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Rubber Research Institute of Sri Lanka




Annual Review 2002

Rubber Research Institute of Sri Lanka - Annual Review - 2002

Rubber Research Institute of Sri Lanka

Annual Review – 2002

1 st January 2002 to 31 st December 2002

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

Head Office & Laboratories
Dartonfield
Agalawatta

Board Office & Laboratories
Telewela Road
Ratmalana

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Dr (Mrs) N M V Kalyani Liyanage, Senior Lecturer, Dept. of Polymer Chemistry, University of Sri Jayawardenapura

Dr Sudantha Liyanage, Senior Lecturer, Dept. of Chemistry, University of Sri Jayawardenapura
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Mr Rahim, Managing Director, Rahim & Co.
CEO, Kahawatta Plantation Ltd.
CEO, Lak Latex (Pvt.) Ltd., Centrifuging Factory
Mr Mangala Gunasekara, Managing Director, Textrip Ltd.
Dr L P Nethsinghe, Group Technical Manager, Dipped Products Ltd., Colombo 10
Mrs Himali Bandara, Sinwa
Mr Rifaadh, Sinwa
Mr S W Karunaratne, Consultant, Mal Lanka
Mr Upali Herath, Diretor, Trelleborg
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Mr Lal Motha, Plastic & Rubber Institute
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Mr P P Jayasinghe, RRI
Mr P H Sarath Kumara, RRI
Mr M R C Peiries, PRI

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Lawyers

Attorney General
Attorney General's Department
(Government Institutions)
P O Box 502
Colombo 12

Auditors

Auditor General
Auditor General's Department
Independence Square
Colombo 07

Bankers

Bank of Ceylon
Corporate Branch
75, Janadhipathi Mawatha
Colombo 1

Bank of Ceylon
Agalawatta

Head Office and Laboratories
Dartonfield, Agalawatta

Telephones:

Director	034 - 2248457
Deputy Director Research (Biology)	034 - 2248458
General	034 - 2247426
	034 - 2247383
	034 - 2223078
	034 - 2248459
Fax:	034 - 2247427
E-mail	dirrri@tradenetsl.lk

Rubber Research Institute - Substation
Nivitigalakele, Matugama

Genetics and Plant Breeding Department
Telephone: 034 - 2247368

Rubber Research Institute - Substation
Kuruwita, Ratnapura
Telephone: 045 - 2262115

Board Office and Rubber Chemistry & Technology Laboratories
Telewela Road, Ratmalana

Telephones:

Chairman	011 - 2635142
Director	011 - 2605171
General	011 - 3633351
	011 - 2635851
	011 - 2635852
Fax:	011 - 2605171

RUBBER RESEARCH INSTITUTE OF SRI LANKA

STAFF

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Director	L M K Tillekeratne, BSc (Cey.), MSc (Aston), PhD (Aston), FI Chem C, FPRI, FNASSL
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Deputy Director – Research (Technology)	W M G Seneviratne, BSc (SL), PhD (Sussex)

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Experimental Officer (Technical Officer to the Director)	K K Liyanage, BSc Agric (SL)

RESEARCH DEPARTMENTS

Genetics and Plant Breeding

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Assistant Geneticist and Plant Breeders	*Mrs S Herath, BSc Agric (SL)
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Experimental Officers	K W Rupatunga
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Research Officer (Intercropping) (Principal Research Officer)	V H L Rodrigo, BSc Agric (SL), MSc (Essex), PhD (Wales)
Botanist	L S S Pathiratne, M I Biol, MSc (Reading), MPhil (SL)
Assistant Botanists	A M W K Senevirathna, BSc (SL), MSc (SL), PhD (Wales)

Assistant Botanists	N A A D Wickramaratna, BSc Agric (SL)
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Experimental Officers	K A G B Amaratunga
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	*D N P Wickremasinghe, BSc (SL)

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	G V L Nilmini, BSc (SL)
Experimental Officers	E B Fernando
	D Ramawickrema
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Polymer Chemistry

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	Mrs C J Wellappili, BSc (SL), MSc (SL)
Experimental Officers	H N K K Chandralal, BSc (SL), MSc (SL)
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	Mrs C S Lokuge
	R S Wijesundera

Experimental Officers	L P P Vitharana
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	N L D Nihal
	N V U S Vijitha Kumara
	A B Nakandala

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Assistant Field Officer	J R C Jayalath
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Junior Assistant Field Officer	V G D N Gunaseela

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	Mrs S K Hadunge

* On study leave overseas

RUBBER RESEARCH INSTITURE OF SRI LANKA

DIRECTOR'S REVIEW

L M K Tillekeratne

The price of Natural Rubber in the world market started improving from the middle of year 2002 reaching a price of over Rs.80/- per kg of for sheet rubber by the end of the year. The price of latex crepe also improved rapidly during the period. Owing to the very high demand for good quality RSS and concentrated latex in the country, they have been imported under the control of the BOI by some rubber product manufacturers since June 2001. The price paid for imported sheet rubber is reported to be about Rs.15/- higher than price for the FOB RSS in Sri Lanka. Owing to the increasing demand for rubber, both locally and internationally, sheet rubber prices are expected to reach close to Rs.130/- by the middle of 2003, while latex crepe is expected to reach a price closer to Rs.150/- in the first quarter of 2003 itself.

The global rubber production in the year 2002 has been about 130,000 MT lower compared to the previous year particularly due to the action taken by Thailand, Indonesia and Malaysia (tripartite agreement) to curtail their production by 4%, The total NR production in the world in 2002 was 7 001 000 MT while the global synthetic rubber production in that year had been 10 599 500 MT. From these figures it is clear that the percentage of synthetic rubber consumption has been nearly 59% of the total elastomer consumption which is the figure reported in the previous year as well. The major NR producer in 2002 had been Thailand while Indonesia and India were in the 2nd and 3rd places respectively.

The major consumer of NR in the world in 2001 was China consuming 1,295,500 MT while USA was in the 2nd place consuming just over 1,000,000 MT. Consumption of synthetic rubber-wise, USA had been in the lead consuming 1,828,000 MT while China consumed 1,715,000 MT in the same year. Sri Lanka is expected to sign the co-operation agreement along with Indonesia, Malaysia, Thailand and Vietnam at the next Rubber Co-operation Dialogue in Bangkok. This will enable to show the strength of NR producers in the region in order to keep NR prices stable and high in the future too.

It has been observed from the drought prevailed in the Southern Province of Sri Lanka bordering Hambantota district in year 2002 that rubber is the only crop which can survive drought conditions compared to tea and coconut. Hence, action has now been taken to launch a rapid rubber planting programme in Moneragala district in year 2003 to cater to the growing need of NR for the rubber based industries in the country. The RRI provides all technical support such as clone recommendation and maintaining nurseries ensuring quality planting material for the project to plant 2000 ha initially in the district in year 2003. RRI recommended high yielding clones *viz.* RRIC 100, 102 and 121 have yielded record yields going up to

2796 kg/ha/annum. This highest yield reached is reported from the Bible Estate. The other estates that recorded over 2,200 kg/ha under commercial conditions for these clones are Arappolakanda, Paiyagala, Sorana, Padukka and Dartonfield. Dartonfield estate is under the management of RRI. What is emerging from these yield figures is that in order to get the best from the new technology introduced to the growers, the management should also be very efficient, because in order to get these yields; maintaining the stand, proper weeding and manuring and also proper exploitation is essential. If other rubber plantations also follow the same, increasing the National Productivity of rubber to the 1500 kg/ha level will not be a day dream for our plantations.

Based on the escalating Rubber prices reported and the ever-increasing demand for NR in the country, it is clear that investing money on rain-guards for 2003 would be highly beneficial.

Advisory Services wing of the RRI was able to continue with the 100 day programme of the new government throughout 2002 and was able to covert 513 MT of small holder latex into grade I and II RSS rubber in all rubber growing regions in the country. They had 129 processing centers belong to Smalholders for this quality improvement process while having 50 more identified for starting in year 2003. The marketing venue for made rubber initiated by the ASD through Forbes Commodity Brokers and Ceyexxee Ltd. and also organizing sales to local products manufacturing Companies such as DSI was not only able to give a very attractive price for their product; sometimes even above the auction price of RSS I to the farmers, while curtailing the importation of RSS I – III grades into Sri Lanka from South-East Asia. No lower grades have been produced in any of these centers during the year.

New RRISL clones, RRISL 201, RRISL 205, RRISL 203 and RRISL 2001 continued to give high rubber yields and vigorous growth in large scale trials. The Clones RRISL 201, RRISL 202, RRISL 217 showed mild to moderate level infection by the Corynespora leaf disease. Hybridisation programme involving 17 crosses were completed during the year resulting in a breeding population of 186 seedlings. New experiments were planted to test 64 new clones in small scale clone trials and three new clones are being tested under smallholder conditions as well.

In commercial plantings extremely high yielding individuals were identified and true to type propagation of them were undertaken. The possibility of obtaining a second generation of rubber plants after harvesting the trees of the first generation at different heights from the stock union is being tested. Rubber medicinal plant intercropping systems were developed with five medicinal plant species.

To establish *Muccuna bracteata* as a cover crop for rubber suitable planting material and management practices were developed. Further, new management practices were introduced to the industry to overcome the adverse effects of soil moisture stress for rubber.

The incidence of secondary leaf fall was mild during the year while abnormal leaf fall and bark rot were extremely low. However, Corynespora leaf fall disease

was detected on several new clones. Bitter gourd was identified as an alternate host for *Corynespora* while Ugurassa was shown to be harbouring *Colletotrichum acutatum*. It was found that the vitamin, "Biotin" can be used to induce sporulation of fungi *Corynespora* and *Botryodiplodia*. This enabled to obtain considerable level of spores required for experimental purposes.

Crepe rubber produced in Sri Lanka has been presented to the market over the years by grading them visual on appearance. It has been noticed that by introducing technical specifications, customers will have the option of selecting the correct crepe rubber grade they need for their product. Sri Lanka Rubber Cluster has launched an extensive market promotion programme on this subject with the help of US counterparts with the funding support from the USA – Aid. RRISL is directly involved in the project which is known as the Sri Lanka crepe rubber repositioning programme.

RRISL launched a Scientific Committee (Technology) meeting programme, a forum which will be attended by both industrial and the plantation sector personnel. The forum will facilitate to exchange views between these two parties which may enable the producers of raw rubber (plantation sector) to go into product manufacturing business. It is the anticipation of the RRISL that this forum will subsequently be helpful to strengthen the rubber based manufacturing sector in Sri Lanka.

RRISL, technological departments have formed task groups in the following product manufacturing sectors.

1. Foam rubber products
2. Rubberized coir products
3. NR gloves
4. Foot wear sector
5. Tyres and Tyre retreads
6. Other rubber products.

The objective of forming these task groups is to help the existing industries and new investors by providing them with information regarding manufacture, equipment and marketing.

The most menacing problem in the raw rubber processing factories is the pollution created due to discharge of waste water generating from processed rubber. The treatment methodology developed by the RRISL has proven that this pollution problem could be very successfully eradicated. Around 60 commercial scale treatment plants have been installed in rubber factories in the country by the end of year 2002.

OVERSEAS VISITORS

Dr C R Ireland, Writtle College, UK
Dr D Joseph Francis, Hindustan Latex Ltd., India
Ms Janet Riney, Rothmasted Experimental Station, UK
Ms Margaside Cardosde
Ms Florian, Austria
Mr Narongsak Senanarong, RRI, Thailand
Mr Prasat Kesawapitak, RRI, Thailand
Mr Arumugan, Malaysia
Mr Jirakorn Kosaisawe, RRI, Thailand
Dr Nougen Vanmy, Vietnam
ABD Hamid Yusoff, W Malaysia
Mr Schneider, Germany
Mr Michek Wilks, The Netherlands
Dr W Peterson, The Netherlands

GENETICS AND PLANT BREEDING

D P S T G Attanayaka

SUMMARY

The clones, RRISL 201 RRISL 205 and RRISL 206 continued to show vigourous growth in all the sites tested under genotype-environment interaction studies. The clone RRISL 2001 gave a very promising commercial yield in its first year of tapping followed by RRISL 205 and RRISL 206. The test tapping yields from large- scale clone trials of RRISL 217 and 201 too showed a promising yield trend. In testing of the foreign clones, the clones PB 235 and PB 260 continued to show high performance.

The three new clones, RRISL 201, 203, 205, that have been planted on experimental basis under smallholder condition showed a very promising growth in all the sites.

In small scale clone trials, the test entry HP 95-55 was the most vigourously growing clone and the two seedling progenies of RRIC 100 × PB 255 and RRIC 121 × PB 255 were identified as promising for both growth and yield.

The final fruit- set success of the annual hand pollination programme was 0.95% from a total of 9606 pollinations.

The *Hevea* molecular biology work was continued at a slow pace due to non - availability of funds and technical staff.

DETAILED REVIEW

Staff

The Head of the Department, Dr D P S T G Attanayaka, Development Officer, Mr K B Karunasekera, Experimental Officers Mr K W Rupatunga, Mr L S Kariyawasam, Mr I D M J Sarath Kumara, Technical Officers Mrs A K Gamage, Mr T M S K Gunasekera, Mr H P Peiris were on duty throughout the year. Mrs S P Withanage, Assistant Geneticist and Plant Breeder resumed her duties after completing postgraduate training at the PAU in India on 7th August. Mrs S P Herath Assistant Geneticist and Plant Breeder continued her postgraduate studies at the University of Nagoya, Japan. Mr B M S G Peiris, Experimental Officer was granted no pay leave from 8th August to 16th September. Mrs S D P K L Peiris, Clerk/Typist went on maternity leave with effect from 2nd December.

Research students

- Mr P L N Lakshman a postgraduate student of the PGIA competed his research training in February.

Meetings and Workshops attended

Officer	Subject	Organization
D P S T G Attanayaka	Specialist Group on Plant Breeders, Tissue Culturists and Biotechnologists	CARP
D P S T G Attanayaka	Research Committee Meetings	CRI
D P S T G Attanayaka	Board of study in Biochemistry and Molecular biology	PGIS
Mrs S P Withanage	Presented a paper on Molecular Analysis of Ph^1 Induced Introgression for Rust Resistance from *Aegilops ovata* into *Triticum aestivum* at the Seminar Session	CARP- ICAR Training Programme Peradeniya
Mr K W Rupatunge	Participated in a training programme on Participatory Rural Appraisal	

LABORATORY INVESTIGATIONS

Molecular biology of *Hevea* GPB/MM/97

The laboratory work on *Hevea* molecular biology was continued with little progress due to the non-availability of funds and technical staff. A simple and rapid DNA extraction method, which does not require liquid Nitrogen was demonstrated to be successful in isolating DNA from different tissues of *Hevea* (S P Withanage).

FIELD EXPERIMENTS

Hand pollination (HP) programme – 2002(GPB/BST/HP/02)

Mother trees from clones of RRIC 130, IAN 45/873, PR 261 from Neuchatel estate and RRISL 205, RRISL 2001 from Pallegoda estate were selected for the cross pollination programme. The final fruit set success of the pollinations done during the year was 0.95%. The number of pollinations done in each cross, number of pods produced and seedlings obtained are given in Table 1.

Table 1. *Details of 2002 hand pollination programme*

Cross	No. of pollinations	No. of fruits collected	No. of Seedlings
RRIC 130 × RRIC 121	1452	12	26
RRIC 130 × PB 260	646	06	12
RRIC 130 × PB 235	722	10	29
RRIC 130 × RRISL 205	114	01	02
RRIC 130 × RRISL 2001	901	18	36
RRIC 130 × RRIC 130	49	00	00
IAN 45/873 × GPS I	108	04	12
IAN 45/873 × RRISL 2001	128	03	09
PR 261 × RRISL 2001	161	06	12
PR 261 × PB 260	120	04	03
PR 261 × GPS I	85	03	02
RRISL 2001 × RRIC 130	1677	08	15
RRISL 2001 × RRISL 205	976	07	13
RRISL 2001 × RRIC 102	436	01	03
RRISL 2001 × RRIC 121	1041	01	03
RRISL 2001 × GPS I	972	01	03
RRISL 205 × RRISL 2001	18	06	20
RRISL 205 natural pollen	-	03	09
Total	9606	94	209

(D P S T G Attanayaka, K B Karunasekera, T M S K Gunasekera and A K Gamage).

Evaluation of hand pollinated progenies

Small scale clone trials

Two small scale clone trials *i.e.* GPB/BST/HPS/76/1 and GPB/BST/HPS/82/2 were discontinued during the year. Four new trials were planted to evaluate HP progenies of 1990 and 1999. The list of the Small Scale Clone Trials monitored by the Department to-date is given in Table 2.

Table 2. *Details of small scale clone trials*

HP year	Site	Planting date
1986	Kuruwita	May 1990
1987	I) Clyde - Kethhena	May 1993
	II) Gallewatta	June 1988
1988	Dartonfield	July 1993
1992	Dartonfield	May 1993
1995	Sorana	June 1998
1996	Kuruwita – I and II	May 1999
1991	Pallegoda	Aug 2000
	Vogan	Nov 2000
1997	Clyde – I & II	June 2000
1998	N'Kele I, II & III	June 2001
	Kuruwita I, II &III	July 2001
1990	Kuruwita	July 2002
1999	Kuruwita I,II, & III	June 2002

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

Twelfth year girth measurement and the results of the Duncan's Multiple Range Test for girth of the promising clones are given in Table 3. Yield data relevant to the fourth year of tapping based on four test tappings are given in Table 4. The highest girth was obtained from clone 86-81 followed by 86-21. The highest yield was obtained from the control clone RRIC 121. The most vigorous HP clone 86-81 has given a mean yield of 35.19 g/t/t during the year.

Table 3. *Mean girth (12^{th} yr) in cm of promising H.P. clones*

Clone	Mean girth (cm) and DMRT grouping
86-81	78.67 ^{A}
86-21	73.63 ^{AB}
RRIC 121	73.52 ^{AB}
86-77	72.65 ^{ABC}
86-24	68.95 ^{BCD}
86-87	68.73 ^{BCD}
86-76	66.70 ^{BCDE}
86-82	65.34 ^{CDEF}
86-37	65.22 ^{CDEF}
86-22	64.80 ^{DCDEG}
RRIC 110	64.69 ^{CDEFG}

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

Clone	Yield (g/t/t) and DMRT grouping
RRIC 121	55.27 A
86 - 25	45.32 A B
86-87	45.25 A B
86-24	42.48 B C
86- 10	40.77 B C
86-11	40.42 B C D
86-22	40.22 BCD
RRIC 110	38.95 BCDE
86-32	36.68 BCDEF
86-17	35.74 BCDEFG

(D P S T G Attanayaka, H P Pieris and K B Karunasekera).

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

Ninth year girth measurement and the results of the Duncan's Multiple Range Test for girth (DMRT) are given in Table 5. Seven test tappings were done during the year. Mean yield of the four high yielding test entries of this trial in the fourth year of tapping is given in Table 6. Very high bark consumption rates were observed in this clearing.

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

Clone	Girth in cm	DMRT Grouping
RRIC 121	69.79	A
87-370	67.67	AB
RRIC 110	65.01	B C
87-371	64.11	C
87-364	61.73	C D
RRIC100	59.73	DE
87-372	57.96	D EF
RRIC 102	57.37	EF
87-383	57.26	EF
87-375	56.96	EF

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

Clone	Yield (g/t/t)	DMRT Grouping
RRIC 121	46.68	A
87-369	41.18	AB
87-382	39.70	AB
87-370	39.48	AB
87-372	38.26	ABC
RRIC 110	37.15	BCD

(D P S T G Attanayaka, I D M J Sarathkumara and K B Karunasekera)

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

Yield data relevant to the 3rd year of BO-2 panel of each family are based on three test tappings. Progeny size, mean girth and mean yield of the seedling families are given in Table 7.

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	09	74.22	38.52
RRIC 101 × GT 1	28	59.45	17.22
RRIC 100 × GT 1	49	78.66	50.24
RRIC 100 × RRIC 101	10	71.45	43.96
RRIC 100 × RRIC 110	09	79.83	42.51
RRIC 100 × RRIC 121	30	75.55	43.42
PB 86 × RRIC 121	15	72.27	26.29
RRIC 102 × GT 1	03	85.50	82.33
RRIC 121 × RRIC 110	26	73.15	35.81
RRIC 110 × RRIC 100	08	69.81	47.13
RRIC 110 × RRIC 121	02	66.00	62.50

(D P S T G Attanayaka, T M S K Gunasekera and K B Karunasekera).

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

The ninth year girth measurement was taken and the mean girth of clones were grouped using the Duncan's Multiple Range Test (Table 8). Mean yields and the DMRT grouping of some selected clones based on three test tapings in the second year 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
88-31	64.68 ^{A}
88-32	62.43 $^{A\ B}$
88-36	61.02 $^{A\ BC}$
RRIC 102	60.88 $^{A\ B\ C}$
88-15	60.38 $^{AB\ C\ D}$
88-28	59.28 $^{AB\ C\ DE}$
RRIC 100	57.69 $^{B\ C\ DEFG}$
RRIC 110	56.47 $^{B\ C\ DEEFG}$

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

Clone	Mean yield and DMRT grouping
88-10	41.35 ^{A}
RRIC 102	29.68 ^{B}
88-50	28.35 ^{BC}
88-25	28.31 ^{BC}
88-14	28.29 ^{BC}
RRIC 121	25.78 $^{BC\ D}$
RRIC 100	16.36 ^{DEFGHI}

(D P S T G Attanayaka and L S Kariyawasam)

Evaluation of 1992 H.P. Seedlings - Dartonfield estate (GPB/BST/HPS/92)

The trial is in the third year of tapping. The family means of the eighth year girth measurements taken at 150 cm from the ground level and the yield based on eight test tappings are given in Table 10. Two seedling progenies, *i.e.* RRIC 100 × PB 255 and RRIC 121 × PB 255 showed high performance with respect to both growth and yield.

Table 10. *Family means of girth and the yield of the 1992 HP progeny*

Family	Girth (cm)	Yield (g/t/t)
RRIC 100 × RRIM 712	58.47	25.03
RRIC 100 × PB 255	67.08	35.74
RRIC 100 × PR 255	58.37	23.89
RRIC 121 × PB 255	65.97	33.05
RRIC 102 × PB 255	61.00	21.77
BPM 24 × RRIM 712	53.00	24.20
RRIC 100 × PR 309	61.77	27.97
RRIC 121 × PR 255	57.20	20.15
RRIC 102 × PR 309	53.50	15.28
RRIC 121 × PR 309	56.75	17.95

(D P S T G Attanayaka, A K Gamage and K W Rupatunga)

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

The fourth year girth taken at a height of 120 cm is given in Table 11. Clones 95-55, 95-50 continued to show vigorous growth. There were 14 new entries exceeding the growth rate of 10 cm per year under estate management conditions

Table 11. *Mean girth in cm of the 1995 HP progeny*

Clone	Mean girth and DMRT grouping
95-55	46.06 ^{A}
95-50	45.06 ^{AB}
95-48	42.71 ^{BC}
95-23	42.71 ^{BCD}
95-33	42.70 ^{BCD}
95-45	42.50 ^{BCDE}
PB 255	40.83 ^{CDEFGHI}
RRIC 121	39.75 ^{CDEFGHIJKLM}

(D P S T G Attanayaka, I D M J Sarathkumara and K B Karunasekera)

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

Girth measurements at a height of 120 cm were taken from both trials. Table 12 shows the third year girth of the promising entries and of the control clones in both trials.

Table 12. *Mean girth at 120 cm of the 1996 HP progeny*

Clone	Mean girth (cm) 96-1 Trial	Clone	Mean girth (cm) 96-2 Trial
96-59	24.60	RRIC 121	24.00
96-15	22.00	96-37	21.16
96-31	21.92	96-54	20.86
96-4	21.50	96-26	20.74
96-13	21.11	96-36	20.46
RRIC 121	19.07	96-53	20.19
PB 260	18.90	RRISL 205	18.93
RRISL 205	18.46	PB 260	17.50

(D P S T G Attanayaka, H P Peris and K B Karunasekera)

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

The second year girth measurements at 120 cm were recorded from these trials. There were seven test entries above the best control clone of RRISL 205 from the trial 91-01 and one entry above the control clone RRIC 121 from the 91-02 trial (Table 13).

Table 13. *Mean girth in cm of the 1991 HP progeny planted at Pallegoda and Vogan estates*

Pallegoda		Vogan	
Clone	Mean girth (cm) 91-01 Trial	Clone	Mean girth (cm) 91-02 Trial
91-5	18.10	91-71	17.00
91-4	18.00	RRIC 121	15.85
91-12	17.81	91-63	15.07
91-7	17.78	91-83	14.60
91-10	17.73	91-53	14.50
91-2	17.67	91-75	14.30
91-8	17.66	91-48	14.26
RRISL 205	17.46	91-62	14.14

(D P S T G Attanayaka, K W Rupatunge and K B Karunasekera)

Evaluation of 1997 H.P. clones - Clyde estate (GPB/BST/HPS/971/01 & 91/2)

The second year girth measurement was taken at a height of 120 cm. The mean girth of the best five clones and control clones are given in Table 14.

Table 14. *Mean girth in cm of the 1997 HP progeny planted at Clyde estate*

Clone	Mean girth (cm) 97-01 Trial	Clone	Mean girth (cm) 97-02 Trial
97-2	17.90	97-48	18.26
97-19	17.78	97-55	18.03
97-3	17.66	97-83	17.70
97-10	17.36	97-66	17.46
97-32	17.13	97-78	17.43
RRIC 121	17.03	RRISL 205	15.96
RRISL 205	15.80	RRIC 121	15.70

(D P S T G Attanayake, T M S K Gunasekera, K B Karunasekera)

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

First year girth measurements were taken at a height of 120 cm from these six trials. The clones 98-219, 98-230, 98-68, 98-18 from the experiments at Kuruwita and 98-122, 98-104, 98-273 from the experiments at Nivithigalakele had a girth of more than 10 cm.

Testing of proven foreign clones received under SRRP II (GPB/FC/SRRP/91/1-*6*)

Under this programme, only the experiment planted at the Salawa estate was monitored. Other sites were discontinued due to the lack of funding for transport. Thirteenth year girth measurements and the test tapping yields from the two blocks planted at Salawa estate are given in Table 15.

Table 15. *Mean girth (cm) and yield (g/t/t) obtained from SRRP II clone trials*

Clone	Block I		Block II	
	Girth cm	g/t/t	Girth cm	g/t/t
PB 217	59.47	47.45	60.31	41.60
PB 235	63.57	46.51	60.30	46.02
PB 260	-	-	60.72	45.39
RRIM 712	52.07	44.44	52.96	44.31
PR 255	54.57	40.80	56.67	36.60
PR 261	57.62	33.25	57.87	40.07
BPM 24	53.14	44.43	53.25	33.60
RRIC 100	60.77	44.43	61.07	41.41
RRIC 121	62.94	46.04	64.91	46.17

(D P S T G Attanayaka, B M S G Peiris and K B Karunasekara)

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

Fourth year girth measurements were recorded and presented in Table 16. Analysis of variance showed the presence of highly significant differences in growth between clones, sites and the presence of significant genotype × environment interactions (Table 17).

Table 16. *Mean girth (cm) of the clones in each site*

Clone	Sites								
	Gane palla	Muwan kanda	Atale	Palm Garden	Pelma dulla	Badde gama	Bibile	Sorana	Clone mean
RL201	30.14	30.27	30.94	25.52	28.00	32.28	22.88	39.02	29.88
RL205	32.88	32.36	33.47	23.61	26.80	31.66	23.14	43.50	30.93
RL206	29.77	32.26	34.52	25.35	28.36	33.84	24.06	39.82	31.00
RL210	28.96	23.79	29.54	21.07	23.20	27.97	19.67	32.50	25.84
RL215	26.21	29.47	29.05	23.94	26.36	28.79	23.52	35.94	27.91
RL217	27.71	25.79	29.78	21.98	26.96	29.78	22.66	38.30	27.87
RL218	28.22	29.47	30.43	20.55	26.50	33.40	21.73	40.69	28.87
RL220	27.88	28.41	26.17	17.24	24.16	30.52	18.69	30.55	25.45
GPS 1	24.07	22.61	26.20	16.68	17.00	24.38	21.41	29.5	22.73
RRII105	29.65	26.37	30.28	21.42	23.94	32.20	19.31	35.66	27.35
RM712	27.66	24.61	27.14	19.09	24.64	27.53	20.62	27.54	24.85
RC130	27.61	24.87	27.05	23.78	27.16	27.94	20.37	34.03	26.6
HEN2	24.70	27.28	27.52	20.43	21.70	27.27	20.91	31.41	25.15
PB260	27.20	26.78	29.38	22.53	25.23	30.93	21.12	34.55	27.22
Site Mean	26.18	25.62	27.43	20.21	23.33	27.9	20.01	32.87	25.44

RL = RRISL

Table 17. *The results of the analysis of variance*

Source	DF	Mean square	Significance
Clones	14	569.03	***
Sites	7	5263.16	***
Clone × Sites	98	46.89	***

*** 0.1%

(D P S T G Attanayaka, K B Karunasekera, K W Rupatunga, I D M J Sarathkumara, H P Peiris and S P Withanage)

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

The third year girth measurement was taken. Highly significant differences between the treatments and blocks were observed. Table 18 shows the mean girth of each treatment, *i.e.* control monoclone plots and plots of Bi – and Tri - clonal mixtures.

Table 18. *Mean girth of each treatment*

Treatment	Mean girth (cm)
RRIC 121	25.11^{A}
RRIC 102/RRIC 121	24.60^{AB}
RRIC 102/RRIC 133/ RRIC 121	23.98^{BC}
RRIC 133/RRIC 121	23.69^{BCD}
RRIC 100/102/121	23.42^{CD}
RRIC 102	23.36^{CD}
RRIC 100/ RRIC 121	23.35^{CD}
RRIC 102/ RRIC 133	23.15^{CD}
RRIC 100/ RRIC 102	23.08^{CD}
RRIC 100/102/133	22.52^{DE}
RRIC 100/133/121	22.50^{DE}
RRIC 100	21.76^{EF}
RRIC 133	21.54^{EF}
RRIC 100/133	20.89^{F}

(D P S T G Attanayaka, K B Karunasekera, H P Peiris in collaboration with Plant Science Dept)

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

The second year girth measurements were recorded. ANOVA showed significant differences between the treatments (selected seedlings, unselected seedlings and clones) (D P S T G Attanayaka, K W Rupatunga and K B A Karunasekera).

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

Annual girth measurements were taken from all the trials. Table 19 shows the girth measurements of the current year with the information on planting.

Table 19. *Annual girth measurements recorded from ECTs*

Clone	Site	Year of planting	Girth in cm
RRISL 205	Pallegoda	1995	59.4
	Vogan	1997	56.3
	Neuchatel	1997,b-I	55.4
	Neuchatel	1997,b-II	47.7
RRISL 204	Neuchatel	1997,b-I	47.0
		1997,b-II	45.8
	Tempo	1996	46.8
RRISL 206	Pallegoda	1995	53.0
	Vogan	1997	51.3
	Neuchatel	1997,b-I	50.4
		1997,b-II	47.2
	Salawa	1999	31.7
RRISL 211	Siriniwasa	2001	8.58
	Kuruwita	1995	49.6
	Vogan	1997	47.4
RRISL 218	Pallegoda	1995	50.0
	Siriniwasa	2000	8.9
RRISL 2001	Pallegoda	1995	54.4
RRISL 201	Tempo	1996	52.7
	Moralioya	1996	52.8
	Kuruwita	1994	60.0
	Salawa	1999	25.7
RRISL 202	Moralioya	1996	52.0
	Kuruwita	1994	54.0
RRISL 215	Tempo	1996	45.3
	Salawa	1999	33.7
	Siriniwasa	2001	9.9
RRISL 220	Salawa	1999	29.0
RRISL 221	Salawa	1999	25.7
RRISL 226	Salawa	1999	27.7
	Pallegoda	2000	15.3
	Siriniwasa	2001	8.83
RRISL 2000	Pallegoda	1998	38.1
GPS I	Pallegoda	1998	21.9
RRII 105	Pallegoda	1998	31.9
RRII 176	Pallegoda	2000	15.9
PB 255	Pallegoda	1998	38.8
RRIC 133	Kuruwita	1995	61.0
	Salawa	1999	26.6

(D P S T G Attanayaka, K B Karunasekera, K W Rupatunga, I D M J Sarathkumara, L S Kariyawasam, H P Peiris, B M S G Peiris, T M S K Gunasekera and A K Gamage)

Yields from ECTs

ECTs at Dartonfield, Tempo and Moralioya divisions were opened for tapping during the year. The yield data from these trials will be monitored from next year. Daily volume of latex was recorded from the Pallegoda estate for new clones and the calculated yield for each month is given in Table 20. 91% of the RRISL 205 trees were tappable during the year followed by 84% in RRISL 2001 and 74% in RRISL 206. Yield per hectare for RRISL 205, RRISL 206 and RRISL 2001 calculated on the basis of the tappable percentage of trees and for 120 taping days were 1190, 987 and 1914 Kgs respectively. RRISL 2001 showed very high yield during the first year of tapping.

The estate yields obtained from RRISL 201, 202 and 217 of the Kuruwita ECT trial in the first year of tapping (S2/d3) based on the metrolac reading figures are given in Table 21.

Number of test tappings done on the clones RRISL 211, RRISL 208 , RRISL 219 and RRISL 216 planted in Dartonfield estate were inadequate to calculate the mean yields of the year (D P S T G Attanayaka, K W Rupatunga, K B Karunasekera, B M S G Peris, 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

All three clones planted under this programme showed vigorous growth. Girth measurements from a sample of 30 trees were taken at a height of 120 cm from each site and given in Table 22. The brinjal cultivation that had been used as an intercrop at the Homagama site was culminated in September.

Table 20. *Tapping details of RRISL 2001, RRISL 205 and RRISL 206 from Pallegoda estate*

Clone	Month	No. of tappings	No. of trees tapped/day	Volume (liters)	DRC g/100 ml	Kg	g/t/t
RRISL	January	13	254	379	31.0	117.4	35.5
2001	February	14	254	458	32.0	146.5	41.2
	March	12	254	289	28.0	80.9	26.5
	April	07	254	91	28.0	25.4	14.3
	May	07	254	101	30.0	30.3	17.0
	June	12	254	365	31.0	113.1	37.1
	July	14	254	621	30.0	186.3	52.3
	August	10	254	334	32.0	106.8	42.0
	September	12	254	355	33.0	117.0	38.4
	October	08	254	249	32.0	79.6	39.2
	November	05	254	153	31.0	47.4	37.3
	December	13	254	499	32.0	159.6	48.3
	Total	115				1210.3	
	Mean						30.65
RRISL	January	13	273	325	32.0	104.0	29.3
205	February	11	273	185	31.0	57.3	28.1
	March	06	273	82	30.0	24.6	15.0
	April	07	273	80	30.0	24.0	12.5
	May	03	273	39	31.0	12.0	14.7
	June	06	273	100	31.0	31.0	18.9
	July	11	273	162	33.0	79.5	17.8
	August	-	-	-	-		
	September	10	273	149	36.0	53.8	19.7
	October	06	273	120	37.0	44.4	14.7
	November	06	273	112	34.0	38.0	23.2
	December	11	273	322	36.0	115.9	38.6
	Total	90				584.5	
	Mean						21.13
RRISL	January	14	224	328.0	30.0	98.4	31.3
206	February	13	224	208.5	33.0	68.8	23.6
	March	09	224	73.0	32.0	23.3	11.5
	April	07	224	91.0	34.0	30.9	19.7
	May	07	224	98.0	34.0	33.3	21.2
	June	12	224	198.0	32.0	63.3	23.5
	July	14	224	219.0	33.0	72.2	23.0
	August	08	224	111.0	34.0	37.7	21.0
	September	11	224	156.0	36.0	56.1	22.7
	October	06	224	101.0	36.0	36.0	27.0
	November	02	224	25.0	32.0	8.0	17.8
	December	10	224	36.0	36.0	86.4	38.5
	Total	113				614.4	
	Mean						23.4

Table 21. *Test-tapping details of RRISL 201, RRISL 202 and RRISL 217 from Kuruwita estate*

Month	RRISL 201 (No.of trees tapped 304)		RRISL 202 (No.of trees tapped 303)		RRISL 217 (No.of trees tapped 197)	
	No. of tapping days	Yield Kg.	No. of tapping days	Yield Kg.	No. of tapping days	Yield Kg.
January	8	104	7	80	8	48
February	7	69	7	48	7	32
March	6	42	7	45	8	50
April	5	37	7	44	5	35
May	2	14	4	24	3	19
June	5	40	5	50	7	56
July	8	66	8	68	6	47
August	7	72	7	59	8	63
September	5	44	8	59	7	50
October	5	31	5	29	5	29
November	5	52	4	34	5	46
December	7	84	8	84	7	61
YPH*		1015		882		1181

* for 110 days of tapping and stand of 300 tappable tress/hectare

Table 22. *Mean girth of the SRT trials planted in 2001*

Site	Expt. No.	Farmer	Clone	Mean girth cm
Kegalle	SRT/01/01	K A L Munasingha	RRISL 201	10.5
			RRISL 203	10.9
	SRT/01/02	T A Bandula Kumara	RRISL 205	8.9
Homagama	SRT/01/03	D C Ratugama	RRISL 201	10.4
			RRISL 203	8.6
			RRISL 205	10.4

(D P S T G Attanayaka, K B Karunasekera, L S Kariyawasam and E A T Senadeera)

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

With regard to this project only minimum maintenance work was possible due to lack of funds. Majority of the genotypes require pruning and propagation to prevent from extinction (D P S T G Attanayaka, K B Karunasekara, S P Withanage and T M S K Gunasekera).

New planting

(I) GPB/BST/HPS/90/01, GPB/BST/HPS/99/01, GPB/BST/HPS/99/02 GPB/BST/HPS/99/03 Kuruwita)

Four Small Scale Clone Trials were planted at Kuruwita sub station to test the 1990 and 1999 HP progenies. RRIC 121, RRIC 130 and RRISL 205 were included as control clones. Each clone was replicated 8 times in a completely randomized design. Planting was done in July (D P S T G Attanayaka, H P Pieris and K B Karunasekera).

(II) Estate/ RRI collaborative clone trials- (GPB/BST/ECT/02/01)

A tapping task of RRISL 225 was planted at the Nivithigalakele division in July.

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

Three sites from Kalutara district and two sites from Ratnapura district were planted under the Smallholder SRT progrmme. A research grant for this experiment is sought from CARP.

Table 23. *Details of the SRT trials planted in 2002*

Site	Expt. No.	Farmer	Clone	No. of Palnts (date of planting)
Kalutara	SRT/02/01	K A Wimalasiri	RRISL 205	150 - 09/08/2002
	SRT/02/02	R A Gunathilaka	RRISL 201	100
			RRISL 205	100
			RRISL 206	100
			RRIC 121	100 - 20/08/2002
	SRT/02/03	K C Gunathilaka	RRISL 201	100
			RRISL 205	100
			RRISL 206	100
			RRIC 121	100 - 16/07/2002
Ratnapura	SRT/02/04	A L D Jayasena	RRISL 201	133
			RRISL 205	133
			RRISL 206	133 - 16/07/2002
		C Gankanda	RRISL 201	100
			RRISL 205	100
			RRISL 206	100
			RRISL 121	100 - 27/07/2002

(D P S T G Attanayaka, K B Karunasekera, L S Kariyawasam, H P Peiris, B M S G Peiris and E A T Senadeera)

PLANT SCIENCE

P Seneviratne

SUMMARY

Better results were shown in auxillary shoot elongation using media with activated charcol and high sucrose levels. Girth and height increments were significant in both polybagged and ground rootstock plants with "Aqua Spa" irrigation system.

Increasing the planting density significantly lowered the growth and the percentage trees in tapping. However yield percentage increased with increasing planting density. Leaf Area Index (LAI) was highest in the highest planting density, showing potential for higher sunlight capture.

The new tapping treatment, 2 × ½ S (↓) d/3, showed higher annual tree yields, than ½S d/3 + 2.5% ET (4/y).

Paired row system of planting rubber was seen to be a practical and a feasible spatial system for intercropping perennials, if space within the double rows could be increased to minimize intra-specific competition. Both paired and three row systems allowed greatest area for intercropping as the exposed area and therefore, the light penetration were highest.

Rubber could be successfully integrated with traditional cropping systems providing many benefits to the smallholders, including earlier and greater latex yield and an additional income.

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, Botanist, Dr A M W K Seneviratne, Botanist, Mr N M C Nayanakantha and Mr N A A D Wickramaratna, Assistant Botanists, Mr K A G B Amaratunga, Mr R P Karunasena, Mrs G A S Wijesekera, Mr U S Weerakoon, Mr S Wilbert, Mrs R K Samarasekera, Mr M N de Alwis, Mr M K P Perera, Mr T U K Silva Experimental Officers, Mr D L N de Zoysa, Mr P D Pathirana, and Mr P K W Karunatilaka, Technical Officers and Mrs D E Jayawardena, Clerk/Typist were on duty throughout the year.

Dr A M W K Seneviratne was promoted to the post of Botanist with effect from 01st November. Mr J Robert retired on 27th March after 42 years of service in the Institute.

Research students

- Ms B T Perera, Research Assistant continued her project on clonal propagation under the supervision of Dr (Mrs) P Seneviratne.

- Mr S T G C de Silva, Research Assistant continued his project on "Harvesting of *Hevea brasiliensis* genotypes introduced to areas marginal with regard to elevation" under the supervision of Dr A Nugawela.

- Ms Kokila Gunasekera, Research Assistant continued her project on "Determination of optimum tapping regimes for new *Hevea brasiliensis* Muell Arg. genotypes" under the supervision of Dr A Nugawela.

- Ms Inoka Munasinghe, Research Assistant, continued her work on intercropping and farming systems project funded by DFID, under the supervision of Dr V H L Rodrigo.

Seminars/Conferences/Meetings/Work-shops attended

Officer	Subject	Organization
Dr (Mrs) P Seneviratne	Capacity building on research needs relevant to climate change	Ministry of Environment
L S S Pathiratna	Intercropping medicinal plants with rubber	Vinivida ITN Television Programme
N M C Nayanakantha and N A A D Wickramaratna	Priority research areas in science and technology"	YSF of NASTEC at SLAAS
N A A D Wicramarathna and P K W Karunatilaka	Participatory rural appraisal	The Institute for Participating Interaction in Development
Dr (Mrs) P Seneviratne Dr V H L Rodrigo and Dr W Seneviratne	Research priority setting	ISNAR
V H L Rodrigo	Managing with scarce resources	Forest Department

Training programmes

Client	Subject	No. of programmes
Smallholders	Growing medicinal plants under rubber	01
Plantation Sector	Rainguards	01
Plantation Sector	Tapper training	29
Plantation Sector	Preparation of stumped buddings	03
Plantation Sector	Field Officers – Nursery Practices	02
Rubber Development Department	Budwood nursery management	01

Advisory visits

Client	No. of visits
Plantations	5
Smallholders	1

LABORATORY INVESTIGATIONS

Tissue culture

Propagation of clonal Hevea

Axillary shoot elongation of *Hevea* clones on media containing activated charcoal and high sucrose levels showed better results. New RRISL series clones were also used to compare growth performance under *in vitro* conditions.

Micropropagation of other species

Mucuna seeds cultured *in vitro* in a medium containing cytokinin produced multiple shoots. The degree of browning of explants was reduced to a great extent by culturing them in media containing antioxidants. Callus formation was possible with different explants obtained from *in vitro* grown *Mucuna* seedlings. Axillary shoot elongation was possible in a medium containing a combination of hormones.

In vitro propagation of *Paulownia*, which is a fast-growing hardwood tree recently introduced from China that yields timber within six to eight years, was experimented for mass propagation. Sterilization of *Paulownia* seeds was possible with chlorox. Germination of *Paulownia* seeds was done *in vitro* and *in vivo* after some pre-treatment (P Seneviratne and N M C Nayanakantha).

FIELD EXPERIMENTS

Clonal propagation

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

Plants were obtained by rooting of cuttings taken from mature RRIC 100, 121 and 130 trees. They were field planted for further studies (P Seneviratne and G A S Wijesekera).

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

Plants raised from high yielding inviduals of clones RRIC 130 and PB 28/59 are maintained in a nursery for further propagation (P Seneviratne and G A S Wijesekera and R K Samarasekara).

Propagation of Mukuna

Differences were observed between the cuttings taken from vines of different growth stages. Tender apical cuttings performed better (P Seneviratne and G A S Wijesekera).

***Phase change of* Hevea**

Seedlings were planted each year commencing from 1991. Observations are being made on growth, flowering and wintering etc. of these plants (P Seneviratne and G A S Wijesekera).

Variation in budded plants

Rootstocks are being propagated to be used as same. Number of plants produced from each individual seedling varied from 2-10. Most of the plants are now in buddable stage (P Seneviratne, B T J Perera and G A S Wijesekera).

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

Plants with tap roots and fibrous roots of same genetic make up were established in the field to study the performance of the root system (P Seneviratne and G A S Wijesekera).

Rootstock nurseries

The effect of mist on the seed germination of rubber (RN/2002/3- Dartonfield)

The main objective of the study was to cut down on the cost while improving the quality of stock plants (less cumbersome method for seed germination).

A preliminary study was done to test the germination of seeds in the mist propagator as stacks of about 1-1½ feet of height, a single layer without sand and 3-4 layers without sand. Results on germination did not show a significant variation and the study will be repeated next year (P Seneviratne and N M C Nayanakantha).

The effect of method of watering on growth of seedlings (RN/2001/3-Dartonfield)

Height and girth measurements taken from polybag and ground rootstock plants with/without irrigation show that there is a significant girth and height increment in both polybag and ground rootstock plants with the irrigation system. The water consumption is three times less when "Aqua Spa" irrigation system is used instead of manual watering.

Table 1. *Mean girth and height measurements of polybagged plants with /without the Aqua Spa micro porous irrigation system*

Age	Girth (mm)		Height (cm)	
(Months)	Aqua Spa	Control	Aqua Spa	Control
5	9.2±0.2	8.3±0.2	68.3±1.7	65.4±1.6
11	22.3±0.5	17.7±0.5	189.4±3.4	133.2±3.3

Budgrafting

Effect of the position of the bud on growth - BG/2001/1 - Dartonfield

The plants were field planted in Padukka estate (P Seneviratne and G A S Wijesekera).

Successive grafting - BG/1999/1 - Dartonfield

Only one passage was possible during the year. About five passages have been obtained up to now (P Seneviratne and G A S Wijesekera).

Crown budding

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

Mean girth of RRIC 110 trees crown budded with RRIC 100, 102, 117, 130 and *H. spruciana* at Padukka estate are given in Table 2.

Table 2. *Mean girth of RRIC 110 trees crown budded with RRIC 100, 102, 117, 130 and* H. spruciana

Minerigama Division

	H. sp	RRIC 100	RRIC 102	RRIC 117	RRIC 121	RRIC 130
Mean Girth (cm)	45.23	52.66	56.12	52.30	60.70	54.59
No. of plants	115	200	143	145	76	103
SEM	0.5283	0.441	0.6607	0.4785	0.6289	0.5883

Main Division

	H. sp	RRIC 100	RRIC 102	RRIC 110	RRIC 117
Mean girth (cm)	48.61	45.68	47.68	60.32	47.24
SEM	1.49	0.37	0.54	-	0.555

(P Seneviratne, S Wilbert 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 2002 is given in Table 3. Since the girth of crown budded trees was less when compared to unbudded trees (not crown budded). RRIC 100 and RRIC 121, yield data were gathered from another field where the girth of trees were similar to crown budded trees.

High yields of unbudded (not crown budded) trees in the same field can be attributed to higher girth. When the yields of crown budded trees are compared with control, crown budded trees have given a higher yield (P Seneviratne and S Wilbert).

Table 3. *Average yield and girth of crown budded trees and their control trees (number of tappings are given in brackets)*

	Monthly average	
Treatment	**Mean girth**	**Yield ml/t/t.**
T- RRIC 121, C- RRIC 100	55.16	89 (6)
RRIC 121 (not crown budded)	79.61	181.6 (6)
RRIC100 (not crown budded)	76.85	18.4 (6)
RRIC 121 (control)	50.3	29.7 (10)
RRIC 100 (control)	52.1	62.5 (10)

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

Average yield and girth of RRIC 130 trees with its own and *Hevea spruciana* crowns are given in Table 4.

The yield increases with the girth of the tree in both crown budded and control trees (P Seneviratne and S Wilbert).

Table 4. *Average yields and girth of crown budded and control trees of RRIC 130 (Number of tappings done are given in brackets).*

Crown	Tree No.	Girth (as at 8.8.2002)	Average volume of latex/tapping (ml)
H. spruciana	1	55.5	82.1 (10)
	2	56.0	90.0 (10)
	3	49.0	60.2 (10)
	8	70.0	150.0 (10)
	Mean	57.6	95.5
RRIC 130	4	48.0	50.6 (10)
	7	57.5	43.4 (10)
	9	78.0	291.5 (10)
	10	81.0	206.0 (10)
	11	68.0	216.0 (10)
	12	57.5	129.0 (10)
	13	76.0	376.5 (10)
	Mean	66.6	187.5

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

Mean girth of RRISL 224 trees having different crowns are given in Table 5.

Table 5. *Mean girth of the trees with different crowns*

Crown clone/clones	Mean girth (cm)
RRIC 100	40.53
RRIC 102	27.00
RRIC 100/RRIC 121	38.85
RRIC 100/RRIC 121/*H. spruciana*	40.00
H. spruciana	37.07
RRIC 121	41.54

(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

Girth of control, crown budded and pollarded trees do not show effect of the treatment as the measurements were taken only two months after pollarding. However, clonal differences are evident (Table 6).

Table 6. *Mean girth of trees with different crown /trunk combinations*

Treatment	Trunk	Crown	Mean Girth (cm)
1	PR 305	Control*	16.86 ± 0.39
	PR 305	RRIM 717	18.25 ± 0.59
	PR 305	Pollarded	16.76 ± 0.76
2	RRIM 717	Control*	17.82 ± 0.41
	RRIM 717	PR 305	17.78 ± 0.56
	RRIM 717	Pollarded	17.05 ± 0.72
3	BPM 24	Control*	17.77 ± 0.65
	BPM 24	PB 260	16.5 ± 4.67
	BPM 24	Pollarded	16.81 ± 1.18
4	PB 260	Control*	19.63 ± 0.93
	PB 260	BPM 24	18.09 ± 0.86
	PB 260	Pollarded	17.35 ± 0.85
5	RRIC 121	Control*	21.19 ± 0.53
	RRIC 121	RRISL 217	21.88 ± 1
	RRIC 121	Pollarded	18 ± 0.87
6	RRISL 217	Control*	19.91 ± 0.39
	RRISL 217	RRIC 121	20.48 ± 0.51
	RRISL 217	Pollarded	17.69 ± 0.62
7	RRIC 121	Control*	21.09 ± 0.99
	RRIC 121	RRIC 130	24.17 ± 3.17
	RRIC 121	Pollarded	22.72 ± 0.91
8	RRIC 130	Control*	21.7 ± 0.51
	RRIC 130	RRIC 121	21.48 ± 0.92
	RRIC 130	Pollarded	22.08 ± 0.63

* Not crown budded

(P Seneviratne and L Zoysa)

Budwood nurseries

Budwood availability

BN/1991/DF

These nurseries were established in 1991 and 1992 and they are to be uprooted. The number of plants in these nurseries are about 288.

BN/2000/DF

This budwood nursery was established in 2000 with new RRISL clones in order to provide authentic material for the establishment of budwood nurseries.

BN/2000/Olikanda

This budwood nursery was established in 2000 with new RRISL clones in order to provide authentic material for the establishment of budwood nurseries.

BN/2002/Dartonfield

A new budwood nursery was established at Olikanda in Dartonfield estate with new RRISL 2000 series clones.

The clonal composition of the new nurseries are given in Table 7.

Table 7. *Number of plants available from each clone*

Clone	BN/2001/DF	BN/2001/Olikanda	BN/2002/Olikanda
RRISL 200	14	7	-
RRISL 201	33	11	-
RRISL 202	27	3	-
RRISL 203	33	18	-
RRISL 205	33	15	-
RRISL 210	27	-	-
RRISL 215	31	5	-
RRISL 217	46	98	-
RRISL 218	27	-	-
RRISL 219	35	-	-
RRISL 2000	-	-	120
RRISL 2001	-	-	82
RRISL 2002	-	-	40
RRISL 2003	-	-	83
RRISL 2004	-	-	53
RRISL 2005	-	-	52
RRISL 2006	-	-	25
Total	306	157	455

Authentic material for budwood nurseries

A total of 534 budwood yards were issued to both the plantation sector and private nurseries for the establishment of multiplication nurseries (Table 8).

Table 8. *Authentic material issued during 2002 to establish budwood nurseries*

	Name of estate and No. of budwood yards given							
Clone	**Padukka**	**Dumbara**	**Atale**	**Maddegedara (Private)**	**Mirishena**	**Sunnycroft**	**Plant Breeding Dept..**	**Total**
RRIC 121				25				25
RRISL 200		25	4		7			26
RRISL 201	5	25	4					34
RRISL 202		25	4					29
RRISL 203	5	25	4					34
RRISL 205	5	25			7	30		67
RRISL 217	5			45				50
RRISL 218				10	7	20		37
RRISL 219				45		45		90
RRISL 210							75	75
RRISL 215					7	50		57
Grand total								534

(P Seneviratne, U S Weerakoon and M N de Alwis)

Nursery inspection

No Budwood nurseries were inspected during the year (P Seneviratne, U S Weerakoon, M N de Alwis and L Zoysa).

Planting techniques

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

Mean girth and SEM of the plants of different treatments are given in Table 9.

Table 9. *Mean girth and SEM of the plants of different treatments*

Treatment (Planting method)	Polybag plants	Young buddings
T1 - With the polybag	24.33 ± 1.14	20.88 ± .0.59
T2 - Without base of the polybag	27.36 ± 1.0	21.35 ± 0.66
T3 - T2 + 4 slits on the bag	25.81 ± 1.04	21.28 ± 0.7
T4 - With 4 slits on the bag	25.75 ± .68	21.83 ± 0.63
T5 - Whole bag removed (current recommendation)	27.1 ± 1.24	22.61 ± 0.7

(P Seneviratne and U S Weerakoon)

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

The mean height and girth of plants grown in bad, moderate and good soils are given in Table 10.

Table 10. *The mean girth, girth increment (cm), mean height, height increment (m) in 3 types of planting holes*

Soil condition	Girth (cm)	Girth increment (m)	Height (m)	Height increment (m)
Bad	7.6	1.83	3.08	0.89
Moderate	7.5	1.91	3.12	0.87
Good	7.8	2.11	3.24	0.92

The correlation between current and initial growth for good moderate and bad hole types are given in Table 11.

As Table 11 shows, the correlation between the initial girth and girth after one year and height are highly significant.

Mixed planting - PT/1996/1 - Dartonfield

Estate is maintaining the clearing and data on yields will be collected once the trees are opened for tapping (P Seneviratne and L Zoysa).

Table 11. *The correlation between current and initial growth*

		Bad	Moderate	Good
Initial girth vs girth after 1 year	R	.689	.660	.677
	p	<.0001	<.0001	<.0001
	n	109	71	214
Girth vs height	R	.718	.799	.732
	p	<.0001	<.0001	<.0001
	n	109	71	214

r - correlation , p - probability n - number
(P Seneviratne and L Zoysa).

Planting at high density - PT/1992/1 - Kuruwita

Details of treatments and the experimental layout are given in the Annual Review 1992. Growth and yield parameters of the clones tested under four different densities are given in Table 12. Similar to the results shown in 2001, growth of rubber (as indicated by mean girth, bark thickness and % trees in tapping) has significantly decreased with the increase of planting density. Therefore, latex yield at individual plant level (g/t/t) was highest in the lowest density and it was vice versa in the highest density. However, number of trees in tapping increased with increasing density resulting in similar yield per hectare (YPH) across different densities. Leaf area index (LAI) was highest in the highest planting density and also in clone RRIC 121 indicating the potential for higher resource capture. Highest g/t/t and YPH were recorded in the clone RRIC 121 whilst they were lowest in RRIC 110 (the clone affected by *Corynespora* leaf disease).

Planting at low density – PT/1996/Gallewatta and Nivithigalakele

The effective trees were renumbered and girth measurements were taken during the year. Girth increased with decreasing planting density (Fig.1).

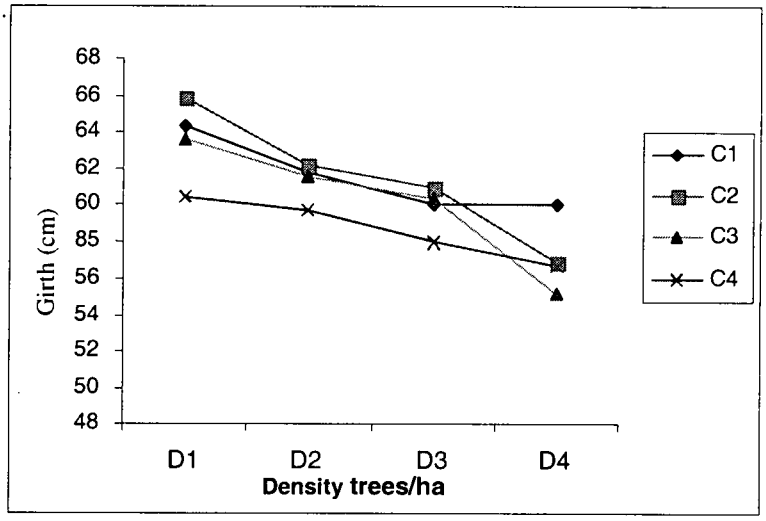
Table 12. *Effect of planting density on growth and yield parameters of rubber. In (a) plant girth (cm) and bark thickness (mm) at 150cm height, leaf area index and % trees in tapping, (b) tree yield (g/t/t) and estimated YPH (kg/ha/year)*

(a)

Density	RRIC 100					RRIC 110					RRIC 121				
	Girth (cm)	Bark thickness (mm)	Leaf area index	% Trees in tapping	Tappable trees/ha	Girth (cm)	BT (mm)	Leaf area index	% Trees in tapping	Tappable trees/ha	Girth (cm)	BT (mm)	Leaf area index	% Trees in tapping	Tappable trees/ha
500	58.25	7.09	4.09	93.21	466	54.86	6.73	3.94	72.79	364	61.37	6.94	5.60	90.46	450
600	57.25	6.84	4.06	92.58	555	50.93	6.03	3.97	66.38	398	60.46	6.83	4.84	90.56	543
700	54.02	6.73	3.69	90.32	632	48.92	5.94	3.56	57.73	404	58.59	6.47	5.30	89.22	625
800	54.12	6.76	4.17	85.75	686	47.96	5.98	4.42	54.17	433	57.00	6.35	6.57	90.39	723

(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	27.77	1278.41	24.84	904.06	38.48	1718.62
600	26.17	1442.97	22.36	907.43	31.83	1701.22
700	20.58	1292.56	21.41	876.64	29,59	1806.07
800	22.92	1554.39	21.21	917.96	26.89	1920.37



C1- RRIC 100 C2 – RRIC 121 C3 – RRIC 133 C4- PB 260
D1-350 Trees/ha D2- 425 Trees/ha D3 –500 Trees/ha D4-575 Trees/ha.

Fig. 1. Mean girth of trees of four clones at 4 densities

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

Expansion of rubber into areas marginal with regard to elevation, viz mid country wet zone

This trial was established in 1996 to investigate and recommend area specific technology for growing rubber beyond the traditional areas. In this trial clones RRIC 100, RRIC 102, RRIC 130, and PB 260 were planted and replicated 4 times. Two replicates were planted at an elevation of 650 m from mean sea level (msl) and other two at 850m from msl. From each replicate 50 plants were selected randomly for annual girth measurements. Growth of clone RRIC 130 is significantly higher than the other clones in each replicate. However growth of plants in replicates, in elevation of 850m msl was poor (Table 13).

Table 13. *The mean stem girth (cm) at 120 cm above union of different clones at two elevations*

Clone	Replicate at 650 m	Replicate at 850 m
RRIC 102	42.75 ^{AB}	20.30 ^{B}
PB 260	37.55 ^{B}	23.15 ^{AB}
RRIC130	50.15 ^{A}	31.25 ^{A}
RRIC 100	48.35 ^{A}	23.20 ^{AB}

Values with the same superscript in each column are not significantly different at the P=0.05 level according to Duncan's Multiple Range Test (A Nugawela, S T G C Silva and K A G B Amaratunga).

Coppicing mature and immature rubber

The objective is to look into the possibility of regenerating shoots from mature and immature rubber trees by pollarding at different heights and at different ages. Trees were selected from existing clearings in the Dartonfield group and were cut at 6", 12"18" and 24" from the union. Girth of the regenerated shoots after about 6 months of growth is given in Table 14.

Table 14. *Girth (cm) of 6 month old shoots when trees were pollarded at different heights from the union*

	6"	12"	18"	24"
No. of plants	6	6	7	2
Mean height (cm)	57.87	60.16	91	147.13
Mean Girth (cm)	2.78	2.67	4.73	2.86

Cultural practices during immature phase

Branch induction - CP/2000/1 – Pallegoda

Details of this experiment are reported in the Annual Review for the year 2001.

Girth and the girth increment for different treatments to end of the year are given in Table 15.

Table 15. *Girth and the girth increment of trees in different treatments (The SEM is given within brackets)*

Treatment	Girth (cm)		Girth increment (cm)	
	RRIC 121 only	Mean of all clones	RRIC 121 only	Mean of all clones
Leaf cap method (T1)	46.94	46.96	7.0	7.2
	(1.02)	(0.83)	(0.31)	(0.26)
Cut and remove all leaves (T2)	44.89	43.84	7.1	6.8
	(0.93)	(1.02)	(0.29)	(0.29)
Removing 3" portion of the apex (T3)	46.73	46.37	7.37	7.38
	(0.94)	(0.67)	(0.43)	(0.32)
Control (T4)	45.19	44.24	7.05	6.6
	(0.16)	(0.65)	(0.2)	(0.26)

Canopy architecture of the trees were as good, moderate and bad visually and the data are given below.

Treatments	Good	Moderate	Bad
T1	13	11	6
T2	11	7	17
T3	12	11	2
T4	2	8	23

(P Seneviratne and U S Weerakoon)

Exploitation

Assessment on the adoption of recommended tapping practices

RRIC 100, 1986 replanting - Gallewatta (TP/2001/01)

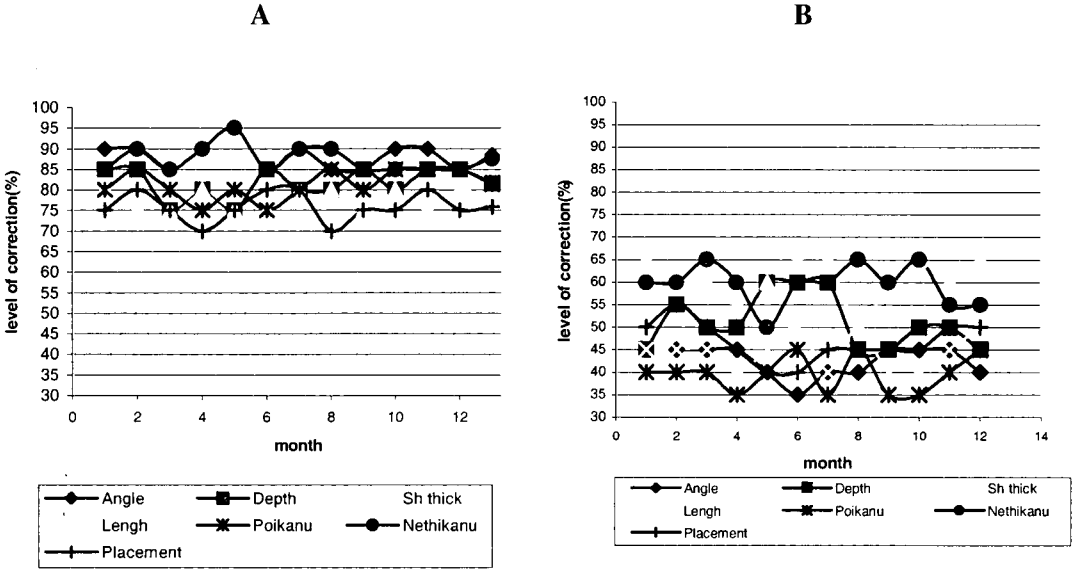


Fig. 2. The time cause variation in the level of adoption (% trees) of different tapping policies. (A- corrected, B-control)

There is a marked difference in the level of adoption of tapping policies between corrected and non-corrected tapping blocks. Even though monthly visits have been made it was not possible to perfect even a single practice (N A A D Wickramarathna, V H L Rodrigo, A Nugawela and K A G B Amaratunga).

Developing of leech repellents – LR/2001/01

Out of the compounds tested, citronella oil was found to be the best in repelling leeches. This was incorporated into a paste developed by the Link Natural Products (Pvt) Ltd. in order to improve the convenience of application and to reduce the cost.

Being water soluble, the retention power of the paste on the skin was not satisfactory under field conditions. Therefore, a new oil-based mixture was developed by the same company. In addition, a byproduct of nutmeg oil extraction was also incorporated in order to strengthen the repelling ability. Newly formulated mixture will be tested under field conditions during the Yala rainy season of year 2003 (N A A D Wickramarathna, V H L Rodrigo and A Nugawela).

Exploitation of renewed bark

In treatments where the higher panels were exploited to provide more time for bark renewal in the lower panels, the yields were poor when the rested lower panels were tapped. This practice is adopted by some plantations to achieve high yields from poorly renewed lower panels. Anyhow this study clearly show that the intended objective cannot be achieved through this practice (Table 16).

Table 16. *The dry rubber yield (g/t/t) of different treatments tested in trials ERB/93/1 and ERB/93/2*

Treatment		Annual mean g/t/t			
Previous	Current	ERB/93/1		ERB/93/2	
		Test Tapping	Estate Records	Test Tapping	Estate Records
½ S(↓) d/2 (BI-1)	¼ S(↑) + ½ S (↓)d/2	99.9	87.0	100.7	82.1
½ S(↓) d/2 (6" above BI-1)	¼ S(↑) + ½ S (↓)d/2	74.5	93.2	96.2	79.6
½ S(↑) d/2 (HO-1 × 2)	½ S(↓) d/2 (BI-1)	35.0	33.4	54.3	45.9
½ S(↓) d/2 (HO-1× 2)	½ S(↓) d/2 (BI-1)	30.1	33.1	48.2	38.5
PT d/2 (HO-1× 2)	½ S(↑) d/2 (BI-1)	45.6	72.8	37.0	39.1
	½ S(↓) (HO-1x2)	42.1	42.3	51.8	52.3

(A Nugawela and R P Karunasena)

Girth at opening

(TG/95/1), (TG/95/2), (TG/95/3)

Details of the trial are given in Annual Review 1995. Generally yield increases with the increasing girth. Trees of treatments T2, T4 and T6 when tapped tends to give high yields, even during the first year of tapping. This further confirms that yield increases with the increasing girth. This is more significant in RRIC 130 amongst the clones tested (Table 17) (A Nugawela, R K Samarasekera and S Wilbert).

Table 17. *The mean yield i.e. g/t/t recorded during the year for different clones*

	Clones and Mean g/t/t			
	RRIC 130	**RRIC 121**	**RRIC 100**	**Mean**
T1	37.57	40.19	42.62	40.1
T3	53.13	37.54	42.56	44.4
T5	62.47	47.05	51.0	53.5
T7	56.67	39.04	51.39	49.0
T8	57.85	40.82	52.64	50.4
T2	62.04	42.03	42.08	48.7
T4	100.89	48.05	42.85	63.9
T6	120.62	55.70	52.46	76.2

In clone RRIC 100 the girthing of untapped trees continued to be superior to that of tapped trees, *i.e.* T1, T3 & T5. Nevertheless, in clones RRIC 121 and RRIC 130 the difference in girth increment between tapped and untapped trees were marginal (Table 18) (A Nugawela, R K Samarasekera and S Wilbert).

Girth at opening (TG/99/1)

The yield increases with increasing girth at opening in all clones tested. Further, low frequency tapping with stimulation tends to give high per tapping and annual yields (Table 19).

Table 18. *Influence of tapping on subsequent girthing of clones RRIC 100, 121 and 130*

Clone	Treatment	Initial girth (cm)	Girth increment (cm)						
			1st	2nd	3rd	4th	5th	6th	7th
RRIC 100	T1	41.9	4.5	3.5	4.8	4.09	1.57	1.46	2.25
	T2	41.7	8.2	6.5	5.7	4.59	2.2	1.02	3.51
	T3	44.6	4.8	3.5	4.8	4.5	1.66	1.09	1.73
	T4	45.1	8.8	7.0	6.7	5.39	3.09	0.8	2.38
	T5	50.2	3.7	4.5	5.1	5.19	1.81	1.17	2.18
	T6	49.3	9.3	6.6	6.7	6.56	3.61	0.61	2.30
	T7	42.0	8.3	3.9	3.4	4.79	1.88	0.91	1.91
	T8	45.0	8.9	3.8	3.9	5.46	2.2	1.14	3.1
RRIC 121	T1	42.2	5.1	4.3	4.1	1.9	3.18	3.07	2.6
	T2	42.6	6.3	5.5	4.6	2.44	4.52	4.09	2.69
	T3	44.9	5.2	4.2	3.8	1.41	2.55	2.37	2.29
	T4	44.6	6.6	5.2	4.4	2.89	3.2	3.93	2.89
	T5	49.6	6.2	4.5	4.2	2.2	2.99	3.07	2.72
	T6	49.6	7.6	5.8	4.4	2.23	4.87	5.43	2.42
	T7	42.6	7.1	4.1	4.1	2.02	3.06	3.06	2.57
	T8	44.7	6.1	4.3	4.3	1.96	3.02	3.71	1.67
RRIC 130	T1	42.9	4.9	4.2	2.2	2.77	1.69	3.91	1.19
	T2	42.4	8.1	6.2	3.9	4.53	4.07	2.36	1.17
	T3	44.6	5.7	5.5	2.1	4.28	1.48	4.93	1.80
	T4	45.1	8.8	6.8	4.5	4.99	5.86	2.77	0.92
	T5	49.5	5.7	5.0	1.5	4.36	3.96	2.95	1.34
	T6	49.8	9.6	7.6	4.6	5.9	5.53	3.10	1.76
	T7	42.6	8.2	3.9	2.0	3.5	2.79	4.12	1.39
	T8	44.7	8.5	4.2	1.8	3.11	2.98	6.21	1.55

Table 19. *Effect of different tapping regimes on yield and mean girth increment of clones RRIC 102, RRIC 121 and RRISL 211 tapped at different girths. Means of each category with the same letter are not significantly different at p>0.05*

Clone	Treatment	Yield						Growth Girth increment (%)
		g/t/t	Kg/t/yr	g/t/t	Kg/t/yr	g/t/t	Kg/t/yr	
RRIC 102	T1	28.200^{A}	4.878	20.898^{B}	3.615	26.967^{A}	4.665	17.057^{A}
	T2	29.257^{A}	3.364	25.437^{AB}	2.925	29.494^{A}	3.391	17.618^{A}
	T3	24.296^{A}	2.794	31.431^{A}	3.614	30.746^{A}	3.535	16.751^{A}
RRIC 121	T1	35.278^{B}	6.103	23.165^{C}	4.007	23.723^{B}	4.104	19.683^{A}
	T2	34.267^{B}	3.940	59.840^{B}	6.881	25.014^{B}	2.876	19.964^{A}
	T3	60.717^{A}	6.982	76.682^{A}	8.818	42.149^{B}	4.847	18.989^{A}
RRISL 211	T1	22.307^{A}	3.859	24.240^{A}	4.193	33.240^{A}	5.750	15.373^{A}
	T2	25.724^{A}	2.958	32.727^{A}	3.763	32.821^{A}	3.774	14.999^{A}
	T3	28.193^{A}	3.242	34.901^{A}	4.013	40.868^{A}	4.699	14.068^{A}

(A Nugawela, V H L Rodrigo, K Gunasekera and R P Karunasena).

Low frequency tapping

Udabage estate – LFT/2000 -/1

This experiment was established in year 2000 at Udabage estate in collaboration with the estate management.

Three tapping blocks were selected for each treatment. One tapper was assigned for each of the d/3 treatments and 1.5 for each of the d/2 treatments. Task size was 400 trees for all treatments.

A new tapping treatment, *i.e.*2 × ½ S(↓) d/3 was introduced from July. Three tapping blocks were selected for this treatment and task size of each block was 250. Task size of the other treatments were reduced to 300 trees.

The effect of ethrel on d/2 tapping was negligible as evident by g/t/t.

Highest annual tree yield was evident from the new tapping treatment, 2 × ½S (↓) d/3 (Table 20).

Table 20. *Effect of tapping systems on growth and yield parameters*

Treatment	g/t/t	Tapping days/year	Yield tree/year (kg)	Stimulation/ year	Girth increment (cm) 2001	Tapping panel dryness (TPD) (%)
T_1 - ½S d/2 – Control	25.83	147	3.79	-	2.21	3.75
T_2 - ½S d/2 + E* 4/y	26.56	143	3.79	4	2.16	2.64
T_3 - ½S d/3 + E* 6/y	29.57	98	2.89	5	2.96	3.53
T_4 - ½S d/3 + E* 4/y	28.04	96	2.69	4	2.92	4.18
T_5 - 2 x ½S (↓) d/3	41.85	48*	2.01**	-	2.71	7.73

E* 2.5% ET, Ba 1.6 (2.5) * No. of tappings/6 months ** Yield/tree/6months

(A Nugawela, V H L Rodrigo and S Wilbert)

Ambetenna estate - LFT/97/1

½S d/3 tapping with different frequencies of stimulation was tested with ½S d/2 system of tapping.

Three tapping blocks were selected for each of the d/3 systems whilst two blocks were selected for the d/2 system. One tapper was assigned for each treatment. ½ S d/3 with 4 rounds of stimulation per year using 5% ethrel has given the heights g/t/t levels (Table 21). Further, even with a lesser number of tapping days/year this treatment has given à similar yield/tree/year as the d/2 treatment tested. Girth increment is less in d/2 treatment. Tapping panel dryness of all treatments were higher than in the previous year. Bark consumption is slightly over the recommended levels in both d/2 and d/3 treatments. However as expected bark consumption rate was less in d/3 than in d/2 frequency of tapping.

New system for stimulation (CS/02/01)

This was a short-term pilot trial established in April, at Dartonfield estate to assess the feasibility of using an alternate stimulating system. A piece of sponge was soaked with 10ml of 10% Ethrel and it was tied to the rubber tree ca.10cm below the tapping cut using rubber bands obtained from discarded cycle tubes. The sponge was covered with polythene to prevent the Ethrel being washed off. Rubber bands allowed the movement of the sponge to different positions, minimizing the possibility of bark rotting.

Table 21. *Effect of tapping systems on growth and yield parameters*

Treatment	g/t/t	Tapping days/year	Yield tree/year (kg)	Stimulations/ year	Girth increment (cm) 2001	Bark consumption rate (cm/year)	Tapping panel dryness (TPD) (%)
T_1 - ½S d/3 + E* 4/y	28.92	81.0	2.34	2*	1.80	18.4	8.8
T_2 - ½S d/3 + E**. 4/y	30.08	91.3	2.75	2*	2.05	17.4	7.68
T_3 - ½S d/3 + E* 6/y	27.93	88.0	2.46	4*	2.03	17.1	10.76
T_4 - ½S d/2	21.04	131.0	2.0	-	1.18	28.8	10.97

*2.5% Ethrel; ** 5.0% Ethrel
*Stimulation was stopped from September 2002.

(A Nugawela, V H L Rodrigo and S Wilbert)

Forty trees with similar yielding capacity were selected for the study. Half of the trees were stimulated as mentioned above and the rest were left as the control without stimulation. Latex yields recorded for two months showed no significant improvement suggesting that tested method of stimulation is not effective (N A A D Wickramarathna, V H L Rodrigo and R P Karunasena).

Tapping Panel Dryness (TPD/2002/01)

To identify the significance of tapping panel dryness in latex production and its key determinants at different stages of exploitation and with respect to genotypes, a project proposal was developed seeking funds from CARP. This includes a TPD survey in Kalutara region, biochemical studies of affected and healthy trees and continuous monitoring of TPD from the commencement of exploitation of high yielding clones grown at present. Until the funds are received for the study, sites were selected from Dartonfield, Ambetenne, Kiriwanaketiya and Usk Valley estates. The tapping blocks were selected from these sites and monitoring of TPD is in progress (A M W K Senevirathna, V H L Rodrigo and S Wilbert).

Intercropping

Spatial arrangements

Usk Valley, 1992 Replanting-IC/S/92/1

This study aims to find out suitable spatial arrangements for planting rubber in order to facilitate long-term rubber based intercropping systems. Details of the experiment are given in the Annual Review 1992. There were five systems of spatial arrangements comprising 1) traditional single row (SR), 2) paired row (DR), 3) three-row (TR) systems and, 4) a three plant triangular (CT) and 5) four plant square cluster (CS) systems of planting. Planting density of rubber remained constant across the treatments and systems were assessed for a period of nine years. Plants in traditional avenue system and in the new cluster systems tested performed better than those in the rest of the treatments with respect growth and yield (Table 22). However, canopy closure was rapid in these systems, hence poor light penetration (Table 23; Fig. 1). Both paired and three row systems provided highest exposed area hence light penetration allowing greatest area for intercropping. Considering overall performance, paired row system (DR) of planting rubber offers practically feasible spatial system for intercropping perennials, provided increased space within the double rows in order to minimize intra-specific competition of rubber. The gap between rubber rows (*i.e.* of the avenue) in the presently recommended planting system for rubber/tea intercropping is 12 m and that has not been sufficient to provide required light for long-term tea cultivation. Hence, with the improved gap

provided between rubber rows, *i.e. ca.* 14m, DR system would provide a better system; however further increase in the gap between rubber rows will be advantageous. In this regard, it is suggested that a distance of 2.7-3m should be considered for the space given within the double rows (*i.e.* instead of 2.4m), whilst a distance of 15-18m may be suitable between double rows (V H L Rodrigo, T U K Silva and E S Munasinghe).

Table 22. *Treatment effect on crop establishment growth and yield. Treatment codes are, SR- single row, DR- double row, TR-three row, CT-cluster triangular and CS- cluster square*

Treatment	Casualties (%)	Weak plants (%)	Plants with TPD (%)	Trees in tapping (%)	Yield per hectare (kg/ha)	Yield per tree(g/t/t)
SR	0.00	0.00	9.29	90.71	1530.20	29.33
DR	11.43	2.56	0.00	86.00	1179.93	23.90
TR	10.47	5.13	2.19	82.22	1063.70	22.65
CT	21.11	0.00	1.85	77.04	1379.63	31.12
CS	12.94	0.00	1.75	85.31	1368.32	28.34

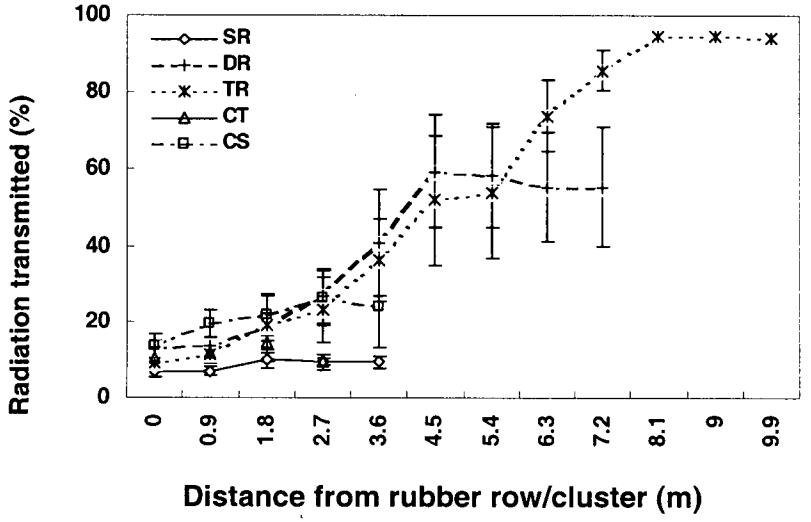


Fig. 3. *Radiation profile across the gap available for intercropping between rubber rows/clusters. Error bars represent the S.E. of means where n=6 (i.e. for each half of the transect and three replicate plots). Treatment codes are as for Table 22* (V H L Rodrigo, T U K Silva and E S Munasinghe).

Table 23. *Summery of canopy spread in different spatial systems. Treatment codes are as for table 22. Exposed distance and area indicate the gap available without the canopy cover between rubber rows/clusters, with respect to absolute distance and overall ground area, respectively. Shaded distance shows the distance covered by the canopy from rubber trees across the transect*

Treatment	7 YAP			8 YAP			10 YAP		
	Exposed distance (m)	Shaded distance (m)	Exposed area (%) (m)	Exposed distance (m)	Shaded distance (m)	Exposed area (%) (m)	Exposed distance (m)	Shaded distance (m)	Exposed area (%) (m)
SR	0.75	3.68	9.23	0.68	3.71	8.41	0.54	3.78	6.72
DR	6.74	3.68	41.62	5.49	4.30	33.90	4.69	4.71	28.94
TR	12.65	3.73	52.05	11.41	4.35	46.95	10.66	4.72	43.86
CT	0.00	2.47	0.00	0.00	2.47	0.00	0.00	2.47	0.00
CS	0.13	3.18	2.86	0.03	3.24	0.51	0.01	3.24	0.31

Intercroping systems

Rubber/Timber – IC/RT/92/1&2

This study was initiated to investigate the feasibility of growing timber crops with rubber. In addition to the testing of timber species grown in between rubber rows (details are given in Annual Review 1992), the systems where timber species grown on the boundary and in vacant patches of rubber clearings (as a means of infilling) were assessed with a rapid appraisal. Alstonia showed a competitive effect on growth and yield of rubber, if both crops are established together. Establishment of Mahogany was successful under the shade of rubber, however it was not the case for Alstonia. In order to minimise the competition on rubber, it is suggested to plant timber crops allowing first 2-3 years for the establishment of rubber. The paired row system of planting rubber facilitated the establishment of timber crops even at a later stage, however this system must be improved in order to minimise the intra-specific competition of rubber. No clear competitive effect on rubber was found, if timber trees are grown either along the boundaries or in the vacant patches of mature rubber clearings (V H L Rodrigo, T U K Silva and E S Munasinghe).

Rubber/banana intercropping project

This project commenced aimed to assess the potential for intensified banana/rubber intercropping on smallholdings in Sri Lanka and funded by the Department for International Development (DFID), UK. The project was completed in year 2002 and the final technical report was submitted. The details of the project activities and outputs have been included in the final technical report. In brief, the study was located within two agro-climatic zones, the Wet and Intermediate zones, which encompass the widest possible range of socio-economic and climatic conditions under which rubber is grown in Sri Lanka. Rubber is a traditional crop of the Wet zone and has more recently been introduced to the Intermediate zone where livelihoods are largely rural based and chena cultivation still predominates.

On-farm trials confirmed the advantages of high density intercropping on growth of rubber and yield of banana. Growth and foliar nutrient content of rubber in the high density banana/rubber intercrop indicated that the benefits of intercropping on rubber could not simply be explained by improved access to soil nutrients when fertilizer was applied to the component banana intercrop. Instead, gas exchange studies implicated a role for the beneficial effects of shade in the intercrops, alleviating high radiation stress thereby allowing leaves to maintain a positive CO_2 fixation for a greater duration of the day. In addition to the benefits of intercropping on early growth of rubber, the study has also shown that intercropping results in long-term benefits in terms of earlier and higher latex yield returns.

Discounting analysis showed that whilst rubber and banana may not be as profitable as other crops such as tea and pepper, the majority of smallholders preferred to cultivate them because of the low cost of establishment. Smallholders showed a clear preference for rubber due to its relatively low demand in terms of labour inputs. In addition, banana is very popular with smallholders because it is a highly flexible crop that has no particular seasonal demands for activities such as weeding, harvesting *etc.*

Full-time farmers, particularly the land poor in the Intermediate zone where infrastructure is less well developed than in the Wet zone, were identified as having the greatest potential to benefit from high density rubber intercropping. The major constraint to uptake being access to effective extension information and advice.

Traditionally, the performance of smallholder rubber has been considered inferior to that of the estate sector and the attempt was to raise productivity by promoting monoculture-based plantation practices. The outputs of this project show this approach to be severely misguided and in the case of smallholders, rubber-based intercropping systems can be developed that are not only compatible with, but also improve the productivity of traditional systems. High density intercropping of rubber offers a win scenario; rubber can be successfully integrated with traditional cropping systems to provide many benefits to smallholders including earlier and greater latex yield, an additional income from the intercrop and better security of subsidy payments and property rights. Indirect benefits to soil fertility and stability could also accrue from the introduction of trees to traditional annual and perennial cropping systems (V H L Rodrigo, A M W K Senivirathna, P D Pathirana, P K W Karunathilake and E S Munasinghe in collaboration with University of Wales, UK and University of Sri Jayawardenapura).

Screening crops for rubber based intercropping (IC/2002/01)

Objective of this experiment is to screen crops for intercropping with rubber by assessing physiological parameters.

Pot plants were raised with nine species given in Table 24 and 8-11 plants from each species (depending on plant availability) were kept under four light regimes. Light regimes were open condition and 25%, 50% and 75% shade levels. Plants were fertilized as per the rubber fertilizer mixture for polybagged plants and were watered when ever necessary.

Table 24. *Plant establishment by end of year 2002 (as % success)*

Crop	Planting date	Open	25% shade	50% shade	75% shade
1. Coffee	28/12/02	80%	100%	100%	100%
2. Pepper	28/12/02	54.5%	90.9%	90.9%	90.9%
3. Cinnamon	28/12/02	70%	100%	90%	100%
4. Cocoa					
Var. W5/5	28/12/02	87.5%	100%	87.5%	100%
millawana	28/12/02	75%	75%	100%	100%
5. Tea	22/01/02	70%	80%	100%	100%
6. Mahogany	22/01/02	40%	80%	90%	70%
7. Alstonia	22/01/02	60%	100%	100%	100%
8. Passion fruit	01/02/02	50%	60%	100%	80%
9. Cardamom					
Var. C/37	12/02/02	0	90%	90%	50%
mysoor	12/02/02	0	63.5%	81.8%	81.8%

As shown in Table 24, the establishment of plants under full sunlight was poorer than that under different shade levels. In the case of cardamom, not a single plant could be established under open conditions. Mahogany showed poor performance under both zero and highest shade conditions. In contrast, establishment rate of tea was improved with increasing the shade levels (V H L Rodrigo W Seneviratne and W Karunatilaka).

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

The experiment was laid down in accordance with split-plot statistical design and comprised 4 spatial arrangements (paired row systems of planting) as main treatments and 4 intercrops as sub treatments (Table 25). Treatments were replicated in 3 experimental blocks.

Cinnamon, Rambutan and Durian were planted in 2001 during SW monsoons. Each plot for tea was subdivided into two, one to rehabilitate with Mana and the other for direct planting (planted in July/August 2001). Rubber in one experimental block was planted in 2000 (NE monsoon) and the rest in 2001 (SW monsoon).

Table 25. *Details of the treatments. Spacing within and between paired rows are given within and outside the brackets, respectively*

Main treatments	Sub treatments
T1. (3m × 3m) -15m	S1. Tea
T2. (3m × 3m) -18m	S2. Cinnamon
T3. (3.5m × 3.5m) -15m	S3. Rambutan
T4. (3.5m × 3.5m) -18m	S4. Durian

Girth of rubber measured at both 120 cm and 150 cm heights showed similar performance irrespective of either spatial arrangement of planting or type of intercrop grown (Table 26). Height of cinnamon plants and base diameter of both cinnamon and tea were measured. As was the case for rubber, growth development of tea and cinnamon was similar across the spatial arrangements of planting rubber (Table 27). Nevertheless, according to the survival rate of different intercrops (Table 28), both rambutan and cinnamon were easy to be established, whilst it was vice versa for durian.

Table 26. *Girth of rubber as at August 2002*

Treatment	Planted in May/June 2001		Planted in October/November 2000	
	Girth at 120 cm	150 cm	Girth at 120cm	150 cm
T1	8.8	8.4	13.7	13.1
T2	11.7	11.2	12.1	11.5
T3	8.8	8.5	15.1	14.5
T4	10.6	10.2	14.6	14.1

Table 27. *Growth performance of cinnamon and tea as at December 2002*

Treatments	Cinnamon		Tea
	Diameter (mm)	Height (cm)	Diameter (mm)
T1	11.2	97.1	12.1
T2	8.6	73.1	12.5
T3	10.3	84.5	10.8
T4	11.3	101.3	13.0

Table 28. *Establishment rates (%) of intercrops*

Treatments	Tea	Cinnamon	Durian	Rumbutan
T1	86.0	92.2	44.4	96.3
T2	83.6	93.8	73.6	97.0
T3	88.4	90.9	33.3	100.0
T4	87.7	94.8	33.3	100.0

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

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

This intercropping trial was established in October 1996 with three indigenous species of rattan (Annual Review 1996). The growth of rattan was good and it was difficult to measure the height of the plants due to its growth habit and inaccessibility due to the thorny fronds. The plants which could not cling on to the rubber plants started to fall and attempts were made to hang them on to branches of the rubber trees (L S S Pathiratna and M K P Perera).

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

The experiment was established at the RRISL sub station in Kuruwita and the experimental details are given in Annual Review 1998.

Rubber with a 7.2 m interrow space continued to have the lowest girth. Girth differences in other treatments were not significant at this stage (Table 29).

The bark yield per bush was highest in the treatment with the 13.2m spacing and was lowest in the 7.2m spacing in the single row planted rubber. Similarly high bark yields were obtained in the treatments with 16.8m, 18.0m in the paired row system and in the monocrop cinnamon plots (Table 30).

In the other experiment where cinnamon was established under mature rubber (1984 clg.) at the Kuruwita sub-station, the treatment with the cinnamon spacing 1.2 m × 0.91 m had a significantly higher bark yield than that of 0.9 m × 0.61 m treatment (Table 31). The effect of the level of fertilizer and the polythene barrier this stage was not significant (Table 32).

Table 29. *Effect of spacing on the growth (girth, cm) of rubber*

Treatment (inter row space, m)	Girth of rubber (cm)
Single row of rubber	
7.2	39.3 ^{AB}
8.4	41.3 ^{AB}
9.6	42.0 ^{AB}
10.8	42.2 ^{AB}
12.0	42.3 ^{AB}
13.2	43.2 ^{A}
Paired rows of rubber	
13.2	41.2 ^{AB}
14.4	39.7 ^{ABC}
15.6	39.7 ^{ABC}
16.8	39.2 ^{BC}
18.0	40.9 ^{ABC}

Table 30. *The effect of spacing on the performance of cinnamon*

Treatment (inter row space, m)	Bark yield (g/bush)	% yield of bark oil	
		Middle of inter row	Under canopy of rubber
Single row of rubber			
7.2	62.8 ^{E}	-	-
8.4	65.0 ^{DE}	0.81	1.02
9.6	70.5 ^{CDE}	-	-
10.8	78.8 ^{BCDE}	1.56	1.05
12.0	88.1 ^{ABCD}	-	-
13.2	107.7 ^{A}	1.66	0.92
Paired rows of rubber			
13.2	66.6 ^{CDE}	1.49	1.13
14.4	81.2 ^{BCDE}	-	-
15.6	77.4 ^{BCDE}	1.36	2.09
16.8	90.6 ^{ABC}	-	-
18.0	101.6 ^{ABC}	1.46	0.97
Cinn. Only control	101.7 ^{AB}	1.45	

Table 31. *Effect of spacing on the yield of* Cinnamon *under mature rubber*

Treatment (Cinnamon spacing)	Cinnamon bark yield
.91 m × .61 m	52.4^{A}
1.2 m × .91m	36.2^{B}
1.7 m × 1.2 m	48.8^{AB}
1.1 m triangular spacing	44.4^{AB}

Table 32. *Effect of the level of fertilizer on the bark yield of* Cinnamon under mature rubber

Fertilizer level	Cinnamon bark yield (g/bush)
1 + polythene barrier	47.0^{A}
2	45.5^{A}
3	46.0^{A}
4	43.3^{A}

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

Intercropping medicinal plants under Rubber -IC/RM/2001 – Kuruwita, Millewa

A project was initiated in February 2001 to study the possibilities of intercropping five species of medicinal plants *viz. Indigofera tinctoria* (Nilavariya), *Solanum virginianum* (Katuwelbatu), *Aerva lanata* (Polpala), *Plumbago indica* (Ratnitul) and *Piper longum* (Thippili) as intercrops under rubber.

Experiments were started in two smallholdings in the Kalutara and Ratnapura districts and a large scale experiment in the RRISL sub-station at Kuruwita. The two smallholder plots were established in May/June 2001 and the main experiment at the RRISL sub-station in September/October 2001.This work was completed in August and the terminal report was submitted in September. (Contract Research Project MP/RP/6, Sri Lanka Conservation and Sustainable Use of Medicinal Plant Project (L S S Pathiratna and M K P Perera).

Testing of economically important Medicinal Plant species as intercrops with rubber (Hevea) under smallholder conditions

Twenty four rubber smallholders from three districts, Kalutara, Ratnapura and Moneragala were selected and they were provided with fertilizer, tools and planting material of five species viz: *Indigofera tinctoria* (Nilavariya), *Solanum virginianum* (Katuwelbatu), *Aerva lanata* (Polpala), *Plumbago indica* (Ratnitul) and *Piper longum* (Thippili). On farm training and instruction sessions were held.

Kalutara and Ratnapura sites were completed in May/June and planting in the Moneragala sites were delayed till September due to the lack of rain.

Harvesting of Nilavariya and Katuwelbatu in most of the sites in the Kalutara were done on time and buyers were contacted for the marketing of the produce. (Contract Research Project MP/RP/18, Sri Lanka Conservation and Sustainable Use of Medicinal Plant Project (L S S Pathiratna and M K P Perera).

PLANT PATHOLOGY AND MICROBIOLOGY

C K Jayasinghe

SUMMARY

Secondary leaf fall incidence was extremely low and no *Phytophthora* leaf and bark rot infections were reported. *Corynespora* leaf fall incidence on RRISL 202 was evident throughout the year at Moralioya and Kuruwita estates. Vitamin H (Biotin) was found to be effective in inducing spore production of *Corynespora cassiicola* and *Botryodiplodia theobromae.* Silver melon was proved to be an alternative host for the pathogen *C. cassiicola.* Enzymes responsible for the pathogenesis of *Phytophthora meadii* were characterised and found that lower moleculaar weight polygalacturonase enzyme is responsible for the pathogenesis of the highly virulent *P. meadii* isolates.

DETAILED REVIEW

Staff

The Department functioned under the overall supervision of Dr C K Jayasinghe. Dr K E Jayasuriya, and Dr Miss W P K Silva, Plant Pathologists and Mr W Amaratunge, Audio Visual Production Officer were on duty throughout the year. Dr R Jayaratne resigned from the post of Principal Research Officer in Plant Pathology with effect from 21.10.2002. Mr K E Jayasuriya successfully completed his post-graduate studies leading to Doctor of Philosophy degree. He was awarded the doctorate with effect from 1st June 2002 from the University of Colombo.

Mr E B Fernando, Mrs T H P S Fernando, Mrs B I Tennakoon and Mrs D Wijeratne Experimental Officers; Mr C Wijeratne, Mr S R D P Peiris, Mrs N Dharmadasa and Mr E A D N Nishantha, Technical Officers continued to work in the Department. Clerk Typist, Mrs P Amarasekera was on duty throughout the year.

Research Students

- Mr W S C Hemantha of the University of Ruhuna carried out his final year specialization project entitled "Induction of the sporulation of *Botryodiplodia theobromae*" under the supervision of Dr C K Jayasinghe.

Seminars/Conferences/Meetings/Workshops attended

Officer	Subject	Organization
C K Jayasinghe	Steering Committee on National Plant Quarantine	Council for Agricultural Research Policy
C K Jayasinghe	Pesticide Technical Advisory Committee	Department of Agriculture
C K Jayasinghe	Specialist Committee on Plant Protection	Council for Agricultural Research Policy
C K Jayasinghe	Ad Hoc Committee on Implementing Plant Quarantine Regulations	Ministry of Agriculture
C K Jayasinghe	Safety in Microbiological Laboratories, a Need in the New Millennium	Institute of Chemistry Ceylon (22nd Feb.)
C K Jayasinghe	National Committee on Coconut Mite Control	Ministry of Plantation Industries
R Jayaratne	Executive Committee Meetings	Institute of Biology

Seminars/Training programmes conducted

Dr C K Jayasinghe, Dr R Jayaratne, Dr K E Jayasuriya and Dr (Miss) W P K Silva served as resource personnel in following training programs.

Client	No. of programmes
Estate Managers	1
Trainee Asst. Managers	2
Asst. Managers	3
Field Officers	2

Mr E B Fernando, Mrs T H P S Fernando, Mrs I Tennakoon and Mrs D Wijeratne 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. Dr R Jayaratne continued to be a Visiting Lecturer at the University of Colombo.

Dr C K Jayasinghe participated as a resource person in following training programmes and workshops.

- Training programme for the National Plant Quarantine Officers on "South American Leaf Blight and other Quarantine Pests of Rubber Plantations". This workshop was held on 24th January as a requirement of the ANRPC agreement on SALB.

- Regional Training programme on the "Application of Sanitary and Phytosanitary Measures" held at National Plant Quarantine Station, Sri Lanka from 25th February to 22nd March.

- Priority Setting Workshop of the Coconut Research Institute held on 21st February.

- 52nd Meeting of the Research Committee held on 26th July to review the progress of Crop protection research at Coconut Research Institute.

Advisory visits

Department staff made 18 advisory visits during the year.

GENERAL

Dry weather that prevailed at the beginning of the year resulted in early and fairly even wintering. Consequently, incidence of secondary leaf fall was extremely low in all rubber growing districts during the refoliation period. The incidence of *Phytophthora* leaf fall and bark rot was extremely low. No new *Corynespora* infections were reported on clones recommended under group I. However, severe defoliation was noticed on RRISL 202, a group II clone towards the latter part of the year at Kuruwita sub-station and Moralioya estate.

Preparation of a safety guide entitled "Safety Hand Book: Precautions Against Chemical Hazards & Biological Threats" was undertaken. This publication will provide information on hazards and precautions to be taken for the safe handling of chemical and biological material during both laboratory and field operations. It will provide step-by-step advice to protect the researcher and the environment. "රබර් රෝග පිළිබඳ සියවසක කතාව", is a swabasha publication which presents the history of rubber diseases together with disease symptoms, prevention and control of all economically important maladies of *Hevea*. This hand book will serve as a disease diagnosis and management guide for small holders, extension staff and field officers.

All research projects of the department were evaluated for the purpose of setting priorities by a team consisting of outside scientists and stake holders. This project was funded by ISNAR and all senior research officers of the department were actively engaged in this programme. Only the projects which were categorised under the priority groups high and moderate are being conducted presently.

LABORATORY AND FIELD INVESTIGATIONS

Chemical Control of *Hevea* Diseases (CC/89/1)

***Screening of fungicides against* Rigidoporus microporus (in vivo)**

House hold disinfectants such as Detol, Phynol and Harpic Fresh were

screened with the view of recommending a common economical chemical in managing white root disease. Even 10% solutions of these chemicals were found to be ineffective *in vitro* (R Jayaratne, C K Jayasinghe and D Siriwardene).

***Screening of fungicides against* Corynespora cassiicola**

Spraying programmes were continued at four locations namely; Dartonfield, Lagos, Salawa and Kuruwita estates. Three rounds of fungicides were sprayed during refoliation period and another two rounds of fungicide application were done at the latter part of the year. Experiment will be continued for several years (C K Jayasinghe, R Jayaratne and C Wijeratne).

Water soluble sulphur for the management of* Oidium *leaf fall

An experiment was initiated at Kuruwita substation in February to test the efficacy of soluble sulphur in preventing *Oidium* leaf fall (OLF). Unfortunately experiment has to be discontinued as OLF did not reach the epidemic proportions during the year under review (C K Jayasinghe and C Wijeratne).

Biology of Common Pathogens

***Induction of sporulation in* Corynespora cassiicola**

Poor sporulation of *C. cassiicola* on artificial media is a major constrain to the most of the laboratory studies including clonal screening programmes. After testing various chemicals it was shown that biotin induces the spore production of *Corynespora* cultures when incorporated to potato dextrose agar (W P K Silva, C K Jayasinghe and N Nishantha).

***Alternate hosts for* Corynespora cassiicola.**

Several new isolates of *C. cassiicola* from hosts other than rubber have been collected from different rubber growing districts and Koch's postulates were proved with the silver melon isolate.

Experiments are in progress to investigate the cross infection potential of these isolates (W P K Silva, C K Jayasinghe and N Nishantha).

Pathogenesis of* C. cassiicola *from different hosts

It was found that all the isolates collected from alternate hosts namely okra, brinjal and silver melon were pathogenic on all the susceptible rubber clones tested (W P K Silva and N Nishantha).

***Induction of sporulation in* Botryodiplodia theobromae**

It was observed that some isolates of *B. theobromae*, a fungus responsible for die-back of nursery plants, stem nodules, blue stain of rubber wood and discolouration of crepe rubber do not sporulate profusely. With this background a

series of experiments was designed to induce the sporulation of isolates with poor sporulating ability. The vitamin, biotin at concentrations around 0.002% enhanced the production of pycnidia (C K Jayasinghe, W S C Hemantha and N Dharmadasa).

Studies on cell wall degrading enzymes produced by* Phytophthora meadii *isolates

Degree of virulence of some *P. meadii* isolates were compared with the production of cell wall degrading enzymes by them in liquid medium. All *P. meadii* isolates tested produced one form of Polygalacturonase (48-85 kDa) except MAD86 (IMI 385259) which produced two forms (48 or 750 kDa). However, all forms are more or less similar in both media in which either pectin or rubber cell walls were used as the sole carbon source, except in MAD 86 where a smaller form (25 kDa) was produced in the medium having cell wall (Table 1).

Table 1. *Polygalacturanase enzymes produced by Phytophthora meadii isolates in liquid meadia containing either pectin or rubber cell walls*

P. meadii isolates	Degree of virulence*	Molecular weight (kDa) in liquid meadia with **	
		Citrus pectin	Cell walls
MAD 86 (IMI 385259)	55.6 ± 3.5	48 ± 0.5	21 ± 0.8
		70 ± 0.2	66 ± 0.2
PEE 102b	50.6 ± 1.5	48 ± 0.8	45 ± 0.2
ARA 121	48.3 ± 3.1	>85 ± 1.7	74 ± 0.8
GL 130	45.6 ± 3.2	70 ± 0.8	66 ± 0.6
PEE 100	42.9 ± 2.6	62 ± 0.8	62 ± 0
DF 600 (IMI 385260)	9.9 ± 1.3	66 ± 0.6	66 ± 0.5
ELS 105b	0	62 ± 0	62 ± 0.5

Results are mean of 10 replicates* or 4 replicates** ±SEM

No pectin lyase activity was detected in liquid medium of any of the *P. meadii* isolates examined. However it was shown that, the highly virulent isolate (MAD 86) produced two forms of PG or low molecular weight form (PEE 102b produce 48 kDa form) and thus the smaller form can contribute to the high virulence (K E Jayasuriya, R L C Wijesundera and B I Tennakoon).

***Biology and pathogenicity of* Colletotrichum acutatum *and* Colletotrichum gloeosporioides**

Investigations to find the effect of temperature, humidity and UV radiation on spore germination and viability have been completed (C K Jayasinghe, T H P S Fernando and N Dharmadasa).

Authentification of* Colletotrichum acutatum *and* Colletotrichum gloeosporioides *using molecular technology

DNA has been extracted from 40 isolates collected from different rubber growing districts. RAPD-PCR technique will be employed to distinguish different species responsible for *Colletotrichum* leaf disease (W P K Silva, C K Jayasinghe, T H P S Fernando, E H Karunanayake - collaborative project with University of Colombo).

Screening of *Hevea* Clones for Leaf and Panel Diseases (SC/89/1)

Maintenance of recommended and potential clones in different agroclimatic zones

Weeding, fertilizer application and numbering were done in nurseries established at Atale, Polatagama, Padukka, Pitiyakanda, Nakiyadeniya, Bibile, Hapugastenna and Dartonfield estates (C K Jayasinghe, W P K Silva and C Wijeratne).

Nursery of the recommended clones: Kuruwita sub-station

The nursery established with recommend clones in all three groups at Kuruwita sub-station was visited four times and dead plants were replaced with polybag plants. This plot was established in the vicinity of RRIC 110 and RRIC 202 clearings specially to screen the clones against *Corynespora* leaf fall disease (C K Jayasinghe and T H P S Fernando).

Corynespora leaf fall on RRISL 202

Severe leaf fall was observed in the clone RRISL 202 at Kuruwita sub-station and at Moralioya estate during the 3rd quarter of the year (C K Jayasinghe, W P K Silva, E B Fernando, T H P S Fernando and N Nishantha).

Budwood nursery level infections were noticed in RRIM 600, RRISL 205, Tjir 1, RRISL 222 and PB 28/59 at Kuruwita sub-station. With regard to the trials at other locations lesions were noticed on following clones at several sites. The clones were RRISL 217, PB 217, BPM 24, RRIC 117, RRISL 202, RRIM 600, RRIM 717, PR 261, RRISL 201, GPS 1, RRISL 219, PB 260, PB 28/59, PB 255 and RRIC 102 (C K Jayasinghe, W P K Silva, T H P S Fernando, C Wijeratne and N Nishantha).

Oidium leaf fall

Surveys were conducted for the 3rd consecutive year to detect the field susceptibility of recommended clones to secondary leaf fall specially to *Oidium heveae*. The climatic conditions were extremely unfavourable for the pathogen to multiply and spread during the refoliation period. Under these climatic conditions only two clones namely RRISL 204 and RRIM 712 were susceptible to the disease severely (Table 2) (C K Jayasinghe and E B Fernando).

Table 2. *Field Screening of recommended clones against secondary leaf fall in year 2002. (An year where the climatic conditions were unfavourable for pathogens to multiply and spread).*

Clone	Disease severity	
	Level of infection on leaves*	**Condition of the canopy***
RRIC 100	No infection	No defoliation
RRIC 102	Mild infection	No defoliation
RRIC 121	Mild infection of *Oidium* & *Colletotrichum*	0 - 25% defoliation
RRIC 130	Mild infection of *Oidium*	No defoliation
PB 217	Mild infection of *Oidium* & *Colletotrichum*	0 - 25% defoliation
PB 28/59	Mild to Moderate infection of *Oidium* & *Colletotrichum*	0 - 25% defoliation
RRIC 117	Mild infection of *Oidium* & *Colletotrichum*	0 - 25% defoliation
RRIC 131	No infection	No defoliation
RRIC 133	No infection	No defoliation
RRISL 201	Mild infection *Oidium* & *Colletotrichum*	No defoliation
RRISL 202	Moderate infction *Oidium* & *Colletotrichum*	25- 50% defoliation
RRISL 203	Mild *Oidium* infection	0- 25% defoliation
RRISL 205	Mild infection of *Oidium*	0-25 % defoliation
RRISL 206	Mild to Moderate infection of *Oidium* & *Colletotrichum*	25-50% defoliation
RRISL 210	NA	
RRISL 211	NA	
RRISL 215	Mild infection of *Oidium* & *Colletotrichum*	0-25% defoliation
RRISL 217	Moderate infection of *Oidium* & *Colletotrichum*	25 - 50 % defoliation
PB 235	Severe infection of *Oidium*	25 - 50 % defoliation
PB 260	Mild infection of *Oidium*	25 - 50% defoliation
BPM 24	Moderate infection of *Oidium*	25 - 50% defoliation
RRISL 200	NA	
RRISL 204	Severe infection of *Oidium* & *Colletotrichum*	50 - 75% defoliation
RRISL 208		
RRISL 218	Mild infection of *Oidium*	25 - 50% defoliation
RRISL 220	NA	
RRISL 221	NA	
RRISL 222	No infection	No defoliation
RRISL 225	NA	
RRISL 226	NA	
RRISL 227	NA	
GPS 1	NA	
RRIM 712	Moderate to severe infection of *Oidium*	50 - 75% defoliation
PB 255	No infection	No defoliation
PR 255	Moderate infection of *Oidium*	25 - 50% defoliation
PR 305	NA	
RRII 105	No infection	No defoliation
RRISL 2000	Not in tapping but mild infection of *Oidium*	0 - 15 % defoliation
RRISL 2001	Mild infection of *Oidium*	0 - 25 % defoliation
RRISL 2002	NA	
RRISL 2003	NA	
RRISL 2004	NA	
RRISL 2005	NA	
RRISL 2006	NA	
PR 261	Moderate infection of *Oidium*	25 - 50% defoliation
RRIM 600	Mild infection of *Oidium*	0 - 25% defoliation

NA, data not available

Screening of clones at N'kele budwood nurseries

Forty seven clones were screened at N'kele budwood nurseries against CLFD and *Corynespora* disease symptoms were noticed on 12 clones. However, except RRISL 217 all the other clones had only mild infections. The results were informed to the Genetics and Plant Breeding Department (C K Jayainghe, W P K Silva and N Nishantha).

Screening of the progeny of the hand pollination programme 2000

One thousand six hundred and thirteen seedlings were screened against CLFD as a response to a request made by Genetics & Plant Breeding Department (C K Jayasinghe, W P K Silva and N Nishantha).

Biological Control of *Hevea* Disease (BC/89/1)

Biological control of white root disease

Ten autoclaved basal media were prepared using different proportions of clay or red soils, cowdung, sawdust and rice bran. The viability of *Trichoderma* sp. (Tr3 isolate) was tested in the above media for 4 consecutive months and found that T1, T5 and T10 media were potentially suitable for long term storage of Tr3. However proliferating tests has shown that T10 was more suitable, as Tr3 abundantly proliferated in it. Therefore studies are in progress using T10 basal medium (K E Jayasuriya and B I Tennakoon).

Biological control of rubber nursery diseases

The highly antagonistic *Trichoderma* sp. isolated from leaf phylloplane (Tr21) was tested for growth in liquid media. It was noted that the fungus did not grow properly in tested media except in 3% mollases. Therefore it was maintained on half strength PDA. Initial trial on spraying spore suspension of Tr21 (in 3% sterilised mollases) against *Colletotrichum* inoculant on detached rubber leaves were carried out in the lab. In addition, trials on glass slides to test the inhibition of spore germination of *C. gloeosporioides* was also carried out and the experiments are in progress (K E Jayasuriya and C Wijeratne).

MISCELLANEOUS

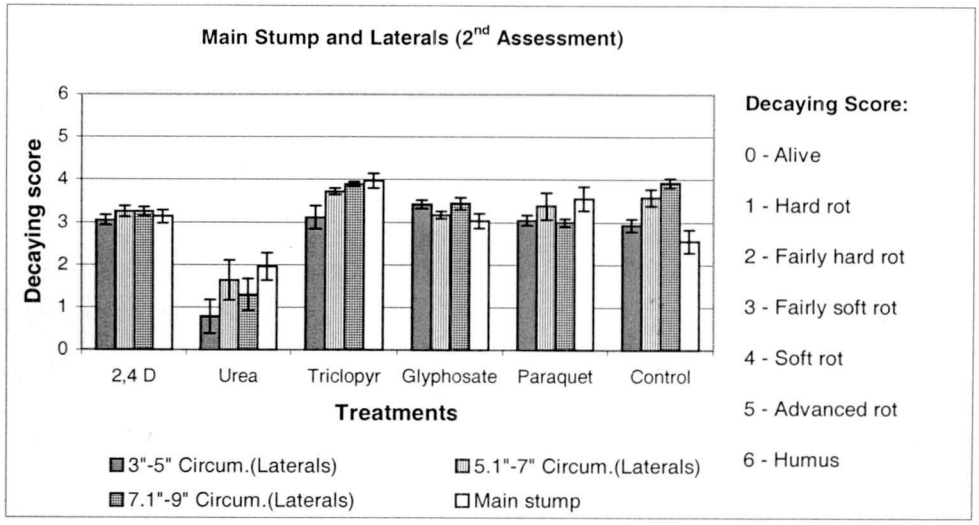
Knots on RRIC 133

Knots, rounded swellings developed from the cortex of the untapped bark were noticed on the trunks of the clone RRIC 133 at Kuruwita substation. Most of these Knots burst resulting in latex exudation and streaks of coagulated latex can be seen along the trunks of the affected trees. Eventhough the fungus *Botryodoplodia theobromae* was isolated from these wounds it seems that this abnormality is a malady of non-parasitic origin characteristic to clone RRIC 133. However, cork

layers are produced underneath the cracks of the protrusion and healing of the bark takes place without causing a serious damage (C K Jayasinghe, E B Fernando, T H P S Fernando and N Dharmadasa).

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

The final assessments (24 months after introducing the treatments) on the decaying of the poisoned stumps were obtained and the results were summarised. According to the Fig. 1, a fairly high decaying score has been recorded for the main stump, when 2,4D, Glyphosate, and paraquat were used as 10% solutions while Triclopyr demonstrated same effect even as a 5% solution. With regard to the decay of laterals it has been noted that the treatment of stumps with Triclopyr, glyphosate, or paraquet has resulted a fairly high decay rate. Therefore in general, those three chemicals could be further tested in further trials. According to the technical data available, Triclopyr will not be available in the list of approved chemicals, and therefore it has to be withdrawn from future trials (R Jayaratne, C K Jayasinghe and E B Fernando).



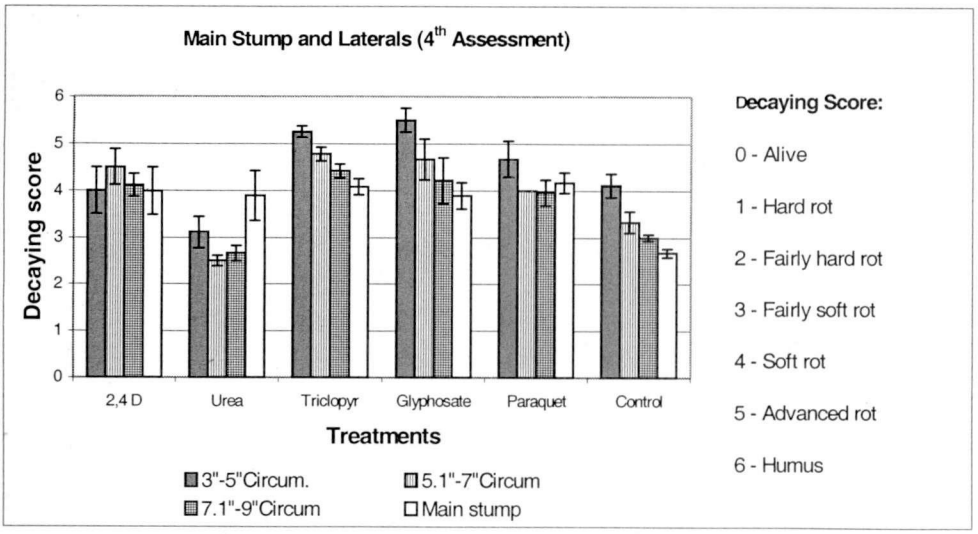


Fig. 1. Visual assessment on decaying rates of roots 12 (2nd assessment) and 24 (4th assessment) months after introducing the treatment

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. An integrated fertilizer programme was formulated combining reduced quantity of chemical fertilizer and rice straw for both virgin and renewed panels. Data reveals that use of semi mature stem cuttings would give the highest establishment success and a successful method of planting for *Mucuna* in the field can be recommended.

It seems to suggest that mulching is a successful agronomic practice that improves growth of young rubber plants in comparatively drier areas and data shows 13cm girth increment during the 3rd year of planting. Data on C sequestration indicate that the total biomass produced by a rubber tree and by a hectare of rubber at the age of 33 years is 1.8MT and 903MT, respectively. The amount of carbon sequestered in one hectare of a 33-year-old rubber stand of trees is 596MT. The total amount of carbon sequestered in a hectare of rubber as biomass, latex produced and cover crop is computed to be 680MT. Accordingly, the carbon credit revenue per hectare at the end of 33 years is approximately Rs.1,021,500/ha and this revenue could play a key role in ensuring that rubber continues to be replanted.

The site-specific fertilizer recommendation programme for mature rubber provided fertilizer recommendations for 3700 hectares in the estate sector. The Department analyzed approximately 3000 samples for outside organizations during the year.

DETAILED REVIEW

Staff

The Head of the Department, Dr (Mrs) Lalani Samarappuli, Experimental Officers, Messrs H D S P Perera, R Hettiarachchi, C Maheepala, S N Silva, P Karunadasa, U Mitrasena, A N Yakandawela and T B Dissanayake and Technical Officers, Messrs V Edirimanne, A Thevarapperuma, P R Puhambugoda, J A S Chandrasiri and T Gunatilleke and the English Stenographer Mrs L Rupasinghe were on duty throughout the year.

Soils Chemist, Mr R S Dharmakeerthi and Assistant Soils Chemist, Mr D N P Wickramasinghe continued their postgraduate studies in Canada and USA, respectively.

Research students

- Miss S R Sanjeewa Udeshi, an undergraduate student from the University of Ruhuna, completed her final year project on "Contribution of different soil management practices in rubber plantations as a measure to combat the adverse effects of climatic conditions" under the supervision of Dr Lalani Samarappuli.

Seminars/Conferences/Meetings/Work-shops addressed

Officer	Subject	Organization
Lalani Samarappuli	Method of fertilizer application to rubber	Scientific Committee Meeting, RRISL
Lalani Samarappuli	*Mucuna*: The ideal cover crop for rubber	Scientific Committee Meeting, RRISL

Seminars/Conferences/Meetings/Work-shops attended

Officer	Subject	Organization
Lalani Samarappuli	Technical Committee Meeting of the Tender Board	Rubber Development Department
Lalani Samarappuli	Working Group on Organic Fertilizers	Sri Lanka Standards Institution
Lalani Samarappuli	Scientific Committee Meeting	Rubber Research Institute
Lalani Samarappuli	Project Priority Setting	ISNAR/ Rubber Research Institute
Lalani Samarappuli	Sri Lankan Agriculture for the Next Decade: Challenges and Opportunities	Agrarian Research and Training Institute

Training programmes

Client	No of programmes
Plantation Executives	02
Estate Managers	10
Field Officers	04
Estate Workers	02
Rubber Development Officers	02
Smallholders	01
University Students	04
NDT Students	03

Advisory visits

Client	No of visits
Plantations	11
Smallholdings	03

LABORATORY AND FIELD INVESTIGATIONS

Soil fertility management

Mulching

In experiment SMC-Ag/M/88/1, mulching was continued during mature phase. 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) (Lalani Samarappuli, P Karunadasa and U Mitrasena).

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 kieserite (g/tree/yr)
Virgin	05	125	50
Renewed	05	75	25

Ground cover management

New cover crop species

The experiment on *Mucuna bracteata* in comparison with *Pueraria*, was continued. The effect of growing *Mucuna* on soil organic carbon, CEC, bulk density and porosity is given in Tables 2 and 3 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 2. *Effect of growing Mucuna on soil organic carbon and CEC*

Species	Organic C (%)	CEC (meq/100g)
Pueraria	1.2	3.4
Mucuna	2.8	5.3

Table 3. *Effect of growing Mucuna on bulk density and porosity*

Species	Bulk density (g/cm3)	Porosity (%)
Pueraria	1.2	3.4
Mucuna	2.8	5.3

Another experiment was initiated at Main division, Payagala estate to study the establishment success of *Mucuna bracteata* stem cuttings. The treatments consisted of 3 different stages of stem cuttings; seeds (P1), stem cuttings (P2) and rooted cuttings (P3). The effect of different treatments on establishment success is given in Table 4 (Lalani Samarappuli, P Karunadasa, U Mitrasena, V Edirimanne, T Gunatilleke and S Chandrasiri).

Table 4. *The effect of different growth stages of stem cuttings on establishment success*

Growth stage	Establishment success (%)
Soft	34
Medium	72
Hard	65

At Sapumalkanda estate, Deraniyagala an experiment (SMC-GC/C/97/1)) was initiated in a 1997 replanting to study the influence of *Wedelia biflora* (Arunadevi), on growth, nutrient enrichment and other desirable characteristics in comparison with *Pueraria*. Effect of this cover crop on girth and annual girth increment of rubber plants is presented in Table 5 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 5. *Effect of* Wedelia biflora *(Arunadevi) on girth of rubber plants*

Treatment	Girth (cm)	Girth increment (cm)
Pueraria phaseoloides + P	37.9^{A}	9.1
Wedelia biflora + P	36.3^{A}	8.9
Wedelia biflora + NPKMg (level 1)	39.9^{A}	11.0
Wedelia biflora + NPKMg (level 2)	38.9^{A}	8.5

(Means with same letter are not significantly different)

Field experiment (SMC-GC/C/02/1), commenced to study and identify leguminous cover crop species with multiple advantages and would satisfy a dual function of being a cover crop and a cash crop at the same time was not successful due to non-availability of seed materials (Lalani Samarappuli and T Dissanayake).

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 were continued. The study consisted of three P treatments: no P, ERP and IRP and two cover types: *Mucuna bracteata and Flemingia macrophylla.* Effect of these treatments on girth of rubber plants at the end of five and a half years from planting is presented in Table 6. The data seems to suggest that ERP can be used as the source of P for *Mucuna* and *Flemingia* without any adverse effect on girth of rubber plants (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 6. *Effect of different sources of phosphate* for Mucuna and Flemingia *on the growth of rubber plants*

Treatment	Girth (cm)	
	Mucuna	***Flemingia***
No P	46.4^{A}	46.1^{A}
ERP	43.7^{A}	46.4^{A}
IRP	46.1^{A}	46.3^{A}

(Means with same letter are not significantly different)

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 continued. The treatments consisted of 3 planting practices; *Crotolaria micans* only, *Flemingia macrophylla* only and *Crotolaria + Flemingia.* Effect of these treatments on girth of rubber plants is presented in Table 7 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 7. *Effect of different planting systems on girth of rubber plants*

Treatment	Girth (cm)
Crotolaria micans	33.1
Flemingia macrophylla	33.0
Flemingia + Crotolaria	33.0

Soil conservation and development of degraded lands

The survey started to categorize the rubber lands into 3 slope classes and to estimate their relative extents in rubber growing districts was extended to Galle and Matara (Lalani Samarappuli and T Gunatilleke).

Weeds and weed control

A field experiment was planned to study the performance of Paraquat and different types of Glyphosates on weed control during the immature stage of rubber. Control of weeds as a percentage and duration of weed control by the second application of Paraquat and different types of Glyphosates are presented in Tables 8 and 9, respectively (Lalani Samarappuli, T Gunatilleke and A Thevarapperuma)

Table 8. *Control of weeds as a percentage*

Weedicide	Weed control (%)	
	2nd week	4th week
Surpass	85	100
Touchdown	78	95
Ammo super	79	96
Gramoxone	75	96
Weedol	73	90

Table 9. *Duration of weed control*

Weedicides	Duration (days)
Surpass	100
Touchdown	90
Ammo super	90
Gramoxone	73
Weedol	80

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

Field experiments (SMC-Ag/F/88/3) at Nalanda estate, Ulpotha, (SMC-Ag/F/98/1) and (SMC-GC/C/99/1) at Bibile estate, Bibile, (SMC-Ag/F/99/1) and (SMC-Ag/M/99/1) at Nottinghill estate, Kahapathwela and (SMC-GC/TL/98/1) at Kumarawatta estate, Monaragala are in progress to study the soil moisture stress management with different soil management and fertilizer practices (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Mulching

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 (M4)

and green manure (M5). Girth at three and a half years after planting is given in Table 10 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 10. *Effect of different mulching materials on girth of rubber plants*

Treatment	Girth (cm)	Girth increment (cm)
No mulch	30.4^{A}	10.2
Paddy straw	33.6^{B}	13.2
Coir dust	31.4^{B}	11.1
Paddy husk	32.6^{B}	11.4
Green manure	32.7^{B}	11.3

(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. Although this experiment was continued girth measurements were not done due to non-availability of transport facilities (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Fertilizer practices for overcoming moisture stress

A field experiment (SMC-Ag/F/88/3) is 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. Although this experiment was continued girth measurements and test tapping were not done due to non-availability of transport facilities (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Three field experiments SMC-Ag/F/95/1, SMC-Ag/F/99/1 and SMC-Ag/F/98/1 are in progress at Clyde estate, Kalutara, 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 three different agro-climatic conditions; comparatively wet, intermediate and dry. Treatments consisted of two mulching techniques; no mulch (M0) and surface mulching (M1) and four potassium levels; half the recommended level (K1), recommended level (K2), one and half the recommended level (K3) and double the recommended level (K4). Girth measurements recorded in the different regions, wet, intermediate and dry are given in Tables 11, 12 and 13, respectively (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 11. *Effect of potassium and mulching on girth (cm) of rubber plants (1995 replanting) (wet region)*

Mulching	Level of K			
	K_1	K_2	K_3	K_4
M_0	54.1^A	57.7^A	57.1^A	56.2^A
M_1	57.4^A	58.5^A	58.6^A	56.7^A

(Means with same letter are not significantly different)

Table 12. *Effect of potassium and mulching on girth (cm) of rubber plants (1999 replanting) (intermediate region)*

Mulching	Level of K			
	K_1	K_2	K_3	K_4
M_0	32.2^A	32.9^A	31.5^A	28.7^A
M_1	31.1^A	32.6^A	33.3^B	31.2^B

(Means with same letter are not significantly different)

Table 13. *Effect of potassium and mulching on girth (cm) of rubber plants (1998 replanting) (dry region)*

Mulching	Level of K			
	K_1	K_2	K_3	K_4
M_0	23.6^A	23.9^A	31.4^A	32.3^A
M_1	27.4^B	27.8^B	34.0^B	35.8^A

(Means with same letter are not significantly different)

Rubber based cropping systems to increase water use efficiency of rubber plants

An experiment is in progress at the RRI Sub Station in Kuruwita (SMC-Ag/I/93/1) to study the water use efficiency of rubber plants when multicropped with tea (Lalani Samarappuli, S M Iqbal, P Karunadasa and U Mitrasena).

Soil moisture requirement of rubber under different densities

An experiment (SMC-Ag/D/97/1) was started at Dorset division, Clyde estate to study the soil moisture requirement of rubber under different densities. Treatments consisted of 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]. Effect of different densities on girth of rubber plants at the end of five and a half years from planting and girth increment during the year is presented in Table 14 (Lalani Samarappuli, P Karunadasa and U Mitrasena in collaboration with the Plant Science Department).

Table 14. *Effect of different plant densities on girth of rubber plants*

Planting densities	Girth (cm)	Girth Increment (cm)
500 trees/ha [4.5m × 4.5m]	48.9^{A}	6.8
600 trees/ha [4.2m × 4.2m]	47.6^{A}	6.9
700 trees/ha [3.8m × 3.8m]	45.2^{B}	6.5
800 trees/ha [3.5m × 3.5m]	44.2^{B}	5.8

(Means with same letter are not significantly different)

Silt pitting for soil moisture conservation

Although a field experiment was planned to study the effect of silt pits on the moisture conservation at Bibile estate, Bibile the experiment was not started due to non-availability of transport facilities (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Rubber as a system to mitigate climate change

Adaptability of rubber trees in capturing rainfall

This study is in progress at different localities of rubber growing areas. Fields of different ages were selected to represent different canopy levels and special devices are fixed to rubber trees to measure throughfall, stem flow *etc.* This project is funded by the Ministry of Environment and Natural Resources (Lalani Samarappuli, Wasana Wijesuriya, R Puhambugoda, A Thevarapperuma and T Gunatillake).

Carbon sequestration in rubber plantations

A study was initiated to estimate the carbon sequestration in rubber plantations under Sri Lankan conditions to highlight it's potential in relation to carbon trading for purposes of sustaining rubber cultivation in the country. Data on biomass accumulation and carbon sequestration in rubber for its economic life span of 33 years is presented in Table 15.

Table 15. *Biomass accumulation and carbon sequestration in rubber during its economic life span of 33 years*

Item	Biomass (MT/ha)	C sequestration (MT/ha)
Rubber tree	903	596
Latex	67	59
Cover crop	50	26
Total	1020	681

Fertilizer use and plant nutrition

Fertilizers to nursery plants

This project was continued (R S Dharmakeerthi, Lalani Samarappuli and S N Silva).

Fertilizers to immature rubber

Different fertilizer sources

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

An experiment, is in progress at Pembroke division, Payagala estate in a 2001 replanting to study the feasibility of using dolomite during the first year of planting. Girth measurements were done once in three months and a leaf nutrient analysis was also done twelve months after planting. Effect of different treatments on girth of rubber plants and leaf Mg content at the end of 15 months after planting are presented in Table 16. Although the data seems to suggest that dolomite can be used as the source of Mg during the first year of planting, a new experiment was initiated on the same subject at Nottinghill estate, Kahapathwala to confirm the results (Lalani Samarappuli, T Gunatilleke, U Mitrasena and P Karunadasa).

SUL-PO-MAG based fertilizer mixtures

Experiment (F/SPMg/94/1), started at Culloden estate, Neboda to study the effectiveness of SUL-PO-MAG based mixtures in comparison with the conventional mixtures 12:14:14 and 7:9:9:3 on immature rubber was continued. SUL-PO-MAG based treatment was formulated by adding urea, rock phosphate and muriate of potash to SUL-PO-MAG to meet the nutrient ratios of N,P,K and Mg recommended for rubber in conventional mixtures. Investigating on the effect of treatments on yield was continued and results are presented in Table 17 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 16. *Effect of different treatments on girth and leaf Mg content of rubber plants*

Fertilizer treatments	Girth (cm)	Leaf Mg (%)
75g kieserite in 2 applications (Control)	10.5^{A}	0.18^{A}
25g kieserite + 75g dolomite	09.8^{A}	0.17^{A}
50g dolomite + 75g dolomite	10.3^{A}	0.17^{A}
75g dolomite only (planting hole)	10.4^{A}	0.17^{A}
75g dolomite (planting hole) + 25g kieserite	10.1^{A}	0.16^{A}
100g dolomite (planting hole) + 25g kieserite	09.4^{A}	0.19^{A}
50g dolomite (planting hole) + 75g dolomite	09.7^{A}	0.17^{A}
75g dolomite (planting hole) + 25g kieserite	09.7^{A}	0.16^{A}
100g dolomite only (planting hole)	10.0^{A}	0.17^{A}
150g dolomite only (planting hole)	09.7^{A}	0.19^{A}

(Means with same letter are not significantly different)

Table 17. *Effect of different treatments on yield of rubber*

Treatment	Yield (g/t/t)
Control (no fertilizer)	23.1^{A}
Urea based	29.8^{A}
SA based	28.3^{A}
Sulpomag based	28.9^{A}

(Means with same letter are not significantly different)

Foliar nutrients

A field experiment was started in 2000 replanting to study the effect of a foliar fertilizer; Humat 2000, on the performance of rubber plants. Effect of Humat 2000 on the girth of rubber plants at the end of two years is given in Table 18 (Lalani Samarappuli, U Mitrasena and T Gunatilleke).

Table 18. *Effect of different treatments on growth of rubber plants*

Treatment	Girth (cm)
Normal recommendation (Control)	14.7^{A}
Humat foliar application	15.1^{A}
Humat soil application once a year	15.5^{A}
Humat soil application once in 2 years	15.2^{A}

(Means with same letter are not significantly different)

Fertilizer requirement for different cropping systems

Fertilizer requirement of rubber under different densities

An experiment (SMC-Ag/D/96/1) was started 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). Effect of different fertilizer treatments on girth of rubber plants at the end of six and a half years showed no significant difference between densities tested (Lalani Samarappuli, P Karunadasa and U Mitrasena in collaboration with the Plant Science Department).

Another experiment (SMC-Ag/D/97/1) was also started at Dorset division, Clyde estate to study the fertilizer requirement of rubber under different densities with same treatments. Effect of different densities and fertilizer levels on girth of rubber plants at the end of five and a half years from planting and percentage of trees having 45cm girth are presented in Tables 19 and 20, respectively (Lalani Samarappuli, P Karunadasa and U Mitrasena in collaboration with the Plant Science Department).

Table 19. *Effect of different fertilizer and density treatments on girth (cm) of rubber plants*

Fertilizer levels	**Planting densities**			
	500/ha	**600/ha**	**700/ha**	**800/ha**
Recommended level (F1)	49.0	48.0	45.3	45.2
Reduced level (F2)	49.2	47.7	45.2	43.6
1st 3 yrs. Recommended level then reduced level (F3)	48.5	47.2	45.1	43.8

Table 20. *Effect of different fertilizer and density treatments on percentage of trees having more than 45cm girth*

Fertilizer level	**Planting densities**			
	500/ha	**600/ha**	**700/ha**	**800/ha**
Recommended level (F1)	76.0	77.5	52.3	55.8
Reduced level (F2)	88.5	77.5	48.3	37.0
1st 3 yrs. Recommended level then reduced level (F3)	79.5	69.0	57.3	37.5

Nutrient requirement of rubber based cropping systems

The study on nutrient requirements of rubber based cropping systems was continued (Lalani Samarappuli, N Wickramasinghe, U Mitrasena and S Chandrasiri).

Application technique

Reduced frequency of fertilizer applications

A field experiment (F/Ap/95/1), is in progress to the study the effect of reduced frequency of fertilizer application during the immature period on the growth of rubber plants. Treatments consisted of (a) 25 applications/immature six year period (urea based), (b) 20 applications/immature six year period (SA based), (c) 19 applications/immature six year period (urea based), (d) 14 applications/immature six year period (SA based) and (e) 14 applications/immature six year period (urea based) (Lalani Samarappuli, P Karunadasa and U Mitrasena).

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).

Method of fertilizer application

An experiment was started at Gallewatta division, Dartonfield estate to study the effect of different methods of fertilizer application *viz.* forking and broadcasting during mature stage. Yield data was collected but it is too early to come into any conclusions (Lalani Samarappuli, R Puhambugoda and S Chandrasiri).

Soil and foliar survey programme

Improvements to soil and foliar survey programme

Estate sector

This experiment was continued (L Samarappuli, N Wickramasinghe, W Wijesuriya and V Edirimanne).

Smallholder sector

A study was initiated to provide fertilizer recommendations to mature smallholdings in different rubber growing districts using leaf nutrient values of both smallholdings and surrounding estates. A fertilizer programme was formulated for both virgin and renewed panels for all rubber growing districts (Table 21) (L Samarappuli, V Edirimanne and T Gunatillaka).

Table 21. *Fertilizer programme for mature smallholdings*

Location	Type of fertilizer	Quantity (g/tree/year)	
		Virgin panel	Renewed panel
Kegalle	Urea	200	150
	Eppawela rock phosphate	100	-
	Muriate of potash	100	75
All other regions	Urea	200	150
	Eppawela rock phosphate	100	-
	Muriate of potash	200	150

Soil and foliar survey programme - Fertilizer recommendation

The site-specific fertilizer recommendation programme for mature rubber provided fertilizer recommendations for 3700 hectares in the estate sector.

Fertilizer requirement of new clones

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

The trial at Lagos division, Paiyagala estate was established in 1992 and consists of five clones (RRIC 121, RRIC 110, RRISL 203, PB 260 and RRIM 712) and four fertilizer levels (0, 0.5, 1 and 1.5 times the currently recommended fertilizer levels). Statistical analysis on the yield data (g/t/t) revealed that there were significant differences among fertilizer levels and clones but the clone × fertilizer level interaction effect was not significant at $p< 0.05$. The PB 260 clone gave the highest yield, when averaged from 1999 to 2002, where as RRIC 121 gave the lowest yield among the clones tested (Table 22). Also the application of fertilizers increased the yield significantly, but there were no statistically significant differences among the fertilizer added treatments (Table 22).

Another trial was established in the Eladuwa estate in 1998 using RRISL 201, RRISL 202 and BPM 24 and different combinations of P, K and Mg levels (*i.e.* 0.6, 1.4 and 2.2 times the currently recommended levels). Nitrogen was applied at the currently recommended level for all treatment combinations. The treatment combinations of this 3^2 factorial experiment were laid down according to a confounded incomplete randomized block design. Girth measurements and leaf nutrient levels have been measured since the establishment of the trial. The statistical analyses on these data are now being conducted (R S Dharmakeerthi, L Samarappuli, S N Silva and A Yakandawala).

Table 22. *Effect of clone and fertilizer level on latex yield averaged from 1999 to 2002*

Clone†	Yield‡ (g/t/t)	Fertilizer Level	Yield† (g/t/t)
PB 260	54.6 ^{A}	No fertilizer	27.6 ^{A}
RRISL 203	40.1 ^{A}	0.5 Current Recommendation	42.4 ^{A}
RRIM 712	38.5 ^{B}	1.0 Current Recommendation	44.1 ^{A}
RRIC 110	36.6 ^{B}	1.5 Current Recommendation	44.8 ^{A}
RRIC 121	28.9 ^{C}		

†Tapping system for clone PB 260 was S/2 D/3, whereas for all other clones it was S/2 D/2
‡ values with the same superscript in a column are not significantly different at $p< 0.05$

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 continued. Girth measurements at five years after planting are given in Table 23 (L Samarappuli, A Dissanayake, P Perera, S Chandrasiri and Chitra Maheepala).

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

Treatment	Girth (cm)	
	RRIC 100	RRIC 121
Urea, IRP, MOP, Dolomite	44.4	44.5
Urea, IRP, MOP, Kieserite	44.7	43.1
SA, IRP, MOP, Dolomite	44.4	46.1
Urea, IRP, MOP, Dolomite, Epsom salt (level 1)	43.2	46.9
Urea, IRP, MOP, Dolomite, Epsom salt (level 2)	42.6	44.2
Urea, IRP, MOP, Dolomite, Epsom salt (level 3)	42.9	43.9
Urea, ERP, MOP, Dolomite, Epsom salt (level 1)	44.1	45.7

Organic fertilizers

Planting stage

An experiment was started in Pembroke division, Payagala estate in a 2001 replanting to study the effect of application of different organic materials into the planting hole. Treatments consisted of; no organic manure, straw, poultry litter, cow dung, green manure, compost, coir dust, paddy husk, tea dust and saw dust. Girth at 6 and 18 months after planting and the girth increment are 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)		Girth increment (cm)
	At 6 months	At 18 months	
Nil (control)	5.0	11.0	6.0
Rice straw	4.4	11.2	6.8
Poultry	4.7	11.9	7.2
Cow dung	4.9	11.6	6.7
Green manure	4.6	11.3	6.7
Compost	5.4	12.3	6.9
Coir dust	4.7	11.3	6.6
Paddy husk	4.9	11.4	6.5
Tea dust	4.9	12.0	7.1
Saw dust	4.7	11.4	6.7

Immature stage

Use of animal wastes

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 during 3rd year + 5th year. Effect of treatments on girth at the end of one and a half years is given in Table 25 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

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

Treatment	Girth (cm)
T1	10.1^{A}
T2	12.6^{A}
T3	11.5^{A}
T4	12.2^{A}
T5	11.6^{A}
T6	11.5^{A}

(Means with same letter are not significantly different)

Use of green manure

A field experiment, (FPN-Org/Gm/97/2) is in progress at Dorset division, Clyde estate to study the effect of plant materials as an organic manure for rubber. Treatments consisted of combinations of three sources of N *viz.* full inorganic (N1), ½ inorganic + ½ green manure (N2) and full green manure (N3) and three sources of K *viz.* full inorganic (K1), ½ inorganic + ½ straw (K2) and full straw (K3). The nine different treatment combinations were applied in a randomized block design with four replicates. Effect of treatments on girth of rubber plants at the end of five and a half years is given in Table 26 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 26. *Effect of different treatments on girth (cm) of rubber plants*

Sources of N	Sources of K		
	K1	K2	K3
N1	47.7^{A}	48.4^{A}	47.8^{A}
N2	47.4^{A}	47.1^{A}	45.8^{A}
N3	48.6^{A}	48.2^{A}	46.3^{A}

(Means with same letter are not significantly different)

Refused tea and wood ash

A field experiment (SMC-Ag/M/97/1) is in progress at Sapumalkanda estate, Deraniyagala to study the effect of different quantities of refused tea and wood ash on growth of *Hevea* plants. Treatments consisted of three quantities of refused tea and wood ash /plant/annum; no refused tea (T0), refused tea, level 1 (T1), refused tea, level 2 (T2), no wood ash (W0), wood ash, level 1 (W1) and wood ash, level 2 (W2). Plant girth at five and a half years after planting is given in Table 27 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 27. *Effect of refused tea and wood ash on girth (cm) of rubber plants*

Level of refused tea	Level of wood ash		
	W_0	W_1	W_2
T_0	39.2^{A}	39.1^{A}	33.4^{A}
T_1	33.1^{A}	37.5^{A}	36.0^{A}
T_2	38.2^{A}	35.3^{A}	35.8^{A}

(Means with same letter are not significantly different)

Use of sludge

An experiment was started at Payagala estate to evaluate sludge as an organic fertilizer for immature rubber. Residual effect of sludge applied during the

immature period on the yield of rubber is presented in Table 28 (Lalani Samarappuli, U Mitrasena, and T Gunatilleke).

Table 28. *Residual effect of sludge on yield of rubber plants*

Treatment	Yield (ml/t/t)
Without sludge	85.1
With sludge	60.1

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". Effect of different treatments on girth of rubber plants at the end of four and a half and five and a half years after planting are given in Table 29 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 29. *Effect of different treatments on girth of rubber plants*

Treatment	Girth after planting (cm)	
	4½ years	5 ½ years
Chemical fertilizer only	42.5	49.1
Organic fertilizer only	30.2	41.1

Use of rubber factory effluent

The field experiment started at Eladuwa estate to study the possibility of using rubber factory effluent as a fertilizer was continued. Effect of different treatments on girth of rubber plants and tappability at the end of six years are given in Table 30 (Lalani Samarappuli, T Dissanayake and R Puhambugoda).

Rubber growing soils

No work was conducted in this project due to unavailability of staff members in the department.

Land selection and suitability for rubber cultivation

Improvements to land selection programme

This study was continued (Lalani Samarappuli, P Karunadasa, U Mitrasena, and T Gunatilleke).

Table 30. *Effect of different treatments on growth of rubber plants*

Treatment	Girth (cm)	Tappability (%)
N, K, Mg recommended + no RP	51.4	62.7
N, P, K, Mg recommended (IRP)	54.6	78.4
N, P, K, Mg recommended (ERP)	54.3	72.7
Effluent only (no N,P,K,Mg)	49.6	45.2
N, P, K, Mg recommended (IRP) + effluent	52.7	67.9
N, P, K, Mg recommended (ERP) + effluent	53.6	66.5
½ N,P,K,Mg recommended (IRP) + effluent	53.0	65.9
½ N,P,K,Mg recommended (ERP) + effluent	54.1	77.7

Land selection programme for estate sector

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

Routine chemical analysis of soil, leaf, latex and fertilizer samples collected for experimental and advisory purposes were carried out. Details are presented in Table 31.

Table 31. *Details of the analysis done during the year*

Source	No. of analysis				
	Plant	Soil	Fertilizer	Organic manure	Other*
Experimental	1000	100	-	50	-
Soil and Foliar survey	2000	-	-	-	-
Other Departments of RRI	100	40	-	15	100
Research Institutes	-	-	-	-	-
Rubber Development Department	-	-	115	-	-
Plantation Mgt. Companies	04	430	350	20	12
Other Private Companies	16	16	-	36	04
Total	3120	486	411	121	116

*water/bleaching agents/chemicals/rubber

Analytical techniques

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

BIOCHEMISTRY AND PHYSIOLOGY

G V Lakmali Nilmini

SUMMARY

Research and development work on appropriate technology for environmentally friendly management of rubber factory waste was continued through out the year.

Trials were conducted to develop an economically feasible method to extract "Quebrachitol" a valuable biochemical from rubber serum simultaneously with the rubber production process. 5kg of crude Quebrachitol was manufactured and exported to a German pharmaceutical company.

Studies on biochemical changes associated with tapping panel dryness were initiated. Further, colonal and seasonal variations of non-rubber constituents were studied.

Possible causes for variation in latex stability during and after wintering months were also studied.

Investigations on the impact of deviations in rainfall pattern on pollution in main rubber growing areas were initiated.

DETAILED REVIEW

Staff

Assistant Biochemists, Mr W M Thurul and Mrs G V L Nilmini were on duty through out the year. Mrs K V V S Kudaligama Wijesundera, Mr P D J Rodrigo and Mr D Ramawickrama, Experimental Officers, were on duty through out the year.

Seminars/Conferences/Meetings/Workshops attended

Officer	Subject	Organization
W M Thurul	Participatory interaction in development/participatory rural appraisal (PID/PRA)	Rubber Research Institute
G V Lakmali Nilmini	Priority research areas in science and technology	Young Scientist Forum (YSF) of National Science and Technological Commission (NASTEC)
G V Lakmali Nilmini	Science for the needs of the new millennium	YSF (NASTEC)
G V Lakmali Nilmini	Rubber Research Institute – Project Priority Setting	International Services for National Agricultural Research

Training Programmes

Client	Subject	No. of programmes
Planter Trainees	Waste water management	01
Assistant Managers	Waste water management	02
National Plant Quarantine Service	Application of sanitary and phytosanitary measures	01

LABORATORY AND FIELD INVESTIGATIONS

Extraction of Quebrachitol from rubber serum

Extraction of Quebrachitol from rubber serum was initiated on a request made by a German pharmaceutical company. 5 kg of crude Quebrachitol was exported. Further studies were initiated to develop a method to extract Quebrachitol simultaneously with the processing of raw rubber (G V Lakmali Nilmini, W M Thurul, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Biochemical studies of Tapping Panel Dryness (TPD)

This project attempts to identity possible causes for this physiological disorder. As an initial step studies were focused on biochemicals such as carbohydrates and proteins (G V Lakmali Nilmini, W M Thurul, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Studies on non-rubber constituents present in latex

In order to investigate the clonal and seasonal variation of non-rubber constituents present in latex, this study was initiated with 4 clones, *i.e.* RRIC 100, RRIC 121, RRIC 130 and RRIC 102. Latex samples were collected from three replicates and were analysed (G V Lakmali Nilmini, W M Thurul, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Effect of wintering on latex and raw rubber properties of *Hevea brasiliensis*

The research project funded by Ministry of Environmental and Natural Resources was commenced before the on-set of wintering and the stability of latex during wintering months was investigated. Also the latex samples collected from clones RRIC 102 and RRIC 121 were analysed for amino acids and phenolics (G V Lakmali Nilmini, W M Thurul, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Effect of rainfall on the pollution problem associated with natural rubber processing factories

The impact of deviation in rainfall pattern on the pollution problem associated with rubber processing factories was studied in main rubber growing areas. This project is funded by Junior Research Programme of the Climate Change

Enabling Activity (phase11) Project (K V V S Kudaligama, Wasana Wijesuriya and W M Thurul).

Bio-Brush media

Further research was continued to improve the efficiency of Bio Brush media for rubber wastewater treatment (W M Thurul, G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama)

Odour filter

Research on the development of coconut fibre based odour filters was continued. Odour filters installed are performing well (W M Thurul, G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Low cost treatment system configurations and low cost construction materials

Possibility for upgrading the construction procedure of "Covered Activated Ditch" (CAD) system at low cost was tested (W M Thurul, G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Deammoniation and continuous coagulation of skim latex

Developing appropriate techniques for removing ammonia from skim latex and continuous coagulation of skim latex with organic acids were continued (W M Thurul, G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Biological and biochemical treatment of rubber wood

Studies on biological and biochemical treatment methods of rubber wood were continued (W M Thurul, G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Chemical bleaching of rejected treated rubber wood

Development of techniques for bleaching treated rubber wood, rejected due to fungal staining were continued (W M Thurul, G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Biological and biochemical carving of rubber wood

Research work on this was continued (W M Thurul, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Implementation and monitoring of new developments

Rayigam Estate Crepe Rubber Factory

Monitoring and the analytical assessments were made. The system was functioning satisfactorily. A major maintenance operation was recommended for the nearly five-year- old system (W M Thurul, G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Pallegama Estate Sole Crepe Rubber Factory

The effluent treatment system of the factory was functioning satisfactorily. Monitoring and analytical assessment were carried out (W M Thurul, G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Kiriporuwa Estate Centrifuge Latex Factory

Monitoring and analytical assessments were made. The system was running satisfactorily at higher waste loads than designed for (W M Thurul, G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Yatadola Estate Crepe Rubber Factory

Monitoring and analytical assessments were made. The system was functioning satisfactorily (W M Thurul, G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Eladuwa Estate Crepe Rubber Factory

The designed Covered Activated Ditch system was functioning satisfactorily. Monitoring and analytical assessments were carried out (W M Thurul, G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Dalkeith Estate Crepe Rubber Factory

A Covered Activated Ditch system was specially designed for the above factory to facilitate treatment of a large quantity of waste load at low cost (W M Thurul, G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo, D Ramawickrama).

ADVISORY SERVICES

A Dissanayake

SUMMARY

Several projects were identified and carried out at National and Regional level to cover advisory work, extension management and reforms, participation and interaction between farming and research communities to develop appropriate policy measures and training of farmers and extension staff. Number of group processing centres and individual smoke houses were inspected and it was able to improve the quality of RSS produced in them. The staff of ASD was involved in carrying out questionnaire surveys and participatory studies on various aspects of rubber smallholders.

DETAILED REVIEW

Staff

Dr Anura Dissanayake, Head of the Advisory Services Department (ASD) and Regional Advisory Officers; Mr G Gunawardene (Kegalle region), Mr D Dassanayake (Kalutara region), Mr A H Kularatne (Ratnapura region) and 31 Rubber Extension Officers were on duty throughout the year. Mr P Samaranayake, RAO of Colombo/Gampaha region retired from the services of RRI on 01.04.2002. Mr A Kalubowila (RAO Galle/Matara region) was transferred to Colombo/Gampaha region with effect from 15.08.2002.

Seminars/Conferences/Meetings/Workshops attended

Officer	Subject	Organization
A Dissanayake	Meetings of Board of *Thurusaviya* Fund under the Ministry of Plantation Industries	Ministry of Plantation Industries
A Dissanayake	Meetings of the Nuclear Agriculture Committee	Atomic Energy Authority
A Dissanayake	Meetings of the Plantations and Smallholder sub committee under the Ministry of Policy Planning	Ministry of Policy Planning
A Dissanayake	Workshop on Research Prioritization	ISNAR and RRI
A Dissanayake	Workshop on Participatory Interaction in Development	IPID and RRI
A Dissanayake	Final review meeting of the 100 day programme	MPI
A Dissanayake	Workshop on promotion of ERP use in Agriculture	Ministry of Industries
A Dissanayake	Workshop on RSS manufacturing and grading conducted for RDOO and *Thurusaviya* society officials	RDD and *Thurusaviya* Fund

SERVICES

National level projects

Fertilizer application for immature and mature rubber

Promotion of usage of ERP mixtures

Three immature rubber smallholdings for each division coming under Rubber Extension Officers were selected to establish demonstration plots. This project is conducted with the financial assistance of Lanka Phosphate Limited and is in progress.

Promotion of fertilizer usage of mature and immature holdings

Extension officers have successfully attended to this programme and encouraged smallholders in fertilizer application through awareness programs (Table 1).

Table 1. *Number of programs conducted at regional level on fertilizer use*

Region	No. of programs
Kegalle	08
Ratnapura	34
Galle/Matara	07
Colombo/Gampaha	58
Kalutara	38

Growing Mucuna as a cover crop

On the request made by the ASD, training programs on propagating and field planting of *Mucuna* were successfully completed by Head/Soils and Plant Nutrition Dept. for all Extension Officers. Arrangements have already been made to establish *Mucuna* nurseries in Dartonfield and Payagala estates under the guidance and help of Soils and Plant Nutrition Department to distribute plants for the smallholders. Establishment of *Mucuna* in smallholdings selected by the Extension Officers is in progress. This is connected with awareness programs conducted at regional level as follows (Table 2).

Table 2. *Number of awareness programs conducted at regional level on growing Mucuna*

Region	No. of programmes
Kegalle	18
Ratnapura	42
Galle/Matara	-
Colombo/Gampaha	10
Kalutara	05

Rehabilitation of substandard holdings: Correction of stand per hectare

A survey is being carried out to estimate the current stand per hectare in immature smallhlodings, with the objective of using these results to develop appropriate action plans to increase the stand per hectare with the relevant authorities.

Eradication of white root disease

Arrangements have been made with the Plant Pathology Department to carry out a survey on incidence of white root disease in the smallholder sector and to control through effective extension programs on appropriate agronomic measures. A questionnaire was distributed among Extension Officers to collect information on incidence of white root disease in the smallholder sector.

Categorization of smallholdings

Preparation of field monitoring methodologies and scoring sheets to determine the use of RRI recommendations by smallholders during immature and mature periods is in progress. Based on the evaluation rubber lands will be categorized for effective extension programmes.

Production of good quality RSS

100 day programme

Conversion of latex into good quality RSS to curtail importation of RSS1-3 grades and also to enhance the income levels of smallholders is in progress at group and individual levels. Under this project, 20 Central Processing Units and medium level private Smoke Houses were selected representing all rubber growing areas. Preparation of estimates for refurbishing of Central Processing Units were completed and handed over to the *Thurusaviya* Fund for further action. However, production of good quality sheet rubber at these centers was not possible, as the expected repairs were not carried out by the relevant authorities.

Programmes at private processing centers

Under this project, the quality of RSS produced was upgraded in around 360 units of private and group processing centres identified by the Extension Officers and a database was prepared. In addition, arrangements were made to facilitate marketing of RSS while the Extension Officers were advised to identify and improve more number of processing centres. The summaries prepared from the database are given in Figs. 1, 2 and 3.

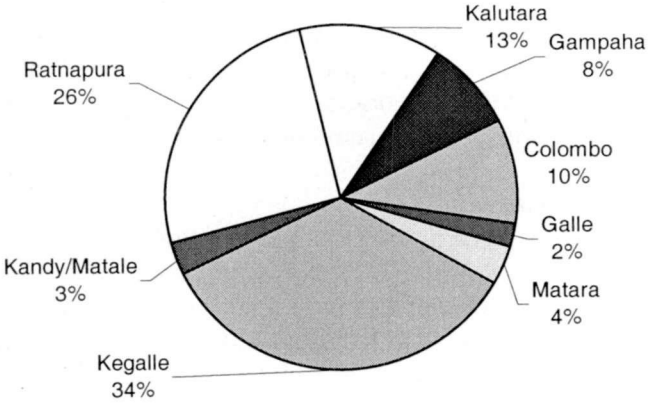


Fig. 1. Area-wise distribution of RSS production

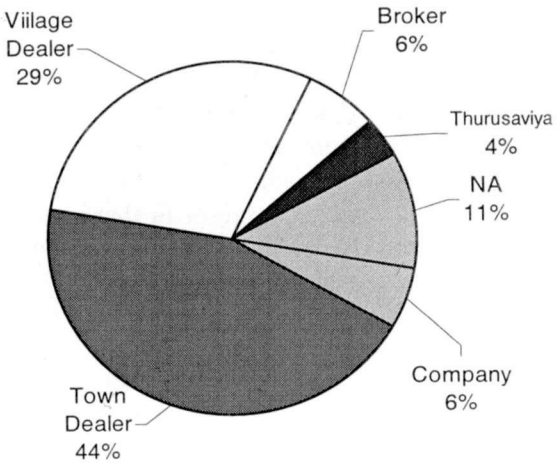


Fig. 2. Different marketing systems of RSS

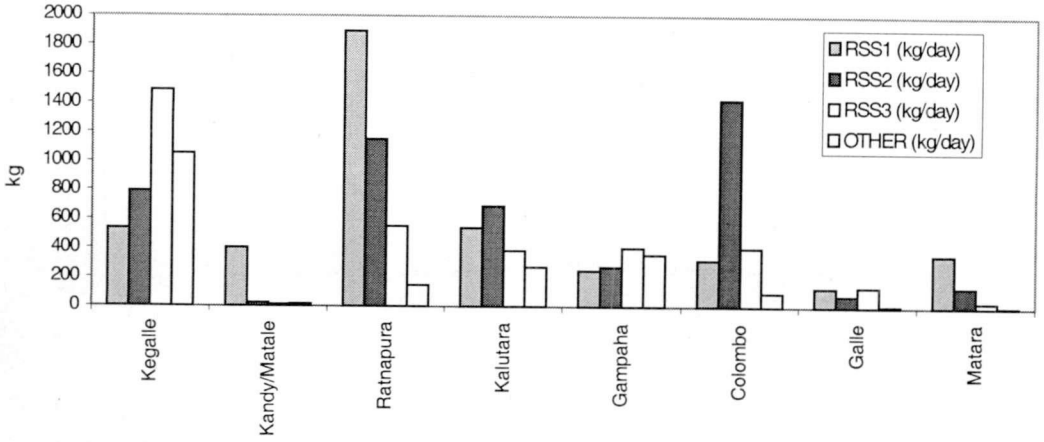


Fig. 3. Quantities of different RSS grades (kg) produced at regional level per day

Survey on existing smoke houses

A survey was carried out to collect details on general and technical aspects of smoke houses owned by smallholders to improve the conditions of smoke houses and thereby to improve the quality of sheet rubber. The information collected from this survey are summarized and given in Figs. 4,5,6 and 7.

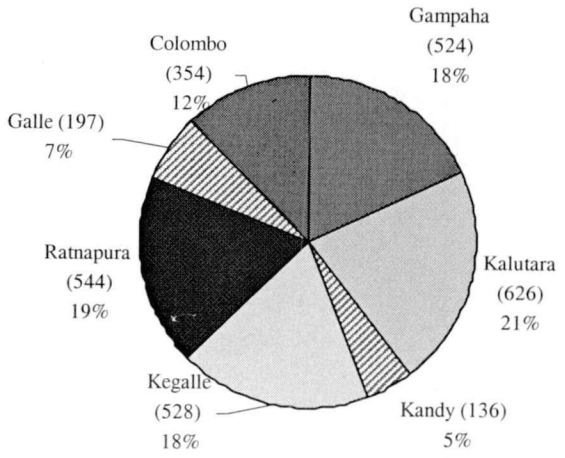


Fig. 4. Distribution of smoke houses in rubber growing areas

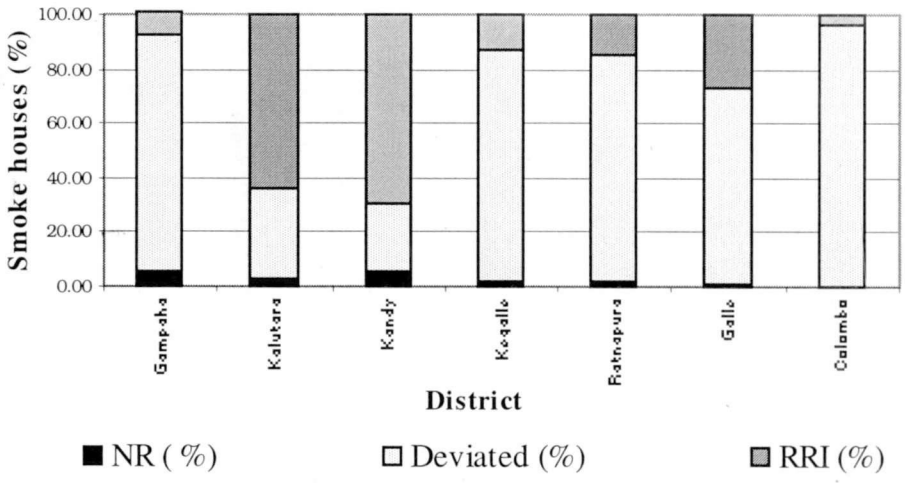


Fig. 5. The condition of smoke houses in different rubber growing areas

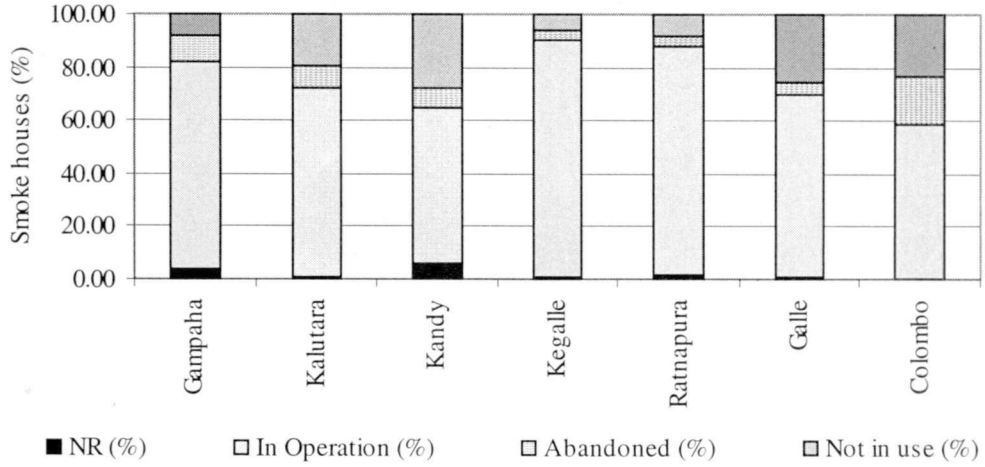


Fig. 6. Operational situation of the smoke houses in different rubber growing areas

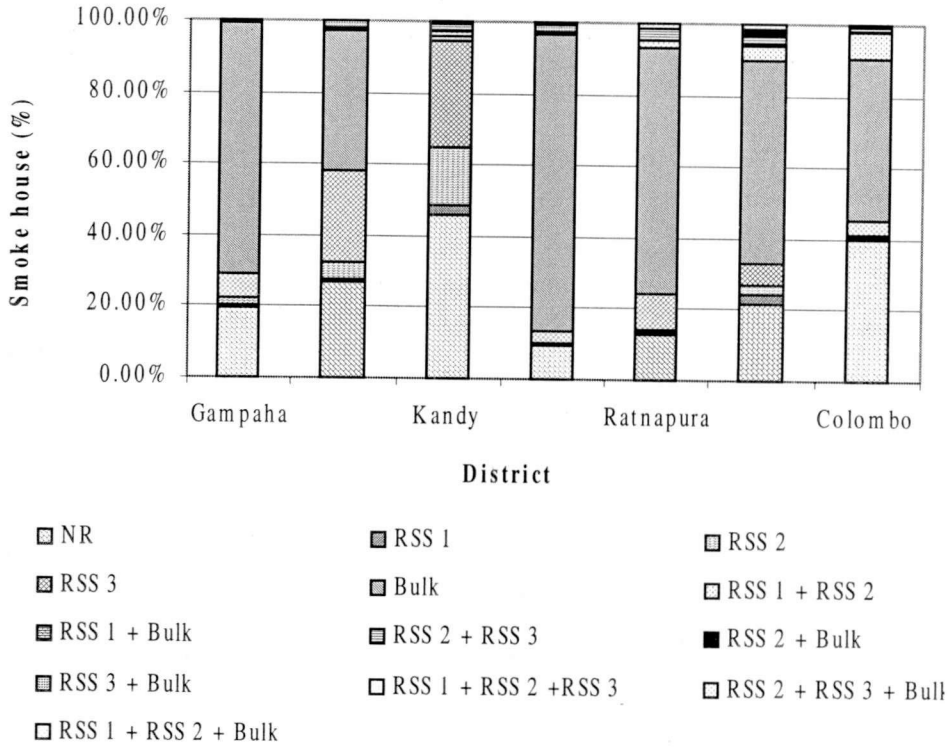


Fig. 7. RSS grades (%) produced by the smallholders in different districts

Regional level achievements

Achievements made on following aspects are presented in Table 3.

i) Repairs to existing processing centres
ii) New processing centers constructed
iii) Arrangements to repair of machinery
iv) Training programs to upgrade the quality of RSS

Table 3. *Important activities completed at regional level*

Region	No. Refurbished	No. Constructed	No. of machinery repaired	No. of skill development programmes
Kegalle	68	15	-	119
Ratnapura	40	13	31	129
Galle/Matara	30	09	19	16
Colombo/Gampaha	17	11	-	150
Kalutara	40	25	-	135

Improvement of tapper productivity and solutions for tapper shortage

Tapper training programs were organized by the Extension Officers at village level in all regions. The number of programs conducted are given in Table 4. Introducing more farmers as tappers through motivation and training by extension officers is in porgress.

Extension activities targeting the farmers in non–traditional areas

Designing of Participatory Rural Appraisal methodologies and preparation of questionnaires for eco-system assessments were completed to identify the farmers' practices and deviations from RRI recommendations with the objective of planning appropriate extension activities in non traditional areas.

Table 4. *No. of tapper traning programs conducted in different regions*

Region	Ranges	No. of programmes
Kegalle	Mawanella	03
	Yatiyantota	02
	Dehiowita	02
	Polgahawela	01
Ratnapura	Ratnapura	01
	Eheliyagoda	01
	Nivithigala	02
	Kuruwita	01
Galle/Matara	Akuressa	02
	Hakmana	01
Colombo/Gampaha	Gampaha 1	01
	Gampaha 2	01

Interactions between the Environment, Society and Technology (INTEREST)

Head of the Department and Extension officers of Yatiyantota, Mawanella, Ruwanwella, Galigamuwa, Kuruwita, Ratnapura, Horana and Agalawatta were involved in rapid sample survey, participatory studies and detailed household survey of the project.

Head of the Department was involved in case studies on stakeholders of the smallholder community and project coordination activities. This is a collaborative research project between Advisory Services Department, Biometry Section, Agricultural Economics Unit and the Faculty of Agriculture of the University of Ruhuna.

Regional level projects

Different projects identified by Extension Officers on specific issues at regional level covering a full range of field management practices, processing, marketing and other related aspects are in progress. Related activities were carried out to address to following issues/problems.

1. Soil conservation practices
2. Exploitation/correction of incorrect practices
3. Unnecessary application of chemicals on tapping panels
4. Fixing of rain-guards
5. Introduction of alternate firewood sources for smoke houses
6. Training programs on yield stimulation methods
7. Introduction of mulching systems
8. Intercropping and establishment of tea-rubber mixed cropping systems
9. Re-commencement of tapping in abandoned rubber lands
10. Replanting of uneconomic rubber lands
11. Improvements for smoke house conditions and upgrading processing facilities
12. Educational programs for school children
13. Tapper training programs for the plantation sector

RUBBER TECHNOLOGY AND DEVELOPMENT

Dilhara Edirisinghe

SUMMARY

A patent was obtained for artificial flowers made out of natural rubber (NR) latex and two beautiful floral decorations were placed for the "Presidential Awards - 2002".

The project on development of latex/carbon black masterbatches suitable for sheet rubber manufacture and as a tyre paint for the tyre retreading industry was continued.

A project was initiated to minimize the extractable proteins, eliminate the powder and improve the physical properties of NR latex based gloves by replacing NR latex with a blend of NR and polyvinyl acetate latices.

A project was initiated in collaboration with the Industrial Development Board (IDB) to develop bio-degradable rubberized coir products which are higher in demand in foreign countries.

Most of the experimental work on interpenetrating polymer networks (IPNs) has been completed.

At the request of industrialists, development of NR latex based moulds, artificial limbs, yellow colour paint, automobile battery terminal caps, arch out of NR latex foam and tyres for old crocks model cars out of dry NR was carried out.

The "Foam Rubber Task Group" and the "Rubberized Coir Task Group" were formed during the year mainly to solve the problems encountered during manufacture of these products and to provide required information to the other potential investors.

Further, assistance and advice were given to several local rubber industries on rubber compound testing, rubber product testing and development of rubber based products.

DATAILED REVIEW

Staff

Mrs D G Edirisinghe, Rubber Chemist was on duty throughout the year. Mrs M M Jayasuriya continued her studies at the RRISL during the year as a part fulfillment of her postgraduate studies leading to a PhD at the Loughborough University, UK.

Mrs M K Mahanama, Mrs S I Yapa and Mrs P C Wettasinghe, Experimental Officers were on duty throughout the year.

Mr P L Perera, Experimental Officer was transferred to the Department from the Raw Rubber and Chemical analysis Department with effect from 1st May.

Miss D N Wickramarachchi, Research and Development Assistant and Mr A I Siriwardena, Technical Officer were on duty throughout the year.

Research students

- Mr Ruwan Kumara, an undergraduate from the University of Colombo underwent vacation training. The title of the project undertaken was "Development of Arches for Shoes out of NR Latex Foam".
- Miss Asha Ariyadasa, a NDT (Chemical Engineering) student from the University of Moratuwa underwent vacation training. The title of the project undertaken was "Some Developments on Latex/Hot Bitumen Blends for Road Applications."
- Mr Ananda Amarasiri, a post-graduate student from the University of Moratuwa prepared prevulcanized latex films required for his MSc research project.

Technological knowledge on dry rubber and latex based products manufacture was transferred to seven unempolyed graduates who are residents of Horana.

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

Seminars/Conferences/Meetings/Workshops

Officer	Subject	Organization
Mrs D G Edirisinghe	Sectoral Committee Meetings on "Chemical and Polymer Technology"	Sri Lanka Standards Institution
Mrs D G Edirisinghe and Mrs M M Jayasuriya	A workshop on "Project Priority Setting"	International Service for National Agricultural Research (ISNAR)
Mrs D G Edirisinghe	Working group meetings on "Rubber Waste Disposal"	Ministry of Science and Technology

Training programmes

Client	Subject	No. of Programmes
Students - Plastics and Rubber Institute	Basic course in rubber technology	1
Officers attached to the plantation sector (organized by the NIPM)	Synthetic rubbers and speciality grades of NR	1
Unemployed graduates, who are residents of Horana	Technological knowledge on dry rubber and latex based products manufacture	1

Advisory visits

Two officers of the department visited the Ceyesta factory in order to look into the sagging problem which they had experienced in their rubberized coir mattresses. Necessary advice was given on preparation of the required dispersions, cure time and temperature, *etc.* to overcome this problem.

The following industries were visited in order to initiate steps for improving Industry-Institute collaboration.

Trelleborg Lanka (Pvt.) Ltd.
Loadstar (Pvt.) Ltd.
Asia Industrial Enterprises (Pvt.) Ltd.
Microcells Ltd.
Lalan gloves (Pvt.) Ltd.
Richard Peiris & Co. Ltd.

LABORATARY INVESTIGATIONS

Latex technology

Natural rubber latex based moulds

A request was made by Shades N' Shadows to develop moulds out of NR latex suitable to produce a range of hand crafted glass ornaments especially manufactured for the export market. A mould which can withstand high temperatures was developed and the technology was transferred to the industry concerned.

Few trials were carried out to develop moulds out of NR latex which can be used to produce decorative candles and other wax articles, on a request made by Auslan International Lanka (Pvt.) Ltd. The trials were successful and the technology developed was transferred to the company.

A request was made by a small scale industrialist to prepare moulds out of natural rubber suitable to build fine concrete structures such as statues, decorative ceiling slabs, *etc.* Few trials were conducted and moulds out of NR latex suitable

for, this purpose was developed. The technology was transferred to the industrialist (D G Edirisinghe and M K Mahanama).

Rubber sheeting

Textrip Ltd. manufacturers and exporters of latex rubber bands and strips requested to formulate a vulcanizing system which would bring about a high modulus for the thin rubber sheeting produced from natural rubber latex, in order to meet their customer requirements. Some modifications to their formulation were suggested which in turn resulted in achieving the modulus required (D G Edirisinghe and D N Wickramarachchi).

Artificial limbs out of natural rubber latex

A request was made by an industrialist to develop a latex compound which can be used to produce artificial limbs. A natural rubber (NR) latex compound was successfully developed by using a room temperature curing system. Further trials were conducted by varying the quantities of blowing agent and filler including carbon black. Satisfactory results were obtained. In addition, an attempt was made to incorporate buffing dust into the NR latex compound. Further work is required to improve the adhesion between buffing dust and NR, which was found to be inferior (M M Jayasuriya, S I Yapa and P C Wettasinghe).

Latex based cement for tyre retreading

Work on this project was continued in collaboration with Associated Motorways Ltd. An attempt was made to prepare a larger quantity of the newly developed latex based cement in the laboratory. However, peel strength determination could not be conducted due to some problems with the quality of centrifuged latex as well as with the antioxidant. Therefore, factory trials had to be postponed until lab scale trials on a larger batch gave satisfactory results (D G Edirisinghe, M K Mahanama, S I Yapa, A I Siriwardena and P L Perera).

Artificial flowers out of natural rubber latex

Mrs Manel K Mahanama obtained a patent for her invention titled "Artificial Flowers based on Natural Rubber Latex for Floral Décor''. A beautiful bridal bouquet and a settee-back out of natural rubber (NR) latex were the two floral decorations displayed by Mrs M K Mahanama at the Technical College, Maradana for the "Presidential Awards 2002". These NR latex based flowers as well as leaves are washable, non - toxic, resistant to extreme weather conditions, requires only a minimum space for packaging, can be squeezed and packed inside a container without formation of any creases, bio - degradable and hence environmental friendly. Also, the appearance and texture of these flowers are very much similar to those of

natural flowers. Hence, these NR latex based flowers are advantageous over plastic or fabric based flowers.

Natural rubber latex based paint

A yellow colour natural rubber latex based paint suitable for rubber carpets was developed on a request made by Microcells Ltd. However, further work is required to improve bonding between the paint and the surface of the carpet (D G Edirisinghe and M K Mahanama).

Latex/carbon black masterbatches

For tyre paints

An alternative method was employed in the preparation of latex/carbon black masterbatches suitable for preparation of tyre paints. This project was initiated on a request made by Associated Motorways (AMW) Ltd. The amount of carbon black retained in rubber was found to be approximately 52%. Also, a literature search was done to find a suitable chemical other than silicone oil, which would impart a glossy appearance to the tyre surface. Further trials will be carried out to improve the appearance of the tyre paint as requested by AMW Ltd. (D G Edirisinghe, M K Mahanama, D N Wickramarachchi and L Wanigatunge).

For sheet rubber manufacture

Preliminary trials on the preparation of latex/carbon black masterbatches suitable for sheet rubber manufacture were carried out successfully. A detailed investigation has already been commenced (M M Jayasuriya, S I Yapa, P C Wettasinghe and D N Wickramarachchi).

NR/ polyvinyl acetate blends for dipped products

This project was initiated on an idea suggested by Lalan Gloves (Pvt.) Ltd. The aim of the project is to minimise the extractable proteins, eliminate the powder and improve the physical properties of NR latex based gloves by replacing NR latex with a blend of NR and polyvinyl acetate latices. Few trials were carried out to blend NR latex with polyvinyl acetate latex, taking precautions to prevent any coagulation. The trials were successful. Work on this project will be extended to study the processability and physical properties of NR/polyvinyl acetate latex blends in comparison with those of NR latex (D G Edirisinghe, D N Wickramarachchi and P C Wettasinghe).

NR latex foam

Development of an arch out of NR latex foam suitable for the shoe industry was undertaken on a request made by Asia Industrial Enterprises (Pvt.) Ltd. A suitable formulation was developed and the technology was transferred to AIE (Pvt.) Ltd. (D G Edirisinghe, S I Yapa and Ruwan Kumara - University of Colombo).

Bio - degradable rubberized coir products

A project on development of bio-degradable rubberized coir products was initiated in collaboration with the Industrial Development Board (IDB) in order to meet the demand for such products in foreign countries. Preliminary trials were carried out to explore the possibilities of enhancing bio- degradability of coir and /or rubber. Coir and/or rubber were chemically heated and the physical properties of heated rubber/coir under various experimental conditions are being evaluated periodically (M M Jayasuriya, P C Wettasinghe, D N Wickramarachchi and S I Yapa).

Natural rubber based caps for automobile battery terminals

A request was made by Associated Battery Manufacturers (Pvt.) Ltd. to develop red and black caps out of natural rubber for automobile battery terminals. Few trials were carried out with NR latex by dipping technique. The trials were successful and the technology was transferred to the above mentioned industry (D G Edirisinghe and M K Mahanama).

A study on the use of natural rubber latex and waste tyre crumbs in road applications

A project was undertaken in collaboration with the Road Construction and Development Corporation (RCDC) with the aim of exploring the possibilities of using natural rubber latex and waste tyre crumbs in road applications. Preliminary trials were conducted and a series of rubberized hot bitumen samples were prepared successfully. Results of four samples prepared according to various experimental conditions are given in Table 1.

The results indicate that the incorporation of natural rubber latex into hot bitumen improves engineering properties such as penetration and softening point. Plans have been made already to prepare asphalt by replacing sand with various amounts of waste tyre crumbs. Also, it was found that incorporation of NR latex into hot bitumen would not have an adverse effect on the viscosity of the resultant blend (M M Jayasuriya, S I Yapa, M K Mahanama, P C Wettasinghe, P L Perera, A I Siriwardena and Asha Ariyadasa - University of Moratuwa).

Table 1. *Properties of natural rubber latex /hot bitumen blends*

Sample	DRC (%)	Penetration 25°C, 100g, 5s	Ductility 25°C, 5cm/min.	Softening point (°C)	% loss by wt. *	Penetration, * % of its original value	Flash point, cleveland open cup (°C)
Latex formula – 1	1	59	103	54.2	0.0145	80	-
Latex formula – 2	1	56	90	53.0	0.0573	75	-
Latex formula – 1	2	58	150	57.0	0.0211	77	-
Latex formula – 2	2	57	107	54.4	0.1067	70	-
Original sample of bitumen		64	140	52.0	0.0097	89	308

* after thin film oven test

Dry rubber technology

Blends of natural rubber (NR) and nitrile rubber (NBR)

A NR compound and a NBR (34 % acrylonitrile) compound (controls) were prepared using the Brabender PL 2000 Plasticorder under similar experimental conditions as for the 30:70 NR/NBR blend compound prepared previously at 60 rpm rotor speed. Cure characteristics and technological properties of the former compounds were evaluated and compared with those of the latter compound. Comparison of the properties of the 30:70 NR/NBR blend with those of the two control samples revealed that the tensile strength, % elongation at break and tear strength of the blend were superior to those of the two control samples. The abrasion volume loss and the percentage compression set of the NR/NBR blend compound were lower than those of the NR compound. Hence the 30:70 NR/NBR blend is suitable as a replacement for the NR compound with regard to the above mentioned physical properties (D G Edirisinghe, M K Mahanama, A I Siriwardena, P C Wettasinghe and P L Perera).

Old crocks model car tyres

A request was made by a small scale old crocks model car manufacturer to develop tyres for his cars made out of iron. A suitable formulation was developed and twenty small tyres were handed over to him on request (D G Edirisinghe, M K Mahanama and P L Perera).

Interpenetrating Polymer Networks (IPN's)

Most of the experimental work with regard to this study had been carried out including the experiments on extraction of homopolymers in IPNs. In addition, attempts were made to analyse these samples using NMR and IR spectroscopy. Writing-up of the Ph D thesis was continued (M M Jayasuriya and D J Hourston).

Technology transfer

Two task groups namely the "Foam Rubber Task Group" and the "Rubberized Coir Task Group" were formed in order to help the natural rubber latex foam based products manufacturers and rubberized coir based products manufacturers, respectively. This is merely to solve the problems encountered during manufacture of these products and to provide required information to the other potential investors. Substantial information on machinery, process development, raw materials and chemicals, specifications and test methods have been collected by the officers of the two task groups.

Work done by the "Task Groups"

Two reports, one on "Foam Rubber Task Group" and the other on "Rubberized Coir Task Group" were submitted to the Chairman, RRB on request.

Few officers of the "Foam Rubber Task Group" visited the SLRMEC, foam rubber factory at Horana, to build -up the relationship between the Institute and SLRMEC and to solve any problems encountered during the manufacturing process.

A rubberized coir based mat useful as a seat and a thin rubberized coir sheet out of coir cuts were developed on requests made by the industry.

Also, a room temperature curing system was developed to produce a thin rubberized coir sheet with dimensions 1 m × 1 m × 1mm at the request of an industrialist, for an export order. The purpose of this thin rubberized coir sheet is to make a trap to catch a particular type of aquatic species in large quantities. The algae which grows on the rubberized coir sheet when it is submerged in water happens to be one of the sources of food for these species.

Industrial extension

The following services were provided by the Department during the year.

Test	Number of industries
Rubber compound testing	13
Rubber product testing	07
Rubber product development	03
Ball-milling of rubber chemicals	02
Analysis of polymer samples	01
Protein analysis	01

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

Also, officers of the department were involved in organizing a stall for the "Srama Udana 2002" held at the Kuruwita Madya Maha Vidyalaya, Ratnapura.

POLYMER CHEMISTRY

Nilmini Liyanage

SUMMARY

Determination of Extractable Proteins in post vulcanised Natural Rubber (NR) films leached in different solutions and in modified LATZ system with Poly Vinyl Alcohol, were carried out under the NSF funded project on NR protein allergy. Some of them appear to give promising results as compared with the presently used leaching technique of chlorination.

Work on the use of NR in the production of artificial limbs to replace presently used Poly Urethane based compound has been satisfactorily completed.

Use of 10% Carboxyl Methyl Cellulose and Aluminium alum were found to be highly satisfactory in producing granulated rubber of fine particles with good appearance for export market.

Development of a transparent tablemat using NR was carried out with different formulations to examine the possibility of achieving similar qualities to that of the imported silicone based tablemat.

Trial experiments on development of a teat for feeding calf were done using crepe rubber with different compound formulations.

Development of a permeable hose to be used in the agricultural irrigation has been initiated in collaboration with DSI group.

Development of an adhesive for nylon fabric has been initiated with a modified NR based compounds.

The use of neem oil, a non-toxic preservative material as a replacement to TMTD/ZnO system to be used in the preservation of concentrated latex has been reinitiated.

The department also actively involved in the work involving blooming of chemicals and the appearance of stains in rubber compounds. Different polymer samples were analysed in the FTIR spectrophotometer for identification of constituent polymers.

DETAILED REVIEW

Staff

Ms Champa Wellappilli, Assistant Rubber Chemist left for her postgraduate studies at University of Cardiff, on 28th April. Ms Nilmini Liyanage, Assistant Rubber Chemist was on duty throughout the year.

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

Research students

The following students were trained in the department.

Ms S Dodampegodage	- MSc student
Ms G D Dias	- MSc Student
Ms Yoga Milani	- BSc Chemistry Undergraduate

Seminars, Workshops and meetings attended

Officer	Subject	Organization
Nilmini Liyanage	Served as a member of the working group on standardisation of Polyurethane foam material for cushioning and mattress	SLSI
Nilmini Liyanage	Workshop on project priority settings	ESNA

LABORATORY INVESTIGATIONS

NR protein allergy

Project on latex protein allergy supported by the NSF grant No RG/99/C/07 was continued. Natural rubber latex from clone RRIC-100, preserved with low ammonia TMTD/ZnO preservative system was tested after incorporation of SS-25.- a recently developed rubber whitener and Polyvinyl alcohol (PVA).

PVA incorporated cast films/gloves effectively reduced extractable proteins (EP) during leaching and it was shown that it is unnecessary to apply talk powder for the above.

Leaching with 3% and 1% HCl, effectively reduced EP in PVA incorporated cast films.

Running hot water leaching at 95^0C showed significant reduction of EP compared to that of chlorination of PVA incorporated gloves.

Wet gel leaching followed by vulcanisation resulted in lower EP level compared to that of PVA incorporated post vulcanised films. However chlorination of both wet gel leached and post vulacanized leached films also reduced the EP content to almost similar levels (L M K Tillekeratne, W M G Senevirathna, Champa Wellappilli, S L G Rangith, Kumudinie Chandrasekara and Laleen karunanayake-University of Sri Jayawardenapura).

Artificial limbs

A request was made by a charitable organisation to develop artificial limbs out of NR instead of Polyurethane based imported product. Several chemical formulae were tested with different ratios of natural rubber and Ethyl Vinyl Acetate. Formula with required density, hardness and abrasion resistance was recommended to the industry (Nilmini Liyanage, H N K K Chandralal and Chitra Kuruppu).

Powered rubber

Trials on the manufacture of powdered rubber for the export market by an economical method starting with field latex were continued. It was found that the particle size depends on concentration of the chemicals, total agitation, speed, maturation period of latex *etc.* Alginates commercially available acrylic copolymers, potash alum were used in some trials. Satisfactory results were obtained using 10% Carboxyl Methyl Cellulose as a partitioning agent and Aluminium alum as a coagulating agent (Champa Wellappilli, H N K K Chandralal and S S Warnapura).

Rubber mats

A request was made by an industry to identify the stain and to produce non-staining coloured rubber strips to be used as the out - line of the black rubber mats. Appearance of the patches in the coloured outside was found to be the stains resulted due to the migration of antioxidants from the black part of the mat. A formulation was developed incorporating a phenolic type antioxidant in the formulation of the black coloured component and regular observations of the development of stains were made under normal sunlight in comparison with the standard product. It was observed that no staining was developed in the coloured part of the mat with the developed formulation.

Another, request was made by the same industry to identify the stains in their black mats. Extractions followed by several chemical tests proved that the stains were due to the improper vulcanisation of the product. Calibrating the temperature measuring equipment at the industry solved this problem (Nilmini Liyanage, H N K K Chandralal and Indra Denevaka).

Stains and blooms

A request was made by an industry to conduct a research on the stains and blooms, which sometimes appear on shoes produced for the export market by the company. By using several chemicals and spectroscopic techniques, these stains were identified as unreacted chemicals, which diffused onto the surface, particularly inorganic fillers and Zinc Oxide incorporated in the compound. Trials were carried out with modified formulations and a formula with optimum performance was given to prevent the blooming without affecting the physical properties (Nilmini Liyanage, H N K K Chandralal and Indra Denevaka).

Rubber teats

A request was made by an industry to develop a teat for feeding calf, out of Natural rubber. Main problem encountered in making this product was uncontrolled swelling of NR in milky medium. Controlled swelling was achieved by using efficient vulcanising system including Ultrasil VN3 and coated $CaCO_3$ in variable proportions. Required physical properties such as hardness, tear strength,

compression set *etc.* achieved and the chemical formula developed was transferred to the industry. The Industry also requested to develop a formula for the same with controlled swelling in Gee medium. Trials towards the target were still under progress (Nilmini Liyanage, H N K K Chandralal, S L G Rangith and Ananda Samarakoon).

Transparent films development

A request was made by an industry to develop, transparent tablemats out of natural rubber to replace silicone based imported product. Several trials were performed using crepe rubber with different filler loadings and EV system. Good quality mats with required thickness and surface finish were achieved by incorporating oil emulsion (Nilmini Liyanage, H N K K Chandralal and S S Warnapura).

Chemical analysis

A request made by an industry to analyse several samples of rubber chemicals such as TMTD and ZnO *etc.* for the confirmation of chemical properties given by the manufacturer. Several parameters for each chemicals were tested and colourimetric procedures were developed for the analysis of minute quantities of the foreign matter present (Nilmini Liyanage, H N K K Chandralal, Chitra Kuruppu and Ananda Samarakoon).

Latex carbon black masterbatches

A project was initiated to study physical properties of the mill mixed compound and C black masterbatch compound. Masterbatch was prepared by addition of optimum amounts of oil emulsion and C black dispersion in to the field latex. Retention percentage of the C black has to be investigated (Nilmini Liyanage and H N K K Chndralal).

Blooms

A project was initiated to analyse blooms appear on rubber straps and soles in collaboration with BATA Shoe company. Blooms on the straps were identified as Zinc Stearate and bloom of the sole was identified as the Antioxidant. Modified formulations were recommended to the industry after some laboratory trials (Nilmini Liyanage and Indra Denawake).

Permeable hose

A project was initiated to develop a permeable hose used for agricultural purposes. Initial trials were carried out in collaboration with D. Samson Group of companies and promising results were achieved extruding buffing dust and compounded latex with suitable adjustments of cooling and heating systems of the extruder. Further developments of the project are in progress (Nilmini Liyanage, H N K K Chandralal and Ananda Samarakoon).

Neem preserved NR latex

Neem based secondary preservative system was developed to replace carcinogenic TMTD used in conventional low ammonia preserved system. Trials were conducted to eliminate the yellow colour appeared in the neem preserved system. Promising results were obtained by bleaching neem derivatives with activated charcoal and fullers earth. Comparison of the physical properties of latex film prepared using conventional preservative system and the neem preserved systems yet to be carried out (Nilmini Liyanage, Chitra Kuruppu and Nadeeja Wickramaarachchi).

Industrial extension

The following industrialists requested the services of the department in product development and testing.

Company/Institution	Service
Asia Industrial Enterprises	Bloom analysis
Micro Cells	Bloom and Polymer analysis
Buwaneka Enterprises	Polymer Analysis
Water Board	Polymer analysis
University of Sri Jayawardenapura	Analysis of the Reaction rate
University of Moratuwa	Polymer Analysis
Glenross Rubber Factory	Polymer Analysis
DSI	Polymer Analysis
Asia Industrial Enterprises	Polymer analysis
BATA	Bloom analysis
Sinwa	Polymer analysis
Hanwella Rubber	Polymer analysis
Associated Speciality Rubbers	Polymer analysis

RAW RUBBER AND CHEMICAL ANALYSIS

S Weeraman

SUMMARY

The following activities were performed during the year:

(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 shippers

(c) Testing and issuing quality certificates for latex.

(d) Analysis of chemicals and water used in the rubber processing and rubber products manufacturing industry.

(e) Analysis of skim adulteration in raw rubber.

(f) Recommendation of chemicals for the industry and analyzing them for purity.

(g) Testing of finished products such as
   1. Rubber gloves for sodium pentachlorophenate content
   2. Vulcanized products for rubber content.
   3. Dipped products for metal ion contamination.

(h) Organizing and participation in inter laboratory cross check programme for latex testing `laboratories owned by state and private sector.

(i) The following research projects were in progress.
   1. Effect of metal ions on properties of dipped NR products.
   2. Effect of gel content on analysis of dirt content.

DETAILED REVIEW

Staff

Mrs S Weeraman, Experimental Officer over looked department activities throughout the year under the guidance of the Director.

Experimental Officers L Wanigatunga, H V K Gamage, C Lokuge, and M Wijesekera, Mr L P Vitharana and Technical Officers, Messrs B Gunasiri, N Karunatilaka, W Vithanage, Instrument Technician, Mr L G P Lelwela and Clerk/Typist Mrs I Wijesinghe were on duty through out the year.

Technical Officer W W Nandasena, vacated the post with effect from 25th April 2002 as he left RRI for employment abroad.

Research and Development Assistant Mrs P Perera, was granted maternity leave with effect from 19th August 2002.

Experimental Officer Mr P L Perera and Technical Officer Ms Shirani Priyanka were transferred to Technology department and Raw Rubber Processing Development and Chemical Engineering Dept. respectively with effect from 1st May 2002.

Research students

- P K D M C Karunaratne a graduate student from University of Sri Jayawardenapura continued his research project on the "Effect of metal ions on the properties of NR Dipped Product "under the supervision of Dr S Liyanage of the University of Sri Jayawardenapura.
- G N T Hallowita and T K Pothpitiya from University of Moratuwa, completed a project on "Effect of gel content on analysis of dirt content" under the supervision of Dr L Karunanayake and Dr S Liyanage of Sri Jayawardenapura University.
- P A U M Perera, NDT student from University of Moratuwa, completed his final year training project and submitted his report on Analysis of Raw Rubber and Latex.

Training

The staff involved in conducting seven (07) practical classes for the Polymer MSc students of the University of Sri Jayawardenepura.

The following officers/students were trained on latex and raw rubber testing.

N Senadeera	- Latex Gloves pvt Ltd.
Sisira Kumara	- Glenross Rubber Co. Horana
S A Samarakoon	- Mahaoya Group Deraniyagala
D Premaratne	- Mahaoya Group Deraniyagala
I S Jayaweera	- SRMC, Mawanella
V S Maddegoda	- SRMC, Mawanella
U K D Ranjith	- SRMC, Horana
Gayathrie Vithanage	- SRMC, Horana
Lalith Sanjeewa	- Lalan Rubbers
P S Gunasekera	- Mal Lanka Pvt. Ltd
N Wijesinghe	- Kiriporuwa Estate
D Wijeratne	- Kiriporuwa Estate
M Gamage	- University of Colombo
A Dharshani	- University of Moratuwa
T Sasikaran	- Eastern University
Y A Y M Yattowitage	- University of Sri Jayawardenapura

Lectures

The officers attended a series of lectures delivered by Professor D J Francis the third countries expert from India who was assigned to re-organize the Colombo departments under JICA grant aid program.

Visits

Visits to the several industries were made by the officers appointed to the three "task groups".

Analytical services

The number of samples tested from each TSR factory during the year are as follows:

TSR Factory	No of Samples
Statcon Block Rubber Factory, Getahetta	315
Sandhagiri Rubber Mills, Dompe	330
Total	645

Details of miscellaneous samples tested during the year are given below:

Raw rubber	433
Latex	302
Chemicals	85
Bleaching agent	193
Gloves	71
Water	33
Powder content	13
Total	1130

Inter laboratory cross check - 2002

Inter laboratory cross check for the year for latex testing laboratories in Sri Lanka was conducted by the department. Centrifuged latex samples prepared were subjected for testing and statistically evaluated. The results of the above cross check were distributed among the participants (W Wijesooriya, S Weeraman, P Perera, L Wanigatunga, H V K Gamage, C Lokuge, M Wijesekara and P Vitharana).

Calibration of latex tanks

Calibration of latex tanks was carried out in order to measure the volume of latex in the tanks accurately in order to determine the correct amount of chemicals to be added for preservation which will minimize the subsequent quality

problems (Udapola, Nakiyadeniya, Kiriporuwa and SRMC, Horana) (L P Vitharana and N Karunatilaka).

Technical data sheet

Samples from a number of estates were tested for raw rubber and physical properties in view of preparing a Technical Data Sheet for crepe rubber (G Seneviratne, S Priyanaka and P Perera).

LABORATORY INVESTIGATIONS

Effect of gel content on analysis of dirt content in rubber

The purest grade of crepe rubber is used for the manufacture of food and pharmaceutical rubber items. The quality of crepe mainly depends on dirt content. According to SLR standard the dirt content should be less than 0.02% for the manufacture of food and pharmaceutical products. The formation of gel during the process of analysis adversely affects the results of the dirt content. A series of samples were tested in different solvents in order to eliminate the formation of gel during analysis. The project was completed satisfactorily (L Karunanayake, S Liyanage, N Hallowita – University of Sri Jayawardenapura, T Pothpitiya and S Weeraman).

RAW RUBBER PROCESS DEVELOPMENT AND CHEMICAL ENGINEERING

W M G Seneviratne

SUMMARY

Eleven advisory visits to raw rubber factories and twenty three visits to industries including rubber factories were made to provide consultancy services with respect to quality improvement of raw rubber and waste water treatment respectively.

Several industrial visits were made to strengthen the relationship between the RRI and the rubber products manufacturing industries and to discuss collaborative research projects beneficial to industries.

Two latex product manufacturing industries were ready for ISO 9002 certification. Staff of the department conducted internal quality audits at several rubber factories.

Waste water treatment plants set up on advice of the department were monitored and construction of five treatment plants was continued. Waste water samples from various industries were tested and certificates were issued.

Generation of bio-gas by anaerobic digestion was affected by the presence of sulphates in the rubber serum. Accumulation of hydrogen sulphide in the anaerobic digester was thought to be the main reason for retardation of bio-gas generation.

The colour of the fractionated bleached (FB) crepe was found to be affected when processing water contains more than 5 mg/l of total iron in rubber. The Plasticity Retention Index was adversely affected when FB crepe contained more than 4.5 mg/g of iron.

Nitrogen content of skim rubber could be reduced by 50% when skim latex was creamed before coagulation. Papain treatment did not give a significant reduction of nitrogen.

Detection of extractable protein levels in different types of raw rubber indicated that FB crepe was virtually free of extractable proteins. Sodium Dodecyl Sulphate Polyacrylamide Gel Electrophoresis (SDS-PAGE) technique was used to identify extractable proteins (EP) in different types of raw rubber and the type of EP depended on the method of manufacture of raw rubber.

An attempt was made to manufacture centrifuged latex with reduced levels of extractable proteins by the incorporation of water-soluble polymers into field latex prior to centrifuging.

DETAILED REVIEW

Staff

Dr W M G Seneviratne, Deputy Director Research (Technology) overlooked the departmental activities.

Mr Susantha Siriwardena, Rubber Chemist, resumed duties on 26th August after submission of his PhD thesis to the University of Science in Penang, Malaysia for evaluation.

Mr Upul Ratnayake, Assistant Rubber Chemist was on duty throughout the year.

Mr P H Sarath Kumara, Assistant Rubber Chemist, continued his study programme of MSc in Polymer Science and Technology at University of Sri Jayawardanepura and successfully completed the theory part. He started his research project as partial fulfillment of the MSc.

Mr P P Jayasinghe, Development Officer was on duty throughout the year.

Messrs C D Senanayake and T A S Siriwardane, Experimental Officers, Mrs Chandrika Nalini, Mr A K D Warnajith Prasad and Mrs V C Rohanadeepa, Technical Officers, Mrs L Ruckmanie, Store Keeper and Mrs Anusha Paranawithana, Typist/Clerk were on duty throughout the year. Mrs U M S Priyanka was transferred to the department with effect from 1st May, 2002, from the Raw Rubber and Chemical Analysis Dept.

Miss N Subasinghe, Temporary Research Assistant recruited to the NSF funded research project (RG/98/EP/01) resigned on 31st February.

Research students

- Mr T Sasikaran - Eastern University, Sri Lanaka
- Miss D H H Munasinghe - University of Colombo
- Mr. P A U M Perera - NDT student, University of Moratuwa
- Miss E Eranga Chandani - University of Colombo

Seminars/Workshops/Meetings

Officer	Subject	Organization
Mr Susantha Siriwardane	Delivered lectures on 'Raw rubber processing and rubber technology' for the Induction course on Plantation Management	NIPM

Officer	Subject	Organization
Susantha Siriwardane	Delivered lectures on Smoking and smoke houses' for Rubber Extension Officers at a refresher course	Advisory Services Department
Susantha Siriwardane	The first meeting to discuss the means of obtaining Forest Stewardship Council (FSC) certificate to rubber smallholding sector.	Sri Lanka Export Development Board
Susantha Sirwardane and Upul Ratnayake	Workshop on research project priority setting	ISNAR
Upul Ratnayake	Workshop on enhancement of productivity through Environmental Management	Ministry of Science and Technology
P H Sarath Kumara	Delivered a lecture on 'Sheet Rubber Processing' at a refresher course	Advisory Services Department
P H Sarath Kumara and T A S Siriwardane	Training programmes for tappers, factory staff and factory workers at several estates of Kegalle Plantations Ltd.	Kegalle Plantations Ltd.

Advisory visits

Eleven advisory visits were made to raw rubber factories in connection with the factory development work and quality improvement of raw rubber.

Twenty three advisory visits were made to raw rubber factories and other industries to look into their waste water disposable problems. Suitable treatment methods based on anaerobic coupled with aerobic techniques were proposed for required industries and suitable guidelines and advice were given to improve the efficiency of the existing treatment plants.

Group processing centres (GPC's) at Eheliyagoda area and Kalutara region were visited with the officials of Advisory Services Department of RRI to provide advice and guidelines to improve these centres to manufacture good quality RSS.

Industrial visits

Following industries were visited by Research Officers of the department in view of strengthening the relationship between RRI and rubber products manufacturing industries and also to initiate collaborative research projects beneficial to the industries. The third countries expert from India Prof. D J Francis who was assigned to re-organise the Chemistry departments under the JICA grant aid programme, also participated to strengthen the RRI team.

1. Trellerborg Company Limited - Industrial tyres
2. Asia industries - Foot wear
3. Loads Star Company Limited - Industrial tyres
4. Microcells Company Limited - Floor mats
5. Lalan Rubbers. - Rubber gloves and rubber bands
6. Richard Peries Comp[any Limited - Tyre retreading and other rubber products

Implementation of ISO 9000 Quality Assurance Scheme

Two Management Review Committee meetings were held during the year to review the Quality Management System (QMS) of the Dartonfield rubber factory. Four internal quality audits were also conducted during the year. Messrs K Herath, Assistant Biometrician and D J Edirisinghe, Assistant Economist were given the task of monitoring the QMS.

Several internal quality audits were carried out at Bo Seang Cey (Latex) Limited, a household and industrial glove manufacturing company at Katana and Busan Dipping Ko Lanka Limited, a balloon manufacturing company. Dr W M G Seneviratne and Mr Sarath Kumara attended few MRC meetings held at these two factories. Adequacy audits and trial audits have been conducted by Sri Lanka Standards Institute (SLSI) for both companies after applying for certification and the two firms were ready for the compliance audit to be conducted by the SLSI.

Mr P H Sarath Kumara conducted an internal Quality Audit at Padukka rubber factory with Mr Jehan Perera, Superintendent, Dartonfield estate.

Effluent treatment and disposal

Construction work of five treatment plants based on anaerobic coupled with aerobic treatment technique was continued at five raw rubber manufacturing factories.

Sample testing

One hundred and eight waste water samples from various industries were tested in the laboratory, and sixty nine certificates were issued to relevant industries to enable them to forward to the Central Environmental Authority of Sri Lanka.

LABORATORY AND FIELD INVESTIGATIONS

Generation of bio - gas from skim rubber

Analytical work on bio-gas composition was continued with the assistance of Refinery Division of Ceylon Petroleum Corporation under the research project (RG/98/EP/01) funded by National Science Foundation (NSF). As expected, sulphate-less skim serum yielded higher methane (CH_4) percentage in the bio-gas

generated while sulphate-rich skim serum yielded lesser amounts of methane by anaerobic digestion process. Since hydrogen sulphide gas accumulated inside the anaerobic digester was thought to be the main factor that retards bio-gas generation when sulphate-rich skim serum is digested anaerobically, experiments were planned and commenced in order to develop suitable methods to minimize accumulation of hydrogen sulphide inside the anaerobic digester (W M G Seneviratne, Upul Ratnayake, T A S Siriwardene, N Subasinghe and U M S Priyanka).

Reduction of extractable protein levels in latex based products

The NSF funded project titled 'Protective measures for the current latex protein allergy problem - A serious threat to NR industry', was continued during the year.

Natural rubber latex extracted from *Hevea brasiliensis* is a colloidal suspension in water containing 30-35% of *cis* poly isoprene, so called natural rubber and approximately 5% non rubber substances such as proteins, lipids, sugar and metals. Latex protein allergy associated mainly with latex based products is caused in certain individuals due to the contact of leachable proteins of these products with their skin. Hence, removal of extractable proteins as much as possible from latex products prior to use is vital in order to minimize the allergenicity in human skin.

Various techniques, leaching methadologies were examined for reduction of leachable proteins. The effects of the use of latices obtained from different processing methods such as double centrifuged latex, gamma irradiated latex, deprotinized latex by enzyme treatment, latex treated with water soluble polymers in latex dipped products were studied to ascertain their effect on the reduction of leachable proteins.

Different leaching techniques of dipped articles and films prepared with the above latices such as standard chlorination technique and leaching in different solutions under varying conditions too were examined to study the effectiveness of leachability of proteins in those solutions. In all these studies the standard BCA protein assay method was used to examine the extractable protein (EP) content. Some of the above samples were subjected to SDS-PAGE analysis for the identification of types of EP present.

Following observations were made from these studies.

- Different types of clones contain different levels of EP
- Heat applied during vulcanization (Pre/Post) is a factor which increases the solubility of some proteins
- Radiation vulcanization increases the solubility of some proteins.
- PVA effectively reduces EP in gloves and cast films.
- Teepol, saline (NaCl), chlorine, hot water (95 °C) effectively reduce EP
- Films prepared from different latices contain different types of proteins.

A thesis on the subject to be submitted to the University of Sri Jayawardenepura, Sri Lanka, for the degree of MPhil is being prepared by the Research Assistant assigned to carry out the project (L M K Tillekeratne, W M G Seneviratne, Kumudini Chandrasekara and C Wellappuli).

Effect of metal ions on the properties of crepe rubber

As the first step of the project the effect of iron (Fe) on the quality of bleached and unbleached crepe rubber was investigated. Results of the study showed that the colour of the fractionated bleached (FB) crepe is affected when processing water contains more than 5 ppm of total iron. It was found that the total iron content in FB crepe rubber is high compared with that in fractionated unbleached (FUB) crepe. It is interesting to note that iron(ii) has less effect on PRI while iron(iii) has a significant effect. Effect of manganese on the quality of crepe rubber was also investigated. It was found that Manganese incorporated as Mn^{+2} has no significant effect on the colour and the PRI of the resultant FB crepe, when processing water containins up to 5ppm of Mn^{+2}. The effect of other forms of manganese on quality of crepe rubber is also being investigated (Upul Ratnayake, P H Sarath Kumara, T A S Siriwardena, A K D W Prasad and C Rohanadeepa).

Quality improvement of skim rubber

A project was initiated to conduct experiments to examine the possibility of reducing the nitrogen level of skim rubber in view of improving its quality for use in the manufacture of selected rubber products.

Hence, an attempt was made to reduce the nitrogen content of skim rubber by papain treatment and by creaming of skim latex. The results of the trials showed that creamed skim latex with a DRC of about 25-30% could be made within 24 hours by incorporation of sodium algenate (Analar grade) as the creaming agent at a concentration of 0.64 %. This could not be achieved with commercial grades of creaming agents. The nitrogen content of skim rubber after coagulation of creamed skim latex was found to be reduced by 50% when compared with that made with uncreamed skim latex. Papain treatment gave no significant reduction in nitrogen content of skim rubber made with either uncreamed or creamed skim latex (W M G Senevirante, Upul Ratnayake, T A S Siriwardena, W Prasad and U M S Priyanka).

Extractable proteins in different types of raw rubber

Different types of raw rubber were analyzed for total extractable proteins (EP) by Bicinchonic acid method. The lowest levels of EP, *i.e.* < 0.05 mg/g, the limiting value of the analysis method, was found in fractionated bleached (FB) rubber while yellow fraction (YF) contained higher levels. Results also showed that crepe rubber, ribbed smoked sheets (RSS) and standard Lanka rubber (SLR)

contained less EP when compared with centrifuged latex. Therefore dry rubber and rubber products made from dry rubber do not significantly contribute to latex protein allergy problems. FB crepe is almost free of EP mainly due to the removal of YF and thorough washing during milling of rubber.

Table 1 gives the results of the EP levels of different types of NR latex while table 2 gives the EP content of different types of dry rubber.

Table 1. *Extractable proteins in natural rubber latex*

Type of latex	Extractable protein (mg/g of rubber)	
	Mean	Std.*
Field latex	4.001	1.384
Fractioned latex	0.237	0.055
Skim latex	6.946	1.369
Low ammonia centrifuged latex	0.739	0.025
High ammonia centrifuged latex	1.028	0.408

*Std - Standard Deviation

Identification of EP in different types of raw rubber was also done using Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis (SDS-PAGE) technique and it was found that the type of EP also vary depending on the method of manufacture of raw rubber (Upul Ratnayake, W M G Seneviratne, Waranajith Prasad and Chandima Rohanadeepa).

Table 2. *Extractable proteins in different types of raw rubber*

Type of raw natural rubber	Extractable proteins content (mg/g of rubber)	
	Mean	Std.*
FB crepe	<0.050	
UFUB crepe	0.163	0.057
YF crepe	0.415	0.210
RSS	0.332	0.039
Skim rubber	0.335	0.098
SLR 20	0.245	0.08

* Std : Standard deviation

Production of centrifuged latex of low extractable protein content

The project has been commenced to study the possibility of incorporation of Water Soluble Polymers (WSP) into field latex in order to reduce the extractable proteins in centrifuged latex. Centrifuged latex was prepared by incorporation of WSP in order to investigate the leachability of extractable proteins. Films of WSP incorporated centrifuged latex were analysed for the extractable proteins. EP levels in films after prevulcanisation of WSP incorporated centrifuged latex were also determined. The results are being evaluated (Upul Ratnayake, T A S Siriwardena and W Prasad).

ADAPTIVE RESEARCH

A M A Perera

SUMMARY

The studies on interplanting of rubber with tea and bee keeping under rubber smallholdings and plantations were in progress. A survey initiated to investigate the adoption level of RRI recommendations by the rubber smallholder sector was completed.

DETAILED REVIEW

Staff

Mr S M M Iqbal, Research Assistant in Agronomy proceeded to UK on 20th April to complete the split postgraduate program. Mr P P Jayasinghe, Mr A M A Perera, Mr R B Gunaratna and Mr W A D D S Wettasinghe Research Assistants and Mr E A T Senadeera Experimental Officer were on duty throughout the year.

Advisory visits

Advisory visits were undertaken to both plantation and smallholder sectors.

FIELD INVESTIGATIONS

Adaptive Research Programme

Adoption level of RRI recommendations by the rubber smallholder sector

Detail survey was completed in the regions of Kalutara (Agalawatta range), Kegalle and Ratnapura. According to the survey, it was evident that most of the growers owning mature rubber had abandoned exploiting of rubber due to its low price (R B Gunaratne, W A D D S Wettasinghe, E A T Senadeera and A M A Perera).

Bee keeping in rubber smallholdings and plantations

The above study was continued. Measures were taken to reintroduce bee colonies into boxes where the colonies had left (W A D D S Wettasinghe and L M K Tillekeratne in collaboration with Training and Extension Division, Department of Agriculture, Peradeniya).

Interplanting of Rubber lands with Tea

Productivity in Rubber/Tea systems (Kuruwita/TR 1)

Details of the above are given in the annual review of 2001. The following assessments were made during the year.

- Growth and yield of rubber and tea
- Biomass production
- Light interception
- Weather data were collected using an automatic weather station.

(S M M Iqbal, A M A Perera and S Wettasinghe).

Productivity in Rubber/Tea systems (Agalawatta/TR 2)

The above experiment was in progress. Yields of rubber and tea were monitored by test tapping and test plucking respectively (S M M Iqbal and A M A Perera).

Productivity in rubber/tea system (Vogan estate/TR4)

Experimental details are given in the Annual Review 1998. Growth of rubber plants were recorded (S M M Iqbal and R B Gunaratna).

Smallholder sector

Smallholder trials in Kegalle region were in progress. Yield data of rubber and tea were collected (S M M Iqbal and E A T Senadeera).

AGRICULTURAL ECONOMICS

J Edirisinghe

SUMMARY

A study on profitability of rainguards established in Dartonfield estate was carried out during the year. The database on auction prices was continually updated.

DETAILED REVIEW

Staff

Assistant Agricultural Economist, Mr A K B Naranpanawa was on study leave during the year continuing his postgraduate studies. Mr J C Edirisinghe was on duty through out the year.

Services

Research support

Various cost - benefit analyses, sensitivity analyses were carried out on the request of other researchers.

Data base management

Auction prices

Prices of Ribbed Smoked Sheets (RSS)

The year started with very low RSS prices well below the average RSS 1 price in year 2001. But the prices showed continuos improvement since then. By May 2002, prices of all grades of RSS came above the previous year's average price of RSS1. Normally rubber production shows a seasonal variation and the prices are expected to vary in the same manner. However, in the year 2002 prices showed continuos increase despite the manner in which production/supply varied. The year started with the gap between RSS 01(best quality) and the RSS 05 (lowest quality) being very narrow. The difference between the two prices in January was a mere Rs.2.39 per kg, which gave no incentive for the producer to produce high quality RSS that was in short supply in the country. However, the same was Rs.10.83 in December this year. In the years 2000 and 2001, the highest prices for all grades of RSS were achieved in mid of the year, *i.e.* in June. However, the peak prices were achieved a little later in the year 2002, *i.e.* in September. This may be an indication that the prices are in an increasing trend and would go a bit higher in 2003.

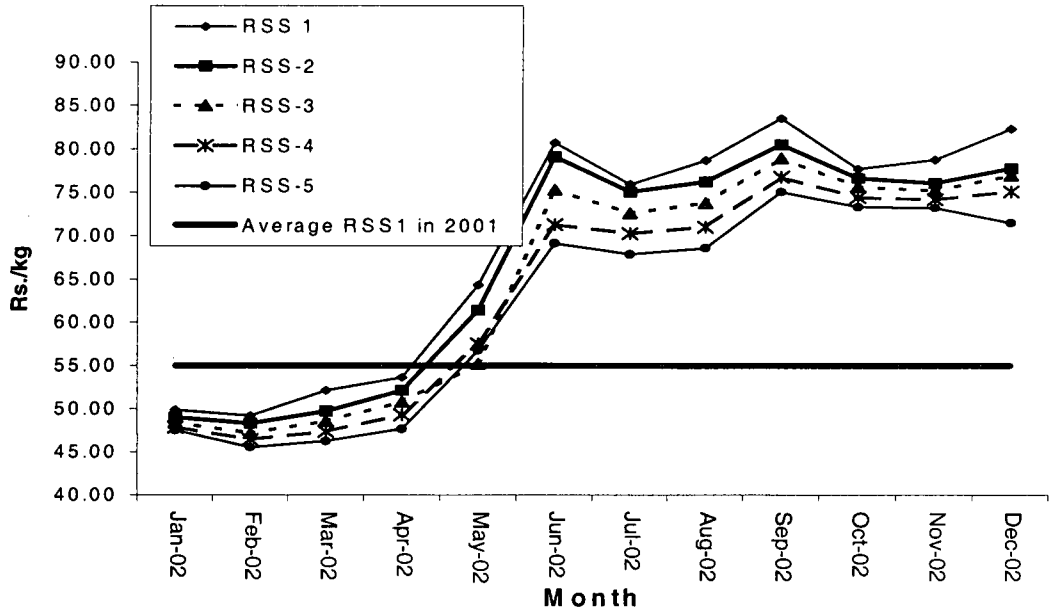


Fig. 1. Average monthly auction prices of RSS grades in the year 2002

Prices of latex crepe

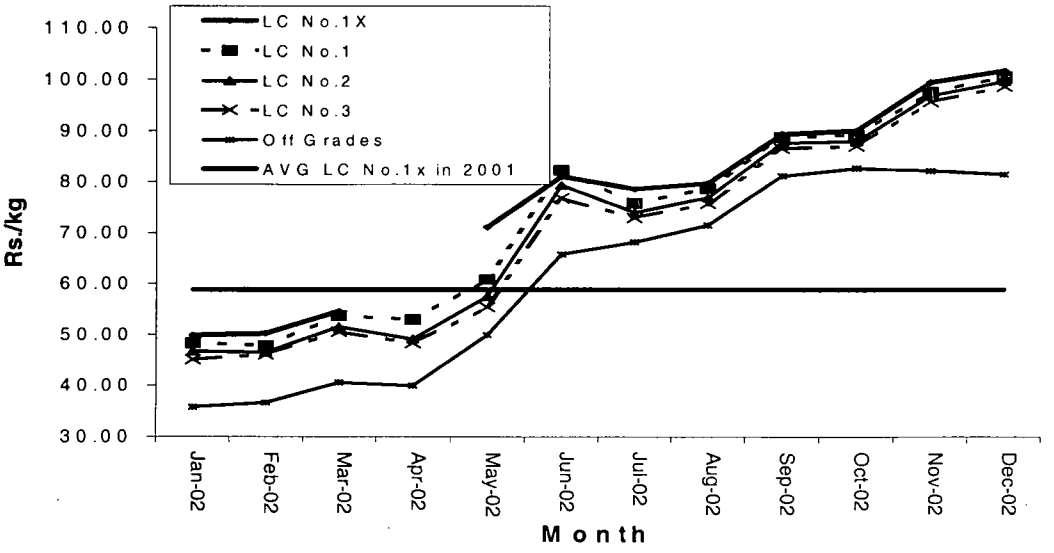


Fig. 2. Average monthly auction prices of latex crepe grades

Prices of latex crepe also showed a similar trend to that of RSS during the year 2002. It was observed that prices of all grades of Latex Crepe (LC) have gone above the average price of No.1X of the year 2001. Similar to RSS grades all prices have begun below the average LC No.1X price in year 2001 and improved thereon. Prices of all grades have gone above the 2001 average by May 2002. All grades in Latex Crepe had highest prices achieved in the month of December, where as in 2001 highest price was achieved in the middle of the year. This suggests that the prices of latex crepe is still in the increasing trend and would probably increase further in 2003.

Prices of scrap crepe

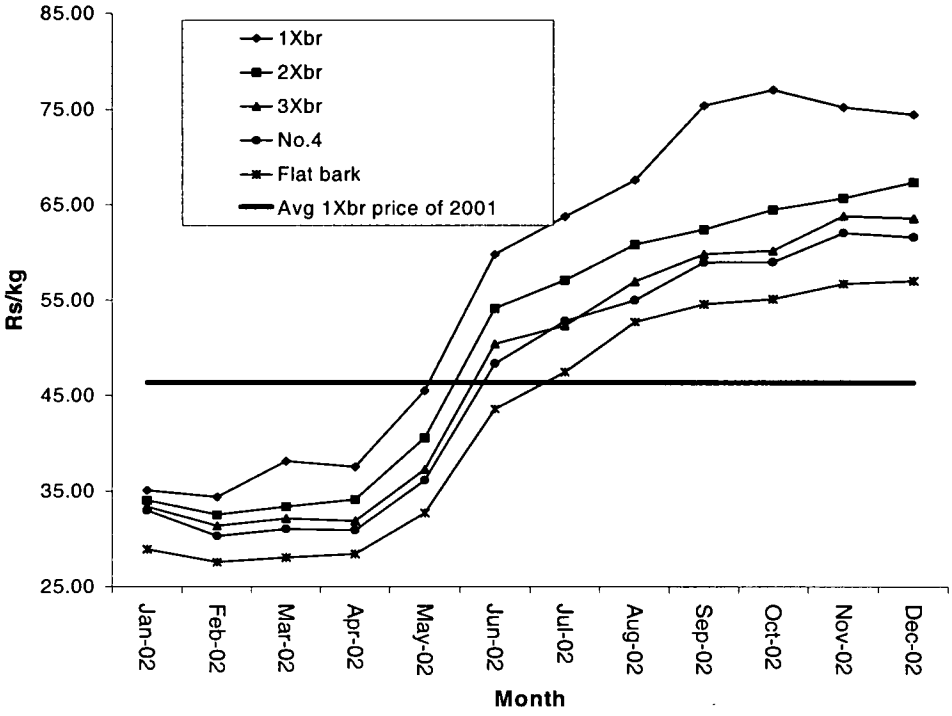


Fig. 3. Average monthly auction prices of scrap crepe

Prices of Scrap Crepe also varied in a similar manner to that of other grades of raw rubber. The average price for 1Xbr received in 2001, the best grade in Scrap Crepe, lied above all grades in 2002 up to May. As in all other cases the prices of all grades of scrap crepe increased from May 2002 and were above the average 1Xbr received in 2001. The highest price of 1Xbr (Rs.77) was achieved in October, where as highest prices of 2Xbr and flat bark was obtained in December. The highest prices

of the other two grades were obtained in the month of November. This also suggests that the prices of scrap crepe grades are still in an increasing trend, and will probably increase further in 2003.

The quantities traded during the year

The variation in quantities traded in the Colombo auction during the year is depicted in Fig. 4. It can be easily noted that the quantities offered for auction during the middle of the year is low due to rainfall received during this period of the year. It is noteworthy that the prices during the year did not follow the quantities offered for the auction. Figs. 1-3 indicate a continuous increase of prices regardless of the quantities offered for the auction.

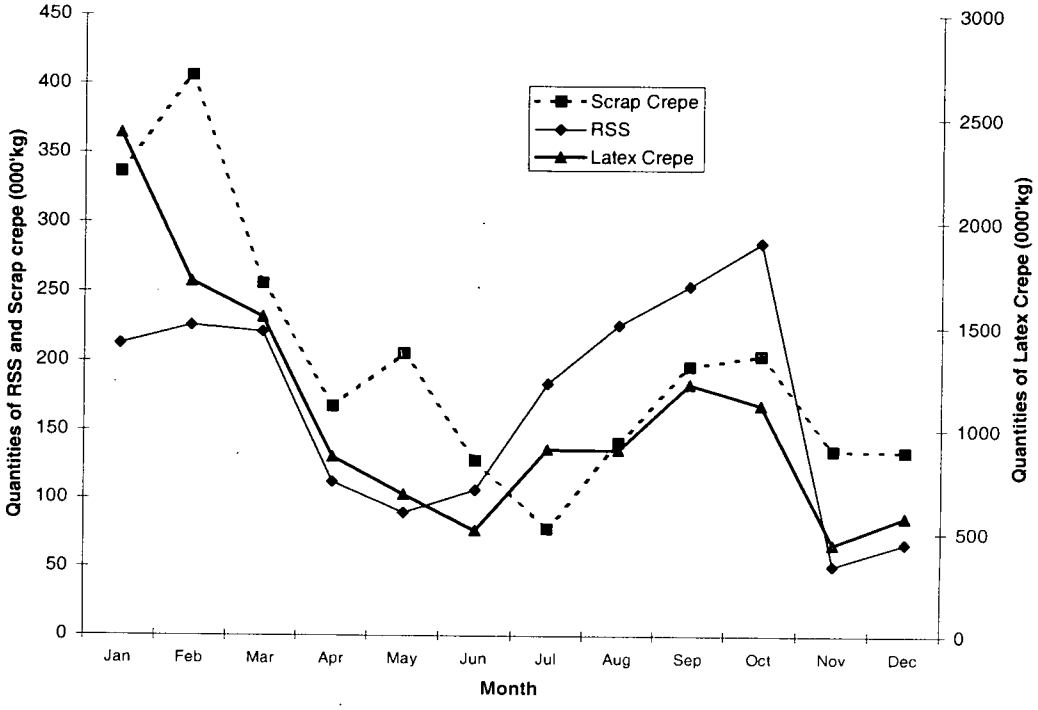


Fig. 4. Quantities traded during the year at the Colombo auction

The Total amounts of rubber offered to the Colombo auction is depicted in Fig. 5. As expected the quantity of latex crepe offered to the auction is the highest.

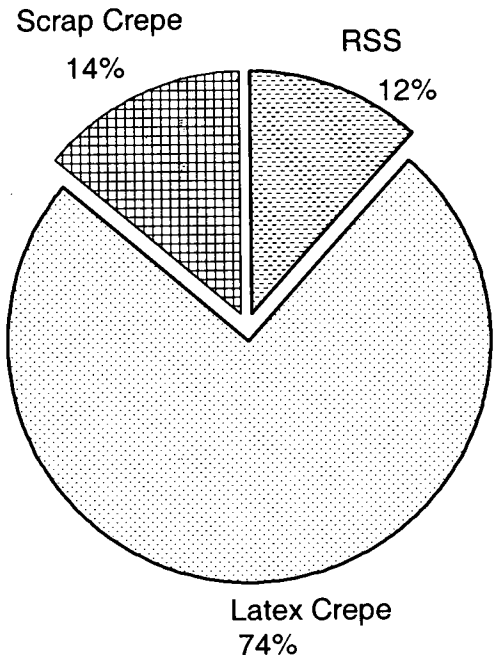


Fig. 5. Total quantities of different raw rubber grades offered to Colombo auction

RESEARCH

Profitability of rain-guards for rubber - A case study at Dartonfield estate

A cost benefit analysis on rain-guards established in Dartonfield estate in the years 2001 and 2002 was carried out. All costs incurred and returns received during each year were converted to represent values at the beginning of that year for comparison. Thus, the year 2001 showed a loss of Rs.45096.31 (Rs.6.66/tree) and 2002 showed a profit of Rs.247199.62 (Rs.29.27/tree). It was clearly evident that with correct use of technology and management, use of rainguards can generate a substantial profit. Price trends in rubber, rainfall pattern, investment costs and liquidity position of the estate are found to be the key criteria which influence the decision of investing in rain-guards.

The cost of rainguards for the year 2002 was found to be higher than the cost in 2001.

High production cost of solid type sealant, excess use of labour and inefficient use of polythene has accounted for the higher per tree cost in 2002. Prices of almost all materials were similar in both years.

Table 1. *Cost of rain-guards during years 2001 and 2002*

	2001	2002
Total No. of trees	6776	8446
Polythene	Rs.4.84/tree	Rs.7.03/tree
Labour	Rs.5.40/tree	Rs.6.85/tree
Sealant	Rs.0.79/tree	Rs.3.54/tree
Other costs	Rs.0.36/tree	Rs.0.66/tree
Total Cost per Tree	Rs.11.39	Rs.18.08

Table 2. *Details of costs of rain-guards for 6776 trees in the year 2001*

Item	Rs./Unit	Quantity	Total (Rs.)
Cost of Sealent			
China Clay	7.42/kg	37.5kg	278.25
Sulphur	30/kg	1.5kg	45.00
Kerosine Oil	18.50/lt	93.75lt	1,734.38
Rubber	25/kg	37.5kg	937.50
Tar	3017/140lt barrel	112.5lt	2,424.38
Sub Total (Rs)			**5,419.50**
Polythene	95/kg	345kg	32,775.00
Stapler Machine			
Stapler Pins			
Stitching	175/roll	13.8rolls	2,415.00
Sub Total (Rs)			**35,190.00**
Labour		296 lab/days	36,650.00
Sub Total (Rs)			**36,650.00**
Total			**77,259.50**

Table 3. *Details of costs of rain-guards for 8446 trees in the year 2002*

Item	Rs./Unit	Quantity	Total (Rs.)
Cost of Sealent			
China Clay	9.20/kg	700kg	6440.00
Sulphur	30/kg	9.5kg	285.00
Kerosine Oil	17.50/lt	315lt	5512.50
Rubber	25/kg	40kg	1200.00
Tar	3017/140lt barrel	3 barrels	9051.00
	3706.60/172lt barrel	2 barrels	7413.20
Sub Total (Rs)			**29901.70**
Polythene	95/kg	625kg	59375.00
Stapler Machine	50/Machine	4 Machines	200.00
Stapler Pins	100/pkt	10pkts	1000.00
Stitching	175/Roll	27Rolls	4375.00
Sub Total (Rs)			**64950.00**
Labour			
February		88 labour days	11093.15
March		308labour days	33282.89
April *		121labour days	13500
Sub Total (Rs)			**57876.04**
Total			**152727.7**

Profitability

Year 2001

Although it is said that the rain-guards are effective for at least nine months it is evident that this has not been the case in the year 2001. This failure is attributed to the inefficiency and the poor quality of the liquid (brushable) sealant. The net returns (Revenue – cost) are discounted to the beginning of the year to be able to be compared. The interest rate used was 15% and assumed to be fixed during the year. Therefore, if this money spent on rain-guards were saved in a fixed deposit yielding a 15% rate of interest it would have been profitable as the analysis on rain-guards show a loss of Rs.45096.31 (Table 4).

Table 4. *Costs and returns of rain-guards in the year 2001*

	March	April	May	June	July	August	Sept	Total
Cost of Rain-guards (Rs.)	78444.43							
Additional Yield (kg)		430.00	145.00	271.00	228.00	82.00	60.00	
Tapping Cost (Rs.)		7770.10	2620.15	4896.97	4119.96	1481.74	1084.20	
Manufacturing Cost (Rs.)		4020.50	1355.75	2533.85	2131.80	766.70	561.00	
NSA (Rs./kg)		58.26	58.26	51.03	51.43	45.86	52.21	
Total Cost (Rs.)	78444.43	11790.60	3975.90	7430.82	6251.76	2248.44	1645.20	
Total Revenue (Rs.)		25051.80	8447.70	13829.13	11726.04	3760.52	3132.60	
Net Returns (Profit)-Rs.	-78444.43	13261.20	4471.80	6398.31	5474.28	1512.08	1487.40	
Discount Factor	0.9634	0.9515	0.9398	0.9282	0.9167	0.9054	0.8942	
Discounted Net Returns (Profit/loss) – Rs.	-75573.36	12618.35	4202.50	5938.75	5018.36	1369.03	1330.06	**-45096.31**

Note : Tapping cost Rs.18.07/kg
Manufacturing Cost Rs.9.35/kg
Yield: Total yields of additional tapping days in all fields

Year 2002

At 15% discount rate, a profit of Rs.247199.62 was observed implying that investing in rain-guards is more profitable than saving in a fixed deposit which yields 15% annual interest. The number of additional tapping days has increased from 31 to 125 from former to the latter year. This is mainly attributed to the quality of the sealant. Further, all possible tapping days have been exploited to good effect during the year. In addition to increased tapping days, the estate has received better prices, which have also contributed to the profits. However, it should be noted that cost per tree in 2002 was very high and above the norm (Jagath Edirisinghe).

Interaction between Environment Society and Technology (INTEREST)

Mr Jagath Edirisinghe was involved in the above project undertaken by the Biometry section of the Institute.

Table 5. *Costs and returns of rain-guards in the year 2002*

	February	March	April	May	June	July	Aug	Sept	Oct	Nov.	Dec.	Total
Cost of Rainguards (Rs)	152727.74											
Additional Yield (kg)		227	1778	1082	1367	1090	1108	1111	2225	1822	907	
Tapping Cost (Rs/kg)		19.61	19.61	24.73	19.96	17.64	16.87	22.58	19.86	21.23	21.85	
Manufacturing Cost (Rs/kg)		9.32	9.32	25.28	9.33	7.39	11.98	7.42	34	8.81	20.03	
NSA (Rs/kg)		47.93	47.93	49.06	72.49	72.51	69.41	77.54	79.11	81.92	91.28	
Total Cost (Rs.)	152727.74	6567.11	51437.54	54110.82	40039.43	27282.7	31965.8	33330	119838.5	54732.88	37985.2	
Total Revenue (Rs.)		10,880.11	85,219.54	53,082.92	99,093.83	79,035.90	76,906.28	86,146.94	176,019.75	149,258.24	82,790.96	
Net Returns (Rs.)	-152727.74	4,313.00	33,782.00	-1,027.90	59,054.40	51,753.20	44,940.48	52,816.94	56,181.25	94,525.36	44,805.80	
Discount Factor	0.98	0.9634	0.9515	0.9398	0.9282	0.9167	0.9054	0.8942	0.8832	0.8723	0.8615	
Discounted Net Returns (Rs.) (Profit/Loss)	**-148979.96**	4155.22	32144.39	-966.00	54812.81	47442.98	40689.04	47230.00	49618.21	82452.34	38600.58	**247199.62**

BIOMETRY

Wasana Wijesuriya

SUMMARY

Biometry section provided necessary research support to the other Research Departments in various aspects; *viz.* experimental design, analysis and interpretation of results. Database and the meteorological station at Dartonfield were maintained satisfactorily. The personnel and project summary databases of the RRI scientists were updated. Research focusing on adoption patterns of technologies in smallholdings, performance indicators for smallholder rubber units and their distributional properties, climate change studies and developing appropriate statistical techniques for interpreting data generated from participatory studies were among the main research concerns of the biometry section.

DETAILED REVIEW

Staff

Ms Wasana Wijesuriya (Biometrician), Mr Keminda Herath (Assistant Biometrician), Ms Chintha Munasinghe (Experimental Officer) and Mr Vidura Abeywardene (Technical Officer) were on duty throughout the year.

Research students

- Ms Cristika Jayasinghe from the Faculty of Agriculture, University of Ruhuna submitted a report on "Analysis of rainfall measurements with appropriate statistical tools" for the partial fulfillment of the BSc degree in Agriculture under the supervision of the Biometrician.

Lectures, committees and training programmes

Ms Wijesuriya was involved in the following activities.

- Served as a visiting lecturer in Biometry in the Faculty of Agriculture, University of Ruhuna.
- As a member of the technical advisory committee of the Centre for Climate Change Studies (CCCS) of the Department of Meteorology.
- As a member of the national committee of socio-economists and policy analysts at CARP

Seminars/Conferences/Meetings/Workshops attended

Officer	Subject	Organization
Wasana Wijesuriya	National Committee of Socio-Economists and Policy Analysts	CARP
Wasana Wijesuriya	Workshop on "Macro-economic policies and their Impacts on the agricultural sector in Sri Lanka"	CARP
Wasana Wijesuriya	Workshop on "Priority research areas"	NASTEC
Wasana Wijesuriya	Workshop on "IPCC-TAR and climate change research for sustainable development"	LASS/MIND/ Meteorological Department
Wasana Wijesuriya	Seminar on research funded by CCCS - Presented a paper on "Effects of climate change on Rubber plantations in Sri Lanka"	Meteorological Department
Wasana Wijesuriya	First year review meeting of the INTEREST	ENPHO, Kathmandu
K Herath	Regional training programme on the application of Statistics in agricultural, medical and biological Sciences	PGIA
K Herath	Training on INFORM	PGIA
K Herath	Seminar on research funded by NSF through CCCS	Meteorological Department

Services

Statistical analysis and interpretation

Biometry section assisted other research departments in designing of experiments, statistical analysis and interpretation of experimental results. Statistical assistance is also provided to undergraduate and postgraduate students.

Database management

a) Meteorological

The Dartonfield meteorological station was properly maintained and daily measurements were entered in the database. Monthly reports were prepared and sent to the Central Meteorological Station. These data were made available to researchers and Agrarian Service Centres (C Munasinghe and V Abeywardene).

b) Management information

The personnel and project summary databases were updated for the year 2002. 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

The following studies were completed in 2002.

Technology adoption in young rubber plantations in Kalutara district

This study was carried out to study the patterns of technology adoption among smallholder farmers during the immature stage of rubber. The socio-economic factors that affect the adoption level of different technologies were studied using logistic regression approach.

Adoption of recommended clones

The study revealed that nearly 81% of the holdings are planted with clone RRIC 100. Several smallholders (18%) have recently recommended clones such as; RRIC 121 or RRIC 102. (There were only 2 holdings with clone PB 86 out of 160). An increasing interest to adopt new clones was observed by the smallholders which is depicted in the Fig. 1. The adoption rate is about 30% when the holdings planted in year 1999 were considered, which is a good indication of satisfactory diffusion.

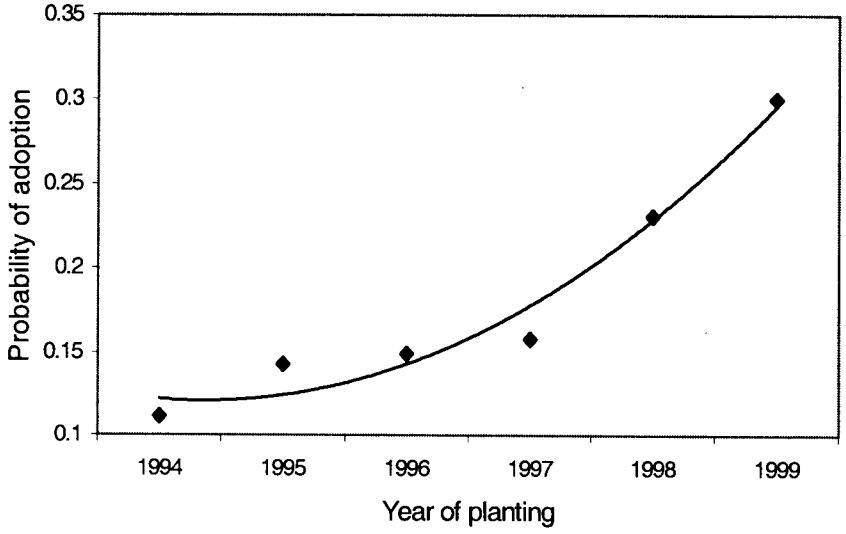


Fig. 1. Rate of adoption of new clones over the years

Adoption of poly-bagged plants

The adoption rate of poly-bagged plants was found to be 53%. However, an increasing trend of uptake is visible from Fig. 2 as nearly 70% of the recently planted holdings had plants raised by poly-bagged plants.

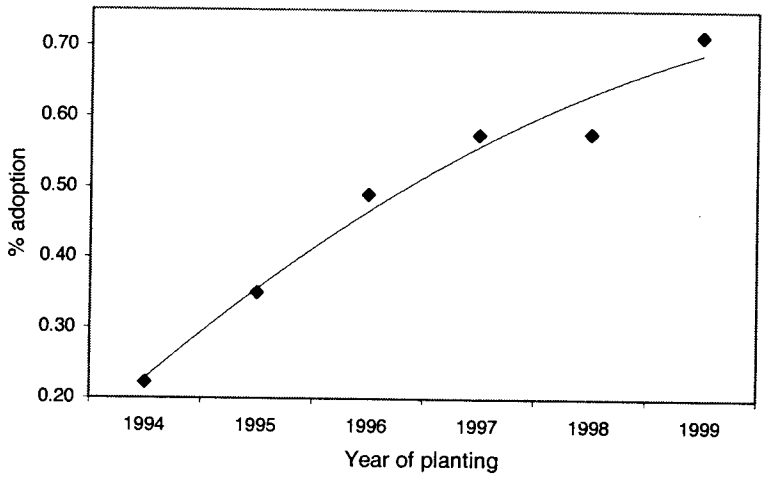


Fig. 2. Adoption rate of poly-bagged plants with time

Adoption of recommended fertilizer application

Seventy five percent of the farmers were of the attitude that fertilizer application is very important, 25% felt important and only 4% stated it is not important. The overall adoption rate of correct fertilizer application was 52%. A higher adoption rate was observed in holdings planted in year 1999 (2 years of age), which is an indication that farmers have identified the need to fertilize their immature holdings. Nevertheless, the rates of adoption in holdings which were planted in 1998, 1997 and 1996 were about 50% (Fig. 3). This may be due to the reason that most farmers were not very keen on rubber cultivation as a result of low rubber prices prevailed for a long time. In some cases the farmers would have paid less attention once the plants are established in the field. A slight increase was observed when the holdings are 6 years of age, because at that time the farmers pay more attention to bring up their holdings for tapping.

Adoption of recommended cover crop management

Among the farmers who opted to grow cover crops, *Pueraria* is the most popular with 63%, *Desmodium* was found in 18% of the fields and 19% of the fields had both types. Nearly 40% of the farmers did not use any kind of planting material to establish the cover crop. The previous cover is allowed to re-establish to form the new ground cover. Seeds were used by 31% and cuttings were used by 21%, and the rest used both seeds and cuttings.

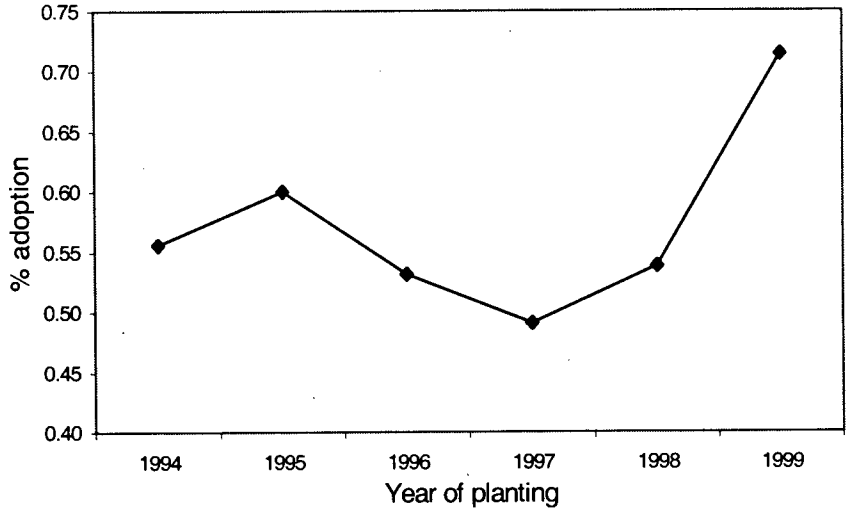


Fig. 3. Change in adoption of recommended fertilizer application with the age of plantation

Cover crops were not established in 11% of the farms due to many reasons. The reasons mentioned by the farmers were lack of awareness of benefits, lack of funds and due to floods. Although it is generally recommended to establish the cover crops before planting, only 15% practiced it. Among those who establish their cover crop after planting, 35% was able to establish during the 1st month after planting. Thirty eight percent of the sample took more than 3 months after planting of rubber. Drought conditions, lack of awareness and lack of planting material were the reasons for the late establishment.

The overall adoption rate for cover crop management was only 24% (good-10% and moderate-14%). In 22% of the fields there was no cover underneath rubber, and in 54% of the fields the cover crop was in bad condition.

Adoption of recommended weed control methods

The recommendation for weed control is to maintain a weed free environment of 1m radius around each tree during both immature and mature stages. The fields were rated on weed control as; good, moderate and bad. Subsequently, the 'good' and 'moderate' holdings were rated as adopters and the 'bad' category was rated as non-adopters. The overall adoption rate for weed control was 23%.

The adoption rates in the holdings of 3 and 4 years are very low compared to the others. There seems to be an increasing interest on weeding towards the end of the immature period and also during the initial years (1 and 2). However, except for 2 out of 160 farmers, all others practiced weed control before fertilizer application. Manual methods were employed by 81%, 4% used chemicals and the remaining 15% used both methods. The method of weeding is mainly circular with 65% of the farmers,

while 35% practiced strip weeding (Wasana Wijesuriya, Keminda Herath and Vidura Abeywardene).

Performance indicators for rubber and their distributional properties

Growth performance indices for the immature stage

The suggested growth indices are as follows.

GPI1

$GPI_{ik} = GTOB_{ik} / GTEX_{ik}$

Where $GTOB_{ik}$ = observed girth, $GTEX_{ik}$ = expected girth and GPI_{ik} is the growth performance index at age *i* of the k^{th} holding. Expected values change with the objective; *i.e.* (a) subsidy requirement or (b) reduced immature period.

GPI2

$GPI_{ik} = (GTOB_{ik} - GTEX_{ik})/SD$ of $GTOB_{ik}$

The uniformity of the stand of rubber is taken into account with an alteration of the distribution by means of subtracting the expected mean from the observed mean.

Studying the distributions of GPI1 and GPI2 are important for rubber since there may be differences in the distributions with the management practices. It also can be regarded as a risk analysis subjected to different objectives; *viz.* eligibility of subsidy payment and possibility of reducing immature period. Therefore, several continuous distributions were fitted to the constructed indices. Subsequently, the changes in distributions among different adoption categories were studied.

The index, GPI1 departed from normality. It had a positively skewed distribution, which fitted well to log Normal and Gamma distributions. GPI1 values ranged from 0.39 to 2.13. A value greater than 1 signified a rubber holding which attained the required girth based on the objective specified; which may be the required girth for the eligibility of subsidy payments or early achievement of tappable girth. GPI2 had the advantage of the uniformity of the stand included in the index. Moreover, the index followed a Normal distribution whereas the GPI1 departed from normality. GPI2 values ranged from -4.665 to 3.357, and therefore a positive value in the index signifies an above average performance.

Yield performance indices for mature rubber

Yield performance indices of any crop can be used to identify the potential farmers to introduce new technologies. In annual crops like paddy, yield performance indices are calculated by dividing the observed yield by the average yield of all farmers in a certain village. This kind of index is not applicable to perennial crops like rubber, where the sample of fields may comprise of different ages of crop, where the yield also varies with the age of crop. A yield performance index is proposed taking age of the crop also into consideration and the distributional properties of this index were also studied.

Collecting yield data in farmer surveys is a difficult task. Only a few have their own records. Further, if we ask for the number of kilograms produced by them per month or year it may confuse them and it is more likely to get unreliable data. Therefore, it was decided to ask for the number of sheets produced per day and the average weight of their sheets during a rapid sample survey in Kegalle, Kalutara and Ratnapura districts.

The index considered in this study was;

YPI = observed yield of the i^{th} holding at j^{th} age/Average yield for j^{th} age

The yield distribution with age in small-holdings in the 3 districts, was studied using the collected data. A suitable model is fitted to the collected data using Standard Curves directive in Genstat 5. Among several rational and exponential models with right sense, the quadratic by quadratic fit the data with 97% of the variance is accounted by the model and a residual mean square of 0.1147. The quadratic by quadratic model that fits the data is:

Yield = A + (B + C*X) / (1 + D*X + E*X*X)

Where X is the year of tapping. The values of parameter estimates and their standard errors are presented below. The fitted model is depicted in Fig. 4.

Parameter	Estimate	Standard error
A	1.72	0.8130
B	4.577	0.871
C	0.0571	0.0190
D	-0.0863	0.0112
E	0.0043	0.0004

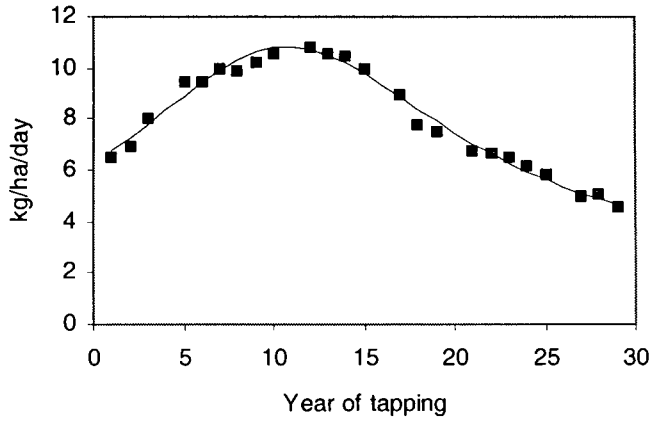


Fig. 4. The fitted quadratic by quadratic model to yield data of smallholder units

The distribution fitting was carried out in Genstat 5, employing the theoretical distributions.

The high deviances observed in all 3 cases suggest that the YPI depart significantly from the normality. Log-Normal distribution was found to be the best fit for all the districts. The fitted log Normal distributions to YPI of 3 districts are given in Fig. 5 (Wasana Wijesuriya).

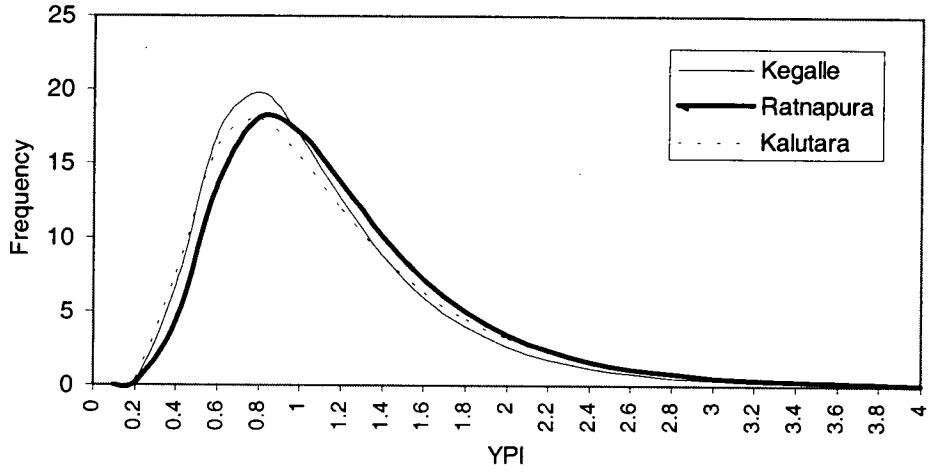


Fig. 5. Fitted log Normal distributions to YPI in 3 districts

Climate change studies

The project funded by NSF through Centre for Climate Change Studies titled "Effects of Climate Change on Rubber Plantations in Sri Lanka" was completed and the report was submitted to the NSF. The conclusions drawn and recommendations are presented below.

Total annual rainfall

a) Long term annual rainfall values showed significant declining trends in Peradeniya, Aranayake, Matara, Nalanda, Ambanpitiya, Galle, Avissawella Matale and Okkampitiya.

b) Random fluctuations in annual rainfall were observed in Agalawatta, Badulla, Kalutara, Ratnapura, Kurunegala and Hanwella with no significant trends.

c) Time series analyses suggested that no cyclic patterns in rainfall except for Agalawatta which exhibits a 10 year cycle.

d) Analysis of annual rainfall under different scenarios suggested that during the period 1981 to 2000, majority of the locations indicated negative deviations indicating decreased rainfall during this period.

Variations in different months

a) Significant declining trends were observed in March for Avissawella, Agalawatta, Ratnapura, Galle, Ambanpitiya, Aranayake and Matale.

b) Declining behaviour in rainfall was observed for December in Ambanpitiya, Aranayake, Peradeniya, Nalanda and Kurunegala.

c) No significant trends were identified in Hanwella, Kalutara and Badulla for any of the months.

d) Although, significant declining trends were observed, the magnitude was small. Therefore, further analyses are needed for different time scenarios to compare the trends.

Start and end of rainy seasons

a) The earliest start date ranged from 23rd February to 24th April in the LCWZ areas. The start dates of selected locations in the mid country areas ranged from 09th April to 13th May. An early start was observed in LCIZ areas; 24th and 29th March, respectively in Okkampitiya and Kurunegala. The rainfall data in the station at Nalanda (MCWZ) indicated a fairly early start on 30th of March.

b) The end of rains in LCWZ areas ranged from 01st July to 25th July. The earliest end date was observed in Ambanpitiya. In the MCWZ, the earliest end date was noted on 18th June at Matale. In Peradeniya and Aranayake areas, the end dates were 27th June and 01st July, respectively. The end dates of the first rainy season at Okkampitiya (LCIZ) was 2nd May. At Kurunegala (LCIZ), it was 07th July. In Nalanda area (MCIZ) a very early end date was detected which was 30th April.

c) Variability in start date for the 2nd rain spell for different locations is comparatively high when compared to the 1st rain spell. The average start date varied from 09th July at Ratnapura to 15th September at Galle. In MCWZ areas, the start dates ranged from 02nd September at Aranayake to 27th October at Peradeniya.

d) The end of rains in LCIZ ranged from 07th November to 20th December. Hanwella end dates showed very high variability. In the MCWZ areas, the end dates ranged from 22nd November to 06th December. The end of rains at Nalanda (MCIZ) extended to 03rd January.

Temporal variation in start and end dates in different locations

a) At Avissawella after 1994, a late start and an early end was observed for the 1st rain spell.
b) In the Ambanpitiya area, the start of the first rain spell was found to be fairly late during the last 4 years. Moreover, the length of the first spell seemed to be narrowing towards the year 2000.
c) Any marked shift was not identified in other locations.

Marked variations were not observed for rainfall in rubber growing areas as well. However, it is important to note any departures from the normal trend as these will be useful to find out adaptation measures with respect to the productivity of a certain crop.

Based on probabilities associated with wet weeks and dry spells, this study identified suitable periods for different farming operations; namely, clearing, holing, planting, fertilizer application, disease control and other operations such as; rain guarding in rubber plantations. Moreover, appropriate statistical methods were employed in this study (Wasana Wijesuriya, Keminda Herath, Vidura Abeywardene and Tharanga Vidyawardene).

The following studies are in progress.

Interactions between the Environment, Society and Technology (INTEREST)

This project is funded by the European Commission and will be carried out in 5 different eco-systems in Asia. The Sri Lankan component is the smallholder sector of rubber. The following were carried out during the year under review.

1. Preliminary discussions at RRI from 28th April to 02nd May and field visits in Kalutara and Ratnapura areas with European members
2. Organizing a 10 day workshop on "Participatory Interaction in Development"
3. A rapid sample survey in Kegalle, Kalutara and Ratnapura districts to collect basic information to derive the sampling plan for the detailed household survey
4. Participatory studies in 3 villages; one in each district selected
5. Case studies with stakeholders of the smallholder community

The results are presented in 6-monthly progress reports and annual reports. The first year's results were presented in the 1st review meeting in December.
The project details are available from the project homepage:
http://www.rothamsted.bbsrc.ac.uk/aen/interest/index.htm
(Wasana Wijesuriya, Mahinda Wijeratne (University of Ruhuna), D M A P Dissanayake, L M K Tillekeratne (Principal Contractor), Keminda Herath, Jagath Edirisinghe and Vidura Abeywardene).

Climate change studies funded by the Ministry of Environment and Transport

a) Senior research programme: Impact of climate change on land productivity of rubber, possible adaptation measures and the role of rubber plantations as a mitigation option
   This study is being conducted in collaboration with the Department of Soils and Plant Nutrition (L Samarappuli and W Wijesuriya).

b) Junior research programme: Impact of climate change on yield of rubber.
   The preliminary work including literature survey and data collection were done during the latter part of the reporting year (K Herath and W Wijesuriya).

LIBRARY AND PUBLICATIONS

S U Amarasinghe

SUMMARY

Main functions of the Library and Publications Section such as maintaining and publishing of Institute's regular publications and collecting and disseminating of information on rubber and related areas were carried out throughout the year.

Staff

Mr S U Amarasinghe, Librarian and Publications Officer, Mrs Thilaka Dantanarayana (Colombo Office) and Mrs Ramani Amaratunga, Library Assistants and Assistant Publications Officers, Mr P M Prema Jayantha, Clerk/Typist and two Library Attendants were on duty throughout the year.

Seminars and workshops

Librarian and Publications Officer attended the following.

- The AGM of the Sri Lanka Library Association at Hotel Galadari on 28.06.2002.
- Two AGRINET librarian's meetings at CARP office on 18.01.2002 and 30.08.2002
- SLISTINET meeting at NSF on 01.02.2002

Resource development activities

The book strength increased up to 5071. Twenty one journals were received on exchange basis and due to financial constraints, the library subscribed to a few journals only.

Publications

The following publications were processed and published during the year.

RRISL Journal Vol.83 (2000) and Vol.84 (2001)
Rubber Puwath Vol.22 (1999)
Advisory Circular - අතුරු ගොඩ වගාව
Annual Report 2001
Cumulative Index of the RRISL Journal Vol.75-84
Cumulative Index of the RRISL Bulletin Vol.33-42

Training

Mr N L D Linton attended the training course on book binding and conservation conducted by the National Library from 23.08.2002 to 26.08.2002.

Equipments

The following equipments were received by the library during the year.

- The binding table
- Stool
- Paper cutter and other binding tools (donated by the National Library)

Inter-library co-operation activities

The Inter-library loan service, Content page service and Literature search service were continued for the benefit of RRISL library users as well as other AGRINET member users.

DARTONFIELD GROUP

J Perera

SUMMARY

The mature and immature extents of the Dartonfield Group were 186.59 and 49.29 hectares respectively during the year.

A crop of 164006 kg. representing a YPH of 879.0 kg. which is an increase of 41.2 kg. over the last year was harvested.

COP for the year was Rs.54.25 per kg. When compared with the last year it had increased by Rs.5.38 though the crop harvested for the season is 3% above the previous year. The reason for same is due to a wage increase by the Government in July 2002. The Group made a profit of Rs.13.86 per kg.

Average intake per tapper was 7.2 kg. This is an increase of 0.6 kg. over the last year.

The Annual rain-fall was 4153.17 mm. The wet weather conditions distributed evenly throughout the year were unfavourable for harvesting of crop.

The Cost of Production and the Net Sale Average for the year were Rs.54.25 and Rs.68.11 per kg. respectively.

DETAILED REVIEW

Staff

Mr Jehan Perera, The Estate Superintendent, Mr K K P Gunawardena, Senior Clerk, Mrs C Dissanayake, Mr A K D Wickramasinghe and Mrs S I K Patirage, Junior Clerks, Mr D S K Ranaweera, Rubber Factory Officer, Mr W D D Senanayake, Assistant Factory Officer, Mr J A Wimalasena, Mr S K S de Silva, Mr T. Somaratne and Mr N L D Reggie, Field Officers, Mr H M Jayantha Premalal, Assistant Field Officer, Mr J K Nakandala, Mr K A Sarath Kumara, Mr B M Siriwardena, Mr N L D Nihal, Mr A B Nakandala, Mr N V U S Vijitha Kumara, Junior Assistant Field Officers and Mrs C S Hettiarachchi, Creche Attendant, were on duty throughout the year. Mr P Kannangara Chief Clerk retired in May 2002.

The group cadre stood at 22 at the end of the year, made as follows:

Senior staff	01
Assistant staff	18
Minor staff	03
Total	22

Hectarage summary – Dartonfield Group

A summary of the hectarage is given in Table 1.

Table 1. *Land distribution in Dartonfield group*

	Dartonfield	Gallewatte	Nivitigalakele	Total
Mature areas	32.67	133.97	19.95	186.59
Immature areas	6.35	25.92	14.30	46.57
Budwood Nurseries	6.54	-	2.00	8.54
Seedling Nurseries	0.73	-	5.69	6.42
Uprooting areas	-	5.13	11.93	17.06
Abandoned 53/54	-	-	3.06	3.06
Difference in field	-	-	2.70	2.70
State land taken	0.27	-	-	0.27
Paddy/Deniya	-	1.22	-	1.22
Waste land	0.19	0.18	-	0.37
Earth-slipped area	3.01	1.26	2.62	6.89
Jungles	0.80	-	0.71	1.51
Rock/Streams	2.14	4.74	2.17	9.05
Buildings	18.67	5.07	7.79	3.153
Roads	2.92	6.86	0.32	10.10
Others – Total	35.27	24.46	38.99	98.72
Grand Total hects.	74.29	184.35	73.24	331.88
Grand Total acres	183.57	455.53	180.98	820.08

Crop

A total crop of 164006 kg. was harvested from an extent of 186.59 ha. during the year. This was 93% of the estimated crop of 175950 kg.

The yield per hectare for the past 5 years is given in Table 2 for the entire group and separately for each division.

Table 2. *The yield per hect. (YPH) in Dartonfield Group from 1998 to 2002*

Division	Year				
	1998	1999	2000	2001	2002
Dartonfield	790	649	730	764	1218
Gallewatte	926	713	828	890	815
Nivitigalakelle	1106	858	885	657	754
Group average	965	728	820	838	879
Group estimate	979	926	1093	901	943

Dartonfield crop had increased by 59% than the previous year due to fixing of Rain guards.

Table 3. *The yield per hect. recorded during the year division wise*

Month	Dartonfield	Gallewatte	Nivitigalakelle
January	96	130	145
February	79	107	86
March	62	52	46
April	78	29	32
May	86	11	07
June	105	45	40
July	120	97	78
August	126	96	79
September	123	108	79
October	103	29	32
November	111	37	42
December	128	74	89

Around 32 and 35% of the annual crop has been harvested during the first and third quarters respectively (Table 3).

Tapper productivity

The average intake per tapper for the last 5 years division wise and for the entire group are given in Table 4.

The intake per tapper could have improved further, if not for intermittent wet weather prevailed throughout the year (Table 4).

Table 4. The average intake per tapper (Kg) division wise for the last five years

Division	Year				
	1998	1999	2000	2001	2002
Dartonfield	7.4	8.5	6.8	7.2	7.1
Gallewatte	7.9	7.5	7.2	8.0	7.8
Nivitigalakelle	6.5	5.6	5.0	4.6	4.4
Group average	7.3	7.7	6.9	6.7	7.6

Table 5. *Vacant blocks recorded in Dartonfield group*

Division	No. of vacant blocks	Percentage
Dartonfield	285	15
Gallewatte	5057.5	18
Nivitigalakelle	1027.5	21
Total	6370	19

The most pressing problem the group experienced during the year was the large number of vacant blocks which caused a remarkable short-fall in crop in all three divisions (Table 5). Percentage of village tappers amounts to 65% and during paddy cultivation and harvesting seasons their out-turn drops drastically..

Tapping cost

Taping cost has increased despite increase in tapper productivity due to increase in labour wages (Table 6).

Table 6. *A breakdown in total tapping cost for last 3 years*

	Cost (Rs.)		
	2000	**2001**	**2002**
Tapping	17.21	16.62	17.78
Double tapping	.47	.50	.67
Kanganies	-	.02	
Over kilos	.63	.88	.73
Scrap pay	.09	-	
Incentive to field staff	.01	0.2	0.08
Curing shed labourer	.02	.03	.09
Total	18.43	18.07	19.35

Rainfall

Total rainfall recorded at Dartonfield, Gallewatte and Nivitigalakele amounted to 3616.23 m., 5093.10 m and 3750.18 mm on 219, 167 and 195 days respectively (Table 7).

Table 7. *Annual rainfall and the number of wet days for the last 5 years*

	Year				
	1998	**1999**	**2000**	**2001**	**2002**
Rainfall (mm)	5790.1	4903.9	3586.2	4144.5	4153.17
Wet days	184	194	176	199	194

Tapping days

Dartonfield division had tapped 330 days this season through the use of rainguards (Table 8).

Table 8. *The number of tapping days, average intake per tapper and yield per hectare for the last 04 years in Dartonfield Group*

	Year			
	1999	**2000**	**2001**	**2002**
1. Tapping days				
1.1 Normal	186	208	204	322
1.2 Late	11	13	17	15
1.3 Double	25*	6	03	20**
1.4 No	168	144	144	111
2. Average intake tapper (kg.)	7.7	6.9	6.6	7.2
3. YPH (kg.)	728	820	838	879

* Dartonfield division
** Gallewatte division

Manufacture

The latex Grade I percentage remained same as for the previous year (Table 9).

Table 9. *The details of the crop manufactured during the year*

Grade	Quantity	Grade %	Latex %	Scrap %
Crepe No.1	129568	79	87	10
Crepe No.3	13863	9	9	-
Scrap Crepe No.1	10046	6	-	72
Scrap Crepe No.2	3500	2	-	25
Scrap Crepe No.3	391	-	-	3
Smoke Sheets No.1	6386	4	4	
Smoke Sheets No.2	252	-	-	

Cost of production and profitability

C.O.P. for the season was Rs.54.25 and N.S.A. Rs.68.11. The estate made a profit of Rs.13.86 per kilo (Table 10).

Table 10. *Labour Rate (Rs) and a break-down of the Cost of Production (Rs./kg.)*

	1998	1999	2000	2001	2002
1. Labour Wage/day (Rs.)	109.25	109.25	112.70	119.70	147.35
2. COP	43.25	45.22	49.20	48.90	54.25
2.1 Tapping	17.24	17.08	18.43	18.07	19.35
2.2 Manufacture	8.75	7.98	8.79	9.35	11.12
2.3 General charges	11.21	12.01	13.21	13.20	16.87
2.4 Upkeep	6.05	8.15	8.77	8.28	6.91
3. N.S.A.	53.45	44.81	58.44	48.19	68.11
4. Profit	10.20	(0.41)	9.24	(0.71)	13.86

NB: Labour rate per day for the year was Rs.109/- + an additional incentive of either Rs.22/- per day depending on the attendance.

Table 11. *Comparative statement of the mature extent, profit per kg. and profit per hectare*

	Year			
	1999	2000	2001	2002
Mature Extent	190.26	185.69	189.17	186.59
Total Profit (Rs. Million)	(0.06)	1.40	(.0.11)	2.2
Profit/Ha.Rs.	(298.62)	7580.79	594.87	12182.45

KURUWITA SUB STATION

S A R Samarasekera

SUMMARY

The total and planted extents of the estate were 99.60 and 88.46 hectares respectively. 48.83 hectares were in bearing during the year.

A crop of 65,377 kg. was harvested during the year which was an increase of 63% over the estimated crop.

The yield per hectare (YPH) and the average intake per tapper were 1357.7 and 9.6 kg. respectively.

The average number of normal, late, double and no tapping days were 252,36,32 and 77 respectively.

The annual rainfall was 2743.2 mm. with 65 wet days as against 3324.5 mm. with 134 wet days during the last year.

The cost of production and net sale average for the year were Rs.31.94 and Rs.53.93 per kg. respectively. The profit per kg was Rs.21.99 and profit made for the year was Rs.1,437,640.23. The total profit inclusive of tea, cinnamon and sundry income was Rs.2,295,335.58.

DETAILED REVIEW

Staff

Mr Anusha S Perera, Visiting Superintendent, Mr S A R Samarasekera, Assistant Estate Superintendent, Mr D S Jayasinghe, Clerk, Mr V G D N Gunaseela, Junior Assistant Field Officer and Mr D M Gunasena, Field Supervisor were on duty throughout the year

Mr J R C Jayalath was appointed as Junior Assistant Field Officer with effect from 25th March and he was promoted to the Post of Assistant Field Officer with effect from 26th September.

The estate cadre stood at 5 at the end of the year made as follows:

Intermediate staff	01
Assistant staff	03
Minor staff	01

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	48.83
Immature area	36.04
Nurseries	0.84
Tea revenue area	1.75
Paddy areas	1.00
Building gardens and roads	9.13
Water tank	0.01
Unsuitable for planting	2.00
	99.60

A total crop of 65,377 kg was harvested from an extent of 48.83 hectares during the year. When compared with the actual of the last year, this is an increase of 20,878 kg. The yield per hectare (YPH) for last 5 years is given in table 2. The average yield per hectare of the estate has increased by 34% from that of the previous year. Also it was higher than the estimate of the year.

Table 2. *Yield per hectare (kg) recorded from 1998 to 2002*

	Year				
	1998	**1999**	**2000**	**2002**	**2003**
Estimate	544.5	740.7	855.0	867.2	819.0
Y.P.H.	546.7	799.6	1,012.2	1,015.0	1,357.7

Table 3. *The YPH (kg) recorded during each month during the year*

Month	Y.P.H. (Kg)
January	176.2
February	118.5
March	85.7
April	46.8
May	40.1
June	102.7
July	130.0
August	144.8
September	142.1
October	96.9
November	117.2
December	157.7

The average intake per tapper during the year was 9.6 kg. This is an increase of 1 kg over the last year.

Tapping cost

The tapping cost of the estate has decreased by 4% than the previous year.

Table 4. *A break down of total tapping cost during last 2 years*

Cost item	Cost/kg (Rs.) and Year	
	2001	2002
Tapping	15.41	14.42
Double tapping	0.35	0.47
Over kilos	0.46	0.68
Overtime on tapping	0.16	0.11
Extra pay to Kangany	0.01	0.02
Scrap	0.18	0.22
Total	16.57	15.92

Rainfall

Rainfall figures for years 2002 and 2001 are given below in Table 5.

Table 5. *Rainfall (mm) distribution during 2002 and 2001*

	Year	
Month	2002	2001
January	80.1	340.3
February	172.6	122.0
March	196.2	144.6
April	197.2	396.2
May	346.1	361.1
June	199.1	220.3
July	154.4	255.3
August	214.3	65.5
September	125.4	435.4
October	586.2	395.4
November	194.7	462.7
December	281.4	125.4
Total	2,743.2	3,324.2

During 2002 the highest rainfall was recorded in the month of October which was 566.2 mm.

Tapping days

When compared with last year there was an increase in both normal and late tapping days. The number of non-tapping days have deceased from 140 to 77 during the year.

Table 6. *The number of tapping days, average intake per tapper and yield per hectare for the last four years*

	Year			
	1999	**2000**	**2001**	**2002**
1. Tapping days				
1.1 Normal	162	196	193	252
1.2 Late	28	44	32	36
1.3 Double	(17)	(45)	(19)	(32)
1.4 No tapping	155	126	140	77
2. Average intake per tapper (kg)	9.2	8.6	8.6	9.6
3. Yield per hectare (kg)	799.6	1012.2	1015.0	1357.7

Cost of production and productivity

The cost of production has increased by Rs.2.08 per kg when compared with the previous year.

Table 7. *Labour rate (Rs.) and a break down of the cost of production (Rs./kg.)*

	1999	**2000**	**2001**	**2002**
Labour rate	95.00	98.00	98.00	109.00
Total C.O.P	31.11	36.49	34.02	31.94
Tapping	14.63	16.36	16.57	15.92
General charges	13.12	14.39	12.01	12.37
Upkeep	2.66	3.92	3.58	3.14
N.S.A.	36.96	49.75	46.68	53.93
Profit	5.85	13.26	12.66	21.99

Labour rate per day for the year was Rs.109/- plus an incentive of Rs.22/- per day depending on the out-come.

Table 8. *Comparative statement of the mature extent profit per kg. and profit per hectare*

	Year			
	1999	**2000**	**2001**	**2002**
Mature extent (Ha.)	40.50	43.25	43.83	48.83
Total profit (Rs.)	199,502.55	580,509.54	563,357.34	1,437,640.23
Prof/Ha. (Rs.)	4,925.99	13,422.18	12,853.24	29,441.74

During the year 2002 a profit of Rs.21.99 on a kilogram and Rs.29,441.74 per revenue hectare were recorded.

Replanting

The replanting programme for the year was completed.

Fertilizer

Fertilizer application for mature and immature fields were carried out as scheduled.

Tea

A crop of 24,228 kg was harvested during the year which was an increase of 35% over the estimated crop for the same period.

The cost of production and the net sale average for the year were Rs.15.28 and Rs.22.38 per kg respectively. The profit per kg was Rs.7.10 and the profit made for the year was Rs.171,989.57.

Cinnamon

13,403 cinnamon sticks were sold at the rate of Rs.6.26 per stick and an income of Rs.83,902.78 was generated during the year.

Meteorological Summary – 2002
Dartonfield Station

Wasana Wijesuriya

A total of 3619 mm of rain experienced during the year, compared to the pervious year and long-term average of 3478mm and 4160mm respectively. The distribution showed considerable deviation from the usual bimodal pattern as shown in Fig.1. The highest rainfall, which is 812 mm, was during October. This is a difference of nearly 336 mm from the long-term average of this month.

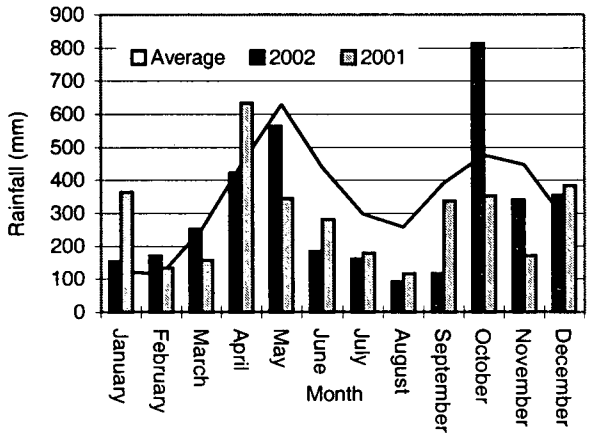
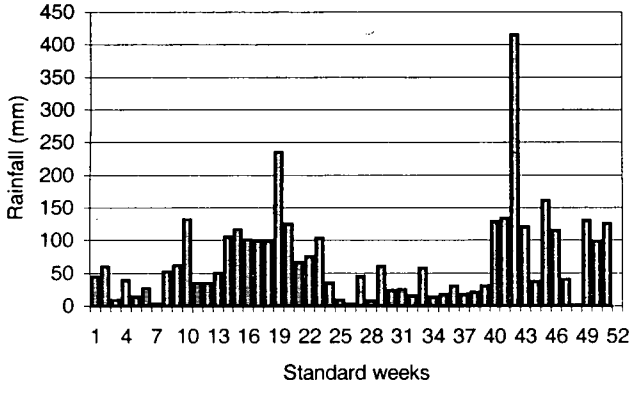


Fig.1. Monthly variation in rainfall

Fairly dry weather was observed during January to February and June to September of the year. Below average rainfall values were observed during May to September and November when compared to long term averages of these months.



The lowest rainfall (90 mm) was observed in August. The distribution of weekly rainfall is illustrated in Fig.2. Seven dry weeks were observed during the year. The highest rainfall experienced during the 42nd standard week (Mid October), which coincided with the North East monsoon.

Fig. 2. Weekly variation in rainfall

Onset of rains

Defining the onset of rains is not easy due to the wide variability of the rainfall pattern in Sri Lanka. Such a definition depends on the particular purpose as well. A rainy day is defined as having a rainfall greater than 0.5mm although an agricultural rain is defined as; having a rainfall greater than 0.3mm per day. The start of rains is defined using three specific components as follows.

a.) The onset of rains is considered, after a stated date; 1st March and 1st August for South West (SW) rains and North East (NE) rains, respectively.

b.) A potential start date will be the first occurrence of at least 30mm of rain summed over 3 consecutive days. At least two out of 3 days should be rainy.

c.) The potential beginning could be a false start if there is a seven-day dry spell within next twenty days after potential start.

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 (1964-2000) for SW and NE rains, respectively. For the year under review, SW rains commenced successfully by 5th March whereas the onset of NE rains occurred by 01st September at Dartonfield. Early onsets of rains were observed in both season compared to the 80% expected dates.

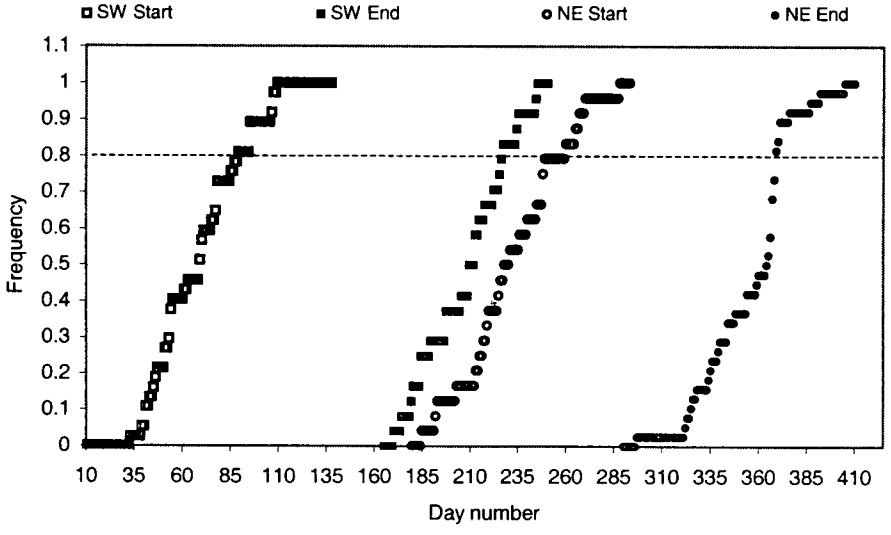


Fig.3. Cumulative probability of the start and end of rains in the two major rainy seasons at Dartonfield

Cease of rains

The date of the end of rains is also difficult to decide due to the intermittent and patchy nature of rains in the Island. The definition of the cease of rains also depends on the particular application. The components that define the cease of rains are as follows.

a) The end date of rains is considered as a stated date after 1st July and 15th January for SW and NE rains, respectively.
b) The first five day dry spell is considered as a potential end of rains.
c) This day is a false one, if the total rainfall over next 20 days exceeds 100mm.

According to Fig.3, rains have ceased in the long-run by 14th August and 05th January for SW and NE rainy seasons, respectively (80% expected). For the year under review SW rains ceased by 13th June whereas NE rains ceased by 23rd December, which can be identified as early ends of rains.

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. However, further research and analyses are needed to come into a conclusion.

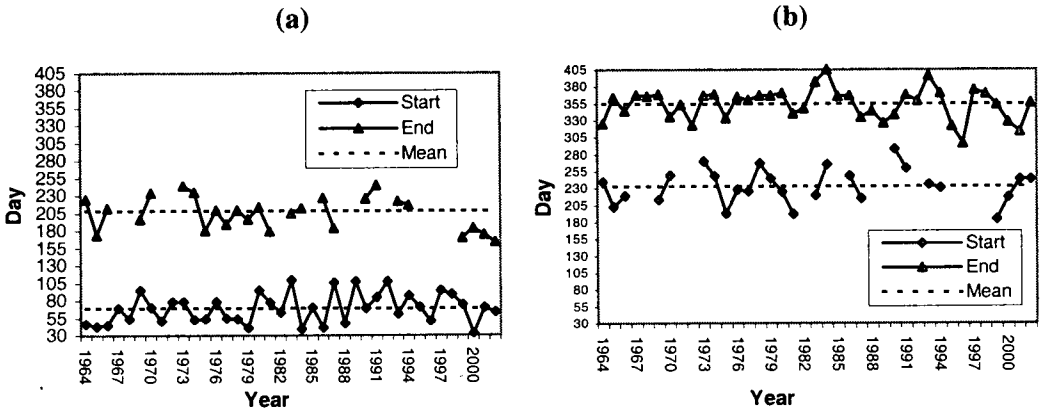


Fig.4. The start and the end of the SW rains (a) and NE rains (b) over 39 years

During the past 39 years, in 13 years, the end of SW rains and onset of NE rains could not be identified due to the continuous rainfall received at Dartonfield. The median length of SW rains is 139 days whereas it is 122 days for NE rains. In year 2002 the respective lengths of SW and NE rains are 100 and 113 days, which are shorter compared to median lengths.

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 231 with 5 months exceeding 20 rainy days. In year 2001 this was 214 rainy days

with 3 months exceeding 20 rainy days. In November 6 days have exceeded 50mm of rain per day.

Intensity of rainfall

High intensity showers are common in the SW monsoon. During the year incidence of high intensity showers were more than that of the last year. The highest rainfall intensity recorded was 72.4mm/hr in February, but it lasted only for 15 minutes. Especially in December, Dartonfield has received a heavy shower with an intensity of 53.8 mm/hr for 90 minutes. For each month, the three highest intensities recorded, their duration, time of occurrence and the average intensity are presented in Table 2.

Table 1. *Monthly variation of rainfall and rainy days in 2002*

Month	Total rainfall (mm)	Average** (mm)	No. of rainy days*	Avg.** days	No. of days under each category			Evaporation
					0.3-2.5 (mm)	2.6-50 (mm)	>50 (mm)	
January	153.4	(121)	13	(10)	03	09	01	2.0
February	170.2	(116)	11	(09)	03	07	01	2.9
March	251.3	(252)	16	(17)	04	11	01	2.5
April	422.1	(449)	27	(21)	08	18	01	2.4
May	562.7	(659)	28	(24)	03	23	02	2.0
June	184.4	(440)	15	(24)	02	13	00	2.1
July	160.9	(299)	21	(22)	07	14	00	2.0
August	90.8	(257)	13	(21)	04	09	00	2.2
September	115.4	(391)	19	(22)	07	12	00	2.6
October	812.3	(476)	29	(22)	06	17	06	2.2
November	340.5	(448)	24	(20)	05	18	01	1.7
December	354.9	(282)	15	(17)	02	11	02	1.9
Total	3618.9	(4160.0)	231	(229)	54	162	15	26.5

* A rainy day is defined as a day with a rainfall 0.3 mm
** Average values for 1980-1992 are shown in parentheses

Table 2. *Rainfall intensity recorded at Dartonfield Meteorological station - 2002*

Month	Date	Intensity (mm/hour)			
		3 highest records	Time of occurrence	Duration (min)	Mean for the month
January	04	24.4	14.00-14.15	15	
	10	21.8	18.00-20.30	150	8.32
	25	14.4	19.30-04.15	105	
February	27	72.4	15.15-15.30	15	
	20	48.8	16.45-17.00	15	18.7
	28	38.4	16.45-17.00	15	
March	05	22.7	16.45-18.15	90	
	30	21.6	15.15-16.45	90	6.97
	16	15.2	16.15-17.45	90	
April	03	56.50	21.15-22.15	60	
	16	37.2	14.00-14.30	30	8.81
	26	17.5	04.45-16.45	120	
May	16	69.0	15.28-15.30	2	
	15	37.2	12.45-12.50	5	8.45
	20	38.0	03.15-04.00	45	
June	01	20.0	06.45-07.00	20	
	06	18.2	12.30-13.00	30	5.23
	04	13.2	17.30-12.00	30	
July	22	9.6	10.00-11.00	60	
	29	8.6	08.00-09.30	90	3.44
	19	7.1	18.00-19.00	60	
August	16	12.6	05.15-06.30	75	
	09	10.6	18.45-19.30	45	4.4
	22	7.7	08.45-09.30	45	
September	04	14.6	22.45-23.15	30	
	25	12.0	12.45-13.00	15	5.02
	16	10.0	18.15-18.45	30	
October	07	29.1	13.15-14.15	60	
	25	27.0	16.30-17.30	60	
	06	17.7	14.30-18.30	180	
November	05	17.4	14.15-19.45	330	
	02	12.1	15.45-16.45	60	4.28
	17	10.1	14.45-17.45	180	
December	19	53.8	15.00-16.30	90	
	04	11.8	18.15-20.00	105	7.86
	14	10.6	15.15-20.15	300	

Other meteorological factors

Table 3 depicts the monthly values of some important meteorological observations together with averages for 1980 to 1992. Minimum temperature dropped below 20^0C for 4, 2 and 1 days respectively in January, December and November. The highest mean temperature of 34.0^0C was observed in February. The lowest value for sunshine hours was observed in December due to overcast conditions resulted by unexpected heavy rains. The average morning RH was in the range of 82 to 93 %. The soil temperatures at 3 different depths are given in Table 4.

Table 3. *Variation of observed meteorological factors at Dartonfield – 2002*

Month	(Latitude 6°32; Longitude 80.09 E Altitude 65.50mm) Temperature (°C)				Sun shine hours	Relative humidity (%)			Wind speed mean (KmPh-1)
	Mean Max	Mean Min	Mean	No. of days Min Temp<20		9.00 am	No. of days 9.00>90%	4.00 am	
January	32.9	21.7	27.3	4	5.3	82 (87)	1	76 (67)	1.5
February	34.0	21.9	27.9	-	7.3	82 (85)	3	68 (64)	1.9
March	33.8	22.4	28.1	-	6.8	88 (84)	11	71 (66)	2.0
April	33.5	22.8	28.1	-	5.3	91 (84)	19	83 (66)	1.7
May	31.7	23.8	27.7	-	4.4	93 (87)	24	79 (73)	2.0
June	31.1	24.0	27.5	-	4.7	91 (88)	19	82 (77)	2.5
July	30.5	23.8	27.1	-	4.4	89 (88)	14	84 (76)	2.9
August	31.0	23.6	27.3	-	5.8	90 (87)	16	74 (74)	2.4
September	32.1	22.9	27.5	-	7.5	90 (86)	16	72 (74)	2.2
October	31.9	22.6	27.2	-	5.1	91 (85)	19	77 (77)	1.7
November	32.3	22.5	27.4	1	4.1	90 (84)	18	83 (77)	1.1
December	32.3	22.3	27.3	2	4.0	91 (84)	19	77 (74)	1.1

** Average values for 1980 – 1992 are shown in parentheses.

Table 4. *Soil temperatures recorded at different depths at Dartonfield - 2002*

Month	09.00 hrs				16.00 hrs			
	5cm	10cm	20cm	30cm	5cm	10cm	20cm	30cm
January	26.8	26.6	27.1	28.2	34.6	32.8	29.9	28.6
February	27.7	27.0	27.9	28.8	36.9	34.5	31.4	29.5
March	28.5	27.3	28.2	28.9	37.2	34.3	31.8	29.8
May	27.9	27.3	-	-	33.3	30.4	-	-
June	27.7	27.0	-	-	33.4	30.0	-	-
July	27.4	26.8	-	-	31.9	29.2	-	-
August	27.4	26.8	-	-	33.4	29.8	-	-
September	27.7	27.2	-	-	34.7	30.6	-	-
October	27.6	26.4	26.8	27.6	32.7	30.9	29.5	28.4
November	27.6	26.4	27.1	27.8	31.4	30.4	29.3	28.3
December	26.9	26.1	27.0	27.7	31.8	30.2	28.9	28.2

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