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Annual Review

2001

RUBBER RESEARCH INSTITUTE OF SRI LANKA

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1 st January 2001 to 31 st December 2001

Editors
L M K Tillekeratne, PhD (Aston)
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Agalawatta

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Ratmalana

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Mr Kiyaz Deen, Chairman/Managing Director, Poly Lanka (Pvt.) Ltd., 31, Attidiya Road, Ratmalana
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Mrs L J C Perera, Secretary to the Board
Mr W Kularatne, Accountant
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Mr S S Warnapura, Elected Committee Member

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Secretary to the Board	Mrs L J C Perera
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Clerk/Typist	Mrs S N Munasinghe

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Attorney General's Department
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Chartered Accountants
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Colombo 8

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Corporate Branch
75, Janadhipathi Mawatha,
Colombo 1

Bank of Ceylon
Agalawatta

Head Office and Laboratories
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Telephones:

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Director	01 - 605171
General	01 - 633351
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RUBBER RESEARCH INSTITUTE OF SRI LANKA

STAFF

DIRECTORATE

Director	L M K Tillekeratne, BSc (Cey.), MSc (Aston), PhD (Aston), FI Chem C, FPRI, FNASSL
Deputy Director – Research (Technology)	Mrs K G K de Silva, BSc (SL), MSc (SL), PhD (Aston), FI Chem C, MPRI (up to 01.05.2001)
	W M G Seneviratne, BSc (SL), PhD (Sussex)
Deputy Director – Research (Biology)	R C W M R A Nugawela, BSc (SL), MSc (Lond.), PhD (Essex)

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

RESEARCH DEPARTMENTS

Genetics and Plant Breeding

Head of Department	D P S T G Attanayake, BSc Agric (SL), PhD (Birm.)
Assistant Geneticist and Plant Breeders	*Mrs S Herath, BSc Agric (SL)
	*Mrs S P Withanage, BSc Agric (SL)
Experimental Officers	K W Rupatunga
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	I D M J Sarath Kumara
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	Miss A K Gamage, BSc (SL)
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Plant Science

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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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	S Wilbert
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	M K P Perera
	W D M N de Alwis
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	P D Pathirana
	P K W Karunathilake, Dip. Agric (Ratnapura)
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Plant Pathology & Microbiology

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Plant Pathologist (Principal Research Officer)	A H R Jayaratne, BSc (SL), MSc (SL), PhD (Sheffield)
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	Mrs T H P S Fernando, BSc (SL), MPhil (SL)
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Head of Department	Mrs M L A Samarappuli, BSc Agric (SL), MSc (California), PhD (SL)
Soils Chemist (Principal Research Officer)	D M A P Dissanayake, BSc Agric (SL), PhD (Aberdeen) (up to 15.11.2001)
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	*D N P Wickremasinghe, BSc (SL)

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	G V L Nilmini, BSc (SL)
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	D Ramawickrema
Technical Officer	P D J Rodrigo

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	Mrs C J Wellappili, BSc (SL), MSc (SL)
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Experimental Officers	Mrs L Wanigatunga
	Mrs H V K Gamage
	Mrs C S Lokuge

Experimental Officers	R S Wijesundera
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Raw Rubber Process Development and Chemical Engineering

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	K B A Karunasekera
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Internal Audit Officer	K C Fernando
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Mechanical Foreman	S D Gunawardene
Building Foreman	M A D K Jayasumana
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	Mrs J A S Dharshanie (Dip. in Management)
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Senior Accounting Assistant	D A Rajapakse
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	G A Kannangara
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	Mrs Irene Perera
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Assistant Store-Keeper	P D Somadasa
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DARTONFIELD GROUP

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Chief Clerk	P Kannangara

Senior Clerk	K K P Gunawardena
Junior Clerks	Mrs C Dissanayake
	A K D A Wickremasinghe
	Mrs S I K Pathirage
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Assistant Factory Officer	W D D Senanayake
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	T Somaratne
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	B M Siriwardene
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	N L D Nihal
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	A B Nakandala

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Junior Clerk	D S Jayasinghe
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	Miss Chitra Gunatilleke
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RUBBER RESEARCH INSTITUTE OF SRI LANKA

DIRECTOR'S REVIEW

L M K Tillekeratne

The world rubber consumption declined to 17.61 million MT during the year 2001 from a figure of 18.214 million MT recorded in the previous year. This is mainly due to the reduction in the vehicle manufacture in countries like US, France, Germany and Japan. However, the number of vehicles registered in US have shown a slightly upward trend. The rubber consumption during the year 2001 has increased in both Asia-Pacific and in African Continents whereas the same has fast declined in Europe and USA. This situation worsened after the terrorist attack in USA in September, 2001.

NR production has increased considerably in Asian countries other than in Malaysia and Sri Lanka. Thailand has produced 2.404 million tonnes in the year which is an increase of 2.5% over the previous year. However, under the Tripartite Agreement arrived in Java among Thailand, Indonesia and Malaysia; the production and exports of these countries will be reduced annually by 4%. This decision was able to slow down the fall of NR prices; but a recovery is envisaged, towards the end of the year. The price of NR in the world market started rising from December, 2001 and it is expected to continue the future too without any interruption.

It has also been reported that the down-turn in rubber consumption in major NR producing countries since January 2001 has reached its trough and will not go down further.

In Sri Lanka, the total rubber production during the year has dropped to 86,232 MT which is a further decline in the production corresponding to the previous year. The exports of NR in the year was only 33,011 MT. Production of latex crepe was 26,112 MT while the sole crepe manufacture was 3,915 MT. There was no sharp increase in the latex crepe production as expected due to the poor price prevailed during the year. Some of the latex crepe producing estates supplied latex direct to the concentrated latex manufacturers, thereby obstructing the smallholders from supplying their latex through agents to latex factories. Hence most of the small holders who were supplying latex to concentrated latex factories had no way of selling their latex and they have no processing facilities too, to convert latex into RSS. This was one of the major reasons for the fall of NR production by smallholders during the year. However, in Thailand, the government has paid a minimum floor price of 25 Baths (Rs.50/-) per kg. throughout the year, which is always above the COP. Smallholders in Thailand have been producing sheet rubber in the country uninterrupted thereby increasing the production from 2.346 million in 2000 to 2.4 million in 2001.

If there had been a similar measure taken by the Government of Sri Lanka, the rubber situation, particularly the total production during the year 2001, would have increased. Rubber products manufacture in the country on the other hand did not come to the small holders who were suffering badly from the very low prices paid for their latex and RSS out of the profits they made from the value added products manufacture.

The Management Companies have almost totally abandoned the replanting programmes due to liquidity problems. In some Companies even the valuable quality planting material produced for the replanting programmes have been neglected or destroyed. Some of the Companies have been continuing with their replacing rubber in Galle and Kalutara districts with oil palm, totally misunderstanding the recommendation of the CRI in their interim survey report. Some of the precious rubber estates and plantations have also been neglected or totally abandoned in this process. When the Government of Sri Lanka is expected to increase its rubber production to at least 100,000 MT level by 2002, to meet the requirements of the fast growing rubber products industry, earning over a Rs.18 billion turn-over annually to the country; such Companies should think twice and carefully analyse the feasibility of this diversification to the country in the long run with special reference to the environment. Further, it has been reported that these Companies who are aiming to produce crude palm oil in the near future do not even have plans to convert their produce into refined palm stearin which is the only oil palm derivative which can be used in edible products and toilet soap industry.

In order to meet the growing demand for NR in the local scenario, specially under the light of the above mentioned diversification, RRI should produce new technologies to vastly increase the NR production in the country. However, out of the Rs.94 million sought from the Treasury for running the Institute in 2002, only a total of Rs.75 million has been allocated. In this allocation, only Rs.0.96 million is kept a side for Research & Development activities which is far below the allocation for 2001. Hence, in order to meet the expectations of BOI, with the help of the Rubber Research Institute to ten fold increase the income from rubber to the country, adequate funds must be made available for the RRI to carry out the important research programmes.

RRI, jointly with the US experts came to draw up the Rubber Cluster programme, identified about 10,000 ha. of land in the Moneragala district for the expansion of the rubber plantation. In Moneragala district due to the prevailing dry weather at least 70% of the rubber available in the tree can be extracted without rain interruption even without making use of rain-guards.

Further, to meet the extensively increasing rubber demand for the future, RRI during the year revised the clone recommendation for planting by promoting the new clone RRIC 130 in group 1 (one) and three other clones in Group III.

From the six clones in Group 1 up to a 10% of the extent from each of the clones are recommended for planting, while from the 15 clones in Group II, 3% of the extent from each of the clones can also be planted.

RRI clones have performed extremely well in commercial level trials carried out in outside estates recording over 2000 kg/ha/yr. In many places yields above 2500 kg/ha/yr have been recorded by the RRIC 100 clones, This is a clean indication that, if careful agronomic practices are followed in estates and in smallholdings, reaching a National productivity target of close to 2000 kg/ha/yr is easy. However, the exercise is purely price-driven and hence some scheme of price stabilisation must be there for the farmers to survive.

Advisory Services Department of the RRI was recommended after 08 years in the last quarter of 2001. This department comprising of 4 RAOO and 30 RAA under a head of the department is responsible for helping both the small holdings and estates in extension matters.

OVERSEAS VISITORS

Mr Gunvor EK, Skanska Project
Mr Clive Ireland, Writtle College, UK
Dr C Stirling, University of Wales, UK
Mr Heba, Petursdoltir, Sweeden
Mrs Beatrice Hagglund, Sweeden
Miss Sissi, Sweeden
Miss Sara, Sweeden
Ms. Zinnea Zjungdihl, Sweeden
Ms. Lisa Rantatlo, Sweeden
Mr Bodi Tersson, Sweeden
Ms. Theresa Sandberg, Sweeden
Ms. Malian Miansberg, Sweeden
Ms. Avne, Sweeden
Mr Patrick, Sweeden
Mr Alex, Sweeden
Mr Eliaoo, Sweeden
Mr Colins Shening, Philippines
Mr T G Mahoruk, Onio, USA
Mr A F S Budiman, IRSG, UK
Mr T H Lloyds, UK

GENETICS AND PLANT BREEDING

D P S T G Attanayaka

SUMMARY

The growth of two new clones, RRISL 201 and RRISL 215 proved to be highly stable in all rubber growing areas tested under genotype and environment interaction studies. Four other RRISL 200 series clones, *i.e.* RRISL 205, RRISL 206, RRISL 217 and RRISL 218 showed high mean performance in their third year of growth but with low stability. RRISL 205, RRISL 206 and RRISL 2000 which were brought into tapping during the year in commercial scale plantings, showed a promising yield trend.

Three new clones RRISL 201, RRSIL 203 and RRISL 205 were introduced to the small-holders under experimental scale in Kegalle and Colombo districts. All these clones show vigourous growth under the smallholder conditions. Thirteen new clones from RRISL 200 series and two new clones from RRISL 2000 series have already been issued to the estates under collaborative clone testing programme and are being closely monitored.

Results of the Small Scale Clone Trials, show the possibility for selection of clones for higher growth rates. The test entry HP clone 95-55 which gave a girth increment of 17cm during the year under estate management conditions is one such clone.

The clones RRIC 121, PB 260 and PB 235 continued to perform better than the other clones tested in SRRP trials. The final fruit-set success of the annual hand pollination programme was 1.44% from a total of 10245 pollinations.

The *Hevea* molecular biology work was continued at a slow pace due to non - availability of research 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 B M S G Peiris, Mr K W Rupatunga, and Mr L S Kariyawasam, Technical Officers Miss A K Gamage, Mr T M S K Gunasekera, Mr H P Peiris and Clerk/Typist, Mrs S D P K L Peiris were on duty throughout the year. Mr I D M J Sarath Kumara, Experimental Officer, underwent a training in rubber breeding at the RRII from 25th January - 25th April. Mrs S P Herath and Mrs S P Withanage, Assistant Geneticist and Plant Breeders continued their postgraduate studies at the University of Nagoya, Japan and the Punjab Agricultural University in India respectively. Miss S P M Wickramaratna resigned from the post of Technical Officer with effect from 30th June.

Seminars/Conferences/Meetings/Workshops attended

Officer	Subject	Organization
D P S T G Attanayake	Specialist Group on Plant Breeders, Tissue Culturists and biotechnologists	CARP
D P S T G Attanayake	National Workshop on Agricultural Research Management	PGIA and CARP
D P S T G Attanayake	Plant Breeders Rights	Sri Lanka Foundation Institute
D P S T G Attanayake	Training programme in Plant Breeding (served as a resource person)	PGIA
D P S T G Attanayake	Research Committee Meeting	Coconut Research Institute

Training programmes

Client	No. of programmes
Postgraduate Institute of Agriculture	01

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 research and technical staff. Progeny individuals derived from 1999 HP programme by crossing PB 260 x IAN 45/710 was assessed by micro- tapping for their yielding ability. The DNA of the low and high yielding individuals was pooled and used for RAPD analysis to identify any polymorphic markers (D P S T G Attanayaka and P L N Lakshman of PGIA).

FIELD EXPERIMENTS

Hand pollination (HP) programme - 2001(GPB/BST/HP/01)

Mother trees from clones of RRIC 100, RRIC 121, RRIC 130, RRIM 712, BPM 24 and PB 260 from Neuchatel estate were selected for the cross pollination programme. The final fruit set success of the pollinations done during the year was 1.44%. The fungicide Benomyl (Benlate), which was very effective in controlling the *Oidium* leaf disease was replaced with Bavistin due to non-availability of Benlate in the market. The control of *Oidum* leaf disease during the flowering season was poor especially in RRIM 712. The number of pollinations done in each cross, number of pods produced and seedlings obtained are given in Table 1.

Table 1. *Details of 2001 hand pollination programme*

Cross	No. of pollinations	No. of fruits collected	No. of seedlings
BPM 24 × RRIC 130	106	07	17
RRIM 712 × PB 260	1524	01	00
RRIM 712 ×GPS 36-84	370	00	00
RRIM 712 × GPS I	1167	00	00
RRIM 712 × RRIC 121	1602	02	05
RRIM 712 × RRIC 130	1494	16	12
PB 260 × RRIM 712	45	04	11
RRIC 100 × RRIM 712	1050	10	29
RRIC 100 × PB 260	264	15	38
RRIC 100 × GPS I	287	06	16
RRIC 121 × RRIC 130	636	84	180
RRIC 130 × RRIC 121	41	00	00
RRIC 130 × RRIM 712	1659	03	07
Total	10245	148	315

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

Evaluation of hand pollinated progenies

Small scale clone trials

The Department continued to monitor the Small Scale Clone Trials listed in Table 2.

Table 2. *Details of small scale clone trials*

HP year	Site	Planting date
1976	Hillstream - Tempo	May 1985
1982	Clyde - Kethhena	Sept. 1987
1986	Kuruwita	May 1990
1987	I) Clyde - Kethhena	May 1993
	II) Galawatta	June 1988
1988	Dartonfield	July 1993
1992	Dartonfield	May 1993
1995	Sorana	June 1998
1996	Kuruwita - I & II	May 1999
1991	Pallegoda	August 2000
	Vogan	November 2000
1997	Clyde - I & II	June 2000
1998	N'Kele I, II & III	June 2001
	Kuruwita I, II &III	July 2001

Evaluation of 1976 H.P. Selections. Tempo division, Hillstream estate (GPB/BST/HPS/76/1)

Yearly girth measurement (at 150 cm) and the test tapping data were recorded from the eight new clones selected and the two control clones (RRIC 100 and RRIC 121). Tapping in this trial was commenced in 1992. The mean yield of the ninth year of tapping (BO 2 panel) based on eight test tappings and the girth of these clones are given in Table 3. The mean girth reported for RRIC 100 last year should be corrected as 78.73 cm.

Table 3. *Mean yield in grams per tree per tapping (g/t/t) and the mean girth of promising clones selected from 1976 HP programme (GPB/BST/HPS/76/1)*

Clone	Mean Yield (g/t/t)	Mean girth (cm)
76- 121	40.33	88.75
76-158/RRISL 2004	44.55	80.53
76-182/RRISL 2003	51.64	92.0
76-198	-	-
76-52/RRISL 2001	49.88	90.60
76-8/ RRISL 2000	55.94	104.92
76-82/RRISL 2002	40.52	92.5
76-9	-	-
RRIC 100	30.60	79.56
RRIC 121	51.55	96.68

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

Evaluation of 1982 H.P. Selections - Kethhena division, Clyde estate (GPB/BST/HPS/82/2)

In this trial 61 new clones are monitored along with five control clones. Seven test tappings were possible during the year. Tapping of the BO 2 panel was commenced in 1999. The yield data reported here are for the 3rd year in BO 2 panel. The bark consumption rate of this trial was observed to be very high. Table 4 shows the mean yield and the girth of promising selections along with the performances of the control clones. The clone 82-163 shows the highest average girth in this trial.

Table 4. *Mean yield and mean girth of promising selections from 1982 HP - Clyde estate (GPB/BST/HPS/82/2)*

Clone	Mean yield G/t/t	Mean girth cm
82 - 15/RRISL 2005	59.71	86.58
82 – 37	39.50	68.69
82 – 54	29.72	86.11
82 – 110	26.98	83.53
82 - 111	26.20	75.16
82 – 124	47.15	67.93
82 - 140/RRISL 2006	53.51	81.21
82 – 144	35.70	81.56
82 – 152	40.84	79.75
82 – 157	36.98	78.26
82 – 163	49.49	90.90
RRIC 100	21.06	67.82
RRIC 102	34.77	72.59
RRIC 121	51.08	80.82

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

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

This trial has been planted in 1990. Eleventh year girth measurement and the results of the Duncan's Multiple Range Test for girth of the promising clones are given in Table 5. Yield data relevant to the third year of tapping based on eight test tappings are given in Table 6. The highest girth was obtained from clone 86-81 followed by RRIC 121. The highest yield was obtained from the control clone RRIC 121.

Table 5. *Mean girth (11^{th} yr) in cm of promising H.P. clones*

Clone	Mean girth (cm) and DMRT grouping
86-81	77.97 ^{A}
RRIC 121	72.78 ^{AB}
86-21	71.72 ^{ABC}
86-77	71.55 ^{ABC}
86-24	68.27 ^{BCD}
86-87	67.84 ^{BCDE}
86-37	64.50 ^{CDEF}
86-76	64.3 ^{CDEF}
RRIC 110	63.75 ^{CDEFG}
86-22	62.71 ^{DEFGH}
BPM 24	48.65 ^{NOPQRS}

Table 6. *Mean yield of promising 1986 H.P. clones*

Clone	Yield (g/t/t) and DMRT grouping
RRIC 121	43.28 A
86 - 87	39.57 AB
RRIC 110	37.05 ABC
82 -22	34.00 BCD
86 - 11	32.59 BCD
86 -24	31.75 BCDE
86 - 82	31.40 BCDE
86 -10	30.49 CDEF
86 - 25	29.15 CDEFG
RRIC 102	28.19 CDEFGH

(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)

Eighth year girth measurement and the results of the Duncan's Multiple Range Test for girth (DMRT) are given in Table 7. Six test tappings were done during the year. Mean yield for the third year of tapping is given in Table 8.

Table 7. *Mean girth and the results of DMRT of the 1987 H.P. selections*

Clone	Girth in cm	DMRT Grouping
87-370	65.31	A
RRIC-121	64.93	A
RRIC 110	62.25	AB
87 – 371	60.77	BC
87 – 364	58.81	CD
RRIC100	57.89	CDE
87 – 372	55.55	DEf
87 – 383	55.53	DEf
RRIC 102	55.10	EF
87 – 382	54.23	FG

Table 8. *Mean yield and the results of DMRT of the 1987 H.P. Selections*

Clone	Yield (g/t/t)	DMRT Grouping
87 - 382	46.00	A
87 - 372	43.83	AB
RRIC 121	37.90	BC
87 - 370	36.05	CD
87 - 365	35.29	CD
87 - 368	34.79	CD
RRIC 110	34.73	CD
87 - 376	33.65	CDE
87 - 369	31.04	DEF
RRIC100	29.85	DEF
87 - 364	27.48	EFG
87 - 375	27.00	GI
87 - 373	26.90	GI
RRIC102	26.79	GI

(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)

Nineteen trees of this experiment were removed in order to make space for the proposed power line by the electricity board. The data was not recorded from a wind damaged tree of the family RRIC 100 × RRIC 121. The total number of experimental trees now amounts to 190. Yield data relevant to the 2nd 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 9. The number of trees test tapped from each family is given within parenthesis.

Table 9. *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	08	72.25	40.98 (06)
RRIC 101 × GT 1	29	58.56	20.12 (14)
RRIC 100 × GT 1	50	74.96	55.22 (38)
RRIC 100 × RRIC 101	09	67.55	29.90 (07)
RRIC 100 × RRIC 110	10	75.10	64.20 (08)
RRIC 100 × RRIC 121	30	71.60	43.60 (24)
PB 86 × RRIC 121	15	69.20	33.00 (09)
RRIC 102 × GT 1	03	80.10	88.00 (03)
RRIC 121 × RRIC 110	26	69.90	30.82 (26)
RRIC 110 × RRIC 100	08	66.90	47.30 (08)
RRIC 110 × RRIC 121	02	61.20	-

(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 eighth year girth measurement was taken and the mean girth arranged according to the Duncan's Multiple Range Test is given in Table 10. This experiment too was affected by the removal of trees for the power line. The experiment was opened for tapping this year. Mean yield of some selected clones are given in Table 11.

Table 10. *Mean girth in cm of the 1988 HP progeny*

Clone	Mean girth and DMRT grouping
88-36	61.17 ^{A}
88-32	61.08 ^{A}
88-28	60.22 ^{AB}
88-31	58.68 ^{ABC}
88-16	57.34 ^{ABCD}
RRIC 100	56.30 ^{ABCD}
88-40	52.90 ^{BCDE}
88-39	55.26 ^{BCDE}
RRIC 121	54.01 ^{CDEF}
88-8	53.84 ^{CDEF}
88-5	53.05 ^{CDEFG}
RRIC102	52.82 ^{DEFG}

Table 11. *Mean yield (g/t/t) of the 1988 HP progeny*

Clone	Mean yield and DMRT grouping
88-16	32.17 ^{A}
RRIC 121	29.42 ^{AB}
88-50	26.93 $^{A\,BC}$
88-9	25.83 $^{A\,B\,CD}$
RRIC 102	24.94 $^{ABC\,D\,E}$
88-38	22.64 $^{ABC\,D\,E\,F}$
RRIC 110	21.53 ^{BCDEFG}
88-39	20.66 $^{BC\,D\,EFGH}$
88-31	19.84 $^{BC\,D\,EFGH}$
88-34	19.00 $^{BC\,D\,EFGHi}$
88-23	18.73 $^{C\,D\,EFGHi}$
RRIC100	16.53 $^{C\,D\,EFGHIJ}$

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

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

The trees of this trial are in the second year of tapping. The progeny size and 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 12.

Table 12. *Family means of girth and the yield of the 1992 HP progeny*

Family	Progeny Size	Girth (cm)	Yield (g/t/t)
RRIC 100 × RRIM 712	60	54.66	27.12
RRIC 100 × PB 255	75	63.78	37.11
RRIC 100 × PR 255	61	54.52	25.18
RRIC 121 × PB 255	44	60.40	34.11
RRIC 102 × PB 255	31	56.01	18.31
BPM 24 × RRIM 712	06	51.50	29.87
RRIC 100 × PR 309	31	53.50	30.56
RRIC 121 × PR 255	11	51.50	27.50
RRIC 102 × PR 309	02	53.50	19.90
RRIC 121 × PR 309	07	45.07	27.87

(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)

In this trial 41 test entries along with two control clones are tested in a randomized block design with four replicates. Plot size of each clone is eight trees. The third year girth taken at a height of 120 cm is given in Table 13. Clones 95-55, 95-50 and 95-33 showed very vigorous growth. The mean girth increment obtained from the best plot of the clone 95-55 was 17cm during the year.

Table 13. *Mean girth in cm of the 1995 HP progeny*

Clone	Mean girth and DMRT grouping
95-55	30.43 ^{A}
95-50	29.56 ^{AB}
95-33	29.15 $^{A\,B\,C}$
95-22	29.14 $^{A\,B\,C}$
95-23	28.30 ^{ABCD}
95-48	27.98 ^{ABCD}
95-29	27.45 $^{BC\,DE}$
95-18	27.40 $^{BC\,DE}$
PB 255	27.39 $^{BC\,DE}$
RRIC 121	26.41 $^{D\,EFGH}$

(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)

Two trials, 96-1 and 96-2 were established in 1999 using fully randomized design with 15 replicates per treatment. In the trial 96-1, 27 H.P. clones and in 96-2 experiment 23 H.P. clones were included with three control clones. Girth measurements at a height of 120 cm were taken from both trials. Table 14 shows the second year girth of the promising entries and of the control clones in both trials.

Table 14. *Mean girth at 120 cm of the 1996 HP progeny*

Mean girth (cm) from 96-1 trials		Mean girth (cm) from 96-2 trials	
Clone	Girth	Clone	Girth
96-59	13.51	RRIC 121	14.00
96-5	12.98	96-26	12.16
96-8	12.92	96-50	11.89
96-15	12.90	96-43	11.62
96-4	12.88	96-39	11.57
96-1	12.70	96-55	11.34
96-7	12.55	96-32	11.33
96-31	12.15	96-54	11.29
96-2	11.91	96-28	11.29
96-17	11.70	96-45	11.28
PB 260	11.04	96-53	11.20
RRIC 121	10.91	PB 260	10.38

(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 and 91/2)

These two trials have been established in year 2000 to test the HP clones derived in 1991. In the trial at Pallegoda estate 30 HP clones are being tested. At Vogan estate (GPB/BST/HPS/91/02) five clones derived from the 97 HP progeny are also being included along with 25 clones from the 91 HP clones. Each experiment is planted in a completely randomized single tree plot size design with 15 replicates per clone. The control clones used in these experiments are RRIC 121 and RRISL 205. The first year girth measurements at 120 cm of the top 11 clones are given in Table 15.

Table 15. *Mean girth in cm of the 1991 HP progeny planted at Pallegoda and Vogan estates*

Mean girth (cm) from 91-01 trial (Pallegoda)		Mean girth (cm) from 91-02 trial (Vogan)	
Clone	Girth	Clone	Girth
91-8	10.07	91-71	8.55
91-9	9.83	91-63	7.94
91-4	9.67	91-83	7.78
91-1	9.29	RRIC 121	7.75
91-12	9.25	91-82	7.56
91-21	9.25	91-58	7.56
91-17	9.13	91-55	7.55
91-2	9.10	91-75	7.55
91-5	9.04	91-48	7.50
91-10	9.00	91-53	7.35
RRISL 205	8.96	91-89	7.28

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

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

Two trials have been planted in year 2000 at Clyde estate to test the 1997 HP progeny. Each trial consists of 30 HP clones and two control clones, i.e. RRISL 205 and RRIC 121. Each clone has 15 replicates with single tree plots. The first year girth measurement was taken at a height of 30 cm. In both trials there were 18 HP entries better than the best control clone. The mean girth of the best 10 HP clones of each experiment is given in Table 16 along with the best control mean.

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

The experiment planted at Bentota estate was discontinued. Girth measurements from the experiments planted at Eladuwa and Yatawatta estates were taken. These experimental sites will be used only for observations on disease incidences in the future. Yearly girth measurements and test tappings were taken from the other sites. Table 17 shows the mean girth and the yields obtained from each site. Only two test tappings (Aug/Sep) were possible from Atala site. The clones PB 235 and PB 260 are tapped following 1/2S/d3 system except in Atale. The clones RRIC 121, PB 260, PB 235 continued to perform better than the other clones in all sites. PB 235 clone was severely affected by *Oidium* leaf disease during the year. The unusual leaf fall observed in the clone BPM 24 in the Salawa estate last year was overcome by rectifying the nutritional imbalance and tapping was resumed early this year. This clone too recorded a high yield in Salawa and Kuruwita sites.

Table 16. *Mean girth in cm of the 1997 HP progeny planted at Clyde estate*

Mean girth (cm) from 97-01 trial		Mean girth (cm) from 97-02 trial	
Clone	Girth	Clone	Girth
97-3	9.27	97-75	10.13
97-19	9.10	97-48	8.60
97-2	9.00	97-50	8.58
97-28	8.81	97-78	8.56
97-23	8.77	97-55	8.52
97-32	8.75	97-66	8.43
97-43	8.72	97-52	8.41
97-10	8.70	97-49	8.39
97-25	8.70	97-83	8.33
97-26	8.66	97-74	8.24
RRIC 121	8.32	RRISL 205	7.67

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

Table 17. *Mean girth (cm) and yield (g/t/t) obtained from SRRP II clone trials*

Clone		Eladuwa	Salawa	Kuruwita	Atale	Yatawatta
PB 260	Girth	59.62	57.76	58.88	64.44	52.10
	Yield		42.51	75.16	42.35*	
PB 235	Girth	61.91	58.39	62.50	63.44	51.87
	Yield		42.33	53.49	40.98*	
BPM 24	Girth	56.43	51.94	48.30	56.26	49.46
	Yield		47.19	57.23	20.17*	
PR 255	Girth	54.08	53.25	47.47	60.65	49.49
	Yield		36.26	36.61	28.70*	
PR 261	Girth	55.42	56.14	47.39	59.64	46.57
	Yield		37.90	36.51	30.33*	
RRIM 712	Girth	55.42	50.68	48.54	61.52	49.67
	Yield		41.23	48.16	34.37*	
RRIC 121	Girth	61.50	61.48	63.98	73.74	54.54
	Yield		42.26	52.82	46.15*	
RRIC 100	Girth	60.27	59.03			
	Yield		42.24			
PB 217	Girth	54.92	58.04			
	Yield	33.56	45.98			

* Mean based on only two test tappings in Aug/Sept (D P S T G Attanayaka, K W Rupatunga, I D M J Sarathkumara, B M S G Peiris, H P Peris and K B Karunasekara)

Genotype environment Interaction (G X E) Studies. (GPB/GE/98)

The experimental site planted at Nalanda estate had to be abandoned due to difficulties in managing the trial. The standard of the general upkeep of all trials by the respective estates was poor. This is reflected by the poor girth values recorded. Third year girth measurement was analysed to study the relative growth performance of the 15 clones included in this trial over the eight rubber growing areas. Analysis of variance showed the presence of highly significant differences in growth between clones, sites and the presence of significant genotype × environment interaction effect (Table 18). The clones RRISL 206, RRISL 205, RRISL 218, RRISL 201, RRISL 215 and RRISL 217 showed high mean performance for growth. Table 19 shows the mean girth measurements and the variance of the clones in the eight sites under study. When the mean performance of clones for growth and their stability over the environment is considered, RRISL 201 and RRISL 215 proved to be the most adaptable clones for all the environments tested (Table 20).

Table 18. *The results of the Analysis of variance*

Source	DF	Mean square	Significance
Clones	14	303.44	***
Sites	7	3320.14	***
Clone x Sites	98	24.79	***

*** 0.1%

Table 19. *Mean girth (cm) and the variance of the clones in each site*

Site Clone	Ganepalla	Muwan kanda	Atale	Palm garden	Pelma dulla	Badde gama	Bibile	Sorana	Clone mean	Variance
RL201	17.1	20.4	19.2	14.9	17.8	20.8	16	25.5	18.96	11.19
RL205	19.1	21.8	20.8	12.1	17.9	21	15.2	29.3	19.65	25.86
RL206	16.7	21.6	21.9	15.1	17.1	22.9	15.8	27.7	19.85	19.23
RL210	16.2	15.3	17.4	12.2	14.4	18.8	12.3	21.6	16.02	10.34
RL215	15.7	20.1	18	13.2	15.5	19.5	15.7	24.6	17.79	12.81
RL217	15.2	16.6	19.3	12.2	15.5	19.3	15	26.4	17.44	18.58
RL218	16	18.8	19.5	18.9	16.6	23	14.3	28.1	19.4	19.24
RL220	16.7	18.1	15.7	12.8	14.5	20.6	12.4	21.2	16.5	10.99
GPS 1	11.8	14.7	15	8.1	9	16.1	13.2	20.8	13.59	16.58
RRII105	16.4	16.8	17.8	11.8	14.7	21.3	12	24.3	16.89	18.57
RM712	15.3	16.7	15.8	8.85	14.5	18.5	13.4	18.5	15.19	9.77
RC130	16	16.4	16.5	14.6	16.2	18.7	14	23.7	17.01	9.22
HEN2	13.5	18.1	16.5	13	12.7	18.1	13.4	21.7	15.87	10.61
PB260	15.3	17.1	18.4	12.7	15.3	20.9	13.8	22.7	17.02	12.02
Site Mean	15.82	18.11	17.95	12.90	15.11	19.89	14.05	24.11	17.23	14.6

Table 20. *Selection of Hevea clones for stability in growth under agro-climatic variability*

Level of growth performance and stability	Clone
High stability with high mean performance	RRISL 201, RRISL 215
Low stability with high mean performance	RRISL 217, RRISL 218, RRISL 206, RRISL 205
High stability with low mean performance	RRIM 712,RRISL 210, Heiken 2, RRISL 220, PB 260, RRIC 130
Low stability with low mean performance	GPS I, RRII 105

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

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

The second year girth measurement was taken. Highly significant differences between the treatments and blocks are evident. Table 21 shows the mean girth of each treatment, *i.e.* control monoclone plots and plots of Bi – and Tri - clonal mixtures.

Table 21. *Mean girth of each treatment*

Treatment	Mean diameter (cm)
RRIC 121	15.26^{A}
RRIC 102/RRIC 121	15.09^{AB}
RRIC 100/RRIC 102/ RRIC 121	14.61^{ABC}
RRIC 100/RRIC 121	14.45^{BCD}
RRIC 102	14.23^{CDE}
RRIC 102/RRIC 133/RRIC 121	14.03^{CDE}
RRIC 133/ RRIC 121	13.99^{CDE}
RRIC 102/RRIC 133	13.90^{CDE}
RRIC 100/ RRIC 102/ RRIC 133	13.79^{DE}
RRIC 100/ RRIC 133/RRIC121	13.73^{DE}
RRIC 100/ RRIC 102	13.62^{E}
RRIC 133	12.96^{F}
RRIC 100	12.88^{F}
RRIC 100/ RRIC 133	12.42^{F}

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

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

This trial was established to test the performance of open pollinated seedlings derived from clones PB 86, PB 28/59, PB 260, RRIC 121 and RRIC 100. The seedlings

were planted along with the budded plants of their respective mother clones. This experiment was affected by a severe drought during the initial two months after planting. As a result, all the seedlings were defoliated but later recovered. The first year girth measurements were taken and given in Table 22. There were no significant differences between the treatments (selected seedlings, unselected seedlings and clones) at the end of the first year in the girth.

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

Budded plants	Girth (cm)	Selected seedlings	Girth (cm)	Unselected seedlings	Girth (cm)
PB 86	8.83	RRIC 100	9.10	RRIC 121	9.16
RRIC 121	8.69	RRIC 121	8.90	PB 260	8.97
PB 28/59	8.51	PB 260	8.76	PB 86	8.94
RRIC 100	7.94	PB 86	8.43	RRIC 100	8.94
PB 260	-*	PB 28/59	8.26	PB 28/59	7.85

* only 30 plants were scored

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

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

Routine monitoring was done. Annual girth measurements taken from these trials are given in Table 23. In the first three years girth measurements were taken at 90 cm height and afterwards at 120 cm.

Yields from ECTs

GPB/BST/ECT/95/01

The 1995 trial planted at the Pallegoda estate was opened for tapping in June 2001, at a height of 150 cm using the Jebong knife following ½ S/d3 system of tapping. The total amount of rubber harvested from the initial five months of tapping is given below in Table 24.

Table 23. *Annual girth measurements recorded from ECTs*

Clone	Site	Date of planting	Girth in cm at different ages						
			1st	2nd	3rd	4th	5th	6th	7th
RRISL 205	Pallegoda	1995		12.8	25.1	38.5	47.8	53.4*[1]	
	Vogan	1997		18.9	29.6	43.1*			
	Neuchatel	1997, b-I		15.8	28.4	43.1*			
	Neuchatel	1997, b-II		12.9	22.8	35.8*			
RRISL 204	Neuchatel	1997, b-I		14.7	23.0	35.8*			
		1997, b-II		14.11	22.3	33.6*			
	Tempo	1996	9.3	15.7	23.6	32.3	42.5*		
RRISL 206	Pallegoda	1995		10.8	20.8	33.3	42.5	47.7*[1]	
	Vogan	1997		20.1	30.0	41.9*			
	Neuchatel	1997, b-I		16.5	25.8	38.8*			
		1997, b-II		14.2	23.2	36.4*			
RRISL 218	Pallegoda	1995		14.3	25.2	33.5	40.7	44.7*[1]	
RRISL 2001	Pallegoda	1995		11.5	21.6	34.8	46.3	51.5*[1]	
RRISL 201	Tempo	1996	9.5	17.0	25.0	35.4	46.3*		
	Moralioya	1996			15.1	27.6	39.9*		
	Kuruwita	1994				19.4	34.4	46.3	52.6*[1]
RRISL 202	Moralioya	1996			17.3	33.0	43.6*		
	Kuruwita	1994				24.0	36.1	42.4	47.2*[1]
RRISL 215	Tempo	1996	9.1	17.5	26.5	33.6	42.0*		
RRISL 217	Vogan	1997	19.4	28.9	38.4*				
RRII 105	Pallegoda	1998		21.3*					
GPS I	Pallegoda	1998		15.1*					
PB 255	Pallegoda	1998		21.3*					
RRISL 2000	Pallegoda	1998		26.3*					
RRII 176	Pallegoda	2000	9.6*						

Clone	Site	Date of planting	Girth in cm at different ages						
			1st	2nd	3rd	4th	5th	6th	7th
RRISL 226	Pallegoda	2000	8.3*						
RRISL 201	Salawa	1999		12.7*					
RRISL 206	Salawa	1999		16.9*					
RRISL 215	Salawa	1999		17.3*					
RRISL 220	Salawa	1999		14.7*					
RRISL 221	Salawa	1999		13.5*					
RRISL 225	Salawa	1999		12.9*					
RRIC 133	Salawa	1999		14.7*					

[1] girth at 150 cm. * 2001 girth

(D P S TG 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)

Table 24. *Tapping details of RRISL 2001, RRISL 205 and RRISL 206*

Clone	Month	Tapping days	No. of trees tapped /day	Volume (liters)	DRC g/100 ml	Kg	g/t/t
RRISL	August	6	250	75	36.2	27.15	18.1
2001	September	6	250	56	32	17.92	11.9
	October	4	250	27	30	8.10	8.1
	November	6	250	63	33	20.79	13.8
	December	8	250	168	44	73.92	36.9
RRISL	August	6	202	69	36	24.84	20.4
205	September	3	202	38	28	10.64	17.4
	October	3	202	49	32	15.68	25.8
	November	4	202	71	35	24.85	25
	December	9	202	231	36	83.16	45.6
RRISL	August	6	199	42	37	15.5	13
206	September	6	199	67	32	21.4	17.9
	October	3	199	19	32	6.08	10.1
	November	4	199	49	35	17.15	21.5
	December	9	199	232	36	83.52	46.6

(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)

GPB/BST/ECT/94/01

The clones of 1994 clearing at the Kuruwita sub station (RRISL 201, RRISL 202 and RRISL 217) were marked for tapping at the end of the year. Yield data will be recorded from the next year (D P S T G Attanayaka, K B Karunasekera and H P Peiris).

GPB/BST/ECT/95/DF

RRISL 211, RRISL 208, RRISL 219 and RRISL 216 planted in Dartonfield estate were marked for tapping.

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

Five hundred germplasm clones were tapped for six months to select clones for yield. 22 clones were selected for further testing for yield. Pollen from GPS 36-84 was used in the hybridization programme (DP S T G Attanayaka and K B Karunasekera).

New planting

I) ***GPB/BST/HPS/98/01, GPB/BST/HPS/98/02, GPB/BST/HPS/98/03 (Nivithigalakele) and GPB/BST/HPS/98/04, GPB/BST/HPS/98/05, GPB/BST/HPS/98/06 (Kuruwita)***

Six Small Scale Clone Trials were planted at Nivithigalakele and Kuruwita sub

stations to test the 1998 HP progeny. Three trials were planted at Nivithigalakele with each having 17 HP selections and three control clones i.e. RRIC 121, RRIC 130 and RRISL 205. Each clone was replicated 8 times in a completely randomized design with the plot size of two trees. Planting was done on 6th July. The experiment at Kuruwita sub station was planted in August 28th. In this trial, 22 HP selections were included with the same control clones used at Nivithigalakele using the same experimental design (D P S T G Attanayaka, H P Pieris and K B Karunasekera).

II) ***Estate/RRI collaborative clone trials- Siriniwasa estate (GPB/BST/ECT/01/01)***

RRISL 215, RRISL 226, RRISL 218 and RRISL 211 were planted at the Siriniwasa estate.on 12th July. 300 trees were planted from each clone.

Nivithigalakele division (GPB/BST/ECT/01/02)

300 plants from clone RRISL 2000, 150 plants from RRISL 2001 and 85 plants from RRISL 2002 were planted at the Nivithigalakele sub-station at the end of the month of August.

III) ***Small holder/RRI collaborative clone trials GPB/BST/SRT/01/01-03***

Details of the trials established under this programe are given in Table 24.

Table 24. *Details of the SRT trials planted in 2001*

Site	Expt. No.	Farmer	Clone	No. of Plants (date of planting)	Remarks
Kegalle	SRT/01/01	K A L Munasingha	RRISL 201	228 (07/06 2001)	
			RRISL 203	230 (28/06/2001)	
	SRT/01/02	T A Bandula Kumara	RRISL 205	285 (13/06/ 2001)	
Homagama	SRT/01/03	D C Ratugama	RRISL 201	200 (22/06/01)	Intercropped with Brinjal
			RRISL 203	200 (22/06/01)	Intercropped with Brinjal
			RRISL 205	200 (23/06/01)	Intercropped with Brinjal

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

PLANT SCIENCE

P Seneviratne

SUMMARY

Rooting of cuttings from high yielding mature trees remained at low level. Seedlings grown in polybags with and without an opening at the base were similar in growth. The water consumption is less, whilst the growth is superior in both polybag and ground nurseries when Aquar-Spa irrigation system is used instead of manual watering. Further it is very cost effective as labour requirement is zero and no water pumps are involved. The growth of plants transplanted with the polybag was comparable to that of the control plants upto date. With increasing planting density the percentage trees in tapping decreased. However, total number of tappable trees per hectare increased with the density. Highest girth and girth increment of immature rubber were observed when branching was induced using leaf cap method.

The yield from RRIC 102 and RRIC 117 crowns were comparable but *Hevea spurciana* continued to give lower yields on RRIC 110 trunks. Stimulating RRIC 130 trees, crown budded with *Hevea spruciana* gave higher yields but only for a short period of time. The girth increments were similar in different clones when tapped using different tapping systems. In trees opened at 16" the highest yield was obtained with ½S d/3 tapping with stimulation.

The adoption of recommended tapping techniques resulted in a 20% improvement, in g/t/t when compared to the control block where the estate practices were continued.

Rambutan and Cinnamon planted as long-term perennial crops showed a 90% success rate in field establishment where as it was poor for Durian.

DETAILED REVIEW

Staff

Dr (Mrs) Priyani Seneviratne, Head of the Department (with effect from 20.06.2001), Dr V H L Rodrigo, Research Officer in Intercropping, Mr L S S Pathiratna, Botanist, 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 de Alwis, Mr M K P Perera, Mr T U K Silva Experimental Officers, Mr L 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. Miss S Liyanage resigned from the post of Technical Officer with effect from July 31st. Dr A M W K

Seneviratne left to University of Wales, Bangor, U K on 28th February to complete his post graduate studies and returned to the Institute on 3rd December after obtaining the PhD.

Miss C W Ranasinghe retired on 11th December after 35 years of service in the Institute.

Mr N M C Nayanakantha and Mr N A A D Wickramaratna assumed duties as Assistant Botanists with effect from 2nd July.

Research students

- Mr M A J Thushara of University of Ruhuna completed his final year project on "Rooting and acclimatization of micropropagated plants of *Hevea brasiliensis* (Muell. Arg.)" under the supervision of Dr (Mrs) P Seneviratne.

- Ms B T Perera, Research Assistant recruited through the NSF started her project on clonal propagation of *Hevea* with effect from 15th August under the supervision of Dr (Mrs) P Seneviratne.

- Ms N A K G I Kumari Research Assistant, recruited through the NSF to work on micropropagation of *Hevea* with effect from 15th August for a period of one year under the supervision of Dr (Mrs) P Seneviratne, vacated the post from 31st December.

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

- Mr K P Sameera Rukshan, Research Assistant was recruited from NSF, to work on "An economic analysis of widely adopted rubber based inctercropping systems of Sri Lanka" under the supervision of Dr V H L Rodrigo.

- Ms Kokila Gunasekera, Research Assistant recruited through the NSF 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
P Seneviratne	Nursery Committee Meeting	Rubber Development Department
L S S Pathiratna	Medicinal Plants Project Monitoring Committee	World conservation Union
N A A D Wicramarathna	Management of Natural Resources	Postgraduate Institute of Science, University of Peradeniya,

Training programmes

Client	Subject	No. of programmes
Rubber Smallholders, Millewa RDO Division	Intercropping practices of Medicinal Plants under rubber	1
Plantation Sector	Exploitation, rainguarding, nursery practices, planting and after care	27
NIPM	Exploitation, nursery and planting practices and Intercropping	1

Advisory visits

Client	No. of visits
Plantations	20
Smallholdings	05

LABORATORY INVESTIGATIONS

Tissue culture

Rooting was possible with both juvenile and mature axillary shoots. Acclimatization was done but with low success rate. Micro-grafting done in order to harvest meristems from clonal part showed positive results. Use of antibiotics to control bacterial growth was not successful (P Seneviratne, C Nayanakantha, S Liyanage and N A K G I Kumari).

FIELD EXPERIMENTS

Clonal propagation

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

Cutting harvested from field grown mature trees were placed in the mist propagator for rooting to be used as a vegetative propagation method. Percentage rooting of cuttings collected from clones RRIC 100 and 130 were 12% and 63%. RRIC 130 branches were harvested from wind damaged trees and hence were better for rooting (P Seneviratne and G A S Wijesekera).

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

The objective of this trial is to see whether the very high yields recorded for some trees will continue their performances if propagated vegetatively. Daily yields were monitored of 3 high and 3 low yielding trees from each of the clones RRIC 100, RRIC 121 and RRIC 130. The variation in the yield of high yielding trees was grater than that of low yielding trees. Monthly mean yield of the plants for a period of one year are given in Table 1.

Direct rooting of cuttings harvested from these trees was not possible. Moreover, budgrafting success of buds harvested from both high and low yielding trees was low, *ca.* 30%. In the grafted plants 50% of the elongated scion produced root systems under mist-propagation. The long period required to confirm whether the resulting plants would give the same high yields is the main draw back in this study (P Seneviratne and G A S Wijesekera and R K Samarasekara).

Rootstock nurseries

Effect of germination time on seedling growth - RN/2001/1 - Dartonfield

The effect of time taken for germination on the growth of seedlings was tested with a batch of seeds collected from Moneragala in January. The height and the diameter of the seedlings germinated after different number of days from sowing are given in Table 2.

Table 1. *Monthly mean yield of the test plants of three clones RRIC 100, RRIC 121 and RRIC 130*

Clone	Category	Girth class (cm)	Tree No.	Mean Volume (ml) (SEM)										
				Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
RRIC 100	High	49-51	16	166.4 (7.1)	181.9 (12.3)	190.9 (9.5)	144.5 (8.5)	131.7 (14.6)	86.5 (7.9)	156.3 (12.7)	145.3 (4.3)	147.8 (4.2)	124.6 (5.0)	116.4 (6.1)
		44-46	54	298.5 (27.8)	330.4 (24.9)	262.3 (23.9)	216.1 (18.9)	230.3 (24.3)	272.3 (7.9)	291 (11.7)	295.4 (4.7)	240 (9.3)	197.8 (9.2)	180.4 (4.0)
		42-44	114	139.6 (6.7)	113.1 (5.2)	117.7 (7.5)	92.2 (9.4)	93.7 (7.2)	108 (10.2)	120 (3.2)	113.2 (7.0)	133.8 (4.2)	137.9 (4.0)	110.7 (5.0)
	Low	49-51	1	115.2 (6.0)	196.9 (15.8)	231.9 (8.6)	158.6 (6.4)	112.9 (12.5)	62 (7.1)	108 (12.7)	121.1 (2.6)	95 (3.4)	90.4 (4.8)	63.4 (5.4)
		44-46	44	73.0 (5.2)	70.3 (4.5)	49.7 (2.7)	49.4 (7.1)	42.4 (4.9)	23.7 (2.1)	23 (12.7)	19.6 (0.8)	22.5 (5.5)	31.8 (3.9)	26.1 (2.8)
		42-44	109	153.5 (7.5)	162.7 (8.6)	146.6 (7.6)	146.1 (8.3)	125.5 (8.5)	164 (16.7)	194.3 (12.7)	190 (4.9)	176.3 (1.4)	141.8 (3.9)	160 (5.3)
RRIC 121	High	49-51	2	178.5 (13.5)	113.2 (6.8)	130.4 (5.8)	146.8 (12.4)	141.5 (10.6)	134.3 (7.9)	135.9 (7.0)	144.6 (4.2)	125.6 (3.4)	78.7 (1.6)	70 (3.6)
		44-46	42	66 (3.1)	68.6 (6.2)	42.1 (3.5)	80.1 (5.5)	80.4 (3.7)	85.3 (4.3)	95.6 6.8)	107.9 (5.2)	92.2 (3.7)	100 (5.0)	93.9 (6.5)
		42-44	107	122.5 (9.5)	92.5 (7.5)	75.9 (4.5)	81.4 (8.2)	97.9 (9.3)	84 (4.8)	113.6 (6.6)	95.7 (4.8)	90 (4.1)	77 (3.0)	66.8 (3.4)
	Low	49-51	15	98 (4.9)	82.5 (5.3)	72.9 (3.6)	69.7 (2.1)	66 (3.4)	60.6 (4.1)	74.7 (5.4)	80 (4.2)	76.6 (2.1)	67.7 (2.6)	66.1 (3.4)
		44-46	59	57.5 (4.1)	50.6 (2.3)	36.6 (2.7)	41 (2.8)	47.2 (12.9)	27.8 (1.6)	58.1 (3.0)	47.9 (1.0)	50 (0.9)	49.7 (3.2)	42.1 (3.3)
		42-44	116	148.6 (12.0)	115.5 (11.5)	107.3 (6.4)	109.9 (15.8)	157.6 (11.0)	146.5 (8.0)	145.1 (7.6)	135 (6.7)	128.4 (7.7)	183.3 (0.9)	16.5 (9.8)

Clone	Category	Girth class (cm)	Tree No.	Mean Volume (ml)(SEM)										
RRIC 130	High	49-51	19	351.9 (11.5)	201.4 (20.6)	176.4 (16.9)	226.9 (18.9)	168.2 (11.3)	157 (7.8)	183.7 (9.5)	153.3 (5.4)	212 (10.4)	155.2 (5.3)	161.8 (9.1)
		44-46	47	202.5 (15.6)	115.9 (4.9)	86.3 (7.3)	106.4 (7.7)	142.1 (7.0)	88.3 (3.9)	117.7 (8.1)	93.7 (2.7)	68.3 (2.8)	53.7 (3.4)	193.2 (21.8)
		42-44	120	128.8 (11.1)	99.5 (5.7)	106.7 (4.5)	114.9 (7.8)	223.3 (18.2)	178.3 (8.0)	134 (6.4)	64 (4.9)	53 (1.7)	51.7 (1.2)	47.1 (8.2)
	Low	49-51	1	81.3 (3.8)	64.5 (4.1)	39.3 (2.7)	58.3 (15.3)	56.5 (2.8)	50.9 (2.4)	57 (2.6)	196.3 (29.0)	373.3 (3.9)	373.7 (11.2)	358.2 (20.4)
		44-46	48	111.3 (13.3)	78 (6.0)	58.5 (2.6)	80 (8.3)	83 (6.8)	56.3 (3.3)	69 (4.2)	58.3 (2.4)	85.7 (12.5)	92.3 (7.1)	58.2 (4.6)
		42-44	102	170 (20.8)	118 (14.0)	87.8 (3.8)	101.7 (11.3)	131.1 (8.4)	111.7 (6.2)	101.7 (4.9)	112 (4.5)	136.3 (6.8)	147.7 (4.8)	116.4 (5.80)

Table 2. *The growth of seedlings germinated after different number of days from sowing. Number of replicates are given in brackets*

Treatment	Germination time	% out of total	Height (cm)				Diameter after 4 months
			6 weeks	10 weeks	14 weeks	18 weeks	
Group 1	14 days	5%	35.64 (50)	48.48 (50)	55.16(50)	67.6(50)	8.7 (50)
Group 2	15 days	9%	36.6 (75)	52.2 (75)	61.9 (75)	78.8(75)	9.6(61)
Group 3	16-17 days	18.9%	33.7 (75)	48.9 (75)	56.6 (75)	69.6(75)	8.4(75)
Group 4	18 days	9.6%	23.9 (25)	40 (24)	50.5(24)	56.4(24)	6.9(24)
Group 5	19 days	4.5%	23.3 (27)	39.5 (27)	45.6(27)	63.7(26)	-
Group 6	20 days	5.8%	22.2 (25)	36.4 (23)	42(23)	61.5(23)	-
Group 7	21 days	5.6%	26.5 (25)	45 (23)	58(18)	59.2(16)	-
Group 8	34 days	1.3%	17.75 (6)	30.67 (6)	40.3(6)	50.6(6)	-
Group 9	37 days	0.7%	15.8 (5)	24.6 (5)	30.6(5)	37.4(5)	-
Group 10	40 days	0.75%	18.8 (5)	30.4 (5)	37.8(5)	37.5(3)	-

The delay in germination and the low percentage of germination, *i.e.* less than 60%, indicate the poor quality of seeds. However once germination commenced the pattern of germination and growth are as same as for a good seed population. Anyhow, from this batch of seeds only 40% of the total appears to be suitable for rootstock nurseries (P Seneviratne and G A S Wijesekera).

Effect of the bag type on growth of seedlings - RN/2001/2 - Dartonfield

The growth of seedlings was measured when grown in 6" ×18" (15 cm × 45 cm), gauge 500, black guzzeted polybags with and without an opening at the base of the bag. Table 3 shows the height and diameter of seedlings until they were bud grafted.

Table 3. *The mean height and diameter of seedlings grown in bags with and without an opening at the base*

Bag type	Mean height (cm)							Diameter after 19 weeks (mm)
	Weeks after planting							
	3	5	7	9	13	15	17	
Without an opening	23.3 ±.99	32.1 ±1.7	4.0 ±1.3	48.5 ±2.6	53.5 ±3.1	58.4 ±3.4	65.7 ± 3.38	8.60
With an opening	24.8 ±.45	29.4 ±1.7	42.9 ±2.2	51.7 ±1.9	57.6 ±2.2	62.2 ±2.9	64.9 ±3.05	8.75

As evident from Table 3, the growth of the plants seem to be independent from whether an opening at the base in present or not. This may be due to very fast root elongation of seedlings and their penetration into the ground in a very short period of time (Table 4).

Table 4. *Mean shoot and root length of seedlings grown in polybags*

No. of days	Mean shoot length (cm)	Mean root length (cm)
3 days	26	15
10 days	31	24
17 days	31	25
24 days	31	27
31 days	33	39*
42 days	38	45*

Though the length of the bag is 45 cm, the depth of the soil core in the bag at time of planting is about 35-38 cm. Therefore, about one month after planting, the tap root reaches the base of the bag and soon penetrates into ground. As it is not practically possible to prevent this, it would be advisable to have an opening at the base of the bag to allow the tap root to grow into the soil without disturbing the growth of the plant. In some cases the tap root grows several rounds at the base of the bag before it finds a place to grow into the ground. In this trial all the plants grown in bags without an opening at the base showed coiling of the tap root at the bottom of the bag while those grown in bags with an opening had tap roots with uninterrupted growth (P Seneviratne and G A S Wijesekera).

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

Both polybag and ground nurseries were used for this study. Manual watering and Aqua Spa Porous Micro Irrigation System in which the porous tubes are berried 6" in the ground were tested. In the polybag nursery, a 1" layer of coir dust was laid on the pipes and polybag plants were placed on the coir dust layer. In the ground nursery germinated seeds, were planted between the porous tubing berried at 6" and 2' apart. For the control treatment plants were watered manually. Height and girth measurements were recorded monthly. The water consumption of the Aqua Spa Porous Micro Irrigation System is 1.5 l/m/h under a pressure of 1.4 bar. The volume used by this is about half of the requirement for manual watering (P Seneviratne, N M C Nayanakantha and G A S Wijesekera).

Budgrafting

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

The effect of the position of the bud on the grafting success, sprouting time and the scion growth was monitored using material from 10 year old budwood plants of clone RRIC 117.

Each bud stick was categorized according to the distance from the union before the buds were removed. Budgrafting success, sprouting time, length and angle of scion shoot and bud type are given in Table 5.

Table 5. *Budgrafting success, sprouting time, length and angle of scion shoot for different bud types harvested from different positions of the tree (A= Axillary, S=Scale)*

Group	Distance from the union (cm)	No. of buds	Success %	Sprouting time, (days)	Shoot length (cm) after 04 months
		A – 14	71.4	35.1 ± 5.7	43.2 ± 8.1
1	40-70	S - 8	87.9	26.3 ± 2.9	40.6 ± 3.3
		A - 30	66.6	27.6 ± 1.7	39.3 ± 2.3
2	70-100	S - 9	100	27 ± 1.9	34.8 ± 6.7
		A - 14	85.7	26.5 ± 2.3	37.7 ±5.3
3	100 – 130	S – 8	62.5	25 ± 2.4	36.2 ± 2.2
		A – 29	68.9	24.8 ± 1.6	43.2 ± 2.9
4	130 – 160	S - 10	90	25.5 ± 2.9	33.6 ± 4.5
		A – 6	100	23.8 ± 0.9	40.3 ± 4.7
5	160 –190	S – 20	80	27 ± 2.5	35.8 ± 2.6
		A – 13	61.5	30.4 ± 4.5	33 ± 6.2
6	190 – 220	S – 5	100	25.4 ±2.0	37.8 ± 3.1
		A – 8	100	26.0 ±3.1	38.8 ± 2.7
7	220 – 250	S - 9	100	28.5 ±4.7	34.8 ± 4.6
		A – 7	100	26.4 ± 1.9	38.1 ± 4.5
8	250 – 280	S – 3	66.6	45 ± 0	40* ± 0
		A – 7	100	29.3 ± 2.4	33 ± 5.5
9	280 – 310	S – 11	100	30.6 ± 3.0	27.5 ± 3.2
		A – 3	100	35.3 ± 11	36.6 ± 3.2
10	310 – 340	S – 7	100	24.5 ± 4.0	25.3 ± 3.8
		A – 0	-	-	-
11	340 – 370	S – 4	75	29.6 ± 4.5	37.3 ± 5
		A – 0	-	-	-
12	370 – 400	S - 6	66.6	27.5 ± 2.6	4.4

Shoot length decreased with the increasing distance from the bud union in both axillary and scale buds (P Seneviratne and G A S Wijesekera).

Successive grafting - BG/1992/1 - Dartonfield

Percentage rooting in the mist propagator and survival percentage of rooted cuttings for five generations are given in Table 6.

Table 6. *Percentage rooting in the mist propagator and survival percentage of rooted cuttings in polybags for five successive generations*

Generation	Percentage rooting after 10 weeks	Survival % of plants
G3 (July 1993)	17.6	17.6
G4 (June 1994)	21.9	14.6
G6 (June 1995)	45.8	33.5
G8 (March 1996)	23.0	15.4
G8 (March 1997)	33.3	33.3

Malfunctioning of the mist propagator affected the rooting of cuttings. A new successive grafting experiment was commenced in March 1999 with RRIC 102 and steps were taken to minimize the time period between generations. Four generations were obtained by October 2001 (P Seneviratne and G A S Wijesekera).

Crown budding

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

Mean girth and annual girth increment of RRIC 110 trees crown budded with RRIC 100, 102, 117, 130 and *H. spruciana* at Padukka estate are given in Table 7.

Trees in the main division were opened for tapping in December 1999 and the yield data are given in Table 8.

The high yields from RRIC 110 crowns is partly due to the higher girth (Table 7). The yields of RRIC 102 and RRIC 117 are comparable but *H. spruciana* is giving low yields (P Seneviratne, S Wilbert and M N de Alwis).

Table 7. *Mean girth to-gether with the standard error and the annual girth increment of RRIC 110 plants crown budded with different clones*

Clearing	Crown Clone	Girth (cm)	Girth increment (cm)
1996 – RRIC 110 Minnerigama Division	RRIC 100	49.5 ± .04	7.9
	RRIC 102	53.2 ± .65	6.9
	RRIC 117	48.6 ± .47	7.7
	RRIC 121	56.6 ± .56	10.0
	RRIC 130	52.8 ± .52	9.4
	H. spruciana	43.2 ± .47	6.0
1994 – RRIC 110 Main Division	RRIC 100	44.7 ± .37	1
	RRIC 102	46.6 ± 51	1.6
	RRIC 117	45.7 ± .52	2.9
	H. spruciana	47.3 ±1.4	1.6
	RRIC110 (not budded)	59.4 ± 1.2	(not available)

Table 8. *Yield data of RRIC 110 trees crown budded with different clones*

	Mean Yield (ml/t/t)			
Crown	July	August	September	November
H. spruciana	55.3 ± 4.26	46.32 ± 3.24	44.48 ± 0.40	40.66 ± 4.28
RRIC 100	67.15 ± 2.39	57.0 ± 2.65	61.22 ± 1.11	62.95 ± 2.97
RRIC 102	85.43 ± 3.53	74.48 ± 3.36	75.5 ± 2.58	79.99 ± 4.14
RRIC 117	85.03 ± 6.45	77.63 ± 4.02	68.71 ± 1.86	78.52 ± 3.87
RRIC 110	110.8 ± 4.61	104.8 ± 3.77	103.78 ± 3.05	111.87 ± 8.00

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

Monthly average yield for a month period during 2001 is given in Table 9. As the girth of crown budded trees are less when compared to unbudded RRIC 100 and RRIC 121 trees, yield data were gathered from another field where the girths of the trees were similar to crown budded trees.

High yields of unbudded trees in the same field can be attributed to their higher girths, 72.3 cm and 68.8 cm for RRIC 121 and RRIC 100 trees respectively. RRIC 100 trees taken for the control treatment have given higher yields while RRIC 121 control trees have given lower yields. These trees are however under girth and hence it is too early to arrive at a conclusion (P Seneviratne and S Wilbert).

Table 9. *The monthly average yield of crown budded trees and their control (number of tappings per month are given in brackets) C= crown, T= trunk*

		Monthly Average Yield (ml/t/t)						
Treatment	Mean girth	Jan.	Feb.	Mar.	Apr.	May	June	Mean
T- RRIC 121 C- RRIC 100	49.1	18.2 (4)	25.3 (8)	11.3 (8)	11.8 (5)	8.6 (6)	24.0 (8)	16.6
RRIC121 (not budded)	72.3	107.2 (4)	96.6 (8)	48.7 (8)	91.9 (5)	35.1 (6)	62.2 (8)	65.3
RRIC100 (not budded)	68.8	82.9 (4)	78.0 (8)	25.6 (8)	20.0 (5)	24.8 (6)	83.8 (8)	52.5
RRIC 121 (control)	43.4	23.2 (7)	26.1 (6)	18.2 (10)	17.0 (8)	11.5 (7)	16.1 (7)	18.7
RRIC 100 (control)	43.3	46.7 (7)	53.1 (6)	33.8 (10)	13.5 (8)	15.1 (7)	37.5 (7)	33.3

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

Monthly average yield of RRIC 130 trees with *H. spruciana* crowns and unbudded RRIC 130 plants are given in Table 10.

Ethrel was applied to all trees on 18.1 2001 and the second application was done in 17.04.2001 to all crown budded trees and on half of the RRIC 130 unbudded trees (*). The tree no.6 was severely infected with Formes and was uprooted and removed. Poor yielding crown appears to have affected the yield of the trunk clone though the girth of trees are satisfactory. In fact the girth of trees crown budded with *H. spruciana* were poor at the beginning due to the removal of the crown. The mean girth of crown budded trees and unbudded RRIC 130 trees are 55.62 and 68.65 cm respectively (P Seneviratne and S Wilbert).

Table 10. *Monthly average yields of crown budded and control trees of RRIC 130. Number of tapping done in each month are given in brackets*

H. spruciana							
	Yield (ml+ ft)						
Tree No.	Girth 8.8.2001	Jan	Feb	Mar	Apr	May	Mean yield ml/t/t
1*	52.1	101.8 (8)	110.5 (9)	31.5 (9)	82.2 (10)	110.9 (9)	87.38
2*	51.6	108.0 (8)	112.2 (9)	55.9 (9)	65.4 (10)	84.3 (9)	85.16
3*	46.6	64.3 (8)	66.6 (9)	60.0 (9)	47.9 (10)	104.1 (9)	125.58
8*	64.4	31.4 (8)	182.7 (9)	110.4 (9)	99.3 (10)	104.1 (9)	125.58
RRIC 130							
4	41.9	129.7 (9)	121.6 (9)	82.6	39.8 (10)	54.8 (9)	85.7
6	61.9	155.7 (8)	311.6 (9)	60.6 (3)	-	-	175.9
7*	53.7	199.7 (8)	328.9 (9)	132.5 (9)	101.5 (10)	143.4 (9)	181.2
9*	69.6	384.3 (8)	703.8 (9)	448.4 (9)	224.3 (10)	255.1 (9)	403.18
10*	73.5	469.3 (8)	721.8 (9)	443.1 (9)	252.7 (10)	324.4 (9)	440.46
11*	62.4	292.5 (8)	463.3 (9)	266.5 (9)	194.9 (10)	215.4 (9)	286.52
12	54.1	221.2 (8)	292.2 (9)	221.9 (9)	107.7 (10)	116.5 (9)	191.9
13	71.2	287.5 (8)	627.0	415.1 (9)	301.0 (10)	345.7 (9)	395.26

* Stimulated trees

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

Details of this trial are reported in the Annual Review for 1999. Mean girth of RRISL 224 trees with different crown clones are given in Table 11.

Table 11. *Mean girth of RRISL 224 trees crown budded with one or two clones. (Number of replicates in a treatment are given within brackets)*

Crown clone/clones	Mean girth (cm)
H. pauciflora (25)	35.35 ± .86
H. pauciflora + RRIC 100 (1)	40.0
H. pauciflora + RRIC 102 (2)	32.24 ± 3.0
RRIC 121 + RRIC 100 (11)	41.1 ± 1.4
RRIC 100 (57)	40.64 ± .75
RRIC 102 (3)	35.72 ± 3.3
RRIC 121	41.72 ± 1.4

(P Seneviratne and M N de Alwis)

RRIC 133, RRII 105 and BPM 24 - CB/1998/1 - Nivithigalakale

Grafting was carried out to form six trunk/crown combinations. Grafting success was around 80% (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

Budgrafting was conducted to get eight trunk/crown combinations (P Seneviratne and L Zoysa).

Budwood nurseries

New nurseries

Two budwood nurseries were established with new RRISL clones inorder to provide authentic material for the establishment of budwood nurseries. The clonal composition of the nursery is given in Table12.

Table 12. *Clonal composition of the two budwood nurseries established with the new RRISL clones*

Clone	Dartonfield nursery	Olikanda nursery	Total
RRISL 200	14	-	14
RRISL 201	33	11	44
RRISL 202	37	3	40
RRISL 203	33	21	54
RRISL 205	34	18	52
RRISL 210	29	-	29
RRISL 215	32	8	40
RRISL 217	46	86	132
RRISL 218	27	12	39
RRISL 219	46	10	56
Total			500

Authentic material for budwood nurseries

Authentic material issued during the year for the establishment of budwood nurseries is given in Table 13.

Table 13. *Clones and the number of plants issued for the purpose of establishing budwood nurseries in the estate sector*

Clone	Name of estate and No. of budded stumps										
	Ayr	Elpitiya	Forcester	Hillstream	Neuchatle	Pussella	Rambukkanda	Salawa	Sorana	Sunderland	Total
RRIC 121				3				20			23
RRIC 117		7	3	3							13
RRIC 130		7	3	3	25			20	3		61
RRIC 133		7	3	3				20	3		36
RRISL 200		7	3			10		20			40
RRISL 201		7		3		10	8	50			78
RRISL 202		7		3		10	8	50			78
RRISL 203		7	3			10	8				28
RRISL 205		7			25		8	20			60
RRISL 206		7			25		8				40
RRISL 210	25						8	10			43
RRISL 217	25	7		3							35
RRII 105		7	3							10	20
RRIM 717		7	3								10
PR 255		7	3							10	20
BPM 24			3						3		6
PB 28/59				3							3
PB 217		7	3	3					6		19
PB 235			3								3
PB 255			3								3
PB 260			3							5	8
Total	50	98	39	27	75	40	48	210	15	25	627

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

Nursery inspection

Eight private nurseries were inspected during the year for the purpose of issuing permits by the RDD. All budwood nurseries of the RDD nurseries were also inspected (P Seneviratne, U S Weerakoon, M N de Alwis and L Zoysa).

Planting techniques

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

Inorder to minimize casualties and planting cost different planting methods were tested for polybag plants and young buddings. The girth of the plants at the end of the second year is given in Table 14.

Table 14. *Mean girth (cm) and SEM of the plants transplanted by different methods (Superscript letters show Duncan grouping)*

Treatment (Planting methods)	Polybag plants	Young buddings
T1 - With the polybag	$19.62 \pm .86^{a}$	$16.22 \pm .38^{a}$
T2 - Without base of the poly bag	$21.97 \pm .72^{a}$	$17.0 \pm .44^{ab}$
T3 - T2 +4 slits	$20.5 \pm .67^{a}$	$16.96 \pm .46^{ab}$
T4 - With 4 slits on the bag	$19.73 \pm .53^{a}$	$17.0 \pm .42^{ab}$
T5 - Whole bag removed (current recommendation)	$21.0 \pm .87^{a}$	$17.68 \pm .44^{a}$

The young buddings were about 6 months younger than the polybag plants. Though the plants transplanted with the bag show the lowest girth, the difference is not significant. However, removing the base only is as good as removing the whole bag as per the current recommendation (P Seneviratne and U S Weerakoon).

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

Polybag plants having two leaf whorls were used for this study. The diameter and height measurements were taken in all test plants. Experimental site was inspected with the help of Soils and Plant Nutrition Department in order to categorize the area according to the soil type. After holing was completed every planting hole was re-inspected and grouped into categories, *i.e.* good, moderate and bad. The effect of the type of planting hole and the initial growth of the planting material on the growth at the field level will be monitored (P Seneviratne and L Zoysa).

Mixed planting - PT/1996/1 - Dartonfield

The girth and the girth increment for the year for different clones are given in Table 15.

The girth increment for the year is satisfactory though the growth of the trees for their age is much below the required standards. Up-keep of this trial is done by the estate whilst the annual girth measurements are taken by the department (P Seneviratne and L Zoysa).

Table 15. *Girth and the girth increment for the year for different clones*

Clone	Girth	Girth increment (cm)
PB 217	27	10.68 ± .6
PB 235	28.79	9.25 ± .62
PB 28/59	27.47	7.38 ± .34
RRIC 100	28.62	8.97 ± .56
RRIC 102	25.27	9.14 ±.94
RRIC 121	28.65	8.40 ± .7
RRIC 130	31.12	12.08 ± .88

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

Treatment details 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 16. Mean girth of rubber has significantly decreased with the increase of planting density, *i.e.* irrespective of the rubber clone with lowest values for the highest density 800 trees per hectare. Bark thickness also showed a similar trend, however such differences among treatments were not statistically significant. In general, percentage trees in tapping decreased with increasing density. However total number of trees in tapping per hectare increased. The lowest mean yield per tree per tapping (g/t/t) was recorded in the highest density, whilst yield per hectare per year (YPH) was comparable among different densities. Although percentage casualties was more or less similar across the densities, percentage week plants was greater in high densities. Chemical applications to control of *Corynespora* leaf disease in the clone RRIC 110 was successful to some extent, however similar to the results shown in previous years, the performance of the clone RRIC110 was poor with respect to all growth and yield (YPH) parameters.

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

Three experimental blocks, 2 at Galewatta and 1 at Nivithigalakele were abandoned due to very high rate of casualties due to animal damages and diseases. Girth measurements were taken from remaining blocks at Nivitigalakele. The girth increased with decreasing planting density, *i.e.* 53.2, 50.8, 49.9 and 44.7 cm for densities of 350, 475, 500 and 575 trees per hectare respectively (A Nugawela, P Seneviratne and K A G B Amaratunga).

Table 16. *Effect of planting density on growth parameters (a) and yield (b) of rubber. Girth and bark thickness (BT) were measured at 150cm height of the trees*

(a)

Density (trees/ha)	RRIC 100						RRIC 110						RRIC 121					
	Girth (cm)	BT (mm)	% Casualties	% Weak plants	% Trees in tapping	Tappable trees/ha	Girth (cm)	BT (mm)	% Casualties	% Weak plants	% Trees in tapping	Tappable trees/ha	Girth (cm)	BT (mm)	% Casualties	% Weak plants	% Trees in tapping	Tappable trees/ha
500	56.67	6.98	0.0	0.0	89.30	446.50	53.14	6.59	10.68	2.43	64.38	321.90	60.73	6.79	1.14	0.0	87.92	439.60
600	55.82	6.64	1.67	0.0	84.57	507.42	49.52	5.92	4.81	5.71	56.15	336.90	57.78	6.68	1.78	0.89	83.81	502.86
700	52.82	6.61	0.0	1.37	82.50	577.50	47.86	5.86	7.78	11.88	42.27	295.89	56.61	6.41	0.0	1.78	78.24	547.68
800	52.71	6.68	0.87	2.87	70.85	566.80	46.74	5.92	10.85	6.15	43.55	348.40	54.64	6.28	0.88	0.51	77.54	620.24

(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	25.97	1043.70	27.32	797.20	27.60	1101.57
600	25.44	1167.11	28.54	886.98	25.91	1176.22
700	20.85	1081.24	27.87	746.74	23.86	1183.28
800	22.12	1128.38	26.28	799.32	21.04	1195.44

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

Cultural practices during immature phase

Branch induction - CP/2000/1 - Pallegoda

Details of this experiment are reported in the Annual Review for the year 2000.

Girth of the trees at the end of the year and the girth increment for different treatments are given in Table 17.

Table 17. *Girth and the girth increment for different treatments*

Treatment	Girth (cm)	Girth increment (cm)
T1 – Leaf cap method	39.6 ± .73	16.01
T2 – Cut and remove all leaves	37.7 ± .7	14.95
T3 – Removing 3" portion of	38.84 ± .59	15.11
T4 – Control	37.51 ± .55	14.45

Girth and annual girth increment are satisfactory in all treatments. Removing the 3" apex has affected the canopy architecture (P Seneviratne and U S Weerakoon).

Girthing of mature and immature plants – CP/2000/1 – Dartonfield, Pallegoda, Culloden

Monthly girth measurements were taken for different clones in different aged clearings in order to study the girthing in different months of the year (Table 18).

Lower girth increment in 2 year old clearings than that of 3 and 4 year old clearings must be due to reasons other than age. Though there are clonal differences, girth increment shows a decreasing trend with the increase of age. Though a seasonal growth patterns cannot be defected, data are being analysed to see whether the growth is correlated with fertiliser application, rain *etc.*

Exploitation

Assessment on the adoption of recommended tapping practices

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

This was an observation trail established in May 2001 at Gallewatta division, Dartonfield group with an objective of assessing levels of adoption of the recommended tapping policies at field level and their effects on yields.

Four tapping blocks (RRIC 100, replanted in 1986) were selected for the study. Initial assessment on tapping quality was performed and thereafter, tappers were advised on the correct tapping policies such as angle, depth and length of the tapping cut, marking of poikanu and neththikanu, shaving thickness, availability and

Table 18. *Monthly mean girth increment of trees of different ages and clones*

Clone	Age years	Estate	Girth Increment (cm)											
			June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
RRIC 100	2	Pallegoda	0.7	0.6	0.4	0.6	0.6	0.6	0.6	0.4	0.5	0.6	0.8	0.8
	4	Pallegoda	1.3	1.3	1.1	1.1	1	1.1	1.1	1.0	0.8	0.9	0.8	-
	6	Pallegoda	0.8	0.9	0.8	0.8	0.8	0.6	0.7	0.5	0.5	0.3	0.1	0.2
	3	Culloden	1.1	0.9	1.3	1.1	0.8	1.2	1	1.1	1.1	1	1.1	-
	11	Gallewatta	0.6	0.4	0.2	0.3	0.4	0.4	0.1	0.1	0.1	0.03	0.02	0.1
	15	Gallewatta	0.2	0.2	0.1	0.04	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
RRIC 121	2	Pallegod	0.5	0.8	0.5	0.7	0.7	0.5	0.6	0.8	0.6	0.6	0.9	0.8
	3	Culloen	1.1	1.2	1.2	1.2	1.2	1.1	1.0	1.1	0.9	1	1	1
	4	Dartonfield	0.8	0.8	0.7	0.8	06	0.8	0.3	0.6	0.2	0.4	0.7	0.5
	5	Gallewatta	0.6	0.6	0.7	0.7	0.7	0.7	0.5	0.4	0.2	0.2	0.5	0.5

position of cups and cup hangers. The percentage of trees with correct adoption of above policies were recorded at the end of each month (Table 19). Tapping angle seems to be the most difficult factor to be corrected. It was too early to comment on the influence of correcting tapping policies on latex yields. However during the period under consideration, there was *ca.* 20% improvement in g/t/t when compared to another tapping block in the same clearing where the estate practices were continued.

Table 19. *Time cause variation in the level of correction (% trees) of different tapping policies with monthly advises given*

Month of monitoring →	Initial level	1st	2nd	3rd	4th	5th	6th	7th
Tapping angle	35.0	43.3	51.25	55	65	71.67	75.8	78.75
Depth of tapping	55.	57.5	58.75	61.67	68.3	76.25	77.5	82.5
Shaving thickness	57.5	60	62.5	66.67	70	71.25	76.25	81.25
Poikanu	31.25	42.5	48.75	56.25	73.3	75	78.75	84.25
Neththikanu	35.0	38.75	66.25	72.5	78.75	82.5	86.25	88.75
Length of tapping	35.0	42.5	50.0	56.25	58.75	61.25	71.17	83.75
Spouts	72.5	72.5	75	80	87.5	91.25	92.5	95
Cups	76.25	80.	80	82.5	88.75	91.75	92.5	95
Cup hangers	67.5	67.5	72.5	81.25	83.75	91.75	93.75	95
Correct placement of spouts, cups, cup hangers	41.25	43.75	47.5	53.75	61.86	72.5	81.25	88.75

(N A A D Wickramarathna, V H L Rodrigo, A Nugawela and K A G B Amaratunga)

Developing of leech repellents – LR/01/01

The objective of this study was to develop a cost effective leech repellent for the use of estate workers. Private sector participation (Link Natural Products (Pvt.) Ltd) was sought to develop such compounds in user friendly manner at commercial level. Each compound/mixture was tested using *ca.* 30 estate workers and details of the initial results are given in Table 20.

Table 20. *Effectiveness of the compounds tested with estate workers*

	Compound/Mixture	Degree of repelling	Long-term effectiveness	Retention in the body	Remarks
1	100% Citronella Oil	very good	poor	very poor	Easily washed off and needs to be applied 4-5 times per day
2	50% Citronella Oil	very good	poor	very poor	- do-
3	10% Citronella Oil	good	poor	very poor	- do -
4	Tobacco leaf extract (aqueous solution)	good	good	very poor	- do-
5	50% of Citronella Oil + 50% of coconut oil	moderate	moderate	poor	Needs to be applied 2-3 times per day
6	25% of Citronella + 25% of Tobacco leaf extract + 50% of coconut oil.	good	moderate	poor	- do-
7	5% Citronella Oil + crude paste	poor	poor	good	Although leaches get on to the body, they can be easily removed and few suck blood. One application could be sufficient.
8	40 ml of paraffin wax + 10 ml of turpentine (mineral base)	poor	poor	moderate	-
9	10 ml of turpentine (mineral base) + crude paste (40 ml)	poor	poor	good	-

(N A A D Wickramarathna, V H L Rodrigo and A Nugawela)

Exploitation of renewed bark

As expected highest g/t/t is achieved from treatments tapped at high intensity adopting current recommendations (Table 21). Rested BI-1 panels have also given a good yield. An economic analysis will be carried out for

exploring the most economical way of exploiting renewed panels, in instances where time given for bark renewal is much less than 12 years.

Table 21. *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
¼ S(↓) d/2 (BI-1)	¼ S(↑) + ½ S (↓)d/2	68.4	80.8
¼ S(↓) d/2 (6" above BI-1)	¼ S(↑) + ½ S (↓)d/2	88.2	64.5
½ S(↑) d/2 (HO-1 x 2)	½ S(↓) d/2 (BI-1)	50.4	40.4
½ S(↓) d/2 (HO-1x2)	½ S(↓) d/2 (BI-1)	59.4	37.3
PT d/2 (HO-1x2)	½ S(↑) d/2 (BI-1)	64.2	33.3
	½ S(↓) (HO-1x2)	39.1	48.5

(A Nugawela and R P Karunasena)

Girth at opening

Generally g/t/t tend to increase with increasing girth in all clones tested (Table 22). The yield differences are more prominent in RRIC 130, the highest yielding clone among the tested. Trees of treatments T2, T4 and T6 were tapped during the year and results confirm that yield increases with increasing girth in all clones and this trend is more significant in RRIC 130 amongst the clones tested (A Nugawela, R K Samarasekera and S Wilbert).

Table 22. *The mean yield,* i.e. *g/t/t recorded during the year for different girths and clones*

	Clones and mean g/t/t			
Treatment	RRIC 130	RRIC 121	RRIC 100	Mean
T1	37.5	43.8	41.0	40.8
T3	47.0	34.5	45.7	42.4
T5	67.4	44.7	49.0	53.7
	52.6	36.3	44.1	44.3
T8	52.6	36.5	53.2	47.3
T2	66.5	32.4	34.8	44.6
T4	89.4	32.9	41.3	54.5
T6	111.8	41.9	46.4	66.7

Table 23. *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
RRIC 100	T1	41.9	4.5	3.5	4.8	4.09	1.57	1.46
	T2	41.7	8.2	6.5	5.7	4.59	2.2	1.02
	T3	44.6	4.8	3.5	4.8	4.5	1.66	1.09
	T4	45.1	8.8	7.0	6.7	5.39	3.09	0.8
	T5	50.2	3.7	4.5	5.1	5.19	1.81	1.17
	T6	49.3	9.3	6.6	6.7	6.56	3.61	0.61
	T7	42	8.3	3.9	3.4	4.79	1.88	0.91
	T8	45	8.9	3.8	3.9	5.46	2.2	1.14
RRIC 121	T1	42.2	5.1	4.3	4.1	1.9	3.18	3.07
	T2	42.6	6.3	5.5	4.6	2.44	4.52	4.09
	T3	44.9	5.2	4.2	3.8	1.41	2.55	2.37
	T4	44.6	6.6	5.2	4.4	2.89	3.2	3.93
	T5	49.6	6.2	4.5	4.2	2.2	2.99	3.07
	T6	49.6	7.6	5.8	4.4	2.23	4.87	5.43
	T7	42.6	7.1	4.1	4.1	2.02	3.06	3.06
	T8	44.7	6.1	4.3	4.3	1.96	3.02	3.71
RRIC 130	T1	42.9	4.9	4.2	2.2	2.77	1.69	3.91
	T2	42.4	8.1	6.2	3.9	4.53	4.07	2.36
	T3	44.6	5.7	5.5	2.1	4.28	1.48	4.93
	T4	45.1	8.8	6.8	4.5	4.99	5.86	2.77
	T5	49.5	5.7	5.0	1.5	4.36	3.96	2.95
	T6	49.8	9.6	7.6	4.6	5.9	5.53	3.10
	T7	42.6	8.2	3.9	2.0	3.5	2.79	4.12
	T8	44.7	8.5	4.2	1.8	3.11	2.98	6.21

In clone RRIC 121 the girthing of these trees continued to be superior to that of previously tapped trees , *i.e.* T1, T3 and T5 (Table 23). Nevertheless, clones RRIC 100 and 130 behaved differently. In these clones the girthing of T2, T4 and T6 trees were less than in the trees of T1, T3 and T6 (A Nugawela, R K Samarasekera and S Wilbert).

Girth at opening (TG/99/1)

The objective of this trial is to develop tapping systems to harvest optimum yields of new clones while minimizing immature costs tapping costs, tapper requirement and injury to the plant.

RRIC 102 – 1995 replanting – Galewatta
RRIC 121 – 1995 replanting – Galewatta
RRISL 211 – 1995 replanting – Galewatta.

From each of the above clones clearings were selected when 60% of the trees had reached a girth of 40 cm. A random sample of 40cm trees were tapped immediately. Whilst others were rested to be tapped at 45 cm and 50 cm growth stages. The 30 trees selected from each clone for commencement of tapping at different girth levels were randomly separated into 3 sub groups each having 10 trees.

The following treatments were introduced randomly (single tree plots) for each group of trees in each clone.

Treatment
T1 - ½ S d/2
T2 - ½ S d/3
T3 - ½ s d/3 + E*
(E* - 2.5% Eth., Ba 1.6 (2.5), 4/y)

Table 24. *Effect of different tapping regimes on yield and mean girth increment of clones RRIC 102, RRIC 121 and RRISL 211. Within a category means with same letter are not significantly different*

Clone	Yield			Growth
	Treatment	g/t/t	Kg/t/yr.	Girth increment
RRIC 102	T1	6.875^{b}	1.189	4.100^{a}
	T2	8.884^{a}	1.003	4.215^{a}
	T3	10.344^{a}	1.174	4.164^{a}
RRIC 121	T1	6.240^{b}	1.079	4.46^{a}
	T2	6.933^{b}	0.783	4.489^{a}
	T3	10.253^{a}	1.158	4.390^{a}
RRISL 211	T1	13.782^{b}	2.384	3.768^{a}
	T2	16.248^{ab}	1.836	3.904^{a}
	T3	19.852^{a}	2.243	3.944^{a}

The highest total dry rubber yield per tree per tapping *i.e.* g/t/t and per unit land area, *i.e.* kg/t/yr. was given from clone RRISL 211 out of the three clones tested.

The different tapping regimes tested have not influenced the girth increment significantly. Based on the results obtained so far on trees of 16" girth low frequency tapping with stimulation was comparable with the other systems tested.

Similar data on trees tapped at higher girths, *i.e.* 18" and 20'' are not yet available to comment on the effects of early tapping of novel clones (A Nugawela, V H L Rodrigo, K Gunasekera and R P Karunasena).

Low frequency tapping

Ambetenna estate - LFT/97/1

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

Three tapping blocks were selected for each d/3 system whilst two blocks were selected for the d/2 system. One tapper was assigned for each treatment (Table 25). The task size was 250 trees.

½S d/3 with 4 rounds of stimulation per year using 5% ethrel has given the highest g/t/t levels (Table 25). Further, even with a lesser number of tapping days/year this treatment has given the highest yield/tree/year. Girth increment and tapping panel dryness were comparable in all treatments. 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.

Table 25. *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	28.61	85	2.43	4	1.45	16.26	4.82
T_2 - ½S d/3 + E**. 4/y	32.01	93	2.98	4	1.81	15.70	2.60
T_3 - ½S d/3 + E* 6/y	27.52	92	2.53	5½	1.52	15.76	4.39
T_4 - ½S d/2	21.79	117.5	2.56	-	1.25	25.30	3.48

E* 2.5% ET, Ba 1.6(2.5) E** 5.0%ET, Ba 1.6 (2.5)

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

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. Treatments and results are given in Table 26.

With respect to g/t/t, the effect of Ethrel on d/2 tapping was marginal. Annual tree yield in d/3 systems were comparable though number of stimulations per year are different. Further yields are lower than that of d/2 systems. However, g/t/t with d/3 tapping was greater than that with d/2 tapping.

Bark consumption was very high in both d/2 and d/3 tapping. However values were comparatively low in low frequency tapping.

TPD was similar in all treatment.

Table 26. *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	Bark consumption rate (cm/year)	Tapping panel dryness (TPD) (%)
T_1 - ½S d/2 – Control	20.7	156	3.23	-	1.82	32.03	3,56
T_2 - ½S d/2 + E*. 4/y	21.6	156	3.37	3	1.33	34.09	3.76
T_3 - ½S d/3 + E* 6/y	25.3	103	2.61	5	1.68	23.50	2.39
T_4 - ½S d/3 + E* 4/y	24.3	106	2.62	3	2.01	25.92	3.85

E* 2.5% ET, Ba 1.6(2.5)

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

Intercroping

Spatial arrangements

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

Details of the experiment are given in the Annual Review 1992. Similar to the results shown in 1999 and 2000, highest values for girth and bark thickness were given by the cluster planting systems (Table 27a). However, cluster systems have given the highest percentage of casualties (Table 27b). Percentage week plants and plants affected with Tapping Panel Dryness (TPD) were more or less similar across the treatments. Tree yield (g/t/t/) was highest in the traditional single row and

in the planting systems. Triple row planting system has given the lowest values for most of measured parameters. Both g/t/t and YPH were statistically comparable in all treatments, except in triple row system where values were lowest and significantly less than those of traditional single row planting system.

Table 27. *Effect of different planting systems on growth and yield parameters of rubber. Values with the same letter in each category are not significantly different*

(a)

Spatial Arrangement	Girth (cm)	Bark thickness (mm)	Yield (g/t/t)	Yield (kg/ha/yr)
Single row planting system	55.55^{bc}	7.10^{ab}	29.33^{ab}	1530.2^{a}
Double row planting system	52.23^{dc}	6.90^{ab}	23.90^{bc}	1179.9^{ab}
Triple row planting system	49.48^{d}	6.59^{b}	22.65^{c}	1063.7^{b}
Triangular planting system	59.91^{a}	7.28^{a}	31.12^{a}	1379.6^{ab}
Square planting system	56.73^{ab}	7.36^{a}	28.34^{abc}	1368.3^{ab}

(b)

Spatial Arrangement	% Casualties	%Weak plants	% TPD	%Trees in tapping
Single row planting system	0.0^{b}	0.0^{a}	9.29^{a}	90.71^{a}
Double row planting system	11.43^{ab}	2.56^{a}	0.0^{b}	86.0^{a}
Triple row planting system	10.46^{ab}	5.13^{a}	2.19^{ab}	82.22^{a}
Triangular planting system	21.11^{a}	0.0^{a}	1.85^{ab}	77.04^{a}
Square planting system	12.94^{ab}	0.0^{a}	1.753^{ab}	85.31^{a}

(V H L Rodrigo, T U K Silva and E S Munasinghe)

Intercroping systems

Rubber and timber

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

Ambetenna, 1992 Replanting - IC/RT/92/2

Experimental details are given in Annual Review 1992. Treatment effects shown in 2001 are quite similar to those in 2000. Alstonia was the most successfully established timber crop resulting in the highest competition to rubber as evident by both growth (*i.e.* mean girth) and yield (*i.e.* g/t/t/ and kg/ha/yr) (Table 28a).

However, bark thickness and percentage of trees in tapping were comparable across the treatments. When the performance of rubber in different sole and high density planting systems are analyzed with compared to that of the rubber/Alstonia system (Table 28b), it is evident that the competition by Alstonia is greater than that from the rubber crop (For instance, growth and yield of rubber recorded in the Alstonia timber plots were less than those in corresponding high density rubber plots). Moreover, though not always statistically significant, performance of double row planting system is slightly poor when compared to that of single row system.

Table 28a. *Effect of timber species on growth and yield parameters of rubber. Values with the same letter in each category are not significantly different*

Timber species	Girth (cm)	Bark thickness (mm)	%Trees in tapping	Yield (g/t/t)	Yield (kg/ha/yr)
No timber	53.91[a]	6.51[a]	92.81[a]	24.56[b]	1388.5[b]
Halmilla	54.17[a]	6.56[a]	87.1[a]	23.94[b]	1275.6[b]
Alstonia	49.22[b]	5.98[a]	80.84[a]	19.25[c]	972.5[c]
Teak	54.46[a]	6.37[a]	93.33[a]	24.68[b]	1418.5[b]
Mahogani	56.68[a]	6.58[a]	92.01[a]	29.89[a]	1666.6[a]

Table 28b. *Performance of rubber with respect to different cropping systems. Since Alstonia was the most successfully established timber crop, out of all intercrops only the rubber/Alstonia system was included in the statistical analysis. Values with the same letter in each category are not significantly different*

Cropping System	Girth (cm)	Bark Thickness (mm)	%Trees in tapping	Yield (g/t/t)	Yield (kg/ha/yr)
Single row system (sole crop)	55.65[a]	6.71[a]	100.0[a]	26.31[a]	1585.0[a]
Double row system (sole crop)	52.18[ab]	6.31[ab]	85.63[a]	22.81[b]	1192.0[ab]
Alstonia intercrop in single row system	51.62[b]	6.06[b]	80.77[a]	19.94[bc]	1051.9[b]
Alstonia intercrop in double row system	46.82[c]	5.89[b]	80.91[a]	18.55[c]	893.1[b]
High density rubber-single row intercropping system	52.99[ab]	6.17[ab]	88.22[a]	22.11[bc]	1166.2[ab]
High density rubber-double row intercropping system	52.16[ab]	5.99[b]	78.98[a]	21.32[bc]	1057.7[b]

(V H L Rodrigo, T U K Silva and E S Munasinghe)

Intercropping project on rubber/banana and smallholder on-farm trials

Details of the study appeared in the Annual Review 1998 and 1999. This project is conducted in collaboration with Universities of Wales and Durham in UK and University of Sri Jayawardenapura, Sri Lanka and, funded by the Department for International Development (DFID) UK. Project comprised two major components as follows:

a. ***On-station shade experiment on rubber and banana (Dartonfield)***

Heavy shade has resulted reduced growth (Table 29) of both rubber and banana as a result of reduced rates of CO_2 assimilation (Table 30a). However, decline in F_v/F_m ratio in both crops was greater under full sunlight conditions (Table 30b) indicating that shade alleviate the radiation stress (photoinhibition) during mid day. Analysis of leaf chlorophyll showed a trend of decreased chlorophyll a/b ratio with increasing shade, indicating the ability of shade adaptation of both crops (Table 30c). Detailed results are given in the PhD thesis of A M W K Senevirathna (2001) on "Rubber/banana intercropping in Sri Lanka".

Table 29. *The growth of rubber and banana as indicated by the stem diameter (at 10 cm height), basal girth (at 10 cm height) and plant height at different shade levels. Measurements are given at 15 months of planting except for unshaded (open) banana where the measurements were made at 11 months of planting. n=15.*

Shade level (%)	Rubber		Banana	
	Diameter/cm	Height/m	Girth/cm	Height/m
Open (0)	5.11 ± 0.16^{a}	4.73 ± 0.13^{a}	58.50 ± 3.45^{a}	2.32 ± 0.13^{a}
Low (33±1.0)	3.55 ± 0.24^{b}	3.24 ± 0.25^{b}	48.76 ± 1.32^{b}	1.99 ± 0.08^{b}
Medium (55±0.5)	2.86 ± 0.18^{c}	2.65 ± 0.17^{c}	55.92 ± 1.55^{a}	2.43 ± 0.10^{a}
High (77±0.7)	1.80 ± 0.21^{d}	1.59 ± 0.17^{d}	46.83 ± 2.73^{b}	1.87 ± 0.20^{b}

Table 30. *Summary of the diurnal changes in* **(a)** *CO_2 assimilation (μ mol m^{-2} s^{-1}) measured on sunny and overcast days (n=12),* **(b)** *F_v/F_m on sunny days (n=10) and* **(c)** *total and 'a' to 'b' ratio of chlorophyll (n=5) of rubber and banana in different shade treatments*

(a)

Shade level (%)	Rubber			Banana		
	Morning	Midday	Evening	Morning	Midday	Evening
Open (0)	16.7±1.0^{a}	17.9±0.5^{a}	14.0±0.7^{a}	20.9±1.0^{a}	19.2±1.6^{a}	12.9±1.5^{a}
Low (33±1.0)	10.6±2.2^{b}	13.8±1.8^{b}	8.3±1.7^{b}	15.9±1.1^{b}	14.9±1.5^{b}	12.3±1.6^{a}
Medium (55±0.5)	9.7±2.0^{b}	12.1±2.9^{b}	6.6±1.6^{b}	12.5±1.7^{c}	13.2±2.7^{b}	7.5±1.3^{b}
High (77±0.7)	6.8±1.6^{c}	2.6±1.3^{c}	2.1±0.6^{c}	7.2±1.5^{d}	7.4±1.8^{c}	4.4±0.5^{c}

(b)

Shade level (%)	Rubber			Banana		
	Morning	Midday	Evening	Morning	Midday	Evening
Open (0)	0.81±0.02^{b}	0.75±0.02^{c}	0.79±0.0^{b}	0.81±0.0^{a}	0.75±0.0^{c}	0.78±0.0^{b}
Low (33±1.0)	0.82±0.02^{b}	0.79±0.01^{b}	0.82±0.0^{b}	0.83±0.0^{a}	0.80±0.0^{b}	0.81±0.0^{ab}
Medium (55±0.5)	0.82±0.02^{b}	0.81±0.02^{b}	0.81±0.0^{b}	0.82±0.0^{a}	0.80±0.0^{b}	0.82±0.0^{a}
High (77±0.7)	0.84±0.01^{a}	0.83±0.01^{a}	0.84±0.0^{a}	0.84±0.02	0.83±0.0^{a}	0.84±0.0^{a}

(c)

Shade level (%)	Rubber		Banana	
	Total/mg g^{-1}	a/b ratio	Total/mg g^{-1}	a/b ratio
Open (0)	0.172±0.002	2.14±0.03	0.018±0.001	2.30±0.19
Low (33±1.0)	0.144±0.003	1.87±0.06	0.027±0.001	2.09±0.11
Medium (55±0.5)	0.137±0.008	1.74±0.08	0.030±0.001	2.01±0.08
High (77±0.7)	0.169±0.008	1.55±0.05	0.023±0.001	1.94±0.02

(A M W K Senevirathna, V H L Rodrigo, P K W Karunathilake and P D Pathirana in collaboration with the University of Wales, UK)

b. ***On-farm trials on rubber intercropping***

Growth in terms of plant girth of both rubber and banana under different on-farm conditions, is shown in Table 31. Agronomic and sociological observations gathered on on-farm trials were discussed in detail with farmers in a two day workshop organised at the RRISL. Scrutinized observations with farmer participation are shown below in list 1. In general, farmers accepted intercropping as a practical means to solve the problem of no income during immature phase of rubber. However, this option does not carry a great weight in most of the areas in the wet zone as farmers depend more on off-farm than on on-farm activities. In intermediate zone, the majority of villages are remote resulting in farmers have few options other than working on on-farm. Therefore, farmers cannot bear the no income period resulting in that the majority of rubber farmers carry out intercropping on rubber lands with their traditional crops at least for first few years.

Farmers preferred two row planting system of banana over either one row or three row system and were in the opinion that should three row system be practised, banana clumps have to be maintained/pruned properly which is not the case with some smallholders. This was particularly important for banana varieties with large canopies such as Ambun, Anamalu. If banana were over crowded, it would affect the yield of banana, but not the growth of rubber.

List 1: Observations made by scientists on rubber based on-farm intercropping experiments.

(a) ***Agronomic observations:***

Intercropping in general,

- Has no adverse effect on growth of rubber, instead facilitates an increased growth rate of rubber.
- Protects rubber plants from heavy sunlight.

Of rubber/banana intercropping,

- Increasing banana density up to three rows would not affect the growth of either rubber or banana.
- Weeds in general, has no strong effect on the growth of rubber, but has a great influence on the growth of banana.
- Application of inorganic fertilizer is essential for the growth of banana.

- Application of inorganic fertilizer for banana has no effect on the growth of rubber.

(b) ***Sociological observation on rubber farmers:***

Rubber in general;

- Farmers grow rubber as a method of acquiring crown lands where possible and to secure the land ownership where it is loosely held.
- Knowledge on rubber plays a significant role in the success of rubber cultivation.

Intercropping;

- Greater the distance to farm lesser the intercultivation activities, hence poor the growth.
- Farmers with less land tend to grow intercrops.
- Farmers in low income category prefer to grow low capital and less labour demanding crops.
- Farmers with additional income sources pay less attention to intercrops.
- Access to market and its stability promote farmers to grow more crops.

In homestead;

- Crop diversity depends on the period of stay on same land, *i.e.* longer the period greater number of crops.
- Increase in the size of homestead increases the total number of crops, but decreases the number of crops per unit area.

Table 31. *Stem girth increment (measured at a height of 10 cm from the ground) of rubber over a 10 month period and basal girth of banana at 14 months after planting in Well and Poor managed rubber/banana intercrops where RB, RBB and RBBB respectively refer to the single, double and triple rows of banana planted between rubber rows in the wet zone (WZ) and in the intermediate zone (IMZ). FER and NFER represent respectively the sub-plots in which banana was either fertilised or not fertilised. Data represent means ± s.e.m. of an average of 45 and 81 (rubber), 135 and 243(banana) replicate plants per treatment respectively from the WZ and IMZ, and 3 and 4 Well, and 2 and 5 Poor managed experimental sites in the WZ and IMZ respectively.*

Management	Zone	Density	Girth inc. (rubber)/cm		Basal girth (banana)/cm	
			FER	NFER	FER	NFER
Well	WZ	RB	6.57±0.50	6.60±1.94	42.26±4.12	29.56±2.97
		RBB	9.05±0.45	5.28±1.01	44.27±1.04	38.03±3.70
		RBBB	8.35±0.37	7.48±1.21	45.40±1.31	34.19±8.26
	IMZ	RB	5.87±2.15	5.56±1.18	53.67±1.97	41.75±5.52
		RBB	8.24±1.42	6.44±1.19	47.33±8.49	43.35±5.19
		RBBB	7.17±2.19	5.61±0.66	43.00±7.48	34.93±6.41
Poor	WZ	RB	4.76±2.10	4.21±1.27	30.35±0.75	19.02±1.73
		RBB	4.92±1.20	4.21±1.28	32.10±5.60	21.76±1.44
		RBBB	4.85±1.07	4.41±0.31	36.89±3.74	23.00±0.20
	IMZ	RB	4.37±0.47	5.19±0.46	32.82±2.94	23.23±1.94
		RBB	4.80±0.23	4.39±0.55	28.83±0.76	22.93±2.54
		RBBB	4.28±0.40	4.53±0.17	25.52±4.91	22.51±2.67

(V H L Rodrigo, A M W K Senevirathna, P D Pathirana and P K W Karunathilake in collaboration with the University of Sri Jayawardenapura and University of Wales, UK)

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

This experiment was established with the objectives of developing suitable spatial arrangements for planting rubber in long term intercropping systems and assessing the feasibility of growing some economically important perennial crops under such systems. The experiment comprised four spatial systems together with 4 perennial crops, *i.e.* Tea, Cinnamon, Durian and Rumbutan. It was laid down on a split plot design where spatial planting systems were taken as the main treatment plots and crops on sub plots.

Planting systems of rubber were, (*i.e.* all four were paired row systems of rubber)

1. 3m x 3m within the paired row and 15 m alley between paired rows
2. 3m x 3m within the paired row and 18 m alley between paired rows
3. 3.5m x 3.5m within the paired row and 15 m alley between paired rows
4. 3.5m x 3.5m within the paired row and 18 m alley between paired rows

Intercropping systems were,

- The two fruit crops; planted as a single row between paired rubber rows at 10m apart.
- Tea and cinnamon; planted at a spacing of 0.6m x 1.2m leaving 2.4-2.7m towards rubber rows. This has given 9 and 12 rows in 15m and 18m alleys, respectively. Planting of tea was done only in half of the subplot leaving the next half for soil rehabilitation with Mana grass which is a prerequisite for planting tea in most soils.

Establishment of rambutan and cinnamon were very successful giving values above 90%. However it was poor for Durian (Table 32). Arrangement has been made to infill causalities with the onset of SW monsoon in 2002.

Table 32. *Establishment rates (% success) of rubber and other crops as at the end of year 2001*

Spatial system	Rubber	*Tea*	Cinnamon	Durian	Rambutan
(3 x 3) - 15	98	86	92	42	96
(3 x 3) - 18	87	84	94	74	97
(3.5x 3.5) - 15	93	88	94	40	100
(3.5 x 3.5) - 18	95	88	94	33	100

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

.Rubber and Cocoa/Cinnamon - IC/CC/91/2 - Dartonfield

This trial was established in 1991 to investigate the possibility of intercropping Cinnamon and Cocoa with rubber.

The growth of rubber was not affected by the intercrops at this stage (Table 33) (L S S Pathiratna and M K P Perera).

Table 33. *Effect of intercrops on the growth of rubber*

Treatments	Girth of rubber (cm)
1. Rubber only	64.9
2. Rubber + Cinnamon (spacing 1)	60.3
3. Rubber + Cinnamon (Spacing 2)	67.2
4. Rubber + Cinnamon (Spacing 3)	65.0
5. Rubber + Cocoa (Spacing 1)	59.3
6. Rubber + Cocoa (Spacing 2)	61.3
7. Rubber + Cocoa (Spacing 3)	57.8

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 as evident by the stem height (Table 34).

Table 34. *The growth of rattan in height*

Rattan species	Stem height (cm)	Annual increment (cm)
1	250.8	163.1
2	367.6	228.8
3	251.3	157.0

(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 had the lowest girth. Girth differences in other treatments were not significant at this stage (Table 35).

In the other experiment where Cinnamon was established under mature rubber (1984 clg.) at the Kuruwita Sub-station, no differences among the spacing treatments were evident (Table 36). The effect of the level of fertilizer and the polythene barrier showed the same trend as in last year (Table 37).

Table 35. *The effect of spacing on the growth of rubber*

Treatment (Inter row space m)	Girth of rubber (cm)
Single row of rubber	
7.2	27.4^{b}
8.4	30.1^{ab}
9.6	29.6^{ab}
10.8	29.2^{ab}
12.0	30.5^{a}
13.2	31.0^{a}
Paired rows of rubber	
13.2	30.6^{a}
14.4	29.5^{a}
15.6	30.3^{a}
16.8	29.5^{ab}
18.0	30.6^{a}

Table 36. *Effect of spacing on the yield of* Cinnamon *under mature rubber*

Treatment (Cinnamon spacing)	Cinnamon bark yield
.91 m × .61 m	45.5
1.2 m × .91m	28.9
1.7 m × 1.2 m	31.6
1.1 m triangular spacing	29.0

Table 37. *Effect of the level of fertilizer on the bark yield of* Cinnamon

Fertilizer level	Cinnamon bark yield (g/bush)
1 + polythene barrier	35.7
2	31.4
3	31.9
4	35.9

(L S S Pathiratna and M K P Perera)

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

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. Several harvests from the short term crops were taken. (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 and P R Lasanthi).

PLANT PATHOLOGY AND MICROBIOLOGY

C K Jayasinghe

SUMMARY

The incidence of secondary leaf fall was moderate while abnormal leaf fall and bark rot were extremely mild. Field surveys indicated that only four clones, namely PB 217, PB 28/59, PB 235 and BPM 24 were severely affected with *Oidium heveae* during the year. Two new clones namely RRISL 202 and RRISL 211 succumbed to *Corynespora* leaf fall. Brinjal and okra, were shown to be alternate hosts for the pathogen *Corynespora cassiicola*. Enzymes responsible for the pathogenesis of *Thanatephorus cucumeris* were characterised. Molecular weights of polygalacturonase in all isolates were similar and were in the range of 53,000 to 58,000 Da. The resistance of some *H. brasiliensis* clones such as RRIC 100 and BPM 24 to *Phytophthora meadii* has been found to be directly correlated to the high activity of Phenylalamine-Ammonia-lyase enzyme.

DETAILED REVIEW

Staff

The Department functioned under the overall supervision of Dr C K Jayasinghe. Dr R Jayaratne and Mr K E Jayasuriya, Plant Pathologists and Mr W Amaratunge, Audio Visual Production Officer were on duty throughout the year. Dr (Miss) W P K Silva, Plant Pathologist assumed duties on 1st March after overseas leave and she was awarded Doctor of Philosophy degree with effect from 1st April from the University of Colombo.

Mr E B Fernando, Mrs T H P S Fernando and Mrs B I Tennakoon, Experimental Officers; Mrs D Wijeratne, 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 K A M Pushpakumara of the University of Ruhuna carried out his final year specialization project entitled "Screening of toxic chemicals to poison *Rigidoporus* affected rubber trees" under supervision of Dr R Jayaratne.

- Mr K D D P Kumarasinghe of the University of Ruhuna carried out his final year specialization project entitled "Characterization of *Corynespora cassiicola* isolates" under the supervision of Dr (Miss) W P K Silva.

Seminars/Conferences/Meetings attended

Officer	Subject	Organization
C K Jayasinghe	Steering Committee on National Plant Quarantine	Council for the Agricultural Research Policy
C K Jayasinghe	Pesticide Technical Advisory Committee	Department of Agriculture
C K Jayasinghe	Specialist Committee on Plant Protection	Council for the Agricultural Research Policy
C K Jayasinghe	Member of the Research Leader's Forum	National Science and Technology Commission
R Jayaratne	Member of the Executive Committee	Institute of Biology

Training programmes conducted

Dr C K Jayasinghe, Dr R Jayaratne and Dr (Miss) W P K Silva served as resource personnel in following training programmes:

Client	No. of programmes
Estate Managers	3
Trainee Asst. Managers	1
Asst. Managers	1
Asst. Managers and Field Officers	2
B.P.L. Certificate Programme	1
Rubber Development Officers	5

Mr E B Fernando, Mrs T H P S Fernando and Mrs I Tennakoon 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 C K Jayasinghe continued to be a Visiting Lecturer at the University of Ruhuna while Dr R Jayaratne served as a Visiting Lecturer at the University of Colombo.

Advisory visits

Client	No. of visits
Plantations	20
Smallholdings	04

GENERAL

The incidence of *Oidium* leaf fall (OLF) was not severe as in year 2000. However, a moderate leaf fall was evident on susceptible clones such as RRIC 121, PB 217, PB 28/59, BPM 24, PR 261 and RRIM 712. An interim circular was sent on

10th January 2001 predicting this situation and rubber growers were requested to apply an extra dose of fertilizer to susceptible clones as a preventive measure. With this background seminars were arranged for planters on the theme "Clonal susceptibility and prevention of *Oidium* leaf fall". It was shown that rubber growers should be cautious of OLF, as three out of six clones recommended in group I succumb to the disease severely in the years which experience favourable weather conditions for it. During these presentations the importance of the judicious application of extra dose of fertilizer and avoidance of the disease prone sites when establishing new clearings using susceptible clones were highlighted.

Phytophthora leaf fall and bark rot was extremely mild. This was due to the poor pod set and unusual dry weather experienced during May-June.

No new *Corynespora* infections were reported on clones recommended under Group I. However, the severity of the disease on RRISL 202 and RRISL 211, two susceptible rubber clones from Group II is being monitored.

It was brought to our notice in June that to undertake replanting, rubber trees of the old clearings have been cut at the ground level instead of uprooting in several estates. Immediate steps were taken to educate the Estate Managers on the importance of the removal of old trees to-gether with the root system and an interim circular entitled "Preparation of Land for Replanting: Uprooting Trees of the Old Clearing is a Must" was sent to executive officers of all Plantation Management Companies.

Dr C K Jayasinghe and Mrs T H P S Fernando received the "President's Research Bonus 1999" in recognition of their innovations and contributions to the global advancement of science. In November Her Excellency the President decided to give awards to the scientists who contributed to the reputation of the country by publishing in internationally accepted journals. In this occasion four officers namely Dr C K Jayasinghe, Mr K E Jayasuriya, Mrs T H P S Fernando and Mrs I Tennakoon from the Plant Pathology and Microbiology Department received awards.

LABORATORY AND FIELD INVESTIGATIONS

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

Screening of fungicides against Rigidoporus microporus (in vivo)

A new fungicide, Melody Deo received from Haychem Ltd. was tested for its efficacy in inhibiting the growth of the fungus *Rigidoporus microporus*. 100% inhibition was shown at 1600 ppm concentration. Further experiments are in progress to evaluate the suitability of this fungicide to control white root disease in the field (R Jayaratne, C K Jayasinghe and D Siriwardene).

Screening of fungicides against Corynespora cassiicola

Field operations were continued at four locations namely; Dartonfield, Lagos, Salawa and Kuruwita estates. Three rounds of fungicides were sprayed during refoliation period (from February to March) and another three rounds of spraying

were done during the rest of the year. During the year, carbendazim was used instead of benomyl as Benlate was banned due to its high mammalian toxicity (C K Jayasinghe, R Jayaratne, E B Fernando and C Wijeratne).

Biology of Common Pathogens (BCP/90/1)

Biology and pathogenicity of* Colletotrichum acutatum *and* Colletotrichum gloeosporioides*: a comparative study

With the discovery of *Colletotrichum acutatum* as the main cause of *Colletotrichum* leaf disease of rubber in Sri Lanka, a series of experiments was launched to compare the two species. Studies on spore production and germination were completed. Investigations to find the effect of temperature, humidity and UV radiation on spore germination and viability are in progress (C K Jayasinghe, T H P S Fernando and N Dharmadasa).

***Ugurassa (*Flacourtia inermis*), an alternative host for* Colletotrichum acutatum**

An island-wide survey was conducted to find the alternate hosts for *C. acutatum* subsequent to the finding that *C. acutatum* plays a major roll in leaf fall of *Hevea* caused by *Colletorrichum* spp. Ugurassa, a common tropical fruit tree cultivated in and around rubber plantations was found to harbour this pathogen. Under the light of this situation several experiments were carried out to characterize the isolate and to check whether Ugurassa isolate can infect the rubber tree (C K Jayasinghe and T H P S Fernando).

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

This project was a part of a PhD programme. Data obtained were analysed and compiled in the thesis submitted to University of Colombo (K E Jayasuriya, R L C Wijesundera and B I Tennakoon).

Studies on pectic enzymes produced by* C. cassiicola *collected from hosts other than rubber

Results of the above study showed that unlike rubber isolates, isolates from tomato, okra and brinjol produce higher amounts of Polygalacturonase (W P K Silva, N Nishantha and C K Jayasinghe).

Survey on species susceptible to* Corynespora *found in and around rubber plantations

During the year, two plant species (okra and brinjol) have been identified as alternate hosts of *Corynespora cassiicola*. The two new isolates were purified from diseased specimens of okra and brinjol and Koch's postulate have been proved (W P K Silva, C K Jayasinghe and N Nishantha).

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

Three new papaya isolates were tested on several rubber clones. Unlike earlier reported papaya isolates these are pathogenic on the tested rubber clones. However the infection was very mild (W P K Silva, C K Jayasinghe and N Nishantha).

***Characterization of cell wall degrading enzymes of* Thanatephorus cucumeris**

Thanatephorus cucumeris is a ubiquitous fungus responsible for many types of diseases worldwide. All rubber isolates tested secreted pectolytic enzymes; polygalacturonase (PG), pectin lyase (PL) and cellulolytic enzymes; β-glucosidase and cellobiase in culture. The extracts of rubber leaf tissue, inoculated with *T. cucumeris* did not show any PG activity. However, PL activity was detected on tissue with the establishment of the infection. The levels of β-glucosidase an inharent enzyme in *Hevea* increased rapidly following infection. However, cellobiase was detected only with the initiation of infection. Molecular weights of PG in all isolates were similar and in the range of 53,000 to 58,000. PL also followed the same pattern showing a molecular weight around 39,000 (C K Jayasinghe, C Wijeratne and T H P S Fernando).

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

Secondary leaf fall

Secondary leaf fall incidence, specially *Oidium* leaf fall was moderate as climatic conditions were not conducive for the pathogen to multiply and spread. However, the island-wide survey initiated in year 2000 was continued to determine the field susceptibility of recommended clones. The survey results revealed that clones namely PB 217, PB 28/59, PB 235, BPM 24, are highly susceptible to *Oidium* leaf fall (Table 1). However, it was noticed that the severity of the disease incidence was low compared to the year 2000. Moderate infections were noticed on clones RRIC 121, RRIC 117, RRISL 205, PB 260, RRIM 712, PR 255 and PR 261 (Table 1). This experiment will be continued during the *Oidium* seasons of the coming years (C K Jayasinghe, E B Fernando and T H P S Fernando).

Corynespora *leaf fall*

The surveys carried out on mature clearings revealed that two clones recommend for planting (Gp II) have succumbed to *Corynespora* leaf fall.

RRISL 202: The symptom was the characteristic fish-bone appearance and about 10% of the leaves were found to be affected with the disease in a 4 year old clearing at Kuruwita sub-station (C K Jayasinghe, D S Wettasinghe and T H P S Fernando)

RRISL 211: Characteristic fish-bone symptom was noticed. Mild defoliation was evident. The clearing is located at Dartonfield (C K Jayasinghe and E B Fernando)

Frequent monitoring of the disease situation on these two clones is in progress.

Phytophthora *leaf fall*

Routine survey was not done as *Phytophthora* leaf fall incidence was negligible during the year.

Establishment of genetic material for screening purposes

Forty six clones were established at Kuruwita sub-station for screening purposes (C K Jayasinghe and T H P S Fernando).

Maintenance of the 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).

Defence mechanisms of *Hevea brasileisns* (DM/89/1)

Studies on the accumulation of pathogenesis-related protein (PR-Protein) in* H. brasiliensis *petioles at* P. meadii *infected sites

Polyacrylamide Gel Electrophorasis showed at least three PR-proteins (≥ 66kDa) in the *P. meadii*-infected detached petioles of RRIC 100, RRIC 121, PB 86 and RRIM 600. In attached petioles of RRIC100, PR proteins were highest 72 h after infection with either virulent (IMI385259) or weak (IMI385260) *P. meadii* isolates. Data were presented to an international journal for publication (K E Jayasuriya, R L C Wijesundera and B I Tennakoon).

Studies on phenylalanin ammonia-lyase (PAL) enzyme activity in* P. meadii *infected* H. brasiliensis *clones

The PAL was extracted from petioles of both healthy or *P. meadii* (*Pm*) infected *Phytophthora* leaf disease resistant (RRIC 100) or susceptible (PB 86, RRIC 121, RRIM 600) clones. The highest PAL activity was observed in petioles of *Pm*-infected RRIC100, while *Pm*-infected PB86 petioles had significantly ($P< 0.05$) lower PAL activity. The probable involvement of PAL on the resistant mechanism of rubber clones by involving in the production of anti-fungal phenolic compounds was discussed and a manuscript was submitted to an international journal for publication (K E Jayasuriya and R L C Wijesundera).

Studies on the secretion of anti-fungal compounds from petiole surface of resistant or susceptible* H. brasiliensis *clones

Compounds (either phenolics or proteins) were secreted from petiole surface of both *Phytophthora* resistant (RRIC 100) or susceptible (PB 86, RRIM 600) clones as a response to the artificial inoculation of sterilized distilled water, sterilized (dead)

Table 1. *Field screening of recommended clones against secondary leaf fall (caused by* Oidium heveae*) in year 2001 (an year moderately favourable for the pathogen to multiply and spread)*

Clone	Disease severity	
	Level of infection on leaves*	Condition of the canopy*
RRIC 100	Mild to moderate infection of *Oidium*	0 - 25% defoliation
RRIC 102	Mild to moderate infection of *Oidium*	0 - 25% defoliation
RRIC 121	Moderate infection of *Oidium*	25 - 50% defoliation
RRIC 130	Mild infection of *Oidium*	No defoliation
PB 217	Moderate to severe infection of *Oidium*	50-75% defoliation
PB 28/59	Severe infection of *Oidium*	50 - 75% defoliation
RRIC 117	Moderate to severe infection of *Oidium*	25-50% defoliation
RRIC 131	No infection observed	No defoliation
RRIC 133	Mild infection of *Oidium*	0-25% defoliation
RRISL 201	NA	
RRISL 202	NA	
RRISL 203	Mild infection of *Oidium*	0 - 25% defoliation
RRISL 205	Moderate infection of *Oidium*	25-50% defoliation
RRISL 206	Moderate infection of *Oidium*	0 - 25% defoliation
RRISL 210	NA	
RRISL 211	NA	
RRISL 215	NA	
RRISL 217	NA	
PB 235	Severe infection of *Oidium*	50-75% defoliation
PB 260	Moderate to severe infection of *Oidium*	25 - 50% defoliation
BPM 24	Severe infectin of *Oidium*	50 - 75% defoliation
RRISL 200	NA	
RRISL 204	NA	
RRISL 208	NA	
RRISL 218	Moderate infection of *Oidium*	0 - 25% defoliation
RRISL 220	NA	
RRISL 221	NA	
RRISL 222	NA	
RRISL 225	NA	
RRISL 226	NA	
RRISL 227	NA	
GPS 1	NA	
RRIM 712	Severe infection of *Oidium*	25-50% defoliation
PB 255	NA	
PR 255	Moderate infection of *Oidium*	25-50% defoliation
PR 305	NA	
RRII 105	NA	
RRISL 2000	NA	
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	NA	

* a range is given depending on sites. NA - No data available as mature clearings are not existing

or live *P. meadii* (*Pm*) zoospore suspension (10^4 spores ml^{-1}) obtained from the aggressive (IMI 385259) or weak (IMI 385260) isolates. Spectrophotometer analysis showed that the secretion of proteins from RRIC100 petioles after 24 h was significantly ($P < 0.05$) high than from petioles of susceptible clones. All clones produced higher concentrations of phenolics as a response to the aggressive *Pm* inoculation than to the weak isolate. The response of all clones to the live *P. meadii* of the aggressive isolate was significantly ($P < 0.05$) high by producing high concentration of proteins. Results were discussed in view of using the assay in a preliminary screening of new rubber clones and a manuscript was submitted to an international journal for publication (K E Jayasuriya and R L C Wijesundera).

Bioassay and the biochemical analysis of ethanolic petiole extracts of different rubber clones

Petiole extracts (Pe) were obtained from RRIC 100, BPM 24 (resistant to *Phytophthora* leaf disease), RRIC 117, RRIC 130 (moderately resistant) and PB 86, RRIM 600 (susceptible). *P. meadii* (IMI385259) zoospore germination assay indicated the presence of inhibitive compound(s) (on germination and growth) in the extracts of healthy or infected resistant clones.

Spectrophotometer analysis showed the presence of high concentration of phenolic compounds in petioles of RRIC 100 and BPM 24. However the Pe of the same *P. meadii*-infected clones contained less phenolics (OD_{380}). Phytochemical analysis showed that the Pe of RRIC 100 contained flavonoids, lencoanthacyanin, steroides or triterpins, tannins or polyphenols, while, the Pe of PB 86 (both in healthy or infected) contained only flavanoids, sterols or triterpines. The infected resistant Pe contained steroids or terpinoids in addition to the contents of the healthy extract. Data were compiled in the PhD thesis (K E Jayasuriya and R L C Wijesundera).

Activity guided isolation of anti-fungal compounds from petioles of RRIC 100 (*Phytophthora *resistant) and PB 86 (*Phytophthora *susceptible)

Oven dried petioles (*ca* 1 kg) of two clones were subjected to solvent extraction. The activity guided isolation procedure comprised solvent partitioning of the crude extracts subsequent purification by silica gel column chromatography. Healthy or *P. meadii* (*Pm*)-infected RRIC 100 petioles contained comparatively low amount of anti-fungal compounds, among which, one was definitely identified as vanillin ($LD_{50} = 0.45$ μmol ml^{-1}). *Pm*-infected petioles of PB 86 abundantly contained anti-fungal compounds such as hydroxycumerins, stilbenes or phenanthrene. Results were compiled in the thesis leading to PhD (K E Jayasuriya, R L C Wijesundera and S A Deraniyagala).

Study on the likelihood effect of petiole ultra-structure and the phyloplane microflora of RRIC 100 (*Phytophthora *resistant) and PB 86 (*Phytophthora *susceptible)

Undisturbed petiole segments of two clones were double fixed with gluteraldehyde and osmium tetraoxide and scanned by electron microscope for structural variation on the surface. PB 86 surface had more external openings and the presence of bacterial or yeast colonies around the openings were abundant than on the resistant surface.

Highly antagonistic *Trichoderma* spp. along with other fungal spp. were isolated from resistant petiole surface, while similar organisms were isolated from the susceptible petioles except *Trichoderma* spp. Surface sterilization of the detached petioles of RRIC100 with 70% (v/v) ethanol, caused significant ($P < 0.05$) increase of the percentage infection rate than non-sterilised petioles, when inoculated with *P. meadii* zoospores (10^4 spores ml^{-1}). A significant ($P < 0.05$) decrease of % infection rate was observed on surface sterilized PB86 petioles than non-sterilized. The likelihood effect of these factors on the disease resistance of rubber clones was discussed and a manuscript was submitted to an international journal for publication (K E Jayasuriya and R L C Wijesundera).

Studies on arbuscular mycorrhizae (M/86/1)

The field experiment initiated at Dartonfield estate to ascertain the effect of arbuscular mycorrhizal fungi was continued. The growth of the plants were monitored by measuring the girth.

Table 2. *Mean girth (cm) of the field established plants after 52 months (Mean of 5 replicates consisting of 10 plants)*

Mycorrhizal type	+P (addition of P)	-P (No addition of P)
Gigaspora margarita	37.07 A	35.93 A
Acaulospora sp.	29.51 B	30.97 B
Natural population	30.10 B	31.81 B
Non-mycorrhizal (initially)	29.19 B	25.85 B

(Means with the same letter are not significantly different at P = 0.05 using DMRT).

MISCELLANEOUS

Screening of clonal seedling root stocks against white root

Seedlings of 14 different clones namely; RRIC 130, RRIM 701, PB 86, PB 260, RRIC 100, RRIC 102, RRIC 121, RRIC 110, RRISL 201, RRISL 217, RRIC 103, BPM 24, IAN 45/710 and *Hevea spruciana* are being screened for resistance against white root disease infection. This experiment is in progress at N'kele sub-station (R Jayaratne and D Siriwardene).

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

Stumps poisoning experiment initiated at Sapumalkanda estate was continued. Visual assessments on the rate of decaying of main tap root and the laterals were taken after 12 months and 18 months of treatment (Fig. 1) (R Jayaratne, C K Jayasinghe, B Fernando and P Peiris).

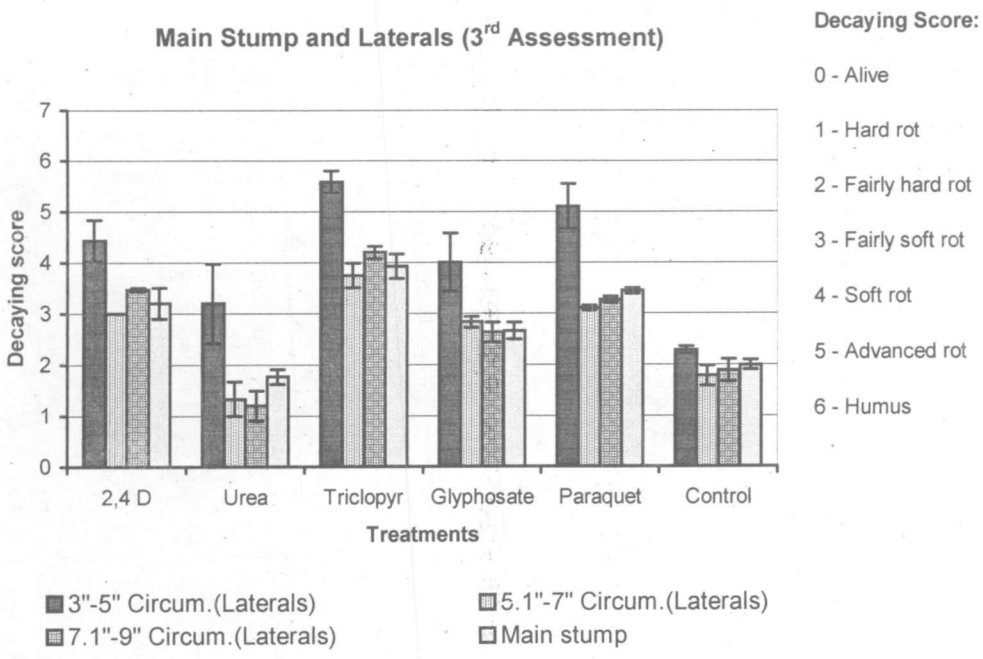


Fig. 1. Visual assessment on decaying rates of roots 18 months after introducing the treatments

Poisoning of live white root infected trees before uprooting

The experiment initiated at Reucastle estate, was continued. Two assessments were taken on the root system for the presence or absence of live mycelium (Table 3) (R Jayaratne, C K Jayasinghe, B Fernando and P Peiris).

Treatments:

T1 – Drenching - 5% Triclopyr (250 ml per plant) ; Tree Nos: 18, 10, 6, 8
T2 – Ring Bark and Drip - 5% Triclopyr (250 ml per plant) ; Tree Nos: 14, 9, 13, 18
T3 – Injection - 50 ml undialuted Triclopyr per plant ; Tree Nos: 17, 1, 3, 12

T4 – Ring Bark and Brush - 50 ml undialuted Triclopyr per plant ; Tree Nos: 15, 20, 11, 7
T5 – Stump poisoning - 5% Triclopyr (250 ml per plant) ; Tree Nos: 22, 23, 24, 25
T6 – Control ; Tree Nos: 5, 4, 21, 19

Table 3. *Visual observations on the presence of live mycelium on the lateral roots after incubation in a moist chamber (2nd assessment, 11 months after introducing chemical treatment)*

Tree No	Rating/Observation	Tree No	Rating/Observation
1	++ (Fallen tree, only stump remaining)	15	+++ (Dead plant)
3	++ (Dead plant with Fomes fructification)	16	++++ (Dead Plant –Only decaying stump remaining)
6	+++ (Dead plant)	17	+++ (Dead plant- stump remaining)
7	+ (Dead plant)	18	+++ (Dead plant)
8	+ (Dead plant)	20	Missing
10	Missing	22	+ (Stump only)
11	++++ (Dead plant)	23	++ (Stump only-Stump Poisoning)
12	++ (Dead plant stump remaining with Fructification)	24	++++ (Stump only-Stump Poisoning)
13	++ (Dead plant)	25	+ (Stump only-Stump Poisoning)
14	++++ (Dead plant –only Stump remaining)	19, 21, 4	Trees still alive

Assessment rating

0 - Free of live mycelium
\+ - Live mycelium appears slightly.
++ - Live mycelium appears in mild form
+++ - Live mycelium appears in moderately
++++ - Live mycelium appears in severely

Control of leeches in rubber plantations

Several conventionally used leech repellents and other compounds were tested for their efficiency as repellents of leeches.

Tobacco extract, diluted solutions of dettol, citronella oil and a mixture of eucaliptus oil and menthol are found to be effective chemicals according to laboratory and field trials. An article on the commercial use of repellents in management of leeches was submitted for publication in "Rubber Puwath" (W P K Silva C K Jayasinghe and N Nishantha).

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. Data reveals that growing both *Crotolaria micans* and *Flemingia macrophylla* together would contribute the highest amount of green matter compared to growing one species alone. It is therefore confirmed that a mixture of *Crotolaria* and *Flemingia* would provide sufficient green matter for mulching young rubber plants throughout the first three year period after planting. It is evident that the contribution of green matter and litter by *Mucuna bracteata* is about 3 times higher and the contribution of nutrients by both green matter and litter is about 2-3 times higher than *Pueraria phasioloides*. Moreover, the data reveals that *Mucuna* is a successful legume species that can be grown with rubber plants in comparatively drier areas compared to *Pueraria*.

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. Considering the effect of ERP and IRP on plant growth during the immature phase as well, ERP was recommended as the source of P for rubber from the second year of planting. However, according to the data available the source of P for nursery and first year plants should be IRP. It is concluded that the number of urea based fertilizer applications during the six year immature period can be reduced to 14 from the recommended 25 applications and thereby reduce labour requirement for fertilizer application. Moreover, studies indicate that poultry litter application to rubber can substitute chemical fertilizers recommended during immature stage.

The site specific fertilizer recommendation programme for mature rubber provided fertilizer recommendations for 1000 hectares in the estate sector. The Department analyzed 1110 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, Dr D M A P Dissanayake assumed duties as Acting Head, Extension and Advisory Services Department with effect from 16th November. Assistant Soils Chemist Mr D N P Wickramasinghe left to USA for his postgraduate studies on 28th July. Assistant Soils Chemist, Mr R S Dharmakeerthi continued his postgraduate studies in Canada. Experimental Officer, Mr G de Mel retired from the services of the Institute on 3rd December. Technical Officer, Mrs K Jayanetti resigned from the services of the Institute on 5th March.

Research students

- Miss D G C Jeewani, an undergraduate student from the University of Ruhuna, completed her final year project on "Micronutrient status of rubber growing soils in Bibile-Monaragala region" under the supervision of Dr Lalani Samarappuli.
- Miss G J P Senevirratne, an undergraduate student from the University of Ruhuna, completed her final year project on "Evaluation of soils in Moneragala and Bibile areas for efficient nutrient management in rubber cultivation" under the supervision of Dr D M A P Dissanayake.

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	Standardization of Organic Fertilizers	Sarvodaya
Lalani Samaappuli	IRS Workshop on Remote Sensing	Geoinformatics (Pvt) Ltd.
Lalani Samarappuli and D M A P Dissanayake	Scientific Committee Meeting	Rubber Research Institute
Lalani Samarappuli	Addressed on new recommendations and importance of fertilizer use for rubber	National Fertilizer Secretariat
Lalani Samarappuli	Addressed on land selection for planting rubber	Scientific Committee Meeting, RRISL
D M A P Dissanayake	Nuclear Agriculture Committee Meetings	Atomic Energy Authority

Training programmes

Client	No of programmes
Plantation Executives	01
Estate Managers	14
Field Officers	04
Estate Workers	02
Rubber Development Officers	05
Smallholders	01
University Students	04
NDT Students	03

Advisory visits

Client	No of visits
Plantations	10
Smallholdings	04

LABORATORY AND FIELD INVESTIGATIONS

Soil fertility management

Mulching

In experiment SMC-Ag/M/88/1, mulching was continued during mature phase. The effect of continuation of mulching (5kg, rice straw/tree/annum) in comparison with the discontinuation of mulching on leaf N and K contents of rubber plants are given in Table 1. Contribution of N and K via 5kg of rice straw per rubber tree during the mature period is given in Table 2. The incorporation of 5kg rice straw per tree would contribute to about 1/3 of N and 2/3 of K recommended as chemical fertilizer for rubber per year during the mature period (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 1. *Effect of different soil management practices on leaf N and K contents*

Treatment	N (%)	Increase (%)	K (%)	Increase (%)
Legumes	2.2	-	0.77	-
Mulching discontinued	2.9	32	1.07	39
Mulching continued	3.1	41	1.22	58

Table 2. *Contribution of N and K via 5kg of rice straw per rubber tree per annum during the mature period*

Nutrient	Amount (g)	Share of requirement
N	30-35	1/3 (33%)
K	70-95	2/3 (66%)

Ground cover management

New cover crop species

The experiment commenced to study the influence of *Mucuna bracteata*, on growth, nutrient enrichment and other desirable characteristics in comparison with *Pueraria*, was continued. Contribution of green matter, litter and nutrients from *Mucuna* is given in Tables 3 and 4. It is evident that the contribution of green matter and litter by *Mucuna bracteata* is about 3 times higher and the contribution of nutrients by both green matter and litter is about 2-3 times higher than from *Pueraria* (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 3. *Contribution of green matter and litter* by Mucuna bracteata and Pueraria

Species	Dry weight, kg/ha	
	Green matter	Litter
Pueraria	2,200	2,000
Mucuna	6,250	6,750

Table 4. *Contribution of nutrients by* Mucuna bracteata *and* Pueraria

Species	Nutrients (kg/ha)			
	N	P	K	Mg
Green matter				
Pueraria	84	6	30	7
Mucuna	194	15	61	15
Litter				
Pueraria	65	4	6	6
Mucuna	192	9	18	14

Another experiment was initiated at Pembroke division, Payagala estate to study the establishment success of *Mucuna bracteata.* The treatments consisted of 3 different planting materials; seeds (P1), stem cuttings (P2) and rooted cuttings (P3) and 3 planting densities; 450 plants/ha (D1), 240 plants/ha (D2) and 120 plants/ha (D3). Due to poor seed quality (poor germination) of *Mucuna* the experiment had to be terminated. However, a new site was selected at RRISL sub station Nivitigalakele

to re-start the experiment in May/June next year (Lalani Samarappuli, P Karunadasa, U Mitrasena and T Gunatilleke).

At Sapumalkanda estate, Deraniyagala an experiment (SMC-GC/C/97/1)) was started 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 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)
Pueraria phaseoloides + P	28.8[a]
Wedelia biflora + P	27.4[a]
Wedelia biflora + NPKMg (level 1)	28.9[a]
Wedelia biflora + NPKMg (level 2)	30.4[a]

(Means with same letter are not significantly different)

Field experiment (SMC-GC/C/98/1), 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 terminated. A new experiment was initiated on the same subject as RRISL sub station, Nivitigalakele (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Phosphate fertilizers for cover crops

The field experiment, (SMC-GC/P/97/1) in Weniwella estate, Kegalle to study the effectiveness of Eppawela rock phosphate (ERP) as a source of P for leguminous ground covers, both creeping and bush/tree types was 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 four 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, A Dissanayake, 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
NoP	38.3[a]	38.7[a]
ERP	38.5[a]	39.3[a]
IRP	36.7[a]	39.3[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*. Contribution of green matter from different practices is presented in Table 7. Data reveals that growing *Crotolaria + Flemingia* would contribute the highest amount of green matter compared to other two planting practices. It is therefore confirmed that a mixture of *Crotolaria + Flemingia* would provide sufficient green matter for mulching throughout the first three years of planting (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 7. *Contribution of green matter*

Treatment	Green matter (dry Wt. MT/ha)			
	1st year	2nd year	3rd year	Total
Crotolaria micans	4.0	2.5	1.0	7.5
Flemingia macrophylla	1.5	5.0	4.0	10.5
Flemingia + Crotolaria	3.5	4.5	3.5	11.5

Soil conservation and development of degraded lands

A survey was done to categorize the rubber lands into 3 slope classes and to estimate their relative extents in major rubber growing districts (Table 8).

Table 8. *Slope classes of rubber lands and their relative extents in major rubber growing districts*

District	Undulating	Moderate	Steep
Kalutara	35%	38%	27%
Kegalle	14%	48%	38%
Ratnapura	6%	61%	33%

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 Paraquat and different types of Glyphosates are presented in Tables 9 and 10, respectively (Lalani Samarappuli and T Gunatilleke)

Table 9. *Control of weeds as a percentage*

Weedicides	Weed control (%)			
	1st week	2nd week	3rd week	4th week
Surpass	40	81	91	96
Touchdown	33	65	73	80
Ammo super	35	70	79	89
Gramoxone	40	79	88	95
Weedol	40	80	88	93

Table 10. *Duration of weed control*

Weedicides	Duration (days)
Surpass	112
Touchdown	99
Ammo super	111
Gramoxone	75
Weedol	110

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 two and a half years after planting is given in Table 11 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 11. *Effect of different mulching materials on girth of rubber plants*

Treatment	Girth (cm)
No mulch	20.25[a]
Paddy straw	20.40[a]
Coir dust	20.83[a]
Paddy husk	21.23[a]
Green manure	21.45[a]

(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. Effect of these two creeping leguminous covers on girth and girth increment of rubber plants is presented in Table 12 and the transpiration rates of *Mucuna* and *Pueraria* are presented in Table 13. The data reveals that *Mucuna* is a successful legume species that can be grown with rubber plants in comparatively drier areas compared to *Pueraria* (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 12. *Effect of different cover species on girth and girth increment of rubber plants*

Treatment	Girth (cm)	Girth Increment (cm)
Pueraria	13.75[a]	6.36
Mucuna	13.35[a]	6.82

(Means with same letter are not significantly different)

Table 13. *Transpiration rates of different cover species*

Treatment	Rate of transpiration ($\mu g/cm^{-2}/s^{-1}$)
Pueraria	11.6
Mucuna	1.4

(Means with same letter are not significantly different)

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 studied and the girth of rubber plants under three planting practices of *Crotolaria* and *Flemingia* is given in Table 14 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 14. *Effect of different treatments on girth of rubber plants*

Planting practices	Girth (cm)
Crotolaria micans only	13.35[a]
Flemingia macrophylla only	14.55[a]
Crotolaria and *Flemingia*	15.65[a]

(Means with same letter are not significantly different)

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. The effect of different K levels on girth, girth increment and yield is given in Table 15 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 15. *Effect of different K levels on girthing and yield of* Hevea

Treatment	Girth (cm)	Girth increment (cm)	Yield (g/t/t)
K_0	62.1	1.3	41.1
K_1	63.3	2.1	44.6
K_2	64.1	3.0	46.9

(Means with same letter are not significantly different)

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 16, 17 and 18, respectively (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 16. *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	52.1^a	53.5^a	53.0^a	52.2^a
M_1	53.4^a	54.5^a	54.9^a	52.9^a

(Means with same letter are not significantly different)

Table 17. *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	16.2^a	18.3^a	19.9^a	20.3^a
M_1	21.4^b	21.9^b	21.8^a	21.3^a

(Means with same letter are not significantly different)

Table 18. *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	18.8^a	19.5^a	23.8^a	24.3^a
M_1	23.6^b	24.8^b	26.0^b	26.8^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 x 4.5m], (ii) 600 trees/ha [4.2m x 4.2m], (iii) 700 trees/ha [3.8m x 3.8m] and (iv) 800 trees/ha [3.5m x 3.5m]. Effect of different densities on girth of rubber plants at the end of four and a half years from planting and girth increment during the year is presented in Table 19 (Lalani Samarappuli, P Karunadasa and U Mitrasena in collaboration with the Plant Science Department).

Table 19. *Effect of different plant densities on girth of rubber plants*

Planting densities	Girth (cm)	Girth Increment (cm)
500 trees/ha [4.5m × 4.5m]	42.1[a]	10.3
600 trees/ha [4.2m × 4.2m]	40.7[ab]	8.8
700 trees/ha [3.8m × 3.8m]	38.7[b]	7.9
800 trees/ha [3.5m × 3.5m]	38.4[b]	7.5

(Means with same letter are not significantly different)

Silt pitting for soil moisture conservation

A field experiment was planned to study the effect of silt pits on the moisture conservation and a site was selected at Bibile estate, Bibile for this purpose (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Fertilizer use and plant nutrition

Fertilizers to nursery plants

Experiment started to evaluate the efficiency of a more soluble fertilizer mixture for young buddings at the Eladuwa estate was terminated. However the different treatments were planted in the field in 1996 to study the residual effect of the treatments. Girth measurements at five years after planting is presented in Table 20. It can be concluded that there is no treatment effect on girth at this stage (R S Dharmakeerthi, Lalani Samarappuli and S N Silva).

Table 20. *Effect of different treatments on girth of rubber plants*

Treatment	Girth (cm)
No fertilizer	47,6[a]
Weekly application	48.8[a]
Bi weekly application	47.9[a]
Monthly application	50.3[a]

(Means with same letter are not significantly different)

Experiment started to study the requirement of a basal application when young buddings are planted in the field was continued. Girth measurements at five years after planting is presented in Table 21. The data seems to suggest that there is no effect of the treatment on girth at this stage (R S Dharmakeerthi, Lalani Samarappuli, S N Silva and A Yakandawela).

Table 21. *Effect of different treatments on girth of rubber plants (five years after planting)*

Treatment*	Girth (cm)
T_1	46.9[a]
T_2	46.4[a]
T_3	47.6[a]
T_4	47.2[a]

(Means with same letter are not significantly different)

* For treatments please see the Annual Review 1996

Fertilizer requirement of new clones

This experiment was continued. Test tapping data collected during the year suggests that there is no significant effect on yield by the different levels of fertilizer applied during the immature period (R S Dharmakeerthi, Lalani Samarappuli, S N Silva and A N Yakandawela)

Efficiency of fertilizer utilization

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 applications 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). Effect of treatments on girth of rubber plants at the end of six and a half years and tappability at the end of five years are given in Table 22. The data suggests that the frequency of urea based fertilizer application during the six year immature period can be reduced to 14 applications from recommended 25 applications and thereby reduce labour requirement for fertilizer application (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 22. *Effect of different treatments on girth and tappability of rubber plants*

Treatment	Girth (cm)	Tappability (%)
25 applications/immature six year period (urea based)	53.2[a]	28.8[a]
20 applications/immature six year period (SA based)	53.4[a]	30.5[a]
19 applications/immature six year period (urea based)	52.6[a]	25.0[a]
14 applications/immature six year period (SA based)	53.8[a]	28.0[a]
14 applications/immature six year period (urea based)	53.6[a]	32.3[a]
No fertilizer	45.4[b]	00.0[b]

(Means with same letter are not significantly different)

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 one month after planting in November and it is too early to come into any conclusions (Lalani Samarappuli, U Mitrasena and T Gunatilleke).

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. Investigation on the effect of treatments on yield was continued and results are presented in Table 23 (Lalani Samarappuli and J G de Mel).

Table 23. *Effect of different treatments on yield of rubber*

Treatment	Yield (g/t/t)
Control (no fertilizer	22.1[a]
Urea based	26.3[a]
SA based	25.3[a]
Sulpomag based	25.0[a]

(Means with same letter are not significantly different)

Foliar nutrients

An experiment was started to study the effect of foliar fertilizers; Humat 2000 and Siraman NR on the performance of young budded plants. The effect of different treatments on the growth of rubber plants at the end of three months after planting is presented in Table 24 (Lalani Samarappuli and A Thevarapperuma).

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

Treatment	Diameter Increment (mm)
Normal soil application (Control)	2.8
Humat soil application only	3.4
Humat foliar application only	3.6
Normal soil application + Humat foliar	3.2
Siraman foliar application only	3.4
Normal soil application + Siraman foliar	3.5

Two field experiments were also started in 2000 and 2001 replantings to study the effect of a foliar fertilizer; Humat 2000, on the performance of rubber plants during first and second years after planting. In 2001 replanting only pre treatment girth was recorded and in 2000 replanting the girth at the end of year 2001 is given in Table 25 (Lalani Samarappuli, U Mitrasena and T Gunatilleke).

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

Treatment	Girth (cm)
Normal recommendation (Control)	9.8
Humat foliar application	9.5
Humat soil application once a year	9.7
Humat soil application once in 2 years	9.5

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 five and a half years from planting is presented in Table 26. No significant difference was observed between densities tested (Lalani Samarappuli, P Karunadasa and U Mitrasena in collaboration with the Plant Science Department).

Table 26. *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)	51.6	48.6	49.4	51.0
Reduced level (F2)	49.5	46.9	46.6	48.2
1st 3 yrs. recommended level then reduced level (F3)	49.5	47.0	48.5	49.2

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 on girth of rubber plants at the end of four and a half years from planting is presented in Table 27. No significant differences were observed between the levels of fertilizer, tested (Lalani Samarappuli, P Karunadasa and U Mitrasena in collaboration with the Plant Science Department).

Table 27. *Effect of different plant densities on girth of rubber plants*

Planting densities	Girth (cm)
500 trees/ha [4.5m x 4.5m]	42.1^{a}
600 trees/ha [4.2m x 4.2m]	40.7^{ab}
700 trees/ha [3.8m x 3.8m]	38.7^{b}
800 trees/ha [3.5m x 3.5m]	38.4^{b}

(Means with same letter are not significantly different)

Nutrient requirement of rubber based cropping systems

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

Fertilizer use in mature rubber

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).

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 recommendation to mature smallholdings in different rubber growing districts using leaf nutrient values of both smallholdings and surrounding estates (L Samarappuli and V Edirimanne).

Soil and foliar survey programme - Fertilizer recommendation

Estate sector

The site specific fertilizer recommendation programme for mature rubber provided fertilizer recommendations for 1000 hectares in the estate sector.

Smallholder sector

The soil and foliar survey programme for the smallholder sector was not undertaken as an economy measure due to the very poor trading conditions prevailing in the country.

Phosphate nutrition

ERP as a source of P for nursery, immature and mature plants

All data gathered on the effect of ERP and IRP as a source of P on plant growth during the immature period was taken into consideration and a recommendation was given suggesting that ERP can be used as the source of P for rubber from second year of planting. However, according to the data available the source of P for nurseries and year one clearings should be IRP (A Dissanayake, P Perera, T Dissanayake, Chitra K Maheepala and R Puhambugoda).

Evaluation of clonal differences in phosphate utilization

Experiments started at Dewalakande (P/IM/93/-01), Payagala (1/IM/94-01) and Ambadeniya (P/IM/96-01) estates to study the ability of different RRIC clones (RRIC 100,102,110 and 121) to utilise ERP were continued (A Dissanayake, T Dissanayake, P Perera and Chitra Maheepala).

Availability of P from ERP

The experiment started to study the effect of different agronomic practices on availability of P from ERP at Culloden estate (P/Ag/93) was continued (A Dissanayake, Lalani Samarappuli, P Perera and S Chandrasiri).

Sulphur 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 (A Dissanayake, P Perera, S Chandrasiri and Chitra Maheepala).

Micro nutrients

A study was done to evaluate the micro nutrient status of the soils in Bibile-Monaragala region in the intermediate zone. Mn, Zn and Mo status of these soils are recorded in the Table 28 (Lalani Samarappuli and D G C Jeewani).

Table 28. *Micro nutrient status of Bibile-Monaragala soils*

Area	Total nutrients (mg/kg)		
	Mn	Zn	Mo
Bibile	348-708	32-120	375-1000
Monaragala	112-584	32-78	416-1250

Organic fertilizers

Nursery stage

An experiment was started to study the effect of using organic materials on the performance of stock plants raised to produce young budded plants. Treatments consisted of; inorganic fertilizer (recommended level), inorganic fertilizer (recommended level) + three levels of compost, inorganic fertilizer (recommended level) + three levels of cowdung. The effect of different treatments on the growth of stock plants, three months after planting is presented in Table 29 (Lalani Samarappuli and Anoma Thevarapperuma).

Table 29. *Effect of organic manures on growth (diameter in mm) of stock plants*

Treatment	Quantity of organic manure			
	0g/bag	25g/bag	50g/bag	75g/bag
Inorganic fertilizer (rec. level) only	7.0	-	-	-
Inorganic fert. (rec. level) + compost	-	7.0	7.1	7.0
Inorganic fert. (rec. level) + cowdung	-	7.0	7.2	7.4

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 measurements six months after planting was recorded (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Immature stage

Use of animal wastes

A field experiment (FPN-Org/An/95/3), is in progress at Dorset division, Clyde estate to study the effect of poultry litter as an organic manure for rubber. Treatments consisted of (a) Inorganic fertilizer (recommended level), (b) Inorganic fertilizer (½ recommended level) + poultry litter, (c) Inorganic fertilizer (¼ recommended level) + poultry litter, (d) Poultry litter only, (e) Poultry litter + IRP + MOP, (f) Poultry litter + IRP + paddy straw and (g) Poultry litter only with natural cover. Effect of treatments on tappability at the end of five and a half years is given in Table 30. The data suggests that poultry litter application to rubber can substitute chemical fertilizers recommended during immature stage (Lalani Samarappuli, P Karunadasa and U Mitrasena).

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

Treatment	(%) Tappable trees
Inorganic fertilizer (recommended level)	28
Inorganic fertilizer (½ recommended level) + poultry litter	47
Inorganic fertilizer (¼ recommended level) + poultry litter	60
Poultry litter only	56
Poultry litter + IRP + MOP	45
Poultry litter + IRP + paddy straw	57
Poultry litter only with natural cover	40
No fertilizer (control)	0

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 four and a half years is given in Table 31. Field experiment, (FPN-Org/Gm/97/1) which was in progress at Dartonfield estate was terminated due to wild boar attack on some treatment plots (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 31. *Effect of different treatments on girth (cm) of rubber plants*

Sources of N	Sources of K		
	K1	K2	K3
N1	40.8[a]	40.5[a]	41.9[a]
N2	41.7[a]	39.9[a]	42.1[a]
N3	40.6[a]	40.5[a]	39.9[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 four and a half years after planting is given in Table 32 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 32. *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	29.7[a]	31.1[a]	24.4[a]
T_1	26.1[a]	30.1[a]	27.9[a]
T_2	30.2[a]	28.2[a]	26.3[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 among the on yield of rubber is presented in Table 33 (Lalani Samarappuli, U Mitrasena, and T Gunatilleke).

Table 33. Residual *effect of sludge on yield of rubber plants*

Treatment	Yield (ml/t/t)
Without sludge	68.4
With sludge	73.6

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 three and a half and four and a half years are given in Table 34 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 34. *Effect of different treatments on girth of rubber plants*

Treatment	Girth after planting (cm)	
	3½ years	4 ½ years
Chemical fertilizer only	30.9	38.2
Organic fertilizer only	22.2	35.1

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 (A Dissanayake, N Wickramasinghe, T Dissanayake and R Puhambugoda).

Soil survey and classification

Soil samples were collected from Bibile, Moneragala areas (A Dissanayake, N Wickramasinghe and Chitra Maheepala).

Land selection and suitability for rubber cultivation

Improvements to land selection programme

Land and soil properties considered in land selecting programme for commercial rubber cultivation and their suitability indices are given in Table 35. Further improvements to these parameters are being done (Lalani Samarappuli, P Karunadasa, U Mitrasena, and T Gunatilleke).

Table 35. *Land suitability indices for commercial rubber cultivation*

Character	Range suitable	Range suitable with correction measures	Range not suitable
Slope	0-20%	20% - 45%	>45%
Rockiness	<50%	-	>50%
Soil depth	>100cm	-	<100cm
Depth of water table	>100cm	50-100cm	<50cm
Stagnation of water	0 days	1-3 days	>3 days
Flooding	Nil	After heavy rain	After light rain
Soil pH	4-6 (3.5-4.0 and 6.0-6.5)	<3.5 or >6.5	-
Organic carbon	2%-3%	<2%	

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, P Karunadasa, U Mitrasena, and T Gunatilleke).

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 36.

Table 36. *Details of the analysis done during the year*

Source	No. of analysis				
	Plant	Soil	Fertilizer	Organic manure	Other*
Experimental	2000	400	-	75	-
Soil and Foliar survey	220	-	-	-	-
Other Departments of RRI	24	120	-	25	66
Research Institutes	40	-	-	-	-
Rubber Development Department	-	-	121	-	-
Plantation Mgt. Companies	-	169	242	25	05
Other Private Companies	-	-	48	-	-
Total	2284	689	411	125	71

* water/bleaching agents/chemicals/rubber

Analytical techniques

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

BIOCHEMISTRY AND PHYSIOLOGY

W M Thurul

SUMMARY

The main focus of the department was on development of appropriate technology for environmentally friendly management of rubber factory waste. Work on other important areas of research was initiated. Due to the curtailing of funds planned improvements to the laboratory were not done. Some long term experiments were discontinued.

DETAILED REVIEW

Staff

Assistant Biochemist, Mr W M Thurul was on duty through out the year. Mrs G V L Nilmini assumed duties as Assistant Biochemist with effect from 5th November, 2001. Mrs K V V S Kudaligama Wijesundera, Experimental Officer, Mr P D J Rodrigo and Mr D Ramawikrama, Technical Officers, were on duty through out the year.

Research and Development

Research and Development activities were continued on following projects throughout the year.

- Biobrush media
- Odour filter
- Low cost treatment system configurations and low cost construction materials
- Deammoniation and continuous coagulation of skim latex
- Other methods of waste utilization and disposal
- Biological and Biochemical treatment of rubber wood
- Chemical bleaching of rejected treated rubber wood
- Biological and Biochemical carving of rubber wood

(W M Thurul, G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo, D Ramawikrama).

Research and Development activities were restarted on following projects.

- Quebrachitol as a valuable biochemical from rubber serum
- Biochemical aspects of Tapping Panel Dryness

(G V Lakmali Nilmini, W M Thurul, K V V S Kudaligama, P D J Rodrigo and D Ramawikrama).

Implementation of new developments

Monitoring of new developments Implemented at the following places were carried out.

Rayigam Estate Crepe Rubber Factory
Pallegama Estate Sole Crepe Rubber Factory
Kiripooruwa Estate Centrifuge Factory
Yatadola Estate Crepe Rubber Factory
Eladuwa Crepe Rubber Factory

(W M Thurul, G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo and D Ramawikrama).

RUBBER TECHNOLOGY AND DEVELOPMENT

Dilhara Edirisinghe

SUMMARY

A set of RVNRL based examination gloves prepared manually was found to meet ASTM specifications. The leachable protein levels of these gloves were found to be below the specified limits.

The use of various coagulants to reduce the extractable protein content of dipped latex films has been looked into.

Irradiated latex was used as a binder in the manufacture of coir dust based products used in horticulture. Fungal growth observed by some coir dust based product manufacturers in their RVNRL coated products was eliminated with the incorporation of sulphur dust.

A latex based cement with improved drying characteristics and bond strength properties has been developed. Some developments were made on a tyre paint on a request made by a tyre retreader.

Stockings out of compounded latex coated grey cloth suitable to protect the paddy farmers against Ceptospirosis (Mee-una) have been developed.

A project was initiated to evaluate the characteristics of deproteinised natural rubber latex prepared out of both field and centrifuged latex.

Cure characteristics and technological properties of carbon black filled NR/NBR blends prepared with varying rotor speeds of the Brabender Plasticorder was compared.

Tensile property measurements, hysteresis studies, cross-link density measurements and IR studies have been conducted on interpenetrating polymer networks (IPNs) of NR/PMMA blends.

The cause for the appearance of white patches on some brown coloured outer soles of shoes manufactured by a footwear manufacturer was identified and some modifications to the formulation were suggested, which helped them to overcome the problem.

DETAILED REVIEW

Staff

Dr (Mrs) N M V Kalyani Liyanage, Head, Rubber Technology and Development Department resigned from the Institute on 30th September.

Mrs D G Edirisinghe and Mrs M M Jayasuriya, Rubber Chemists were on duty through out the year.

Mrs Manel Mahanama, Mrs Sriyani Yapa and Mrs P C Wettasinghe, Experimental Officers were on duty throughout the year.

Miss Nadeeja Wickramarachchi, Research and Development Assistant was on duty throughout the year.

Mr Asela Siriwardena, Technical Officer was on duty throughout the year.

Research students

- Mr Thusitha Wickremasinghe an undergraduate from the University of Colombo underwent vacation training. The title of the project is "Some Modifications to the Latex Based Cement".

Seminars/Conferences/Meetings/Workshops

Officer	Subject	Organization
Dr (Mrs) N M V Kalyani Liyanage	Meetings of the Sri Lankan Research Group on Radiation Prevulcanisation of Natural Rubber Latex	Atomic Energy Authority
Dr (Mrs) N M V Kalyani Liyanage and Mrs D G Edirisinghe	Sectoral Committee Meetings on "Chemical & Polymer Technology	Sri Lanka Standards Institution
Dr (Mrs) N M V Kalyani Liyanage	A workshop on the preparation of the curriculum for a M.Sc course on "Industrial Chemistry"	Open University

Training programmes

Client	Subject	No. of programmes
Assistant Managers (Plantation Sector) - NIPM	Lectures for the Diploma Course in Plantation Management	1
Diploma Students Plastics and Rubber Institute	Diploma Course in Rubber Technology	1

LABORATORY INVESTIGATIONS

Latex technology

Latex protein analysis

Radiation Vulcanised Natural Rubber Latex

The influence of the period of maturation and the leaching condition on the extractable protein content of irradiated latex films were studied. The extractable protein content was found to vary with both the period of maturation and the leaching conditions.

A set of examination gloves was prepared manually out of RVNRL and their technical properties were evaluated at RRISL and at Dipped Products Ltd. All the technical properties of the gloves were in accordance with the ASTM specifications.

The extractable protein content of the gloves were less than 50 μg/g of rubber, when analysed according to the BCA procedure.

Identification of the types of extractable proteins in natural rubber has been done using the SDS PAGE technique (N M V K Liyanage, Upul Ratnayake, H N K K Chandralal, S I Yapa, N Liyanage and S S Kulatunge - Atomic Energy Authority).

Techniques for reducing extractable protein content of latex films

Several natural rubber latex dipped films were prepared using monovalent ionic salts as the coagulants. The aim of this exercise was to observe the effect of the nature of coagulant on the extractable protein content. Films prepared were leached under different temperatures over selected periods. Since the BCA Protein Assay Kit was not available at the time of conducting these experiments, the amount of nitrogen present in the rubber phase was determined instead (N M V K Liyanage, D N Wickramarachchi, P C Wettasinghe and A I Siriwardena).

Latex based cement for tyre retreading

Work on this project was continued in collaboration with Associated Motorways *Ltd.* A new batch of latex cement compounds were prepared by varying the level of special ingredients added into the latex. Peel strength of some of these newly developed latex cements was much higher than the others. Also, the peel strength and the drying characteristics of the former were superior to those of solvent/dry rubber based cement currently used (N M V K Liyanage, D G Edirisinghe, M K Mahanama, S I Yapa and A I Siriwardena).

Use of NR latex in horticulture

Coir pots and coir dust based rods which could be used in horticulture, were prepared using natural rubber latex as a binder, initially. Subsequently natural rubber latex was replaced by irradiated latex as the latter is free of Zn, which is a toxic material for plants. Coir pots turned out were satisfactory in respect of the holding properties. Although rods with rather compact structure were developed, several techniques had to be tried out for easy removal of the rods from the mould as latex tends to stick the product to the mould (N M V K Liyanage, P C Wettasinghe and D N Wickramarachchi).

Latex/carbon black masterbatches suitable as tyre paints for tyre retreading industry

Further developments on a tyre paint, which would impart a good finish and a fair amount of shine to the retread of a tyre, were carried out using latex/carbon black masterbatches. This was initiated on a request made by Associated Motorways Ltd. Also several attempts were made to increase the percentage of carbon black

incorporated into the rubber phase (N M V K Liyanage, D G Edirisinghe, M K Mahanama, D N Wickramarachchi and L Wanigatunge).

Water-proof stockings for paddy farmers

A request was made by the Samurdhi Ministry to develop a cheap water-proof covering profile to cover the legs of paddy farmers in order to protect them against Ceptospirosis (Mee-una). Few stockings were prepared with grey cotton cloth coated with compounded latex. Trials were conducted to improve the rubber to fabric adhesion. The cost of production of a pair of these newly developed stockings appears to be low and they are, water-proof and light in weight. Action will be taken to make this popular among paddy farmers through Samurdhi Movement (D G Edirisinghe and M K Mahanama).

Evaluation of latex characteristics of deproteinized natural rubber latex

A project was initiated to evaluate the latex characteristics, namely gel content, nitrogen content, green strength, protein content, etc. of Deproteinised Natural Rubber Latex prepared out of field latex (DPFL) and centrifuged latex (DPCL). A comparison of the properties of field latex (FL), centrifuged latex (CL), DPFL and DPCL will be done (N M V K Liyanage, D G Edirisinghe and S L G Ranjith).

Dry rubber technology

Blends of NR and NBR

10 phr carbon black filled 30:70 NR/NBR blends were prepared using the Brabender PL 2000 Plasticorder according to a single stage mixing technique, at three different rotor speeds of 20, 40 and 60 rpm. Varying the rotor speed of the mixer from a lower (20rpm) to a higher level (60rpm) had a significant effect on technological properties such as modulus at 300% elongation, hardness, tensile strength, tear strength, abrasion resistance and compression set. The results obtained are given in Table 1. From the results, 60 rpm appears to be the best rotor speed for an improvement in most of the above mentioned properties.

Interpenetrating Polymer Networks (IPNs)

Tensile properties of a series of IPNs based on natural rubber and acrylic monomer based polymers have been determined. Hysteresis studies of a series of IPNs, prepared under various experimental conditions indicated that incorporation of methyl methacrylate into the natural rubber matrix increases the hysteresis. Attempts were made to extract homopolymers, which are present in IPNs and to determine the molecular weight of these polymers. In addition attempts were made to investigate the effect of initiator and cross-linking agents on polymerization of MMA. Furthermore, cross-link density and swelling index of vulcanized rubber samples have been determined. IR studies have been conducted on IPNs for quantitative

analysis of PMMA glassy homo-polymer present in these IPNs. (D J Hourston, M M Jayasuriya, S I Yapa, P C Wettasinghe and A I Siriwardena).

Table 1. *Effect of Brabender mixer rotor speed on properties of 30:70 NR/NBR blends*

Property	Mixer rotor speed (rpm) *		
	20	40	60
Modulus at 100% (elongation (N/mm^2)	1.4	1.4	1.4
Modulus at 300% elongation (N/mm^2)	3.7	4.4	4.7
Tensile strength (N/mm^2)	10.8	11.7	12.6
Elongation at break (%)	515	455	452
Tear strength (N/mm)	39.5	25.9	26.0
Resilience (%)	52.0	52.0	53.0
Abrasion (DIN) volume loss (mm^3)	189.0	145.0	106.0
Compression set (%)	9.3	9.3	8.2
Hardness (Shore A)	43	43	46
Specific gravity	1.03	1.03	1.03
After aging at 100^0C for 22 hrs			
Modulus at 100% elongation (N/mm^2)	1.7	1.6	1.6
Modulus at 300% elongation (N/mm^2)	6.0	5.7	6.9
Tensile strength (N/mm^2)	10.9	13.7	12.7
Elongation at break (%)	369.0	415.0	394.0
Cure characteristics			
Scorch time (s)	209.0	206.0	185.0
90% cure time (s)	634.0	611.0	556.0
Cure Rate Index	0.24	0.25	0.27

*The number of rotor revolutions employed is the same for all the three NR/NBR blends

(D G Edirisinghe, M K Mahanama, P C Wettasinghe and A I Siriwardena).

Bloom analysis of outer sole of shoes

A request was made by Asia Industrial Enterprises (Pvt.) Ltd. to find out the cause for the white patches which appeared on the flat parts of the surface of their brown coloured outer shoe soles. The cause for these patches was found out and some modifications to their formulation was suggested, which helped them to overcome the problem (N M V K Liyanage, D G Edirisinghe, D N Wickramarachchi and P C Wettasinghe).

Industrial extension

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

Test	Number of industries
Rubber compound testing	15
Product testing	6
Protein analysis	1

POLYMER CHEMISTRY

Nilmini Liyanage

SUMMARY

The study on latex protein allergy with NSF assistance was continued. Latex samples from different clones were subjected to prevulcanisation, irradiated and Extractable Protein (EP) content was tested using BCA method before and after leaching using different solutions. Physical properties of treated samples were tested.

A comparative study was carried out to analyze the chemical and physical properties of creamed latex, centrifuged latex, deprotenized and a new type of latex preserved with neem oil.

A project was initiated to manufacture MG rubber using radiation techniques. Heat sensitive gelation system was used for extrusion of latex tubes. Different latex formulations were tested to obtain maximum swelling in plant mediums made using coir pith for horticulture and agriculture based industries.

A project on utilization of buffing dust, a by-product from the tyre retreading industry was continued using material of different particle sizes. Treated buffing dust was compounded in an open mill and the physical properties were tested. NR/NBR blends were prepared to obtain better physical properties to be used in various applications.

Technical know how was given to the rubber industry to prepare a water resistance sealant.

DETAILED REVIEW

Staff

Dr K G Karnika de Silva, Deputy Director Research/Technology, who was in charge of the Polymer Chemistry Department, resigned with effect from 30th April. Mrs Champa Wellappili and Mrs Nilmini Liyanage, Assistant Rubber Chemists were on duty through out the year.

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

Mr W D S Dharmawardana, Laboratory Attendant was transferred to Genetics and Plant Breeding Department, with effect from 15th May 2001.

Training programmes

Client	Subject	No. of programmes
Plantation Managers (NIPM)	Plantation management	01
Diploma students (PRI)	Diploma in Rubber Technology	01

Advisory visits

Client	No. of visits
Industries	01

LABORATORY INVESTIGATIONS

NR protein allergy

Project on latex proteins supported by the NSF Grant No RG/99/c/07 was continued. Latex samples collected from different clones (*e.g.* RRIC 100,102,121) were subjected to deprotenisation and tested for Extractable Proteins (EP). Cast films from different clones were subjected to different vulcanization and leaching systems and the EP content was measured. The EP content of irradiated latex was also measured. It was observed that EP content could change with nature of the leaching and vulcanization systems (Table 1). BCA method was used for analysis of extractable proteins.

Physical properties of the films were tested and compared and the results are summarized in Table 1.

Table 1. *Effect of Leaching Agent on Extractable Protein (EP) and Tensile Strength(TS)*

Sample	Irradiated prevulcanised Heated 30min at 70^{0}C/(ug/g)		Sulphur prevulcanised Heated 30min at 70^{0}C/(ug/g)	
	EP cont	TS/MPa	EPcont	TS/MPa
Without Leaching	2883	21.1	2357	26.3
Leaching in water 45min at 70^{0}C	210	24.5	412	30.6
Chlorination	86	20.6	187	25
Leaching in water 45min at 70^{0}C after 15 min chlorination	58	23.6	137	27.8
Leaching in Mix 1:1 for 5min	86	16.1	166	15.7
Leaching in 0.2% Teepol for 5 min	79	22.4	215	28
Leaching in 0.2% Saline for 5 min	90	23.1	240	27.2

(L M K Tillekeratne, M G Senaviratna, K G Karnika de Silva, Champa Wellappili, S L G Rangith, Kumudunie Chandrasekara and Lalin Karunanayaka - University of Sri Jayawardanapura)

Industrial waste organic matter based planting medium for horticulture and agriculture industries

An improved Zn free formulation was developed with RVNRL to produce good quality coco peat dust rubber latex based sacks for exports. Maximum swelling and required thickness of the sack was obtained by using different concentrations of the thickening agents (K G Karnika de Silva, Nilmini Liyanage, H N K K Chandralal. Keerthi Mohotti TRI).

Use of buffing dust in tyre treads

Utilization of buffing dust selecting different particle sizes of it from the tyre industry was commenced. Buffing dust was treated with a fatty acid derivative in an open mill. As per the results fatty acid treated buffing dust compound found to posses comparatively better physical properties than that of untreated buffing dust compound.

Buffing dust was incorporated with NR up- to 15phr without affecting the physical properties of the standard compound. Trials were carried out successfully with industrial collaboration to incorporate buffing dust into the tyre tread compound formulations to gain improved properties (K G Karnika de Silva, Champa Wellappili and Indra Denawake).

NR/NBR blends

NR and NBR are two well-known incompatible polymers and their blends are not homogeneous, when well mixed. Different mixing methods were used, to blend different polymer ratios with compatabilizers, to improve the homogeneity of blends of NR and NBR (Champa Wellappili and Priyanthi Perera).

Preparation of saw dust blocks for fire wood purpose

Several trials were conducted on the preparation of briquettes using rubber wood sawdust on a request made by a industrialist for the export market. Binding properties of sawdust was tested with various binding agents and starch was identified as a environmentally friendly binder for saw dust. Optimum binding properties for excellent bonding was achieved using a suitably concentrated starch solution and different size briquettes were made using mould (L M K Tillekeratne, S S Warnapura and P L Perera).

EPDM/NR blends

Developing blends of NR/EPDM were carried out on a request made by a rubber based products manufacturer. Different types of accelerator systems were used with different NR/EPDM ratios to achieve optimum properties. New mixing methods were tested in order to improve the performance of the blends. It was shown that the rubber of same Mooney viscosity values yield better physical properties compared

with rubber of different Mooney viscosity values (Champa Wellappili and S L G Rangith).

Use of prevulcanized latex in production of thick walled articles

A request was made by an industrialist to produce thick walled latex tubes with smooth finish for medical applications. This was achieved using pre- vulcanised latex and Poly Vinyl Methyl Ether as a heat sensitive gelling agent.

Glass apparatus was fabricated according to the size of the product with the incorporation of cooling and heating facilities (Champa Wellappili, Nilmini Liyanage, H N K K Chandralal and S L G Rangith).

Rubber based adhesive

An adhesive was developed using NR and SBR blends, on a request made by a manufacturer of natural rubber based strips. A study was carried out to compare the peel strengths of imported and RRI developed adhesives.

Further, development of grafted Neoprene adhesive was carried out on a request made by a manufacturer of sails, using synthetic fabrics and blown polyethylene. Instead of grafting Methyl Methacrylate on to the Neoprene, a blend of MG-rubber and Neoprene was used to prepare the adhesive. Improved performance was achieved with the incorporation of Resorcinol Formaldehyde resin (K G Karnika de Silva, Nilminie Liyanage and Chitra Kuruppu).

Comparison of different lattices

A comparative study was carried out to analyze the chemical and physical properties of creamed latex, centrifuged latex and deprotenized latex. Foaming properties and protein content of creamed latex were evaluated (Nilmini Liyanage, Nadeeja Wickramarachchi and Chitra Kuruppu).

Evaluation of Neem as a preservative for NR latex

A comparative study was carried out to analyse the chemical and physical properties of Neem oil persevered and LATZ latex. Studies were carried out to remove the brown colour of these samples (K G Karnika de Silva, Nilmini Liyanage, Champa Wellappili and Chitra Kuruppu).

Industrial extension

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

Company/Institution	Service
DSI	Consultancy
Water Board	Polymer analysis
Asia Ltd	Bloom analysis
Atomic Energy Authority	Protein analysis
Sri Jayawardenapura University	Rate of reaction analysis of a polymerization reaction

RAW RUBBER AND CHEMICAL ANALYSIS

L M K Tillekeratne and 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 for 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 for purity.
(e) Analysis of skim adulteration in raw rubber.
(f) Recommendation of chemicals for the industry and analysing them for purity.
(g) Testing of finished products such as
1. Rubber gloves for sodium pentachlorophenate content
2. Rubber content in vulcanized products
3. Contaminations of metal ions in dipped products.
(h) Organizing and participation in inter laboratory cross check programme for latex testing laboratories owned by the private sector or the state.
(i) The following research projects were in progress.

1. Effect of metal ions on properties of NR dipped products.
2. Preservative systems to be used in rubberised coir products in Agricultural Sector.
3. The effect of metal ions in well water on the quality of raw rubber.
4. Determination of percentage phosphate ion concentration in the rubber and in aqueous phase of NR latex.

DETAILED REVIEW

Staff

The Director Dr L M K Tillekeratne over looked the department activities through out the year.

Experimental Officers Ms H S Weeraman, L Wanigatunga, H V K Gamage, C Lokuge and Messrs P L Perera, L P Vitharana, Mrs P Perera, Development and Research Assistant, Ms M Wijesekera, Shriani Priyanka, Messrs W W Nandasena,

B Gunasiri, N Karunatilaka and W Vithanage, Technical Officers, Mr L G P Lelwela, Instrument Technician and Mrs I. Wijesinghe, Clerk/Typist were on duty through out the year.

Mrs N Baduge, Graduate Assistant (Technical) was on duty, until her retirement on 2nd December.

Research students

- Mr Tusitha Kosala Potupitiya, MSc student from the University of Sri Jayawardenapura, carried out his project titled "The effect of presence of Cu (II) and Mn (II) metal ions on the properties of Natural Rubber Dipped Products".

The following NDT students, of the University of Moratuwa, carried out a project titled "Effect of field latex characteristics on centrifuged latex".

- Miss S L M Priyanga - University of Moratuwa (NDT)
- Mr U H V S Samaraweera - University of Moratuwa (NDT)

The following Officers from the Plantations and Industries were trained on latex and raw rubber testing.

• K R Upali Senerath	- Mahaoya Group
D P Wijeratne	- Bogawantalawa Plantations
Mr M A Gunapala	- Samson Reclaim Rubber Manufacture of Co. Ltd., Galle
• G D R Samarawickrama	- Ansell Lanka (pvt) Ltd.
• W D N Withana	- Ansell Lanka (pvt) Ltd.
• R D Samarawickra	- Ansell Lanka (pvt) Ltd.
• Indu Widyaratne	- Lalan Rubber Ltd.
Nenton Senadeera	- Lalan Rubber Ltd.
• Upul Nishantha	- Lalan Rubber Ltd.
• L D C Nayanajith	- CISIR

Analytical services

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

TSR Factory	No. of samples
Statcon Block Rubber Factory, Getahetta	96
Ceymac Block Rubber Factory, Horana	218
Sandhagiri Rubber Mills, Dompe	396
Total	710

Miscellaneous samples tested during the year are given below:

Raw rubber samples	431
Latex samples	212
Chemical samples	110
Bleaching agent	184
Glove samples	73
Water samples	11
Polythene samples	05
Total	1026

A new TSR factory, *i.e.* Sandagiri Rubber Mills, Dompe was registered as a TSR producer, according to the TSR regulations. Samples of their products were received regularly for testing.

A query over DRC determination during selling of latex at Woodnd estate managed by Bogawantalawa Plantations was solved. Assistance was extended to set up a new testing laboratory for latex in this estate. The officers of woodland estate were trained to carry out testing of latex on their own.

Interlaboratory cross check for testing centrifuged latex

Interlaboratory cross check organized by RRISL was carried out for centrifuged latex. Samples were prepared and distributed among the participants to carry out testing on scheduled dates to check the performance of their laboratories. Twelve laboratories including Raw Rubber and Chemical Analysis Department of the RRISL participated in this crosscheck exercise (N M V Kalyani, Priyanthi Perera, S Weeraman, Vasantha Gamage, Champa Lokuge and Medavi Wijesekera).

Effect of metal ions on properties of NR dipped products

Metal ions present in rubber are known to cause discolouration and degradation of NR molecules. In this project, effects of transition metal ions Cu (II) and Mn (II) on the properties of NR dipped products were studied. It has been found that both Cu and Mn have adverse effects on the stability of latex due to their ability to make bi-valent compounds with long chain fatty acids, thereby reducing the effective fatty acid anions required for stabilization. (Figs.1 and 2) for the presence of Cu (II) and Mn (II) have adverse effects on tensile properties of latex dipped products too. This could be due to catalytic effect of metal ions caused *via* redox reactions (Figs. 3 and 4).

Discolouration of samples were monitered visually and were also scanned using a digital scanner. The presence of Cu (II) and Mn (II) metal ions in very minute quantities can cause severe problems for the physical properties of dipped

products (L Karunanayake, S Liyanage, T K Pothupitiya, H S Weeraman and P Perera).

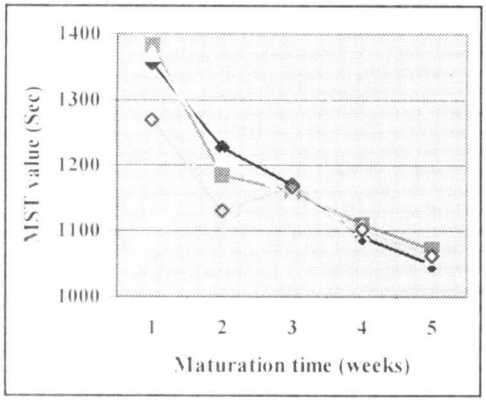


Fig. 1. Variation of mechanical stability time (MST) with maturation time and metal ion concentration

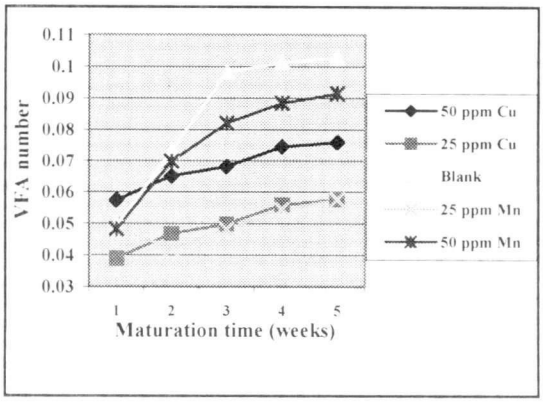


Fig. 2. Variation of volatile fatty acid (VFA) number with maturation time and metal ion concentration

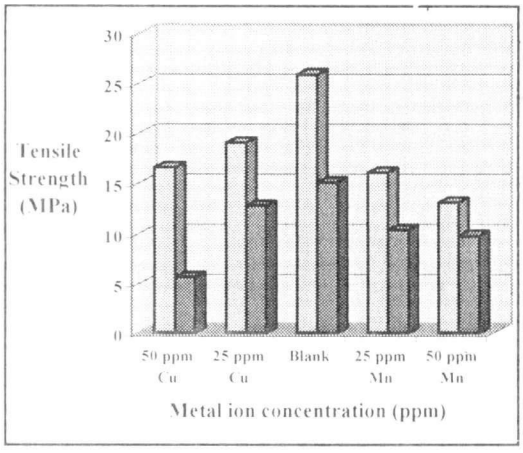


Fig. 3. Variation of tensile strength of vulcanised cast films (before and after ageing)

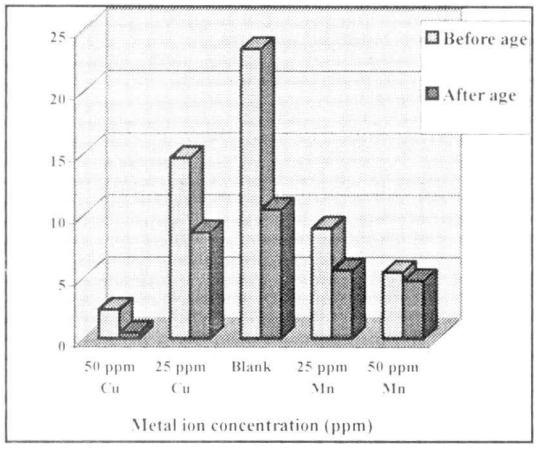


Fig. 4. Variation of tensile strength of vulcanised dipped films (before and after ageing)

Preservative system to be used in coir products used in agricultural sector

An attempt was made to formulate a nature friendly preservative system to minimize microbial attacks on coir pots used in agricultural sector (N M V Kalyani Liyanage, Vasantha Gamage and S Weeraman).

The effect of metal ions in well water on the quality of raw rubber products

Well water is one of the cheapest source of water for day to day use in industrial processes by the industrialists without proper analysis. There is no testing of the quality of well water by the industrialists in the process of using well water in production lines. In the rubber industry, metal ion contaminants in water causes to reduce the quality of final product. Samples of well water in the industrial zone in Ratmalana area were analysed by using the UV spectrophotometer, atomic absorbtion spectrophotometer and titremetric methods (G Seneviratne and Priyanka Shirani).

Preparation of NR and NBR, NR/ CR, NR/ENR blends of different compositions

Above blends were prepared in an open two roll mill in different ratios and a comparison of physical properties were carried out. Blend of 20/80 NBR/NR shows comparatively better physical properties than that of other blends. Trials of NR/CR and NR/ ENR blends are in progress (Champa Vellappili and Priyanthi Perera).

Distribution of introduced phosphate ions in the aqueous and rubber phases of latex

Series of latex samples were prepared using different concentrations of phosphate ions as given below. After two weeks of storage period, phosphate content present in aqueous phase of latex was tested According to the results it was clear that the phosphate ion content present in the aqueous phase is less compared to that in the rubber phase.

Sample	Quantity of PO_4^{3-} added (ppm)	After two weeks PO_4^{3-} in aqueous phase (ppm)
1	10	0.9536
2	20	0.9531
3	30	1.0757
4	40	1.1170

(Kalyani Liyanage, Priyanthi Perera and Medavi Wijesekara)

RAW RUBBER PROCESS DEVELOPMENT AND CHEMICAL ENGINEERING

W M G Seneviratne

SUMMARY

As advisory services on raw rubber manufacture is one of the main functions of the department, about twenty raw rubber factories were visited to solve their manufacturing problems as well as to improve the quality of manufactured raw rubber. In addition, large number of rubber factories and related industries were visited during the year to look into their waste water disposal problems. Appropriate treatment methods based on anaerobic/aerobic techniques were proposed to some of the factories while necessary advise and guidance were given to those having existing treatment plants to improve the efficiency of them. There were about thirty nine such treatment units at the end of the year, mostly in rubber processing industries, which were installed under the guidance and supervision of the department.

Analysis of the composition of bio-gas and to find the optimum conditions for the generation of bio-gas from the treatment/digestion of skim serum are being continued satisfactorily under the National Science Foundation (NSF) funded project.

A study on evaluation of the performance of commercial treatment plants installed under the assistance of the department has been completed during the year. Several important findings on the performance of the treatment plants were observed which can be made use of for the developments of plants to be installed in future.

Effect of metal ions (*i.e.* Fe, Mn, Ca, Mg) on the colour and raw rubber properties of manufactured rubber was continued. Effect of iron (Fe) present in processing water on the quality of crepe rubber too, was studied.

A project has been initiated to examine extractable proteins present in different types of raw rubber specially crepe rubber since there is no data available on this.

Assistance to implement ISO -9002 quality assurance scheme for Ms Boseang Cey (Latex) Limited, a leading glove manufacture and for Ms Busan Dipping Ko - Lanka Limited, a leading balloon manufacturer in Sri Lanka was continued.

DETAILED REVIEW

Staff

Dr W M G Seneviratne, Head of the Department was promoted to the Deputy Director Research (Technology) with effect from 1st of July.

Mr Susantha Siriwardena, Rubber Chemist, continued reading for his PhD at the University of Science in Penang, Malaysia.

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

Mr P H Sarath Kumara, Asst. Rubber Chemist, continued his study programme in Polymer Science Technology started in June at University of Sri Jayawardanepura leading to the degree of MSc.

Mr P P Jayasinghe, Development Officer, Messrs C D Senanayake and T A S Siriwardane, Mrs Chandrika Nalini Experimental Officers, Mr A K D Warnajith and Miss V C Rohanadeepa, Technical Officers, Mrs L Rukmanie, Store Keeper and Mrs Anusha Paranavitane, Typist/Clerk were on duty throughout the year.

Miss N Subasinghe, Temporary Research Assistant of research project funded by National Science Foundation (NSF) was on duty throughout the year.

Research students

4. Miss N Subsinghe, Temporary Research Assistant worked on research project RG/98/EP/01 titled "To develop an efficient and cost effective treatment system to generate bio gas from skim serum" funded by the National Science Foundation.

NDT Diploma students

Three (03) students from University of Moratuwa were trained.

Undergraduates

One (01) student from University of Colombo was trained.

Seminars/Conferences/Meetings and Workshops

Officer	Subject	Organization
W M G Seneviratne	To develop vision and mission statement	NIPM
W M G Seneviratne	Latex industry in Sri Lanka	TIPS
W M G Seneviratne	Industrial Ergonomics	Ms. Global Conventions Private Limited
Upul Ratnayake and P H Sarath Kumara		
W M G Seneviratne	Future of Sri Lanka's latex based industry. Are we competitive?	Rubber Cluster
Upul Ratnayake and P H Sarath Kumara		

Training programmes

The department staff was involved in the following training programmes:

Client	Subject	No. of programmes
Plantation Sector Managers – NIPM	National Diploma in Plantation Management	1
Assistant Managers Agalawatte Plantations	Raw rubber manufacture	1
Plantation Sector Managers – NIPM	Rubber Manufacture and Factory Practice	1
Field Officers – NIPM	Preservation of field latex and Metrolac weighing	1
Rubber factory workers Kiribathgala estate	Skill development	1
Rubber Development Officers	Raw rubber processing	1
Rubber Extension Officers	Diploma in Plantation Management	1
Extension Officers	Diploma in Plantation Management	1
Undergraduates of the University of North Western	Raw rubber processing	1
BSc Plantation Management course at University of Wayamba	Rubber Processing and Manufacture	1
MSc course at the University of Sri Jayawardenepura	Polymer Science and Technology	1
Diploma students – PRI	Polymer Science and Technology	1

Advisory visits

Client	No. of visits
Estates and rubber factories regarding raw rubber manufacture	22
Estates and rubber factories regarding factory waste water disposal	35

Sample testing

About150 waste water samples (*i.e.* factory discharged and treated waste water) were tested for different effluent quality parameters and 102 waste water analysis certificates were issued for relevant industries.

Wastewater treatment and disposal

Commercial implementation of wastewater treatment plants based on high rate anaerobic digestion coupled with aerobic technique in raw rubber processing and other allied industrial sectors was continued satisfactorily and thirty nine such plants have already been commissioned.

Installation of treatment plants at Devalakanda and Panawatta crepe rubber factories belonging to the Kelani Velly Plantations Ltd. was continued during the year and Panawatta plant was commissioned at the end of the year.

Installation of the plants at Talduwa, and Sunnycroft crepe rubber factories and Centrifuged latex processing factory at Vincit estate belonging to Malwatte Velly plantations Ltd was continued and Plant at Sunnycroft estate was to be commissioned at the end of the year.

Proposed plant at Glenross latex centrifuging factory was nearing completion and the operation of the plant could be commenced after fabrication of surface aerators.

Construction work of the treatment plant at Neuchatal estate is almost completed and operation could be commenced early next year.

ISO 9002 Quality Assurance Scheme

The re-assessment of the ISO 9002 QMS at Dartonfield rubber factory was carried out by SLSI assessors at the end of the year and the ISO 9002 certificate was renewed.

Padukka rubber factory was assisted by conducting internal quality audits.

The quality manuals prepared for MS Boseang Cey (Latex) Limited, one of the leading glove manufacturers in Sri Lanka and for Ms Busan Dipping Ko-Lanka Limited one of the leading balloon manufacturers in the world were perfected and are to be handed over to the SLSI with relevant applications for obtaining the ISO 9002 quality certification. The procedure manuals are also completed and minor errors are being corrected at internal quality audits. Several training programmes were also conducted at these two institutions to educate the employees. Quality and productivity improvements have been achieved at Boseang Cey (latex) Private Limited after implementation of ISO 9002 QMS. It is reported that the number of workers has been reduced in certain areas of activity due to improved productivity at Boseang Cey Latex (Private) Limited.

The SLSI competency and certification is expected in these two organizations within the first six months of the year 2002 (W M G Seneviratne, P H Sarath Kumara and A K D Waranaith Prasad).

LABORATORY AND FIELD INVESTIGATIONS

1. Generation of bio-gas from skim rubber

The project titled "To develop an efficient and cost effective treatment system for the serum water that is discharged when latex is centrifuged and also to use the bio- gas generated in the process of treatment as an energy source" funded by National Science Foundation (NSF) was continued, throughout the year.

Studies were carried out to investigate the effect of S^{-2} accumulated inside the anaerobic digester on bio - gas generation when Sulphate Rich Skim Serum (SRSS) and Sulphate less Skim Serum (SLSS) are digested anaerobically. Figures 1 and 2 show the volume of bio-gas generated and accumulated S^{-2} content inside the anaerobic digester when SLSS and SRSS were subjected to laboratory scale anaerobic digestion.

According to the Figures 1 and 2, it is clear that when SLSS is digested anaerobically accumulated S^{-2} content inside the digester does not affect significantly the bio-gas generation where as, when SRSS is digested anaerobically accumulated S^{-2} content does affect significantly the bio - gas generation.

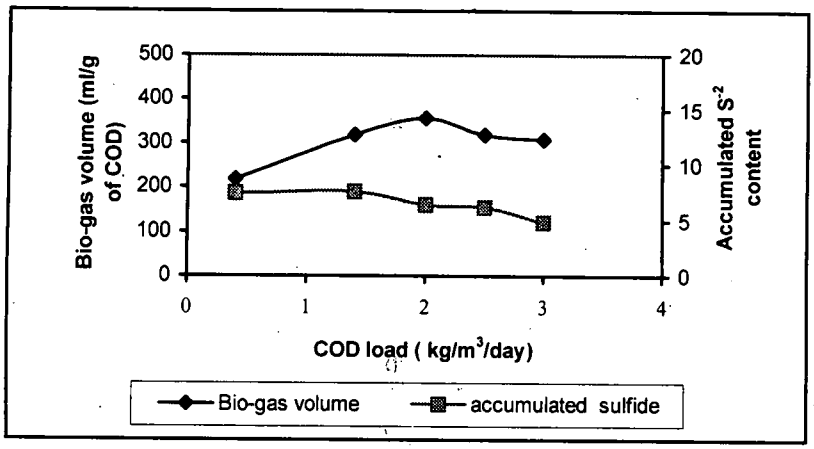


Fig. 1. Effect of S^{-2} in SLSS on bio-gas generation

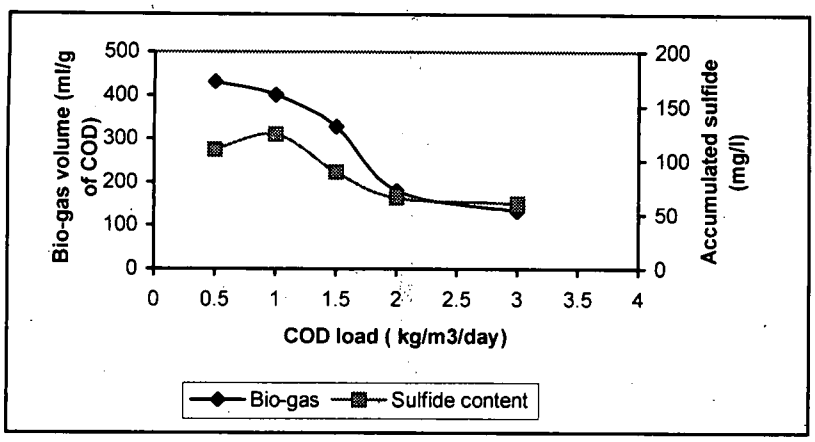


Fig. 2. Effect of S^{-2} in SRSS on bio-gas generation

Further experiments were carried out to determine the H_2S percentage in bio - gas from the anaerobic digestion of SRSS. The results of the study revealed that H_2S percentage is increased with the COD load of SRSS. However, analysis of bio - gas composition using Gas Chromatography was not possible due to non availability of reference samples even in other Research Institutions and Universities in Sri Lanka (W M G Seneviratne, Upul Ratnayake, T A S Siriwardene and N Subasinghe - Temporary Research Assistant of the Project).

2. Performance evaluation of commercially implemented treatment plants based on anaerobic/aerobic treatment technique

Treatment plants installed at Atale, Pusella, and Kiriporuwa rubber factories were selected to evaluate the performance, commercial viability and the sustainability of the system based on anaerobic coupled aerobic treatment technique developed by the department. The study was carried out throughout the year and aimed at understanding the areas that could be further developed to improve the efficiency of the treatment system and to reduce the cost involved for the operation of the treatment plant.

Monitoring study has yielded the following important findings:

1. Adequate capacity of the equalization or rubber trap/equalization tank is important to achieve effluent with consistent effluent quality characteristics for subsequent biological digestions. Maintaining constant flow rates into the anaerobic digester from the equlization/rubber trap tank was found to have a significant bearing on the treatment efficiency.

2. Three days retention time in anaerobic digester is quite adequate and ideal to achieve the required treatment efficiency. Anaerobic treatment efficiencies of each treatment plant reveal that anaerobic digestion alone could achieve the level of treatment expected by the CEA prior to disposal. However, adoption of any simple aeration technique was found to be necessary after the anaerobic digestion mainly to remove the malodour of the treated effluent.

3. Inclusion of a denitrification step is not significant to treat crepe rubber effluent since it does not contain high level of total nitrogen.

4. Generation of biological sludge in both aerobic and anaerobic stages of the plant was found to be very low and insignificant (W M G Seneviratne, Upul Ratnayake, T A S Siriwardena, C Nalini and C Rohanadeepa).

3. Effect of metal ions on crepe rubber

Crepe rubber manufactured by incorporation of different concentrations of iron (Fe) was analyzed to examine the level of retention of iron in crepe rubber and the variation of raw rubber properties after manufacture. Iron is included as $FeCl_3$ at different levels (*i.e.*5 ppm, 10 ppm, 20 ppm *etc.*) into the processing water and crepe rubber was manufactured using this iron contaminated water.

The samples of crepe rubber manufactured were checked for discolouration and raw rubber properties. The samples were also analyzed for the remaining iron content in crepe rubber in order to ascertain the maximum level of iron that could be present in crepe rubber without causing any affect to the raw rubber properties. Experimental results revealed that if processing water contains more than 10 ppm of total iron, the colour as well as the raw rubber properties of the crepe rubber will be affected significantly (Upul Ratnayake, T A S Siriwardena, W Prasad and C Rohanadeepa).

4. Extractable proteins in different types of raw rubber

The project was initiated to determine the extractable protein levels in different types of raw rubber specially crepe, RSS and centrifuged latex. As reported earlier, most dry rubber grades such as RSS, TSR contain low levels of leachable proteins while data on extractable proteins in crepe rubber are not available. Therefore, extractable proteins were analysed for different grades of crepe rubber (*i.e.* UFUB, FB, YF) using bicinchoric acid method and these values were compared with values given in Table 1.

Table 1. *Extractable proteins in crepe rubber*

Sample	Extractable proteins (μg/g of rubber)
Field latex	2327.03
Fractionated latex	126.26
Skim latex	6396.42
UF UB rubber	438.76
FB rubber	29.19
YF rubber	463.21
Skim rubber	374.48

UF UB - Unfractionated unbleached
FB - Fractionated Bleached
YF - Yellow Fraction

The results show that FB rubber contains comparatively very low level of EP than all other grades. This is mainly due to removal of fraction and extensive washing during the milling process (Upul Ratnayake, W Prasad, and C Rohanadeepa).

Identification of natural rubber latex proteins

SDS PAGE (Sodium Dodecyl sulphate polyacrylamide gel electrophorosis) analytical technique was initiated to identify the types of proteins available in natural rubber latex. Extracts obtained from simple water extraction method for different latex films were analyzed using the SDS PAGE technique. However, analysis could not be completed due to non availability of standard protein markers (K Liyanage and Upul Ratnayake).

Effect of water soluble polymers on extractable proteins in centrifuged latex

It was reported that water soluble polymers (WSP) effectively reduce the extractable proteins in radiation vulcanized natural rubber latex (RVNRL). Therefore a project was started to use the same method to reduce the extractable proteins in centrifuged latex. The study is being continued (Upul Ratnayake, T A S Siriwardena and W Prasad).

Use of white rice husk ash (WRHA) as a filler in natural rubber compounds

WRHA contains around 96%(w/w) silica and investigations on the use and the behaviour of it as a reinforcing filler in rubber compounds was carried out. The loading levels of WRHA with different NR compounds with different compositions have been studied. The level with optimum physical properties was found to be as 10phr loadings and deterioration of properties were observed with further increase of loading levels of WRHA. Surface modification of WRHA was found to improve the performance as a filler. Incorporation of silane type coupling agent (A 1289) has resulted in improving the cure characteristics as well as physical properties of WRHA filled NR compounds. The NR compound containing 30 phr of WRHA and 0.5 phr of coupling agent showed better physical properties indicating improved surface interaction between the rubber and the filler phases (R M S M Ratnayake and W M G Senevitratne).

ADAPTIVE RESEARCH

S M M Iqbal

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 in progress.

DETAILED REVIEW

Staff

Mr S M M Iqbal, Research Assistant in Agronomy, Mr A M A Perera, Mr R B Gunaratna and Mr D S Wettasinghe Research Assistants and Mr E A T Senadeera Experimental Officer were on duty throughout the year.

Advisory visits

Client	No. of visits
Plantations	02
Smallholdings	02

FIELD INVESTIGATIONS

Adaptive Research Programme

Adoption level of RRI recommendations by the rubber smallholder sector

Results of the preliminary survey conducted in Kalutara (Agalawatta range), Kegalle and Ratnpura regions.were completed. Based on the data collected a detail survey was conducted selecting twenty smallholders from each of the three regions selected for the study (R B Gunaratne, W A D D S Wettasinghe, E A T S Senadeera and A M A Perera).

Bee keeping in rubber smallholdings and plantations

Three estates, *i.e.* Dartonfield, Salawa, Kuruwita sub-station and five smallholdings were selected for the study. One bee colony and three boxes were supplied to each site. Some bee colonies left the boxes due to pest attacks. Measures were taken to reintroduce bee colonies into such boxes (W A D D S Wettasinghe and

L M K Tillekeratna in collaboration with Training and Extension Division, Department of Agriculture, Peradeniya).

Interpolating of rubber lands with tea

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

The study initiated with the following objectives were continued.

- To determine the relative limitations to dry matter accumulation and yield in tea due to competition for light, soil nutrients and water through the quantification of resource capture under a range of intercrop planting densities.
- To determine the extent of anatomical and physiological adaptations to shade that occurs in tea grown under a range of intercrop planting densities and main crop canopy densities.

Productivity measurements are in progress in a rubber tea intercrop system planted in N-S direction.

The following measurements were made with regard to above studies.

- Growth and yield of rubber and tea.
- Biomass production.
  Detailed growth analysis for tea was conducted through destructive sampling.
- Light interception.
  Radiation levels were measured using solarimeters to quantify the radiation use by tea.
- Water use
  Weather data were collected using an automatic weather station installed at the experimental site.
- Studies on competition.
  The effect of competition from light and roots on the growth, yield and yield parameters of tea is being monitored. The canopy of rubber is thinned artificially to simulate different shade levels.

Rapid Rural Appraisal (RRA) was undertaken to assess the present status of rubber/tea intercroping in Sri Lanka (S M M Iqbal, A M A Perera and S Wettasinghe in collaboration with TSHDA).

Productivity in rubber/tea systems (Agalawatta/TR 2)

The above experiment was continued. Yield and growth of rubber and the yield of tea were monitored. Yield data of tea and girth of rubber are presented in Table 1 (S M M Iqbal and A M A Perera).

Table 1. *Made tea yield and girth of rubber (Rubber stand as a percentage of monocrop stand is given within brackets)*

System	Girth (Rubber) cm.	Made tea yield /bush/year 2001
1.Tea Only 12'x 18' (100%)	N.A.	0.198[a]
2. Rubber 8'x 27' (100%) + Tea	37.885[a]	0.258[a]
3. Rubber 8'x 32' (85%) + Tea	33.768[a]	0.248[a]
4. Rubber 8'x 36' (75%) + Tea	34.083[a]	0.195[a]
5. Rubber 8'x 40' (70%) + Tea	36.373[a]	0.252[a]
6. Rubber 8'x 40' (65%) + Tea	36.790[a]	0.163[a]
7. Rubber only	33.430[a]	N.A.

(Means with the same letter are not significantly different)

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

Experimental details were given in the Annual Review 1998. Growth assessments of rubber were recorded (Table 2). Routine maintenance work, *i.e.* weeding, supplying vacancies and manuaring were done according to the treatments. As plucking is in progress in experimental plots, arrangements will be made to conduct test plucking (S M M Iqbal and R B Gunaratna).

Table 2. *Growth of rubber in tea rubber systems (Vogan estate)*

System	Rubber girth (cm)
1. F1- ½ of the recommended fertilizer level to Rubber	29.343[a]
2. F2- recommended fertilizer level to Rubber	27.469[a]
3. F3 - 1 and ½ of the recommended fertilizer level to rubber	28.470[a]
4. Rubber only 12' × 18'	27.988[a]
5. Rubber 8' × 8' × 46' + Tea	28.93[a]
6. Rubber 8'× 8' × 60' + Tea	28.258[a]

(Means with the same letter are not significantly different)

Smallholder sector

Smallholder trials in Kegalle and Ratnapura regions were in progress (S M M Iqbal, A M A Perera and E A T Senadeera).

AGRICULTURAL ECONOMICS

J Edirisinghe

SUMMARY

A study on Macro Economic Policies and their implications on the Rubber Sector in Sri Lanka was carried out in collaboration with Central Bank of Sri Lanka and the Biometry section of the Rubber Research Institute. A database was developed and initialized for economic related data pertaining to the rubber sector.

DETAILED REVIEW

Staff

Assistant Agricultural Economist, Mr A K B Naranpanawa was on study leave continuing his postgraduate studies throughout the year. Mr J C Edirisinghe assumed duties as an Assistant Agricultural Economist with effect from 15th November.

Services

Research support

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

Data base management

Auction prices

A database on rubber auction prices was maintained throughout the year. Movement of prices during the year is graphically illustrated in Figs. 1-3. A seasonality of rubber prices was observed for all grades, the highest average prices being obtained in May/June period. However, the rubber prices from the year 2000 to 2001 showed a declining trend. While Latex Crepe obtained highest prices throughout the year, it was noted that in many occasions RSS1 was not quoted in the Colombo auctions. Out of total quantity traded through Colombo auction, 79 percent was Latex Crepe, 15 percent was Scrap Crepe and RSS accounted for only 6 percent (Fig. 4).

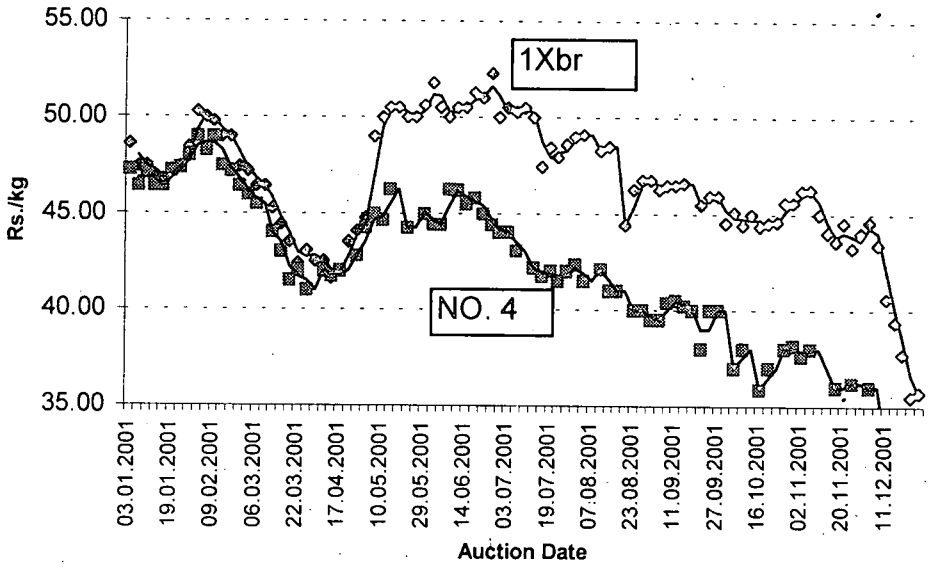


Fig. 1. Variation in prices of Scrap Crepe (1Xbr & No.4) during the year

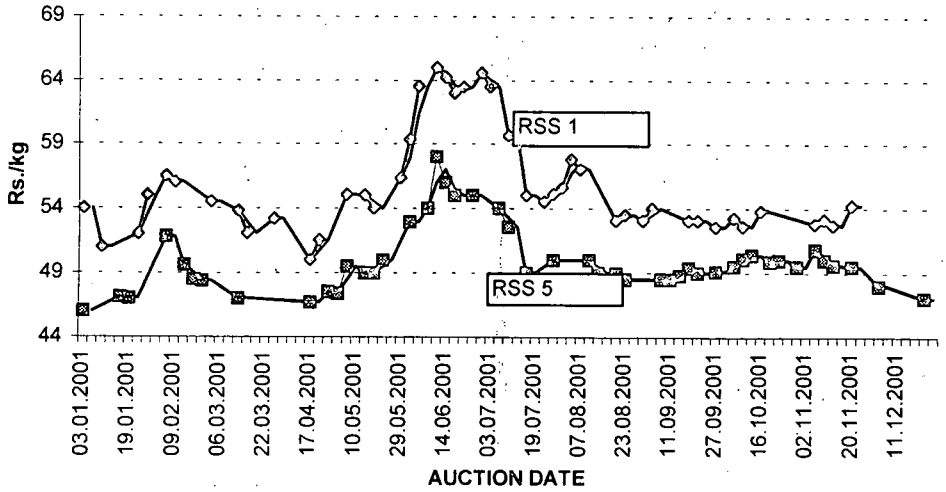


Fig. 2. *Variation in prices of RSS1 and RSS5 during the year*

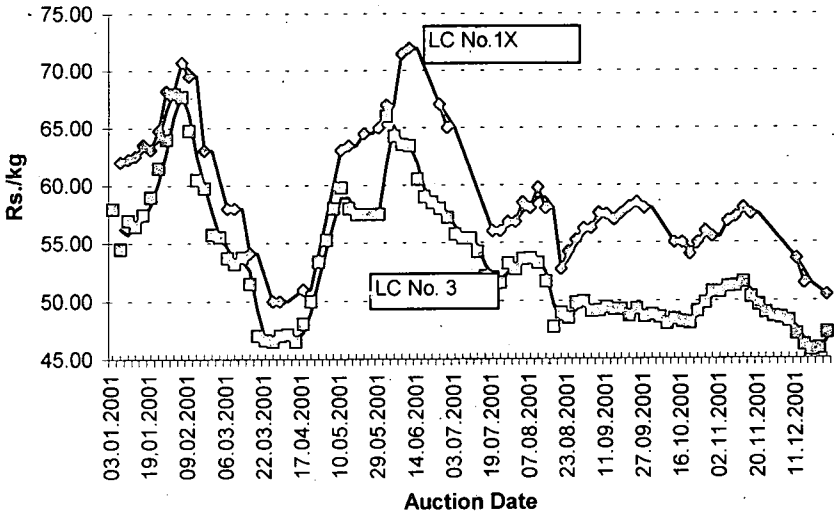


Fig. 3. Variation in prices of Latex Crepe No.1X and No.3 during the year

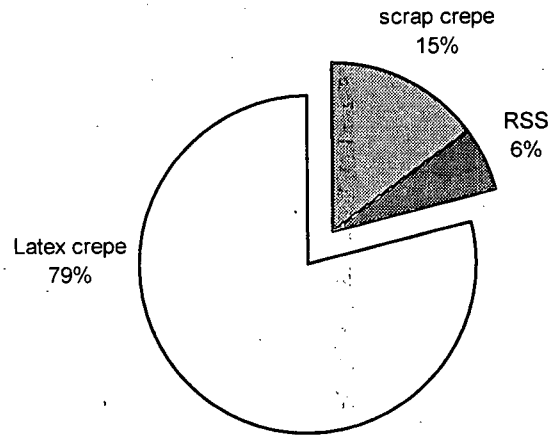


Fig. 4. Percentage quantity of different raw rubber types traded through Colombo auction during the year

World rubber statistics

A database was developed and initialized for world rubber statistics such as world natural and synthetic rubber imports, exports, stocks, production and consumption *etc.* from 1960 to to-date and will be continually updated.

Sri Lankan rubber statistics

A database has been designed and being updated for Sri Lankan rubber statistics from 1970 to to-date.

REASERCH

Macro economic policies and their implications on the Rubber Sector of Sri Lanka

This study was carried out in collaboration with the Biometry section of RRI and the Central Bank of Sri Lanka as part of the broad study on the Agricultural Sector in Sri Lanka initiated by the National Committee of Socio Economists and the Policy Analysts of the Council for Agricultural Research Policy (CARP).

The objective of this study was to identify macro economic parameters that influence rubber sector and to recommend policy measures to remove impediments to the development of the sector. Exchange rate, interest rate and the inflation rate were used in the analysis as macro economic policy tools and the changes in supply of natural rubber and domestic consumption were evaluated from the data for the period 1978 to 2000 using macro econometric models.

The nominal exchange rate and the nominal interest rate were tested significant in the model developed for the domestic consumption of rubber.

Table 1. *Results of the regression analysis of domestic consumption model*

Parameter	Estimate	T for H0	Pr> T	Std. E of
Intercept	-1.4049	-0.44	0.6697	3.2198
Nominal exchange rate	0.9145	11.41	0.00010	0.08016
Nominal interest rate	-0.5146	-2.59	0.0222	0.1983
Price of latex	0.3735	6.88	0.0001	0.05427
Investment in rubber industries under BOI	0.0067	0.74	0.4742	0.0092

The nominal exchange rate, interest rate and the domestic price of latex were found to have significant effect on the domestic consumption of natural rubber. The exchange rate was unified and allowed to float under a managed floating system with the economic reforms in 1977. Under this, Central Bank announced the daily rate at which it would buy and sell foreign exchange from the market within a narrow band. This band was changed from time to time depending on the reserve position of the country. On the 23rd of January 2001 the exchange rate was freely floated and the commercial banks were allowed to determine the exchange rate. Hence although the exchange rate has a significant effect on the domestic consumption of rubber, government can no longer influence consumption through exchange rate as market forces decides the actual rate.

The three-month Treasury bill rate was used as a proxy for the interest rate, which was also significant with the expected negative sign implying a higher interest rate reduces investments and thereby reduces the domestic consumption.

The investment in rubber based industries although not a significant factor in the above analysis has increased from Rs.7 million in 1980 to Rs.8, 846 million in year 2000 where there were 59 projects in commercial operation.

The study has been completed and findings are to be published by CARP (K I. De Silva - Central Bank, Wasana Wijesuriya, Jagath Edirisinghe).

BIOMETRY

Wasana Wijesuriya

SUMMARY

Biometry section provided necessary research support to the other Research Departments in 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 on several aspects; adoption patterns of technologies in smallholdings, climate change impacts and appropriate statistical techniques for experimentation in rubber were among the main research concerns of the biometry section.

DETAILED REVIEW

Staff

Mr Keminda Herath assumed duties as an Assistant Biometrician from 1st of November. The rest of the staff Ms Wasana Wijesuriya (Biometrician), Ms Chintha Munasinghe (Experimental Officer) and Mr Vidura Abeywardene (Technical Officer) were on duty throughout the year. Ms Wijesuriya continued her postgraduate studies while attending to the services of the Biometrician.

Research students

- Mr Dinesh Udawatta, an undergraduate student from the Statistics Department of the University of Colombo completed the module, Industrial Training at RRI and submitted a report titled "Temporal behaviour of rubber production".
- Mr Sarath Kumarasinghe from the Faculty of Agriculture, University of Ruhuna submitted a report on "Time series analysis of natural rubber prices in Colombo market" for the partial fulfillment of the BSc degree in Agriculture.
- Mr Dinesh Udawatta submitted a report on "Analysis of daily rainfall measurements with appropriate use of statistical techniques" for the partial fulfillment of the BSc degree in Statistics.

Seminars/Conferences/Meetings/Workshops attended

Officer	Subject	Organization
Wasana Wijesuriya	Progress review seminar on climate change	Meteorological Department
Wasana Wijesuriya	Steering committee meeting	Young Scientists' Forum, NASTEC

Officer	Subject	Organization
Wasana Wijesuriya	Capacity building on research needs relevant to Climate change	Ministry of Transport and Environment
Wasana Wijesuriya	Use of Indian Remote Sensing Satellite data	Geoinformatics (Pvt.) Ltd. and National Remote sensing Agency, Department of Space in India
Wasana Wijesuriya	Meetings and workshops of INFORM	CARP
Wasana Wijesuriya	Served as the institute's coordinator for the INFORM programme	CARP
Wasana Wijesuriya	Served as a member of the National Committee of Socio-Economists and Policy Analysts	CARP

Ms Wijesuriya served as a visiting lecturer in Biometry in the Faculty of Agriculture, University of Ruhuna.

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

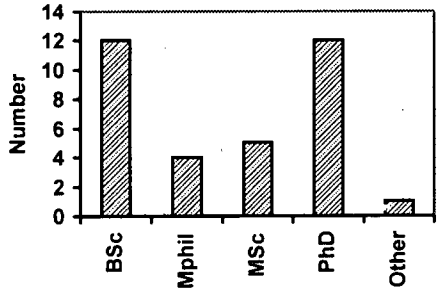
The Dartonfield meteorological station was maintained and daily measurements were entered in the database. Monthly reports were prepared and sent to the Central Meteorological Station. These data were made available to researchers, Agrarian Service Centers and schools in the vicinity of the station (Wasana Wijesuriya, Chintha Munasinghe and Vidura Abeywardene).

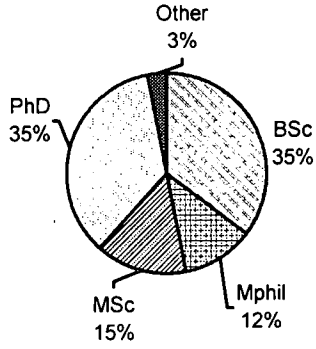
b) Management information

The personnel and project summary databases were updated for the year 2001. The collected information was transferred to CARP to be included in the database of National Agricultural Research System (NARS).

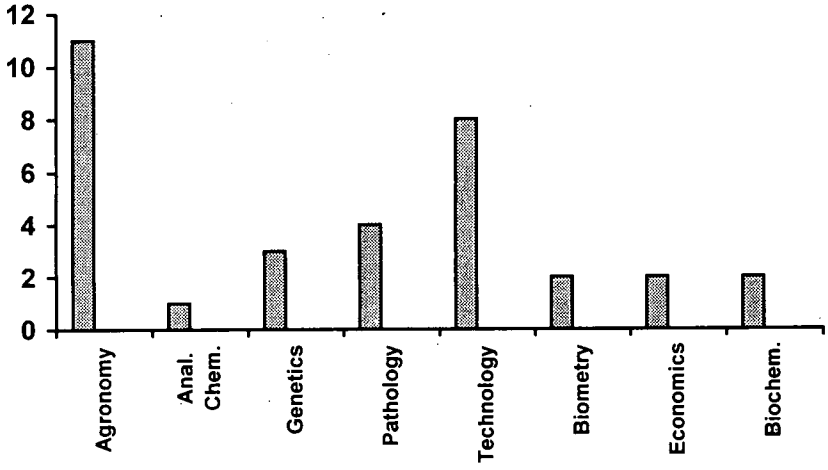
The following are some of the important features of the research system at RRI.

Scientists by highest qualification as at November 2001





Scientists by Discipline



RESEARCH

The following studies are in progress.

Technology adoption in young rubber plantations

This study was carried out to develop adoption indices for rubber farming. A questionnaire covering all technical recommendations for the immature stage was used in the survey. A technical evaluation form was employed to evaluate the holdings. The objective of this study will be to collect relevant information from

smallholders in the Kalutara region to develop adoption indices and subsequently test for statistical assumptions.

Development of the sampling plan

The information on subsidy payments to the small-holders was collected from the Rubber Development Department (RDD) and a database consisting of 47 RDO divisions was established. Timely payment of subsidy was considered as an indirect measure of the adoption of recommended technologies. Subsequently, the holdings in each RDO region were classified into (a) not planted (b) bad (c) moderate and (d) good according to the condition of the holding. Four strata were made based on percentage of 'good' holdings in each RDO division and 40 holdings were randomly selected from each strata. Altogether, 167 holdings were surveyed in the Kalutara district.

Construction of adoption indices

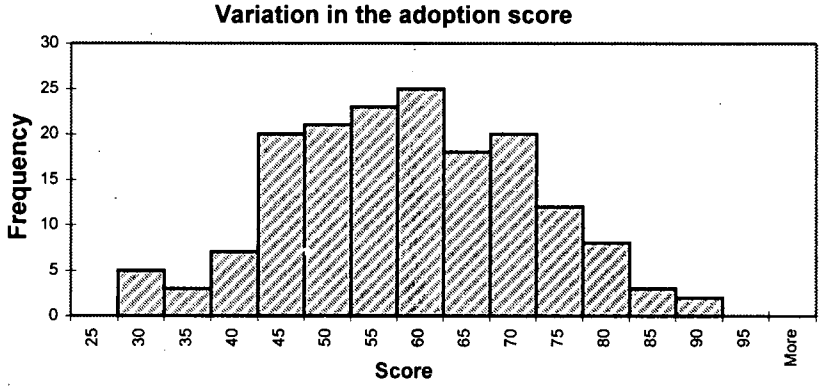
One approach for determining the impact of various components of new technology is to develop suitable indices, which would reflect the aggregate of adoption rates of different components of improved agricultural technology. The reliability of such indices will be indicated by the strength of its relationship with the crop response; girth or rubber yield. Based on the understanding that individual adoption rates would not reflect the overall adoption performance, several indices were developed during this period.

Technical evaluation of holdings

Technical evaluation of the immature rubber holdings comprised of 4 main field operations; *viz.* (i) land preparation (ii) field establishment (iii) ground cover management and (iv) other maintenance activities. Each operation had several sub categories with different weights for the score. The maximum for each operation; *viz.* for i, ii, iii, and iv are 30, 25, 20 and 25, respectively. The status of each holding was assessed by the girth and the uniformity of the growth.

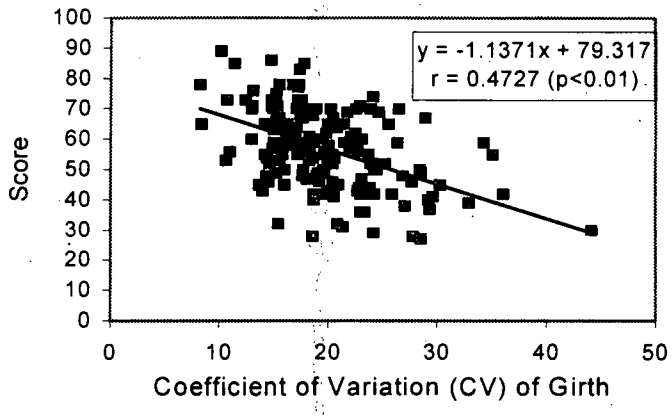
Results

The sample of immature holdings had total scores varying from 27 to 89. The variation is shown in the following figure. The average score for the sample was 57 and the sample standard deviation was 13. Hence, the resulting coefficient of variation (CV) was 23 percent.

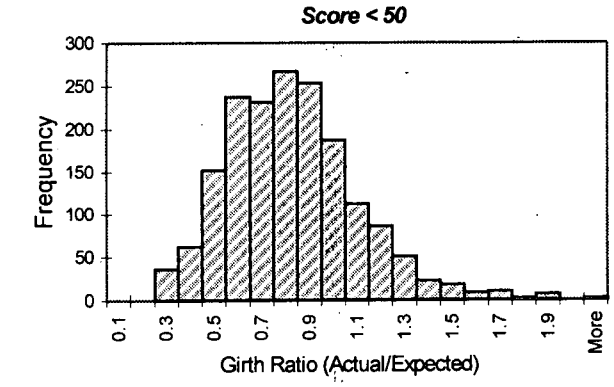


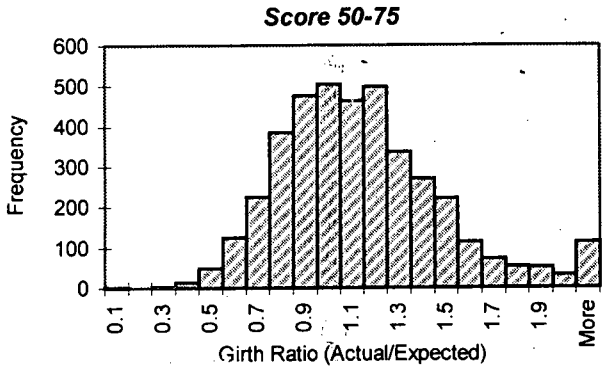
This collective adoption score had a strong relationship with the uniformity in girth (measured in terms of CV for girth) as shown below. Based on the girth the holdings were categorized into good (score > 75), moderate (Score 50 – 75), and bad (Score < 50). Subsequently, ratios of actual girth to the expected girth were calculated considering the age of the holding. The histograms for the above-mentioned categories indicated a clear shift towards right as shown in following figures. These suggest that the scoring system is successful in evaluation of smallholder units. Further analyses will be carried out to study the statistical properties of these distributions. Moreover, this study is in progress to find out the relationships between the adoption score *versus* socio-economic factors of smallholders and agronomic details of the selected holdings. The views of extension officers and scientists on the evaluation score were also compiled and will be tested for any improvements in the proposed score.

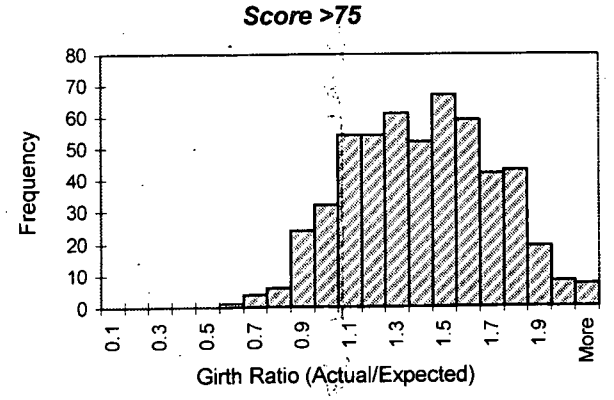
Documentation of the findings is in progress (Wasana Wijesuriya, Keminda Herath and Vidura Abeywardene).



Distribution of the index (actual girth/expected girth) for different categories according to the score



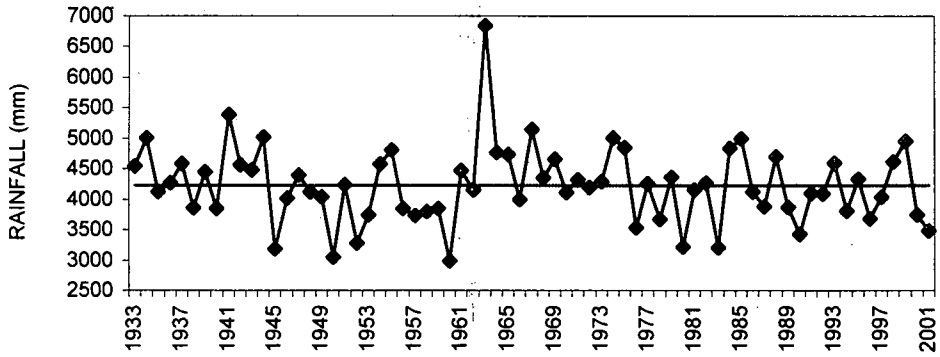




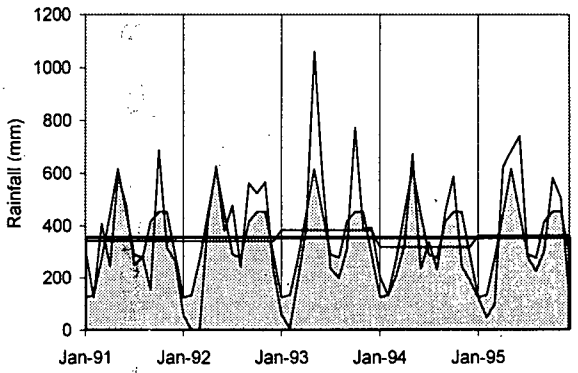
Climate change studies

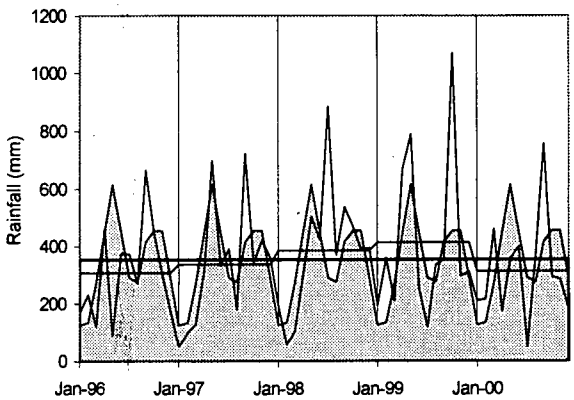
a) ***Observed deviations in rainfall at Dartonfield***

The annual rainfall observed since 1933 is presented in the following figure, which indicates a random event with frequent rises and falls in the series. The lowest rainfall totals (about 3000 mm) per year were observed in 1950 and 1960. The highest annual rainfall was observed in 1963.



Monthly totals of rainfall experienced in the period, 1991-2000 are presented in following figures, together with the seasonal pattern in shaded area. The stepped lines over the thick straight line (mean monthly value) indicate the years with mean monthly rainfall exceeding the long-term average and stepped lines below the straight line indicate years with rainfall less than the long-term mean monthly values. The expected bimodal pattern is observed in the period 1991-1995, except some deviations in the amount of rainfall. Hardly any deviations due to shifting of rainy seasons are observed during this period. In 1993,





both peaks were higher than the average. From 1996 onwards there is a tendency to exceed the average peak at the end of each year. Moreover, a forward shift is observed in the peak at the end of the year.

The descriptive analyses suggest that the rainfall during last 5 years deviated from the long-term seasonal pattern. The annual rainfall showed a random fluctuation around the mean. Moreover, prominent deviations were observed in rainfall seasons. Therefore, detailed analyses on probability of onset and cease of rainy seasons and risk associated with dry spells are to be carried out to investigate any deviations with respect to the time of year. These findings may be subsequently used in defining crop calendars, to suit the existing rainfall pattern. However, one should keep in mind that these changes may be temporary, but should keep a track on them to find ways to minimize crop losses or any other detrimental effects to crop growth. Consequently, attention should be paid to avoid any damages due to diseases and to minimize wastage of inputs such as fertilizer and agro-chemicals to minimize the adverse effects of climatic changes on the productivity of rubber lands (Wasana Wijesuriya, Chintha Munasinghe and Vidura Abeywardene).

b) ***Effect of climate changes on rubber plantations in Sri Lanka***

This study was funded by the Centre for Climate Change Studies (CCCS) of the Meteorological Department and was commenced on 01st June. Daily data were collected from the Meteorological Department for the last 60 years, covering the major rubber growing areas.

The stations selected for the study were as follows.

Low country wet zone		*Low country intermediate zone*	
Agalawatta	Galle	Kurunegala	Okkampitiya
Ratnapura	Kalutara		
Avissawella	Hanwella	*Mid country intermediate zone*	
Ambanpitiya	Matara	Nalanda	
Mid country wet zone		*Up country intermediate zone*	
Peradeniya	Matale	Badulla	
Aranayake			

Totals for standard weeks and months were made using the daily data for all the stations. Descriptive statistics were calculated for annual data and time series analyses were done to identify any trends, seasonals and cyclical changes in annual data. Probability values were computed; *viz.* for the incidence of a wet week after a wet week (W/W), for weekly rainfall totals; /20mm, /30mm, /40mm, and /50mm. Similarly, the probability of incidence of a dry week after a dry week (D/D), was also computed.

The onset of rains in all the rubber growing areas were computed and will be studied in detail to compare them with the existing crop calendar. The final report of this project is being prepared.

Results

The descriptive statistics of rainfall data from the rubber growing areas are presented in the following table.

Descriptive statistics of rainfall in rubber growing areas

Area	Location	Avg.	Min.	Max.	CV%	Q25	Q75
Low Country Wet Zone	Avissawella	3562	1963	4703	16.2	3132	3821
	Agalawatta	4211	3188	5057	12.7	3755	4717
	Ratnapura	3504	2684	4720	14.0	3068	3892
	Ambanpitiya	2453	1098	3342	20.0	2050	2741
	Matara	1547	570	2735	25.7	1330	1754
	Galle	2423	1550	3859	16.5	2180	2599
	Kalutara	2142	1400	3940	20.5	1828	2435
	Hanwella	3178	1797	4561	17.2	2820	3645
Mid Country Wet Zone	Peradeniya	2130	1346	2883	17.5	1920	2365
	Aranayake	2293	1158	3299	20.0	1943	2608
	Matale	3767	2486	5349	11.2	3603	3970
Low Country Intermediate Zone	Kurunegala	2053	1474	2923	16.6	1797	2245
	Okkampitiya	1669	1065	2734	21.2	1420	1907
Mid Country Intermediate Zone	Nalanda	1801	1048	2798	21.1	1520	1994
Up Country Intermediate Zone	Badulla	1743	1175	2607	18.4	1541	1933

CV= Coefficient of variation Q25 = 75% expected value Q75=25% expected value

In some areas, long term annual rainfall values showed declining trends while some areas showed random fluctuations. Annual rainfall values at Agalawatta, Badulla, Kalutara, Ratnapura, Kurunegala and Hanwella had no significant declining trends. However, Peradeniya, Aranayake, Matara, Nalanda, Ambanpitiya, Galle, Avissawella, Matale and Okkampitiya data indicated significant negative trends (Wasana Wijesuriya, Keminda Herath, Vidura Abeywardene and Taranga Widyawardene).

Interactions between the environment, society and technology

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 small-holder sector of rubber. The duration of the project is 3 years and the coordination is done by the IACR-Rothamsted. The official commencement of this project will be 01st February 2002. The basic preparatory work including collection of information, design and creation of databases and preparation of maps were done during the latter part of the reporting year (Wasana Wijesuriya, Mahinda Wijeratne [Proffessor of Economics, University of Ruhuna], Keminda Herath, Jagath Edirisinghe and Vidura Abeywardene).

Economic research

Biometry section attended to the routine economic analyses until the recruitment of the Assistant Agricultural Economist on 15th November. A collaborative research was carried out on "macro economic policies and their implications on the rubber sector" with the Central Bank of Sri Lanka. A detail description of this study is available in the review of the Agricultural Economics Unit.

LIBRARY AND PUBLICATIONS

S U Amarasinghe

SUMMARY

The Library and Publications section was engaged in the following activities during the year.

(a) Maintaining, processing and publishing of Institute's regular publications
(b) Collecting and disseminating of information on NR and related areas.
(c) Participation in AGRINET (Agricultural Information Network) activities

DETAILED REVIEW

Staff

Mr S U Amarasinghe, Librarian and Publications Officer, Mrs Thilaka Danthanarayana (Colombo Office) and Mrs Ramani Amaratunge, Library Assistants and Assistant Publications Officers and Mr P M Prema Jayantha, Clerk/Typist 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 BMICH
- Two AGRINET Librarian's meeting at CARP
- SLISTINET meeting at the National Science Foundation

Resource development activities

The book strength increased up to 5051.The library subscribed to only 15 journals out of 60, due to financial constraints and about 30 other journals were also received as gift/exchange.

Publications

The following publications were done during the year.

- Annual Review, 2000
- RRISL Bulletin, Vol.42, 2000
- Handbook of Rubber Vol.1-Agronomy
- Advisory Circular No.2001/01, Rubber based intercrops
- RRISL Journal Vol.82, 1999

Inter-library co-operation activities

Journals, textbooks and photocopies of articles *etc.* were received from other AGRINET member libraries under the inter-library loan scheme and those services were also provided to them by our library.

Computerized bibliographic data of the year 2001 were sent to the National Library of Sri Lanka and the CARP library for the compilation of the National Union Catalogue and Sri Lanka National Agricultural Bibliography respectively.

SDI service

Routine work on disseminating of information, *i.e.* circulation of content pages of current journals among the Institute's scientific staff were done regularly. Nearly twenty five literature searches on *Hevea*/rubber were done using CD-ROM databases available at CARP library.

Equipments

The following equipment were purchased during the year.

- Uninterrupted Power Supply (UPS)
- Heavy Duty Staple Machine
- Calculator
- Two Staple Machines

DATONFIELD GROUP

J Perera -

SUMMARY

The mature and immature extents of the Dartonfield Group were 189.17 and 49.29 hectares respectively during the year.

A crop of 158496 kg. representing a YPH of 837.8 kg. which is an increase of 23.2 kg. over the last year was harvested.

COP for the season was Rs.48.90 per kg. When compared with the last year it has decreased by cents /-30. Nevertheless, the group incurred a loss of =/71 cts. per kg though the COP was less than previous year where the group made a profit of Rs.9.24 per kg. The main reason attributed for the loss was the low prices prevailed in the rubber market throughout the year.

Average intake per tapper was 6.6 kg. This is a decrease 0.3 kg. over the last year.

The Annual rain-fall was 4144.5 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.48.90 and Rs.48.19 per kg. respectively.

DETAILED REVIEW

Staff

Mr Jehan Perera, The Estate Superintendent, Mr P Kannangara, Chief Clerk, 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.

The group cadre stood at .23 at the end of the year, made as follows:

Senior Staff	01
Assistant Staff	19
Minor Staff	03
Total	23

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	131.91	24.59	189.17
Immature areas	6,.35	28.60	14.34	49.29
Budwood nurseries	6.54	-	2.00	8.54
Seedling nurseries	0.73	-	5.69	6.42
Uprooting Areas	-	4.51	7.25	11.76
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	23.84	34.31	93.42
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 158496 kg. was harvested from an extent of 189.17 ha. during the year. This was 93% of the estimated crop of 170400 kg.

The yield per hectare for the past 5 years is given in table 02 for the entire group and separately for each division.

Table 2. *The yield per hect. (YPH) in Dartonfield group from 1997 to 2001*

Division	Year				
	1997	1998	1999	2000	2001
Dartonfield	1059	790	649	730	764
Gallewatte	1067	926	713	828	890
Nivitigalakelle	800	1106	858	885	657
Group average	1006	965	728	820	838
Group estimate	1038	979	926	1093	901

When compared with last year yield per hectare has increased in two divisions and in the group (Table 02). The main reasons for low YPH in Nivitigalakele division is that the fields have reached uneconomic level and 89% of total tapping area are intensified and 58% of the same extent is between 30-35 years old.

Table 3. *The yield per hect. recorded during the year division wise*

Month	Dartonfield	Gallewatte	Nivitigalakelle
January	60	91	78.2
February	75	102	81
March	74	98	53
April	26	16	10
May	24	17	26
June	70	60	50
July	97	97	72
August	97	106	76
September	76	76	52
October	33	32	20
November	50	76	43
December	82	120	94

Around 32 and 31% of the annual crop has been harvested during the first and third quarters respectively (Table 3).

Tappers productivity

The average intake per tappers for the last 05 years division wise and for the entire group is 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				
	1997	1998	1999	2000	2001
Dartonfield	6.9	7.4	8.5	6.8	7.2
Gallewatte	7.0	7.9	7.5	7.2	8.0
Nivitigalakelle	4.9	6.5	5.6	5.0	4.6
Group average	6.3	7.3	7.7	6.9	6.7

Table 5. *Vacant blocks recorded in Dartonfield group*

Division	No. of vacant blocks	Percentage
Dartonfield	662	16%
Gallewatte	3130	19%
Nivitigalakele	923	22%
Total	4715	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 05. Percentage of village tappers amounts to 65% and during paddy cultivation and harvesting seasons their out-turn drops drastically.

Tapping cost

Table 6. *A breakdown in total tapping cost for 3 years*

	Cost (Rs.)		
	1999	2000	2001
Tapping	15.67	17.21	16.62
Double Tapping	.43	.47	.50
Kanganies	.01	-	.02
Over kilos	.81	.63	.88
Scrap pay	.14	.09	-
Incentive to Field staff	.02	.01	0.2
Curing Shed Labourer	-	.02	.03
Total	17.08	18.43	18.07

Rainfall

Total rainfall recorded at Dartonfield, Gallewatte and Nivitigalakele amounted to 3478.0 m., 5510.2 m and 3445.3 mm on 215, 159 and 192 days respectively.

Table 7. *Annual rainfall and the number of wet days for the last 5 years*

	Year				
	1996	1997	1998	1999	2000
Rainfall (mm)	4501.2	5790.1	4903.9	3586.2	4144.5
Wet days	164	184	194	176	199

Tapping days

Table 8. *The number of tapping days, average intake per tapper and yield per hectare for the last 04 years in Dartonfield group*

	Year			
	1998	1999	2000	2001
1. Tapping days				
1.1 Normal	199	186	208	204
1.2 Late	30	11	13	17
1.3 Double	12	25*	6*	03
1.4 No	135	168	144	144
2. Average intake tapper (kg.)	7.3	7.7	6.9	6.6
3. YPH (kg.)	979	728	820	838

* Dartonfield division only.

Manufacture

The latex grade I percentage was remained same as for the previous year.

Table 9. *The details of the crop manufactured during the year 2001*

Grade	Quantity	Grade %	Latex %	Scrap
Crepe No.1	126708	80%	87%	-
Crepe No.3	18409	12	13%	-
Scrap Crepe No.1	9685	06	-	72
Scrap Crepe No.2	3325	02	-	25
Scrap Crepe No.3	369	-	-	03
Smoke Sheets	-	-	-	-

Cost of production and profitability

Though the cost of production was declined by -/30 cts per kg., when compared with the previous year, a loss of -/71 cts. per kg. has been incurred due to low rubber prices prevailed in the market during the year (Table 10).

Table 10. *Labour rate (Rs.) and a break-down of the cost of production (Rs./kg.)*

	1997	1998	1999	2000	2001
1. Labour	83.00	95.00	95.00	98.00	98.00
2. COP	39.74	43.25	45.22	49.20	48.90
2.1 Tapping	17.93	17.24	17.08	18.43	18.07
2.2 Manufacture	5.38	8.75	7.98	8.79	9.35
2.3 General Charges	12.75	11.21	12.01	13.21	13.20
2.4 Upkeep	5.28	6.05	8.15	8.77	8.28
3. N.S.A.	72.68	53.45	44.81	58.44	48.19
4. Profit	32.94	10.20	(0.41)	9.24	(0.71)

NB: Labour Rate per day for the year was Rs.98/- + an additional incentive of either Rs.8/- or Rs.14/- per day depending on the attendance.

Table 11. *Comparative statement of the mature extent profit per kg. and profit per hectare*

	Year			
	1998	1999	2000	2001
Mature extent	163.90	190.26	185.69	189.17
Total profit (Rs. Million)	1.61	(0.06)	1.40	(0.11)
Profit/Ha. Rs.	9840.00	(298.62)	7580.79	594.87

KURUWITA SUB STATION

S A R Samarasekera

SUMMARY

A crop of 44,499 kg was harvested during the year which is an increase of 17.1% over the estimated crop for the same period.

The actual yield per hectare (YPH) and the average intake per tapper were 1015 and 8.6 kg respectively. The highest intake per tapper recorded during the year was 22 kg in December. This was achieved from clone RRIC 121 from a task size of 250.

The average number of normal, late, double and no tapping days were 193, 32, 19 and 140 respectively.

The annual rainfall was 3324.2 mm with 134 wet days as against 3068.4 mm with 165 wet days during the last year.

The cost of production and the net sale average for the year were Rs.34.02 and Rs.46.68 per kg respectively. The profit per kg was Rs.12.66 and profit made for the year was Rs.563,357.34. The total profit inclusive of sundry income was Rs.1,685,599.09.

Uprooting of around 7.75 ha. of old rubber trees in the Kuruwita Sub Station is in progress and an income of about Rs.1,105386.25 was generated from the sale of trees to the end of the year.

DETAILED REVIEW

Staff

Mr Anusha S Perera was the Visiting Superintendent of the Kuruwita Sub Station. Mr S A R Samarasekera, Assistant Estate Superintendent and Mr D S Jayasinghe, Clerk was on duty throughout the year. Mr A K D I Rukmal, Assistant Field Officer, resigned with effect from 15th November. Mr V G D N Gunaseela was promoted as Junior Assistant Field Officer with effect from 25th January.

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 in Kuruwita substation*

Land distribution	Extent (Ha)
Mature area	43.83
Immature area	33.38
Nurseries	.84
Tea revenue area	1.75
Paddy area	1.00
Building, Garden & Roads	16.79
Water tank	.01
Unsuitable for planting	2.00
	99.60

Crop

The yield per hectare (YPH) for the last 5 years is given in Table 2. The average yield per hectare of the estate has increased by 0.3% from that of the previous year. Also it was higher than the estimate of the year.

Table 2. *Yield per hectare (kg) recorded from 1997 to 2001*

	Year				
	1997	1998	1999	2000	2001
Estimate	624.0	544.5	740.7	855.0	867.2
Y.P.H.	555.3	546.7	799.6	1012.2	1015.0

A monthly breakdown of the actual YPH (kg) in the estate is given in Table 3.

Table 3. *The YPH (kg) recorded for each month during the year*

Month	YPH
January	113.2
February	60.5
March	95.6
April	47.5
May	57.6
June	51.5
July	62.8
August	62.8
September	39.8
October	76.0
November	98.7
December	112.1

A total crop of 44,499 kg. were harvested from an extent of 43.83 hectares, during the year. This is 6,499 kg. above the estimated crop for the year.

The average intake per tapper during the year was 8.6 kg. The intake per tapper was similar to that of last year.

Tapping cost

The tapping cost of the estate has increased by 1.3% over the last year due to the incentive payment to the workers.

Table 4. *A break-down of total tapping cost for the last 2 years*

Cost item	Cost/kg (Rs.) and Year	
	2000	2001
Tapping	14.85	15.41
Double tapping	.61	.35
Over kilos pay	.46	.46
Overtime on tapping	.15	.16
Extra pay to kangany	.01	.01
Tapping KG.	.08	-
Scrap pay	.20	.18
Total	16.36	16.57

Rainfall

The total rainfall during the year is higher than the previous year (Table 5).

Table 5. *Annual rainfall and the number of wet days for the last 2 years*

	Year	
	2000	2001
Annual Rainfall (m.m.)	3068.4	3324.2
Wet days	134	165

Tapping days

When compared with the last year there is a decrease in both normal and late tapping days.

Table 6. *The number of tapping days' average intake per tapper and yield per hectare for the last 03 years*

		Year		
		1999	2000	2001
1	Tapping days			
1.1	Normal	182	196	193
1.2	Late	28	44	32
1.3	Double	(17)	(45)	(19)
1.4	No	155	126	140
2	Average intake per tapper (kg)	9.2	8.6	8.6
3	YPH(kg)	799.6	1012.2	1015

Cost of production and profitability

The cost of production has decreased by Rs.2.47 per kg. A profit of Rs.563,357.34 was made during the year.

Table 7. *Labour rate (Rs.) and a break down of the cost of production (Rs./kg)*

		1998	1999	2000	2001
1	Labour	95.00	95.00	98.00	98.00
2	Total COP	39.03	31.11	36.49	34.02
2.1	Tapping	18.18	14.63	16.36	16.57
2.2	Transport	1.40	.70	1.82	1.86
2.3	General charges	18.22	13.12	14.39	12.01
2.4	Upkeep	1.23	2.66	3.92	3.58
3	NSA	37.03	36.96	49.75	46.68
4	Profit	(2.00)	5.85	13.26	12.66

Table 8. *Comparative statement of the mature extent, profit per kg. and profit per hectare*

	Year			
	1998	1999	2000	2001
Mature extent (ha)	44.00	40.50	43.25	43.83
Total profit (Loss) Rs.	(55238.00)	199502.55	580509.54	563357.34
Profit (Loss)/ha(Rs.)	(1255.40)	4925.99	13422.18	12853.24

During the year a profit of Rs.12.66 on a kilo and a profit of Rs.563,357.34 from the entire revenue extent were recorded.

Tea

A crop of 27,441 kg. was harvested during the year which is an increase of 9.7% over the estimated crop for the same period.

The cost of production and the net sale average for the year were Rs.19.85 and Rs.21.52 per kg. respectively. The profit per kg. was Rs.1.67 and the profit made for the year was Rs.45821.38.

Fertilizer

Fertilizer applications for mature and immature fields were carried out as scheduled.

Replanting

The replanting programme for the year was as follows :

1. Rubber × Perennial crops experiment - 6.00 ha.
2. Rubber × Medicinal plants - 1.00 ha.
3. Rubber only - 2.32 ha. H.P. Clones trial.

Meteorological Summary – 2001
Dartonfield Station

Wasana Wijesuriya

A total of 3478 mm of rain experienced during the year, compared to the pervious year and long-term average of 3740mm and 4160mm respectively. The distribution showed considerable deviation from the usual bimodal pattern as shown in Fig.1. The highest rainfall, which is 633.8mm was during April. This is a difference of nearly 184.8mm from the long-term average of this month.

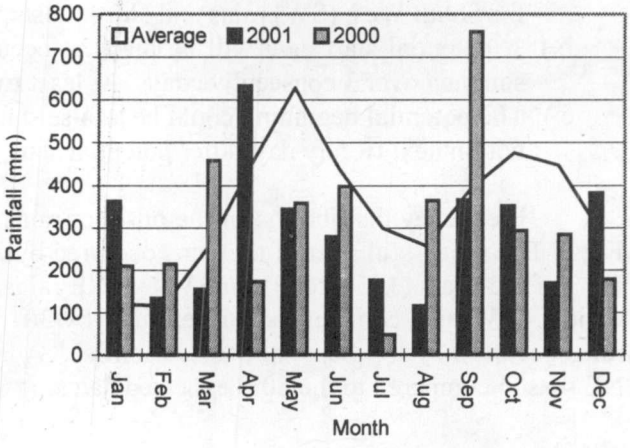


Fig.1. Monthly variation in rainfall

Fairly dry weather was observed during February to March and July to August of the year. Below average rainfall values were observed during March to November except during April when compared to long term averages of these months.

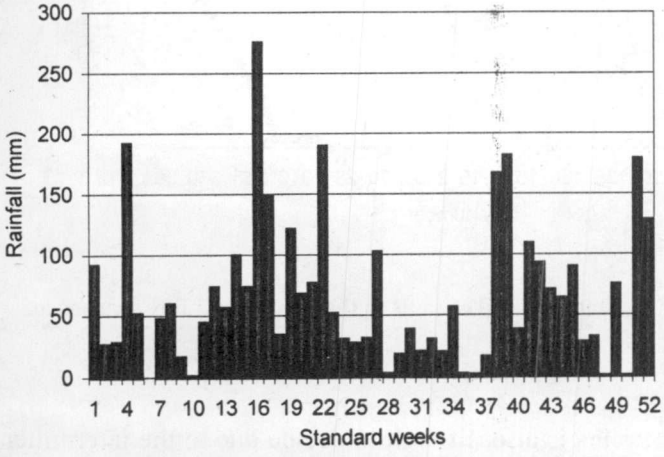


Fig. 2. Weekly variation in rainfall

The lowest rainfall (115mm) 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 16th standard week (late April) coincided with the South West monsoon.

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 30th March whereas the onset of NE rains occurred by 19th September at Dartonfield. A late onset of rains was observed in NE season compared to the 80% expected dates.

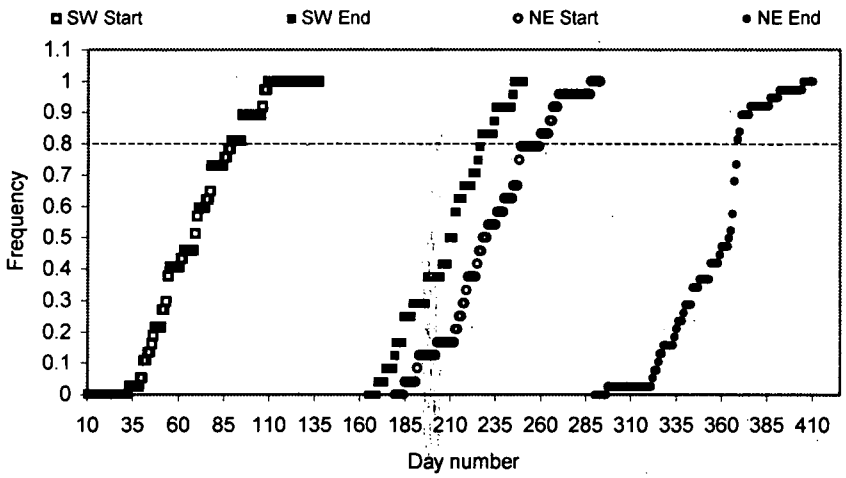


Fig.3. Cumulative probability of the start and end of rains in the two major rainy seasons at Dartonfield

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 exceed 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 11th July whereas NE rains ceased by 24th November, 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 are high during the recent years. However, further research and analyses are needed to come into a conclusion.

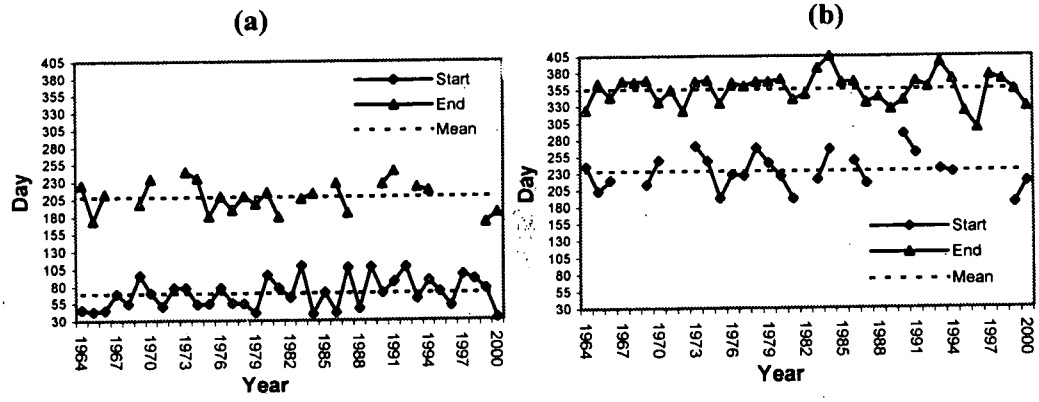


Fig.4. The start and the end of the SW rains (a) and NE rains (b) over 37 years

During the past 37 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 2001 the respective lengths of SW and NE rains are 102 and 97 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 214 with 3 months exceeding 20 rainy days. In April, 4 days have exceeded 50mm of rain per day.

Intensity of rainfall

High intensity showers are common in the SW monsoon. Anyhow, when compared to last year, fairly low intensity showers with long durations were evident during this year. The highest rainfall intensity recorded was 55mm/hr, but it lasted only for 10 minutes. For each month, the three highest intensities recorded, their duration, time of occurrence and the average intensity are presented in Table 2.

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 5 days in February and one day in December. The highest mean temperature of 33.7^0C was observed in March. The lowest value for sunshine hours was observed in January due to overcast conditions resulted by unexpected heavy rains compared to the previous year rainfall figures. The average morning RH was in the range of 80 to 85%. The soil temperatures at 3 different depths are given in Table 4.

Table 1. *Monthly variation of rainfall and rainy days in 2001*

Month	Total rainfall (mm)	Average** (mm)	No of rainy days *	Avg.** Days	No. of days under each category			Evaporation (mm)
					0.3-2.5 (mm)	2.6-50 (mm)	>50 (mm)	
January	363.2	(121)	17	(10)	04	11	02	1.6
February	134.1	(116)	09	(09)	02	07	00	2.5
March	156.3	(252)	07	(17)	02	04	01	3.1
April	633.8	(449)	26	(21)	02	20	04	2.4
May	345.0	(659)	21	(24)	04	16	01	2
June	280.4	(440)	19	(24)	02	15	02	2.2
July	177.1	(299)	20	(22)	08	12	00	2.1
August	115.9	(257)	20	(21)	10	10	00	2.2
September	366.4	(391)	17	(22)	05	10	02	1.8
October	352.7	(476)	27	(22)	07	20	00	1.9
November	170.2	(448)	17	(20)	03	14	00	1.9
December	382.9	(282)	14	(17)	03	08	03	2.1
Total	3478.0	(4160.0)	214	(229)	52	147	15	2.2

* A rainy day is defined as a day with a rainfall $\geq$ 0.3 mm

** Average values for 1980-1992 are shown in parentheses

Table 2. *Rainfall intensity recorded at Dartonfield Meteorological station - 2001*

Month	Date	Intensity (mm/hour)			
		3 highest records	Time interval	Duration (min)	Average
January	26	42.31	15.55 to 17.00	65	
	04	41.33	12.30 to 13.00	30	8.6
	25	16.62	17.30 to 00.30	420	
February	20	28.62	17.10 to 18.15	65	
	19	16.56	15.00 to 16.30	90	5.8
	01	10.91	16.30 to 18.20	110	
March	20	28.75	17.15 to 19.15	120	
	03	17.20	17.15 to 17.40	25	7.7
	18	14.35	19.30 to 22.20	170	
April	19	32.73	13.10 to 15.00	110	
	24	31.71	16.55 to 17.30	35	7.2
	01	29.11	18.35 to 19.20	45	
May	29	55.00	13.50 to 14.00	10	
	01	29.00	13.30 to 14.00	30	6.2
	22	23.78	04.00 to 04.45	45	
June	11	35.00	18.45 to 19.15	30	
	12	23.33	22.30 to 22.45	15	5.5
	29	20.00	10.45 to 11.05	20	
July	06	18.67	0.45 to 1.15	30	
	31	18.67	6.30 to 6.45	15	3.4
	26	14.67	20.15 to 22.45	30	
August	25	17.00	01.00 to 01.30	30	
	11	14.27	08.00 to 09.45	75	3.8
	21	8.00	04.30 to 04.50	20	
September	30	18.00	14.10 to 14.30	20	
	29	13.33	12.00 to 12.15	15	3.2
	25	10.67	04.15 to 04.45	30	
October	26	20.75	19.45 to 21.45	120	
	12	13.24	04.45 to 06.30	150	5.0
	14	12.44	07.45 to 08.30	45	
November	09	12.00	09.05 to 09.30	25	
	05	11.44	15.15 to 16.45	90	3.4
	07	11.33	01.00 to 01.30	30	
December	23	28.79	18.30 to 22.30	240	
	27	26.11	15.45 to 17.15	90	10.8
	31	24.22	15.45 to 18.00	135	

Table 3. *Variation of observed meteorological factors at Dartonfield – 2001*

	(Latitude 6° 32; Longitude 80.09 E Altitude 65.50mm					Relative Humidity (%)			
	Temperature (°C)								
	Mean Max	Mean Min	Mean	No of days Min Temp<20	Sun shine hours	8.30 am	No of days 8.30>90%	3.30 am	Wind speed Mean (KmPh-1)
January	31.5	22.1	26.8	-	4.4	85 (87)	3	74 (67)	1.6
February	33.3	21.1	27.2	5	7.4	84 (85)	-	72 (64)	2.1
March	33.7	22.7	28.2	-	7.4	81 (84)	-	77 (66)	2
April	33.3	22.9	28.1	-	4.8	82 (84)	1	78 (66)	1.7
May	31.9	24.0	27.9	-	5.1	85 (87)	3	72 (73)	2.1
June	31.1	23.7	27.4	-	6.2	82 (88)	1	75 (77)	2.7
July	30.7	23.5	27.1	-	4.5	84 (88)	1	72 (76)	2.7
August	30.9	23.2	27.0	-	5.4	80 (87)	-	71 (74)	2.8
September	32.0	22.8	27.4	-	5.6	81 (86)	1	75 (74)	2.6
October	31.2	23.3	27.2	-	5.2	82 (85)	-	78 (77)	2.4
November	32.1	22.6	27.3	-	5.7	79 (84)	-	81 (77)	1.4
December	33.1	21.8	27.4	1	5.5	79 (84)	-	81 (74)	1.5

**Average values for 1980-1992 are shown in parentheses.

Table 4. *Soil temperatures recorded at different depths at Dartonfield - 2001*

Month	09.00				16.00 hrs			
	6 cm	10 cm	20 cm	30 cm	6 cm	10 cm	20 cm	30 cm
January	26.3	26.1	-	27.5	32.1	31.2	-	27.8
February	26.7	26.4	-	28.0	36.4	34.5	-	28.5
March	28.4	27.9	-	29.2	37.8	36.0	-	29.6
April	28.6	27.4	-	28.7	33.5	32.8	-	29.1
May	28.6	27.9	-	29.0	34.5	33.0	-	29.5
June	28.1	27.6	-	28.5	34.6	33.1	-	29.0
July	27.6	27.2	-	28.3	33.5	32.3	-	28.7
August	27.7	27.2	27.4	28.3	34.6	32.7	30.0	28.8
September	28.6	28.0	28.3	29.3	36.1	34.5	31.5	29.8
October	31.4	27.5	27.6	28.5	33.3	32.2	30.0	29.0
November	28.2	27.3	27.5	28.4	33.0	32.1	30.0	28.9
December	27.8	26.9	27.6	28.2	33.9	32.6	30.1	28.9

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