. 6).

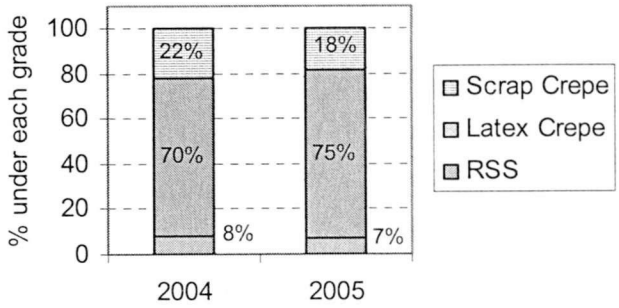


Fig. 6. Percentage of rubber grades traded through Colombo auction in 2004 and 2005

RESEARCH

The following studies were completed in the year under review.

Production behaviour and technical efficiency of smallholder rubber farmers in Kalutara district

This study was done to determine the current level of technical efficiency of the smallholder rubber sector and to identify the factors influencing technical inefficiency of smallholder farmers. Data collection was done during March on 115 smallholder rubber producers in the Kalutara District. Maximum likelihood estimates of the stochastic frontier production model were estimated for latex yield with the independent variables, *viz.* extent of land, age of the plantation, number of tapping days and number of tappers using Cobb - Douglas and Translog models using the

software, Frontier version 4.1. Out of the two models tested, Cobb-Douglas was found to be the best fit for data. According to Cobb Douglas specification, extent of land, number of tapping days and number of tappers showed significant effects on yield. The mean technical efficiency of rubber smallholder sector in study area was 73%. Experience, education, occupation, land extent, number of trees and fertilizer application showed a significant effect on efficiency of smallholdings (Tharanga Herath and J C Edirisinghe).

Development of leading indicators for natural rubber prices at Colombo auction

The price is a relatively important driving force in the production of rubber and its manufacturing industry. It varies within the year (seasonal) and also between years (cyclical). This study was done to identify the cyclical nature of Sri Lankan rubber price and the possible leading indicators to predict the cycle. These cyclical fluctuations are hard to predict using conventional time series analysis. Therefore, this study attempted to find suitable leading indicators for the cyclical fluctuation. Fourteen (14) such data series were found to lead F.O.B price in Colombo out of the 30 tested. The constructed composite leading indicator (CLI) could explain only 19.9% of the cyclical variation in F.O.B prices. However, the estimation of known values of F.O.B prices showed that the estimates were closer to the actual values. Therefore, CLI developed in this study could further be improved to reflect a comprehensive CLI, provided availability of all necessary data. The limitation of quality data has influenced the study and may have lowered the strength of the model (K A I Damayanthi and J C Edirisinghe).

Income, inequality and poverty in the smallholder rubber sector

This study employed a parameterized Lorenz curve to study the incidence, depth and severity of poverty and inequality in the smallholder rubber sector. The study was confined to the 3 major rubber growing districts, *i.e.* Kegalle, Kalutara and Ratnapura with a sample size of 300 individuals.

The estimated measures of poverty are given in Table 1 together with poverty indices published by the Department of Census and Statistics for these 3 districts. Although, Kegalle and Kalutara are the major rubber growing regions in the country, the poverty among smallholders is quite high. The Head Count Index (HC), which is a mesure of % farmers below the poverty line, is highest in the Kalutara district. Nearly 67% of the sample was found below the poverty line. It was noted that the inequality is predominant in the Kegalle district with the highest vale for the Gini coefficient. In general the smallholders in the Ratnapura district are in a better position due to the availability of other income sources. The incidence of poverty in the district as a whole is low when compared to the smallholders. However, inequality of consumption expenditure is low with smallholders when compared to the districts as a whole as evident from the values of the Gini coefficient (J C Edirisinghe, Wasana Wijesuriya, Keminda Herath and D M A P Dissanayake).

Table 1. *The estimated measures of poverty and inequality of the rubber smallholders*

District	Smallholders			District as a whole*		
	Mean consumption (Rs/month/ person)	Head Count Index (HC)	Gini coeffi-cient	Poverty line (Rs/month/ person)	Head Count Index (HC)	Gini coeffi-cient
Kalutara	1333	67	32	1523	23	43
Kegalle	1625	56	37	1451	32	43
Ratnapura	1853	45	33	1437	34	41

*Source: Department of Census & Statistics, (2002)

The following studies are in progress.

An examination of profit inefficiency of smallholder rubber producers in Sri Lanka (CARP contract research project 12/636/479)

This is a collaborative research project with Faculty of Agriculture, University of Peradeniya and funded by CARP. The objectives are to assess the natural rubber (NR) production in Sri Lanka in terms of other NR producing countries in the world, to derive a statistical measure of profit (economic) inefficiency of rubber farmers. A stochastic profit frontier will be used for the three major rubber-growing regions, to relate the household attributes and other social variables to the inefficiency. During the year under review, a detailed review of literature has been conducted. A questionnaire was developed in local language and was pre tested. A sample of 1000 farmers divided among the three rubber growing regions *viz.*, Kegalle, Kalutara and Ratnapura on a 5:4:3 ratio and will be interviewed. Accordingly, 417 farmers from the Kegalle District, 333 farmers from the Kalutara District and 250 farmers from the Ratnapura District will be selected and interviewed. The questionnaire was discussed in detail with the Regional Extension Officers (REO) who will act as enumerators in this study (J C Edirisinghe, Wasana Wijesuriya, D M A P Dissanayake and C Bogahawatta).

Water pollution from rubber industry: Health costs and abatement

This study is funded by the South Asian Network for Development and Environmental Economics (SANDEE) on abatement costs and effect of pollution on health of people living close to rubber estates. Findings will discuss how to use economic instruments in controlling pollution where the command and control system through establishment of pollution control standards have failed. This is a collaborative research project with the Raw Rubber Process and Chemical Engineering Department (J C Edirisinghe, Susantha Siriwardene and Gamini Seneviratne).

BIOMETRY

Wasana Wijesuriya

SUMMARY

Providing necessary research support to other research departments in various aspects; *viz.* experimental design, analysis and interpretation of results is among the major responsibilities of the Biometry section. Statistical assistance is also provided to trainees and University students attached to the research departments. Databases were satisfactorily maintained during the year under review on meteorological data collected at the Meteorological station at Dartonfield and information on research personnel and projects.

The staff of the Biometry section is in a routine process of upgrading their knowledge through a research focus to develop appropriate statistical methods for the rubber sector. Statistical quality control, multivariate statistical forecasting, analysis of participatory studies, boundary line approach as applied to adoption and productivity indices in the smallholder sector and use of multivariate methods in adaptability trials are among the research focuses of the Biometry section. Biometry section in collaboration with the Agricultural Economics Unit and the Advisory Services Department has successfully completed the 3-year research project 'Interactions between the Environment, Society and Technology (INTEREST)' funded by the European Commission during this year. The project 'Role of institutions in global environmental change' is in progress, which is a collaborative one with overseas institutions and various research departments of the institute.

DETAILED REVIEW

Staff

Dr (Ms) Wasana Wijesuriya (Biometrician), Mr Keminda Herath (Assistant Biometrician) and Experimental Officers, Ms Chintha Munasinghe and Mr Vidura Abeywardene were on duty throughout the year.

Research students

- Ms Nishadi Fernando from the Faculty of Agriculture, University of Ruhuna conducted her project on "Appropriate statistical methods to analyze results generated through Participatory Rural Appraisal (PRA)" for the partial fulfillment of the BSc degree in Agriculture under the supervision of the Biometrician.

Seminars/Conferences/Meetings/Workshops attended

Officer	Activity	Organization
Wasana Wijesuriya and Keminda Herath	1st partner meeting of the project "Role of institutions in global environmental change" funded by the START secretariat of Asia Pacific Network (APN)	Energy & Resources Institute, Goa, India.
Wasana Wijesuriya	Scientific committee meetings	Rubber Research Institute
Wasana Wijesuriya	Technical Advisory Committee of the Centre for Climate Change Studies (CCCS)	Meteorological Department
Wasana Wijesuriya	Steering committee of the Young Scientists' Forum (YSF)	National Science and Technology Commission
Wasana Wijesuriya	Executive committee of the Applied Statistics Association of Sri Lanka	University of Peradeniya
Wasana Wijesuriya and Keminda Herath	2nd partner meeting of the project "Role of institutions in global environmental change" funded by the START secretariat APN	Rubber Research Institute of Sri Lanka
Wasana Wijesuriya	The National Capacity Needs Self Assessment for Global Environmental Management (NCSA) Project	Ministry of Environment

Services

Statistical analysis and interpretation

Research support in designing of experiments, statistical analyses and interpretation of experimental results was provided to other Research Departments and students attached to those departments. Several databases were developed for the research departments for routine data recording (W Wijesuriya and K Herath).

Database management

(a) Meteorological

Daily data collected in the Dartonfield meteorological station were recorded in a database. Monthly reports were prepared from this daily database and sent to the Central Meteorological Station and the Natural Resources Management Centre (NRMC), Peradeniya. These data were made available to researchers and organizations on request (K Herath, C Munasinghe and V Abeywardene).

b) Management information

The personnel and project summary databases were updated for the year 2005. The collected information was transferred to CARP to be included in the

database of National Agricultural Research System (NARS) (W Wijesuriya, K Herath and C Munasinghe).

RESEARCH

Studies completed in year 2005

Interactions between the Environment, Society and Technology (INTEREST)

This project was funded by the European Commission and carried out in 5 different eco-systems in Asia. The Sri Lankan component was the smallholder sector of rubber. The final report consisting of last 3 years work was published and sent to European Commission during the year under review. The team was involved in disseminating the research findings during this year in international and local forums (Wasana Wijesuriya, Mahinda Wijeratne (University of Ruhuna), D M A P Dissanayake, Keminda Herath, Jagath Edirisinghe and Vidura Abeywardene).

The following studies/programmes are in progress.

Role of institutions in global environmental change

This is a collaborative project with Energy and Resources Institute (teri) of India, Environment and Public Health Organization (ENPHO) of Nepal. The aim of this project is to educate people on the adverse impacts of climate change and to suggest adaptation measures to minimize the impact on rubber plantations.

The first team meeting of this project was held in Goa, India in January this year. During the year under review, participatory studies and awareness programmes were done in Moneragala, Polgahawela, Mirigama and Matale areas under this project. Booklets were printed in local language covering activities from rubber planting through processing. A 3-day residential workshop was conducted for rubber farmers in Moneragala at the training centre of RRI. In December, the 2nd partner meeting was held at RRI. RRI team presented their findings under the theme, "Responsibilities of local institutions in confronting environmental changes: Special focus on the smallholder rubber sector in Sri Lanka".

The following table describes the proposed institutional targets and specific institutional tasks towards confronting adverse impacts of environmental change (Wasana Wijesuriya, Lalani Samarappuli, Anura Dissanayake, Keminda Herath, Jagath Edirisinghe and Vidura Abeywardene).

Problem	Institutional targets	Specific institutional tasks
Depletion of extent under rubber cultivation	Minimize- converting rubber lands into other crops and uses	• Information base to support the importance of rubber as an alternative forest crop (criteria & indicator development) • Identifying constraints, finding possibilities and formulation of appropriate policies to encourage rubber farmers
	Increase - extent of rubber plantations	• Finding suitable areas for rubber cultivation • Appropriate recommendations • Appropriate action & management plans
	Minimize - repercussions on industrial investment decisions on rubber plantations	• Forming advisory committees • Formulate policies to minimize repercussions
Climate change impacts on rubber cultivation	Minimize- losses to rubber plantations from extreme events	• Identifying vulnerable areas • Recommendations on soil & moisture conservation • Recommendations to combat yield losses due to rain interference (Rainguards) • Creating awareness on the above among growers • Measures towards improving adoption
Adverse environmental impacts of rubber processing	Minimize - adverse environmental impacts of rubber processing	• Developing suitable waste disposal methods • Creating awareness • Setting threshold values, monitoring & legislation

Dissemination of findings under "Strategies for enhancing the productivity of smallholder rubber units in non-traditional rubber growing areas as an initiative to address poverty"

The Centre for Poverty Analysis (CEPA) funded publishing the findings of this project. Arrangements were made through the library to publish a special issue of RRISL bulletin together with publications from other scientists who submitted their papers related to rubber farming in the Moneragala district. This issue is to be launched in the first quarter of 2006 (Wasana Wijesuriya, Anura Dissanayake, Keminda Herath and Jagath Edirisinghe).

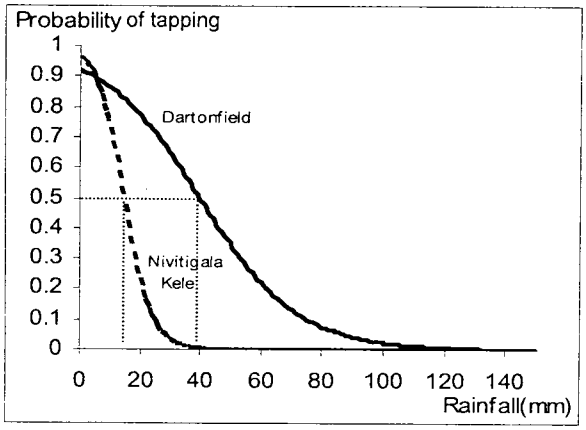
Uncertainty of tapping due to incidence of rainfall

Most of the rubber plantations in Sri Lanka are confined to the wet zone, where the annual rainfall of exceeds 2500 mm. There is about 30 – 35% loss of potential crop each year and, tapping wet panels may lead to panel diseases (RRISL). Therefore, rainfall critically affects tapping leading to an uncertainty of economic returns from rubber. With this background this research is done with objectives to assess the uncertainty of tapping due to rain interference and study the effectiveness of fixing rainguards as a measure to combat rain interference during different rainy seasons of the year. Further, this study extends to model amount and intensity of rainfall with the possibility of tapping. These will be modeled under different scenarios based on time of occurrence of a rainfall event.

Rainfall records were collected from the recording type rain gauge installed at Dartonfield agro-meteorological station. Tapping records were taken from tapping charts maintained in both Dartonfield and Nivitigalakale divisions for the period 2002-2004.

The target is to develop probabilities associated with tapping under different scenarios; *viz.* seasonal and diurnal variation in rainfall and the effect of rainguards. Distribution fitting and log-linear models were employed in the analysis.

Following figure describes the probability of tapping at divisions, Dartonfield (with rainguards) and Nivitigalakale (without rainguards) against a rainfall event received within six hours from tapping. There will be a 50% chance of tapping at Dartonfield even with a rainfall of 40 mm. However, without rainguards, there is no possibility of tapping with a rainfall event of 40 mm occurring within 6 hours before the commencement of tapping. Further analyses are being commenced to identify probabilities associated with tapping under other different scenarios (Keminda Herath and Wasana Wijesuriya).



Application of dynamic factor model technique on economic data of rubber and tea (CARP contract research project 12/572/433)

This is a collaborative research study with Faculty of Agriculture, University of Peradeniya and funded by CARP. Accurate forecasting on economic variables is an important task in the plantation sector. There are many instances in which, ARIMA models have been applied on rubber and tea economic time series data.

However this requires long stationary time series data. But rubber and tea economic data are not stationary in its nature. Some time series are not even long enough for ARIMA models. Further, identification of common trends of economic variables in different contexts (*eg.* common trends in prices at different rubber markets) will be much helpful in decision-making process of both rubber and tea sectors. ARIMA models are not sound enough to address this issue.

Dynamic Factor Analysis (DFA) has been introduced very recently, which can directly use non-stationary time series to identify common trends and the effect of other explanatory variables. However forecasting techniques associated with DFA is not clear. With this background the objectives of this research are to identify common trends of economic time series generated from different scenarios in both tea and rubber sectors and to identify a proper forecasting technique.

Time series data on production, export and prices of different forms of rubber and tea were collected from the sources in RRI and TRI. Developing appropriate models are in progress using Brodgar version 2 (Keminda Herath and S Samita).

Boundary line approach applied to adoption and productivity indices in the smallholder sector

Boundary line approach has been applied to many areas of research. In the present study an attempt was made to apply this method to adoption and productivity indices derived from surveys carried out in the smallholder sector. The objective of this study is to derive a statistical measure for inefficiency and to relate socio-economic variables of households. This study is in the initial stages and analyses are in progress (Wasana Wijesuriya).

LIBRARY AND PUBLICATIONS

S U Amarasinghe

SUMMARY

The prime objective of the library is to provide necessary literature promptly to its clientele for work connected to their research and publications. The library attempts to fulfill this objective by collecting and disseminating information on Natural Rubber and related areas. The other responsibility is to continue the process of publishing institute's regular publications.

DETAILED REVIEW

Staff

Mr S U Amarasinghe, Librarian and Publications Officer, Mrs Ramani Amaratunga, Library Assistant and Assistant Publications Officer, Mr P M Prema Jayantha, Clerk/Typist and two Library Attendants were on duty thought the year.

Mrs Thilaka Danthanarayana, Library Assistant and Assistant Publications Officer (Colombo Office) retired on 14.08.2005 after completing 35 years of service. Mrs Irene Perera assumed duties as the acting Library Assistant (Colombo Office) with effect from 6th June.

Meeting/Seminars

Librarian and Publications Officer attended the following:

- The AGM of the Sri Lanka Library Association at BMICH
- Three AGRINET Librarian's meetings at CARP office
- A seminar on science and technology databases at NSF

Resource development activities

With the arrival of 121 new books, the book strength increased up to 5293. The Library subscribed to a few journals and more than twenty journals were received on exchange basis.

Publications

- Annual Review 2003
- Annual Review 2004
- RRISL Bulletin Vol.44 (2002)
- RRISL Bulletin Vol.45 (2003)

- RRISL Journal Vol.86 (2003)
- Annual Report 2004
- Rubber Puwath Vol.23 (2003)

ILL service

37 articles were sent to various agricultural libraries on their request and vice versa 28 articles were requested for RRISL users. Nearly 15 literature surveys on rubber were done using CD-ROM databases available at CARP and PGIA libraries.

Information services

Computerized bibliographic data up to the year 1995 were sent to the National Library of Sri Lanka and CARP library for compilation of the National Union Catalogue and the National Agricultural Bibliography respectively.

Office equipment

The following were received to the library during the year

- Rhythm Watch – Silver Colour
- Dot Metrics Printer – Epson LQ 300T
- Monitor 14"

DARTONFIELD GROUP

J Perera

SUMMARY

The institute's group of estates, generally known as the Dartonfield Group, comprising of Dartonfield and Gallewatte divisions at Agalawatte and Nivitigalakele division at Matugama, in a total extent of 331.88 hectares, carried a planted hectarage of 230.14, of which 196.15 hectares were tapped during the year under review. The immature rubber extent stood at 33.99 hect.

The weather condition prevailed during the year was not conducive for both tapping and harvesting of crop.

The total crop harvested during the year was 185907 kgs. representing YPH of 948 kgs. However, the crop secured fell short of the estimate by 5.4%, but harvested 16% more than year 2004.

The tapping system (1/2S. d/3. ET. 2.5% Ba 1.6.4/Y) introduced to Gallewatte division in the year 2003 was continued during the year helping to reduce tapper shortages to a larger extent.

The profit from revenue extent and sundry income of the group for the year under review were Rs.10,689,652.50 and Rs.638,478.75 respectively. This was without capital expenditure. The COP and NSA of the group for the year were Rs.86.84 and Rs.144.34 per kilo respectively, achieving a profit of Rs.57.50 per kg. of rubber.

DETAILED REVIEW

Mr Jehan Perera, the Estate Superintendent, Mr K K P Gunawardena, Actg. Chief Clerk, Mrs S I K Pathirage, Junior Clerk, Mr D S K Ranaweera, Rubber Factory Officer, Mr W D D Senanayake, Assistant Rubber Factory Officer, Mr S K S de Silva, Mr H M Jayantha Premalal and Mr T Somaratne, Field Officers, Mr Ajith Nakandala, Mr B M Seneviratne, Mr Jagath Nakandala, Mr N L D Nihal, Mr K A Sarath Kumara were on duty throughout the year.

The death of Mr N L D Reggie, Field Officer attached to the Dartonfield Division, on 19th March 2005 is recorded with regret.

Mrs O V D Namali Udayanthi was appointed as Junior Assistant Clerk with effect from 10th June 2005.

The Group cadre stood as fallow at the end of the year.

Senior Staff	-	01
Assistant Staff	-	14
Minor Staff	-	02
Total	-	17

Hectarage summary - Dartonfield group

Hectarage summary of the Dartonfield group is given in Table 1.

Table 1. *Land Distribution of the Dartonfield group*

	Dartonfield Division	Gallewatte Division	Nivitigalakele Division	Total
Mature areas	39.02	144.62	12.51	196.15
Immature areas		15.27	18.72	33.99
Budwood nurseries	6.54		1.25	7.79
Seedling nurseries	0.73		0.75	1.48
Uprooting areas			13.90	13.90
Abandoned areas		5.13	11.32	16.45
Stake Land taken	0.27			0.27
Paddy/Deniya land		1.22	1.22	2.44
Waste Land	0.19	0.18		0.37
Earth slipped areas	3.01	1.26		4.27
Jungles	0.80		3.29	4.09
Rocky areas	2.14	4.74		6.88
Buildings	16.14	5.07	7.79	29.00
Roads	2.92	6.86	0.32	10.10
Building complex	2.53			2.53
Streams			2.17	2.17
Grand total	74.29	184.35	73.24	331.88

The increase of 04 hectares to the total extent of the group was due to handing back of 04 hect. by the National Institute of Plantation Management which was given to them in year 2004 from Gallewatte Division.

The YPH of the group from year 2001 to 2005 is given in Table 2.

Table 2. *YPH of Dartonfield group*

Division	Years				
	2001	2002	2003	2004	2005
Dartonfield	764	1218	1177	850	859
Gallewatte	890	815	1010	872	997
Nivitigalakele	657	754	613	689	656
Groups average	838	879	1002	863	948
Group's estimate	901	943	989	964	1001

Table 3. *The IPT (intake per tapper) divisionwise for last 05 years in the Dartonfield group*

Division	Years					
	2000	2001	2002	2003	2004	2005
Dartonfield	6.8	7.2	7.1	6.6	6.4	6.8
Gallewatte	6.2	8.0	7.8	9.8	9.6	9.4
Nivitigalakele	5.0	4.6	4.4	4.6	5.9	5.7
Average	6.9	6.7	7.6	8.4	8.7	8.9

Vacant blocks

Table 4. *Vacant blocks divisionwise in the Dartonfield group during last 03 years*

Division	Vacant blocks			Percentage		
	2003	2004	2005	2003	2004	2005
Dartonfield	147	314	402	02%	06%	07%
Gallewatte	1739	1624	1620	11%	12%	10%
Nivitigalakele	202	278	329	07%	16%	18%
Total	2088	2216	2351	07%	11%	11%

The shortage of required tappers was a grave problem the group faced during the year. The crop and income lost to the group merely due to lack of required tappers were 20923 kgs. and Rs.120,307.50 respectively. This could have been much more higher, if not for the low frequency tapping system introduced to the Gallewatte division.

Rainfall

The annual rainfall registered for the group during the year amounted to 4129.3 mm and was above the quinquennial average by 201.1 mm while the quinquennial average of wet days is approximately equal (Table 5). A significant feature to note was that 42% of the annual rainfall was confined to fourth quarter of the year. Nevertheless, harvesting was not adversely affected due to fixing of rain guards in 93% of the mature extent.

Table 5. *Quarterly Rainfall (in mm) and wet days in Last 05 years*

	2000		2001		2002		2003		2004		2005	
	Rain fall	***Wet Days***	***Rain fall***	***Wet Days***	***Rain fall***	***Wet Days***	***Rain fall***	***Wet Days***	***Rain fall***	***Wet Days***	***Rain fall***	***Wet Days***
01st Quarter	884.0	52	653.6	33	574.7	41	811.5	38	401.0	28	503.9	33
02nd Quarter	929.6	56	1259.2	66	1169.2	70	1461.5	70	1035.1	72	1201.4	67
3rd Quarter	1172.1	58	659.4	57	367.1	53	1279.9	71	1400.5	68	677.1	59
4th Quarter	754.6	54	905.8	58	1507.7	68	901.2	50	1513.1	67	1746.9	63
Total	3740.3	220	3478.0	214	3618.7	232	4454.1	229	4349.7	235	4129.3	222

Tapping days

Table 6. *Number of tapping days IPT and YPH during last 5 years*

	2001	2002	2003	2004	2005
Normal Tapping	193	252	204	168	190
Late Tapping	32	36	24	12	06
Double Tapping	(19)	(32)/	-	-	(11)
No tapping	140	77	137	186	104
Rainguard Tapping	-	-	-	-	65
IPT	6.7	7.6	8.4	8.7	8.9
YPH	838	879	1002	863	948

Rainguarding

Dartonfield and Gallewatte divisions were rainguarded during the year. As a result of fixing rainguards, additional 57 and 73 days of tapping were recorded in Dartonfield and Gallewatte divisions, respectively. 15.25% of the total crop harvested in 2005 was due to use of rainguards.

Table 7. *Profit from the use of rain guards*

	Dartonfield Division	Gallewatte Division
Revenue area	39.02	123.19
No of rain-guards fixed	9696	33240
No. of tapping done on rainy days	57	73
Total No. of tapping days	282	292
Additional income from rain-guards	672489.44	2730210.00
Additional profits per hectare	17234.48	22162.59
Total cost per rainguard	13.65	15.95

Profit per hectare

Table 8. *Comparative statement of mature area profit per hectare*

	Years				
	2001	2002	2003	2004	2005
Mature areas (Extent)	189.17	186.59	186.59	184.71	196.15
Total profit in million	(0.11)	(2.27)	(9.86)	09	10
Profit per hectare (Rs.)	594.87	12182.45	52026.85	48728.66	54947.34

The profit per hect. (PPH) increased by 12% when compared with last year. This can be attributed to increase of crop and NSA by 16% and Rs.13.39 per kg. ,respectively in comparison with last year.

Labour-rates and breakdown of cost of production for the year 2005 along with those of last 5 years are given in Table 9.

Table 9. *Labour wages and breakdown of COP*

	2001	2002	2003	2004	2005
1. Labour wages	119.70	147.35	147.35	178.75	216.25
2. Cost of production	48.90	54.25	57.16	74.50	86.84
2.1 Tapping	18.07	19.35	22.33	25.45	29.29
2.2 Manufacture	9.35	11.12	12.66	17.47	16.33
2.3 General charges	13.20	16.87	14.90	19.21	28.35
2.4 Mature area upkeep	8.28	6.91	7.27	12.37	12.87
3. N.S.A.	48.19	68.11	109.07	130.95	144.37
4. Profit per Kgs.	(0.71)	13.86	51.91	56.45	57.50

Manufacture

The group continued to manufacture crepe rubber. The Net Sale Average for the year was Rs.144.34/kg. and percentage of crepe No. 1 was 88.79%. A summary of various forms of manufacture during the year is given in Table 10.

Table 10. *A breakdown of different grades of rubber*

Grade	Quantity	Grade %
Latex crepe		
Crepe No.1	149787	88.79
Crepe No.2	-	-
Crepe No.3	18917	11.21
Total	**168704**	**100.00**
Scrap crepe No.1	12443	72.33
Scrap crepe No.2	4371	25.41
Scrap crepe No.3	389	2.26
Total	**17203**	**100.00**

Due to failure in the boiler-radiator system of the rubber factory, the crepe manufacture was temporarily suspended in September and the entire crop was supplied to the Dipped Products Ltd.

KURUWITA SUB STATION

S A R Samarasekera

SUMMARY

A crop of 69,096 kg. was harvested during the year which is an increase of 21% over the estimated crop for the same period.

The yield per hectare (YPH) and the average intake per tapper were 1451.2 kg. and 8.7 kg respectively.

The annual rainfall was 3903.0 mm with 103 wet days as against 4556.3 mm with 120 wet days during the last year.

The average number of normal, late, rain interference, double, no tapping days were 302, 18, 16, 04 and 29 respectively.

The cost of production and the net sale average for the year were Rs.60.31 and Rs.120.58 per kg. respectively. The profit per kg. was Rs.60.27 and profit made for the year was Rs.4,164,415.92. The total profit made inclusive of sundry income was Rs.5,901,471.93.

DETAILED REVIEW

Staff

The Visiting Superintendent Mr Anusha S Perera over looked the activities of the sub Station throughout the year.

Mr S A R Samarasekera, Assistant Superintendent, Mr D S Jayasinghe, Clerk, Mr J R C Jayalath, Assistant Field Officer and Mr V G D N Gunaseela, 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	47.61
Immature area	32.68
Nurseries	2.00
Tea area	2.00
Fruit plantation	2.00
Paddy	1.00
Proposed replanting area 2006	3.82
Buildings, Gardens, Roads	8.04
Water tank	.01
Abandoned area	.84
	100.00

Crop

A total crop of 69,096 kg. was harvested from an extent of 47.61 hectares during the year.

When compared with the estimated crop there is an increase of 11,996 kg. The average yield per hectare (YPH) of the estate has increased by 58.2 kg from that of the previous year. Also it was higher than the estimate of the year.

A monthly breakdown of the YPH (kg) in the estate is given in Table 2.

Table 2. *The yield per hectare (kg) recorded for each month during the year*

Month	YPH (kg)
January	154.5
February	106.8
March	95.9
April	60.1
May	114.4
June	113.1
July	123.1
August	143.5
September	153.7
October	110.7
November	111.2
December	164.2

Table 3. *Yield per hectare (kg) estimated and recorded during 2001 to 2005*

	Year				
	2001	**2002**	**2003**	**2004**	**2005**
Estimate	867.2	819.0	1080.0	1197.7	1200.0
Achieved (YPH)	1015.0	1357.7	1371.5	1393.9	1451.2

Tapper productivity

The average intake per tapper for the last 5 years of the estate are given in Table 4.

Table 4. *Average intake per tapper (kg.) for the last 5 years*

	Year				
	2001	**2002**	**2003**	**2004**	**2005**
Intake per tapper	8.6	9.6	9.4	8.5	8.7

Rainfall

The annual rainfall figures and the number of wet days for the last 5 years of the estate are given in Table 5.

Table 5. *Annual rainfall and the number of wet days for the last 5 years*

	Year				
	2001	**2002**	**2003**	**2004**	**2005**
Annual rainfall (mm)	3324.2	2743.0	3981.0	4556.0	3903.0
Wet days	165	70	89	120	103

Tapping

There were 336 tapping days during the year. This was possible merely due to the use of rain guards (Table 6).

According to a suggestion of the Plant Science Department, raincoats were supplied to the tappers and the estate made an additional profit of Rs.289,738.97 during the year through minimizing tapping days lost due to rain interference.

The out-tern of the tappers and the vacant blocks percentages were 94.3% and 2% respectively during the year.

Table 6. *The number of tapping days for the last 5 years*

	Year				
	2001	**2002**	**2003**	**2004**	**2005**
Total tapping days	224	290	280	327	336
Normal	193	252	258	306	302
Late	16	36	14	14	18
Rain interference	15	02	08	07	16
Rainguards	-	(70)	(32)	(92)	(88)
Double	(15)	(32)	(46)	(11)	(04)
No. tapping	134	70	75	28	17
Holidays	07	05	10	11	12

Tapping cost

The tapping cost of the estate has increased by 14% over the last year due to the increase of labour wages through price share supplement.

Table 7. *A break down of total tapping cost for last 5 years*

Cost item	**Cost kg. (Rs.) and year**				
	2001	**2002**	**2003**	**2004**	**2005**
Tapping	15.41	14.42	14.67	21.10	24.31
Double tapping	.35	.47	1.33	.54	.17
Overtime on tapping	.16	.11	.18	.22	.28
Over kilos	.46	.68	.48	.31	.33
Extra pay to Kangany	.01	.02	.03	.03	.03
Scrap pay	.18	.22	.36	.39	.61
Incentive pay to Field staff	-	-	.09	.20	.22
	16.57	15.92	17.14	22.79	25.95

Cost of production and profitability

C.O.P. for the season was Rs.60.31 and N.S.A. Rs.120.58. The estate made a profit of Rs.60.27 on a kg. (Table 8).

Table 8. *Labour rate (Rs.) and the break down of the cost of production (Rs./kg)*

	Year				
	2001	**2002**	**2003**	**2004**	**2005**
Labour rate	98.00	109.00	109.00	125.00	125.00
Total C.O.P.	34.02	31.94	34.25	55.11	60.31
Tapping	16.57	15.92	17.14	22.79	25.95
General charges	12.01	12.37	11.39	23.20	23.52
Upkeep	3.58	3.14	4.95	8.37	9.62
N.S.A.	46.68	53.93	83.12	104.89	120.58
Profit per kilo	12.66	21.99	48.87	49.78	60.27

Table 9. *Comparative statement of the mature extent, profit per kg. and profit per hectare during last 5 years*

	Year				
	2001	**2002**	**2003**	**2004**	**2005**
Mature extent (ha.)	43.83	48.83	48.83	44.25	47.61
Total profit (Rs.)	563,357.34	1,437,640.23	3,272,921.64	3,070,281.06	4,164,415.92
Profit/ha. (Rs.)	12,853.24	29,441.74	67,026.86	69,384.88	87,469.35

During the year a profit of Rs.87,469.35 per revenue hectare was recorded.

Other activities

Young budding plants of clone RRIC 121 raised at the estate were issued to estates and smallholders.

A cinnamon crop of 915 kg. was harvested from the intercropped area and made an income of Rs.304,221.50 during the year.

Selected best tappers were rewarded for motivation.

All agricultural practices were carried out in the nurseries, immature and mature areas of the estate.

Meteorological Summary – 2005
Dartonfield Station

Wasana Wijesuriya

The total annual rainfall experienced during 2005 was, 4129 mm, a decrease of 221 mm compared to the previous year and had a departure of 31 mm from the long-term average of 4160 mm. Fig. 1 indicates that the distribution of rainfall during this year followed a bimodal pattern but with significant departures from the average pattern.

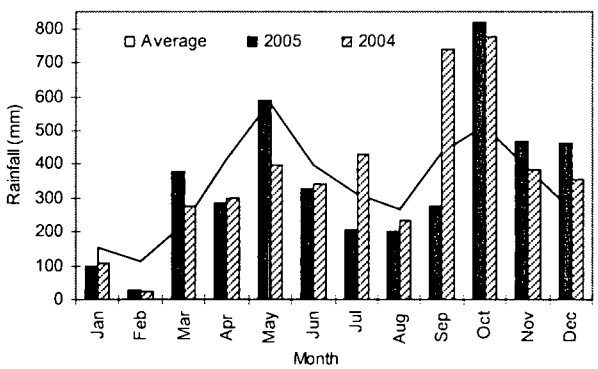


Fig.1. Monthly variation in rainfall

In the year under review, highest monthly rainfall of 815 mm was observed during October, which coincided with Northeast inter-monsoon period. It was a deviation of 302 mm from the long-term average of the month. Fairly low rainfall figures were observed during January, February, July and August as expected. In this year too, heavy showers were observed during the Northeast monsoon like in year 2004.

Fairly dry weather prevailed in February with lowest monthly rainfall of 27 mm, which is 59 mm below the long-term average for the month. Southwest monsoon period had fairly low rainfall with April, June, July and August rainfall values below the recording average level.

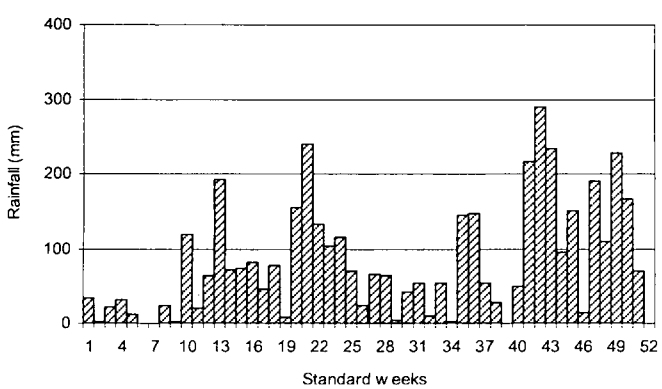


Fig. 2. Weekly variation in rainfall

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 6 weeks in 2004. The highest weekly rainfall was observed during the 42nd standard week (Mid October), which coincided with the Northeast monsoon.

Start and end of monsoon rains

Frequency distribution of the onset of rains for both seasons is illustrated in Fig.3. The successful start of the rains occurred by 29th March and 08th September in 80% of the years (1964-2003) for Southwest (SW) and Northeast (NE) rains, respectively. For the year under review, SW rains commenced successfully by 04th of March, which was an early onset of rains, compared to the 80% expected. The onset of NE rains in the year also took place little early by 29th August.

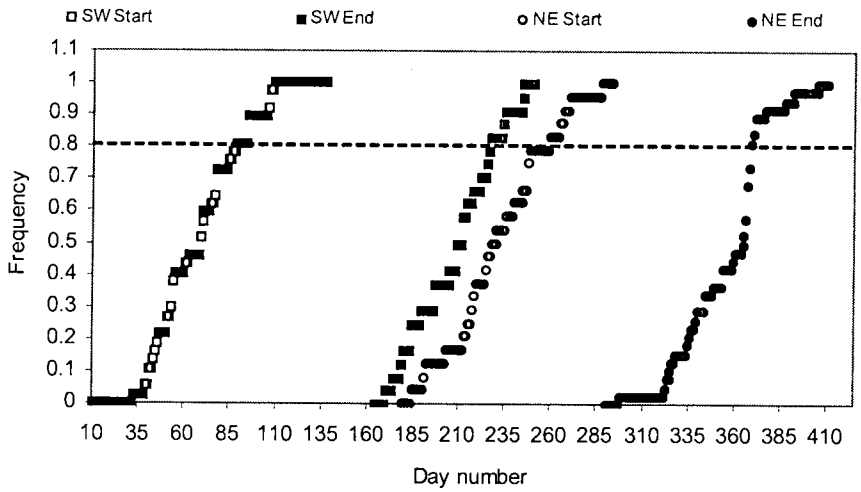
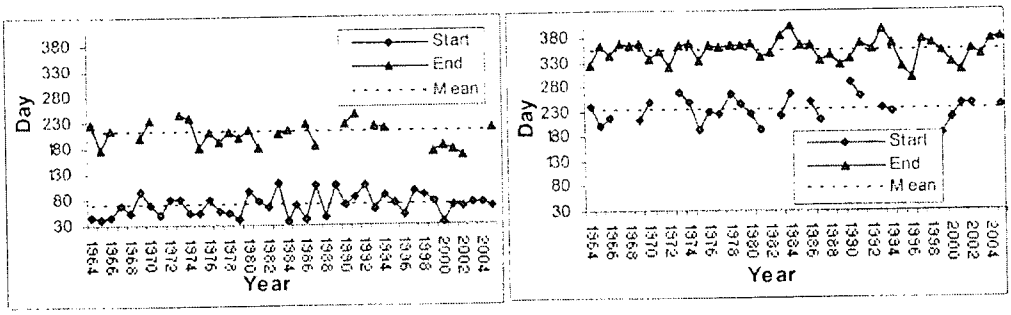


Fig. 3. Cumulative probability of the start and end of rains in the two major rainy seasons at Dartonfield

According to Fig.3, rains have ceased generally by 14th August and 05th January for SW and NE rainy seasons, respectively (80% expected). For the year under review SW rains ceased by 04th August while, NE rains ceased by 17th January 2005. However the cease of SW rains and onset of NE rains could not be clearly identified during last two years.

The temporal variation in onset and ending of rains in SW and NE seasons are depicted in Fig. 4. In general, when compared to the period 1964 – 1980; the variability of the dates concerned is high during the recent years.



(a) **(b)**

Fig. 4. The start and the end of the SW rains (a) and NE rains (b) over 42 years

The median length of the period for SW rains is 139 days whereas it is 122 days for NE rains. In this year they are respectively, 153 days and 141 days and longer than their long-term averages.

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 212, which is fairly lower, compared to last year (235 days) and long-term average (220 days). Pan evaporation during 2005 is 763 mm (2.1 mm/day), which is high when compared to 698 mm in 2004.

Intensity of rainfall

Incidence of high intensity showers was high during SW monsoon as expected. However, during last two years high intensity showers were observed during NE monsoon, deviating from the usual pattern at Dartonfield. The highest rainfall intensity recorded was 48 mm/hr in July lasting for 5 minutes. For each month, the three highest intensities recorded, their duration, time of occurrence and the average intensity are presented in Table 2.

Other meteorological factors

Table 3 depicts the monthly values of some important meteorological observations together with averages for 1980 to 2005. Although, minimum temperature dropped below 20^0C, 12 times in year 2004, there were only two such days observed in 2005. Compared to last year, the minimum temperatures in the year 2005 have taken fairly high values. The highest mean maximum temperature of 33.9^0C was observed in March. The lowest mean minimum temperature of 22.1^0C was observed in February and December. The average morning RH was in the range of 87 to 94% exceeding their long-term averages. The soil temperatures at 3 different depths are given in Table 4.

Table 1. *Monthly variation of rainfall and rainy days in 2005*

Month	Total rainfall (mm)	Average** (mm)	No of rainy days *	Avg.** Days	No. of days under each category			Evaporation (mm)
					0.3-2.5 mm	2.6-50 mm	>50 mm	
January	97.2	(156)	12	(11)	4	8	-	66.0
February	27.1	(114)	5	(09)	2	3	-	87.3
March	379.6	(222)	16	(13)	2	13	1	90.2
April	287.1	(415)	17	(18)	1	15	1	75.7
May	589.3	(584)	23	(24)	6	13	4	65.7
June	325.0	(398)	27	(23)	8	18	1	57.8
July	204.1	(313)	25	(22)	7	18	-	63.7
August	198.7	(268)	15	(20)	3	11	1	59.4
September	274.3	(436)	19	(22)	6	12	1	60.9
October	815.2	(513)	27	(23)	3	20	4	43.8
November	467.7	(387)	20	(20)	3	15	2	38.6
December	464.0	(266)	16	(15)	4	8	4	54.2
Total	4129.3	(4160.0)	212	(220)	49	154	19	763.3

** Average values for 1980-2005 are shown in parentheses.

Table 2. *Rainfall intensity recorded at Dartonfield Meteorological station - 2005*

Month	Date	Intensity (mm/hour)			
		3 highest records	Time of occurrence	Duration (min)	Mean for the month
January	09	32.14	10.30-10.37	7	8.18
	20	21.82	18.30-18.52	22	
	04	17.60	18.15-19.00	45	
February	21	7.83	18.30-20.02	92	3.65
	20	7.50	00.52-1.00	08	
	20	7.16	1.30-2.37	67	
March	30	39.88	18.44-21.00	136	10.53
	30	36.80	14.45-15.30	45	
	11	21.28	18.37-19.30	53	
April	19	33.6	15.15-16.45	90	7.03
	03	22.05	22.45-23.22	37	
	13	17.14	18.37-20.15	98	
May	18	24.45	00.22-01.05	53	6.38
	18	21.71	21.45-23.30	105	
	27	19.36	12.28-16.00	212	
June	17	22.97	22.55-23.30	35	6.31
	20	21.00	07.52-8.00	08	
	14	13.20	15.45-16.05	20	
July	09	48.00	01.15-01.20	05	9.54
	31	29.33	07.22-07.31	09	
	10	24.00	22.15-22.20	05	
August	29	24.00	16.40-17.00	20	5.76
	15	19.58	09.37-10.15	38	
	02	13.33	09.00-9.18	18	
September	01	25.09	01.30-01.52	22	7.07
	03	24.00	19.55-20.00	05	
	04	20.12	18.28-19.02	34	
October	18	23.76	23.00-04.00	300	7.02
	19	22.56	17.30-17.55	25	
	31	20.57	3.15-3.22	7	
November	01	24.18	22.15-23.20	65	5.91
	28	20.8	20.30-22.00	90	
	26	19.6	19.07-19.37	30	
December	15	31.48	17.20-18.45	85	7.17
	03	21.21	13.45 -16.20	155	
	14	17.65	21.22-22.30	68	

Table 3. *Variation of observed meteorological factors at Dartonfield – 2005*

Location-	(Latitude $6^0$32'N; Longitude 80^0.09' E Altitude 65.50m)								
	Temperature (^{0}C)					Relative Humidity (%)			
Month	**Mean Max**	**Mean Min**	**Mean**	**No of Days Min Temp<20**	**Sun shine hours**	**9.00 am**	**No of Days 9.00>90%**	**4.00 pm**	**Wind Speed Mean (km/hour^{-1})**
January	32.3	22.4	27.4 (26.7)	01	4.9	91 (88)	-	70 (68)	1.80
February	33.9	22.1	28.0 (27.1)	01	7.7	86 (86)	11	58 (65)	2.30
March	33.6	23.2	28.4 (27.6)	-	6.2	88 (85)	16	84 (68)	2.10
April	32.8	23.6	28.2 (27.8)	-	5.5	89 (85)	14	78 (75)	1.80
May	32.1	24.3	28.2 (27.6)	-	4.5	92 (88)	22	76 (77)	2.20
June	30.8	24.3	27.5 (26.9)	-	4.0	94 (89)	25	75 (77)	2.30
July	30.5	24.1	27.3 (26.7)	-	4.2	93 (89)	26	73 (75)	2.50
August	31.3	23.5	27.4 (26.6)	-	5.6	90 (88)	22	71 (74)	2.50
September	30.6	23.4	27.0 (26.7)	-	5.1	91 (88)	23	72 (75)	2.50
October	30.9	23.3	27.1 (26.6)	-	4.4	90 (86)	19	80 (77)	1.90
November	30.7	22.9	26.8 (26.6)	-	3.4	87 (85)	11	78 (77)	1.80
December	31.8	22.1	26.9 (26.7)	-	4.9	87 (85)	10	72 (73)	1.80

** Average values for 1980-2005 are shown in parentheses.

Table 4. *Soil temperatures recorded at different depths at Dartonfield - 2005*

Month	09.00 hrs				16.00 hrs			
	5 cm	10cm	20cm	30cm	5 cm	10cm	20cm	30cm
January	26.8	26.3	27.3	28.2	34.0	31.9	29.8	28.8
February	28.1	27.7	29.0	29.8	39.1	35.7	32.7	30.7
March	28.7	27.9	29.3	30.0	37.0	35.0	33.0	30.9
April	28.1	27.4	28.4	29.3	35.5	34.3	32.5	30.4
May	28.4	27.7	28.7	29.5	34.3	32.9	31.8	30.2
June	27.9	27.3	28.1	28.8	33.7	32.0	30.3	29.3
July	27.6	27.1	28.0	28.9	33.5	31.8	30.2	29.4
August	28.1	27.5	28.5	29.3	35.7	33.9	31.7	30.1
September	27.8	27.0	27.8	28.7	34.3	32.4	30.6	29.4
October	28.1	26.9	27.5	28.3	33.1	31.6	30.0	28.8
November	27.2	26.1	26.7	27.6	31.7	30.4	29.1	28.2
December	26.7	25.7	26.6	27.5	32.6	31.2	29.5	28.5

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