ISSN 1391-0043

RUBBER RESEARCH INSTITUTE OF SRI LANKA

Annual Review 2006

RUBBER RESEARCH INSTITUTE OF SRI LANKA - ANNUAL REVIEW 2006

Cover story:

Latex - Timber clones: To meet the challenge of wood scarcity

Photograph by

Dr R.S. Dharmakeerthi

Rubber Research Institute of Sri Lanka

Annual Review – 2006

1st January 2006 to 31st December 2006

Editors
R C W M R A Nugawela, PhD (Essex)
W M G Seneviratne, PhD (Sussex)
C K Jayasinghe, PhD (Sri Lanka)

Head Office & Laboratories
Dartonfield
Agalawatta

Board Office & Laboratories
Telewela Road
Ratmalana

CONTENTS

RUBBER RESEARCH BOARD OF SRI LANKA

BOARD OF MANAGEMENT

Members appointed by the Hon Minister of Plantation Industries

Mr J Y Peries, Chairman, Rubber Research Board
Mr A B Leelasena, Director/Planning, Ministry of Plantation Industries (w.e.f. 03.01.2006)
Mr T M J Bandara, Asst. Director, National Planning, GT (w.e.f 06.01.2006)
Mr S N Guneratne, CEO, Agalawatte Plantations Ltd. (w.e.f.10.01.2006)
Mr R C Peiris, Executive Director, Kotagala Plantations Ltd. (w.e.f.10.01.2006)
Mr J B L de Silva, Chairman, Colombo Rubber Traders Association (w.e.f. 12.01.2006)
Mr Justin Seneviratne, Director, Lalan Rubbers (Pvt.) Ltd. (w.e.f. 26.01.2006)
Prof H P M Gunasena Executive Director, CARP (w.e.f. 09.2006)
Mr K C Fernando, Hony President, SLF Union, RRI (w.e.f. 07.07.2006)
Ms K Kapuge, Hony. Secretary, CFT Union, RRI (w.e.f. 07.07.2006)

Ex-Officio Members

Dr L M K Tillekeratne, Director, Rubber Research Institute (up to 01.09.2006)
Dr A Nugawela, Director, Rubber Research Institute (w.e.f. 03.11.2006)
Mr W Rubasinghe, Director General, RDD (w.e.f. 06.01.2006)
Mr Kavi Senevirtne, Chairman, Planter's Association of Ceylon (w.e.f. 03.01.2006)

STANDING COMMITTEES

Estates Committee

Mr J Y Peries, Chairman, Rubber Research Board
Dr L M K Tillekeratne, Director, RRI (up to 01.09.2006)
Dr A Nugawela, Deputy Director Research and as Director from 6th September 2006
Mr S N Gunartne, Chief Executive Officer, Agalawatta Plantation Ltd
Mr R C Peries, Director- Rubber, Kotagala Plantations Ltd
Mr Nissanka Seneviratne, Manager, Pallegoda Estate, Dharga Town
Mr Salinga Dissanayake, Manager, Doloswela Estate, Nivitigala
Mr Anusha Perera, Manager, Elston Estate, Puwakpitiya & Visiting Agent for Dartonfield Estate & Visiting Superintendent for Kuruwita Sub-station
Mr Jehan Perera, Estate Superintendent, Dartonfield Estate
Mr W Kularatne, Accountant, RRI (In attendance)
Mr Rohitha Samarasekera, Asst. Estate Superintendent, Kuruwita Sub-station (In attendance)

Audit and Management Committee

Mr A B Leelasena, Director/Planning, MPI (w.e.f. 03.01.2006)
Mr T M J Bandara, Asst. Director, National Planning, GT (w.e.f. 06.01.2006)
Mr W Rubasinghe, Director General, RDD (w.e.f. 06.01.2006)
Dr L M K Tillekeratne, Director, Rubber Research Institute (up to 01.09.2006)
Dr A Nugawela, Director, Rubber Research Institute (w.e.f. 06.09.2006)

Scientific Committee

Mr J Y Peries, Chairman, RRB
Dr L M K Tillekeratne, Director, RRI (up to 01.09.2006)
Dr A Nugawela, Director, RRI (w.e.f.06.09.2006)
Dr W M G Seneviratne, Deputy Director Research (Technology), RRI
Dr A Nugawela, Deputy Director Research (Biology) RRI (up to 05.09.2006)
Dr C K Jayasinghe, Head, Plant Pathology and Microbiology, RRI
Dr (Mrs) L Samarappuli, Head, Soils and Plant Nutrition Dept., RRI (upto 01.08.2006)
Dr (Mrs) P Seneviratne, Head, Plant Science Dept., RRI
Dr Anura Dissanayake, Head Advisory Services Dept., RRI
Dr (Miss) W P K Silva, Plant Pathologist, RRI
Dr V H L Rodrigo, Head Biochemistry Dept., RRI
Dr R S Dharmakeerthi, Acting Head Soils & Plant Nutrition Dept., RRI (w.e.f. 14.08.2006)
Dr K E Jayasuriya, Plant Pathologist, RRI
Dr (Mrs) Wasana Wijesuriya, Biometrician, RRI
Dr Susantha Siriwardena, Head, Raw Rubber Process Development and Chemical Engineering Dept., RRI
Dr S M M Iqbal, Agronomist, RRI
Mrs M M Jayasuriya, Rubber Chemist, RRI
Mrs D G Edirisinghe, Acting Head, Rubber Technology and Development Dept., RRI
Mrs S P Withanage, Geneticist and Plant Breeder, RRI
Mrs A H L R Nilmini, Assistant Rubber Chemist, RRI
Mrs G V L Nilmini, Assistant Biochemist, RRI
Mr J Perera, Superintendent, Dartonfield Group, RRI
Dr N Yogaratnam, Consultant, NIPM, Athurugiriya
Mr R C Peries, Director (Plantations), Kotagala Plantations Ltd., Horana
Mr R V K S de Livera, Manager, Kotagala Plantations Ltd., Padukka Estate, Padukka
Mr N M Amarasekera, Director/General Manager Up Country, Kelanivalley Plantations Ltd., 243/1, Main Street, Dickoya
Mr D G Wickramasinghe, Director/General Manager Low Country, Kelanivalley Plantations Ltd., Kiriporuwa Group, Yatiyantota
Mr A P Amarasinghe, Group Manager, Devalakanda Estate, Dehiowita

Mr C S Amaratunga, Estate Manager, Edurapola Estate, Bulathkohupitiya

Mr Abeynande Dias, Director – Operations, Namunukula Plantations Ltd., 310, High Level Road, Nawinna, Maharagama

Mr N B Seneviratne, Superintendent, Pallegoda Estate, Dharga Town

Mr S B Dissanayake, Group General Manager, Mahaoya Group, Dehiowita

Mr Gamini Jayasooriya, Director – Rubber, Lalan Rubber (Pvt.) Ltd., 198 B, Ganendra Mawatha, Nawala

Mr Sriyan Wijesekera, Coordinating Manager, Pussellawa Plantations Ltd., No.228, Havelock Road, Colombo 5

Mr S S Poholiyadda, General Manager, Kegalle Plantations Ltd., 310, High Level Road, Navinna, Maharagama

Mr A C Bertus, Superintendent, Atale Estate, Atale

Mr Dan Seevaratnam, Deputy Chairman, Kahawatta Plantations Ltd., 52, Maligawatta Road, Colombo 10

Mr Viren Ruberu, Group Director, Group Director's Office, Kahawatta Plantations Ltd., Rilhena Estate, Pelmadulla

Mr D P A Perera, Deputy General Manager, Balangoda Plantation Ltd., P.O. Box 8, Palm Garden, Ratnapura

Mr S S R Kombalawithana, Superintendent, Rambukkanda Estate, Ratnapura

Mr Carlyle Lascelles Perera, Director-Rubber, Malwatta Valley Plantation Ltd., 280, Dam Street, Colombo 12

Mr U H Bulugahapitiya, Superintendent, Vincit Estate, Waharaka

Mr Rohan Boudewyn, Deputy General Manager - Plantations, Watawala Plantations Ltd., No.60, Dharmapala Mawatha, Colombo 3

Mr Shirly Abeysekera, General Manager - Plantations, Elpitiya Plantations Ltd., 52, Maligawatta Road, Colombo 10

Mr S A Eriyagama, GM-Plantations (Rubber), Agalawatta Plantations Ltd., No.10, Gnanartha Pradeepa Mawatha, Colombo 8

Mr R S Perera, Manager, Culloden Estate, Neboda

Mr Chula Amaratunga, Manager, We-oya Estate, Yatiyantota

Mr G Wijekoon, Superintendent, Bibile Estate, Bibile

Mr Naresh Ratwatta, General Manager, Hapugastenna Plantations Ltd., P.O. Box 8, Palmgarden, Ratnapura

Secretary, Ministry of Plantation Industries, 55/75, Vauxhall Lane, Colombo 2

Director General, Rubber Development Dept. P.O. Box 184, Colombo

Mr M R C Peries, 16/2, Charlimont Rd., Colombo 6

Mr S D A Jayasooriya, Deputy General Manager, JEDB, 55/75, Vauxhall Lane, Colombo 2

Mr Palitha de Silva, JEDB, Hantane, Kandy

Mr Anusha Perera, Superintendent, Elston Estate, Puwakpitiya

Mr G B S de Silva, Horana Plantations Ltd., 8, Chittampalam A Gardiner Mawatha, Colombo 2

Mr A M A S Dhanasekera, Group Manager, Sirinivasa Estate, Waga
Mr Gunendra Sellahewa, Supplies Manager, Dipped Products, 400, Deans Road, Colombo 10
Mr Asoka Jayawickrema, The Colombo Brokers' Association, P.O. Box 101, 201, De Seram Place, Colombo 10
Dr M R N Fernando, Loadstar Ltd., 3/1. Police Park Terrace, Colombo 4
Mr Salinga Dissanayake, Manager, Doloswela Estate, Nivitigala
Mr Vas Gunawardena, Superintendent, Opatha Estate, Kahawatta
Mr D B S L Perera, Superintendent, Kumarawatta/Moneragala Estate, Moneragala
Mr M R Fernando, Superintendent, Malaboda Estate, Matugama
Mr A H Kularatne, RAO, Advisory Services Dept., Telewala Road, Ratmalana
Mr D D Dassanayake, RAO, Advisory Services Dept., Nivitigalakele Substation, Niyitigalakele
Mr U Prematilaka, Group Manager, Panawatta Estate, Yatiyantota

Provident Fund Committee

Dr L M K Tillekeratne, Chairman, Provident Fund Committee (up to 01.09.2006)
Dr A Nugawela, Director, Rubber Research Institute (w.e.f. 06.09.2006)
Mrs L J C Perera, Secretary, Provident Fund Committee
Mr W D Wimaladasa, Elected Committee Member
Mr H H Jayasinghe, Elected Committee Member
Mr W B Herath, Senior Accountant (In attendance) (up to 01.03.2006)
Mr W Kularatne Accountant, RRI (In-attendance) (w.e.f. 02.03.2006)

Chairman's Office & Board Secretariat

Chairman	- Mr J Y Peiris
Secretary to the Board	- Mrs L J C Perera
Confidential Clerk/Stenographer	- Mrs P Balasooriya

Lawyers

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

Auditors

Auditor General
Auditor General's Department
Independence Square
Colombo 7

Bankers
Bank of Ceylon
Corporate Branch
75, Janadhipathi Mawatha
Colombo 1

Bank of Ceylon
Agalawatta

Head Office and Laboratories
Dartonfield, Agalawatta

Telephones:	
Director	034 - 2248457
Deputy Director Research (Biology)	034 - 2248458
General	034 - 2247426
	034 - 2247383
	060 - 2349999
	034 - 2248459
Fax:	034 - 2247427
E-mail	dirrri@sltnet.lk

Rubber Research Institute - Substation
Nivitigalakele, Matugama

Genetics and Plant Breeding Department
Telephone: 034 - 2247368

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

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

Telephones:	
Chairman	011 - 2635019
Director	011 - 2635142
Deputy Director Research (Technology)	011 - 2633351
General	011 - 2635851
	011 - 2635852
Fax:	011 - 2605171

RUBBER RESEARCH INSTITUTE OF SRI LANKA

STAFF

DIRECTORATE

Director	L M K Tillekeratne, BSc (Cey.), MSc (Aston), PhD (Aston), FI Chem C, FPRI, FNASSL (up to 01.09.2006)
Director	R C W M R A Nugawela, BSc (SL), MSc (Lond.), PhD (Essex) (w.e.f. 06.09.2006)
Deputy Director - Research (Biology)	R C W M R A Nugawela, BSc (SL), MSc (Lond.), PhD (Essex) (up to 05.09.2006)
Deputy Director – Research (Technology)	W M G Senevirante, BSc (SL), PhD (Sussex)
Deputy Director (Administration)	Miss W K V de Silva BA (SL), LLB, Attorney at Law (w.e.f. August 2006)

RESEARCH DEPARTMENTS

Genetics and Plant Breeding

Geneticist and Plant Breeder	Mrs S P Withanage, BSc Agric (SL), MSc (India)
Assistant Geneticist and Plant Breeder	K K Liyanage, BSc Agric (SL)
Development Officer	K B A Karunasekera
Experimental Officers	K W Rupatunga
	I D M J Sarath Kumara
	L S Kariyawasam
Technical Officers	T M S K Gunasekera
	H P Peiris, Dip. Agric (Kundasale)
	Mrs A K Gamage, BSc (SL)
Clerk/Typist	Mrs S D P K L Peiris

Plant Science

Head of Department	Mrs G P W P P Seneviratne, BSc (SL), PhD (Bath)
Botanists	L S S Pathiratne, M I Biol, MSc (Reading), MPhil (SL) (up to 10.12.2006)
	A M W K Senevirathna, BSc (SL), MSc (SL), PhD (Wales)

Assistant Botanists	*N A A D Wickramaratna, BSc Agric (SL)
	*N M C Nayanakantha, BSc (SL)
Experimental Officers	K A G B Amaratunga
	R P Karunasena
	Mrs G A S Wijesekera
	S Wilbert (up to 07.09.2006)
	Mrs R K Samarasekera
	U S Weerakoon
	T U K Silva, BSc Agric (SL)
	M K P Perera, BSc (SL)
	**W D M N de Alwis, BSc (SL)
Technical Officers	D L N de Zoysa
	P D Pathirana, BSc (SL)
	P K W Karunathilake, Dip. Agric (Ratnapura)
Development Assistant	J Chaminda, BSc Agric (SL)
Clerk	Mrs H D D E Jayawardena
	Mrs Aruni de Almeida

Plant Pathology and Microbiology

Head of Department	C K Jayasinghe, BSc (SL), MSc (SL), MSc (Agric) (Aust.), PhD (SL)
Plant Pathologists (Principal Research Officers)	K E Jayasuriya, MSc Agronomy (USSR), MPhil (Edinburgh), C Biol (SL) PhD (SL)
	Miss W P K Silva, BSc (SL), MSc (SL), MPhil (Aust.), PhD (SL)
Assistant Plant Pathologist	Mrs T H P S Fernando, BSc (SL), MPhil (SL)
Experimental Officers	E B Fernando
	Mrs B I Tennakoon, Dip. Agric (Kundasale)
	Mrs E A D D Siriwardene, BSc (SL)
Technical Officers	S C P Wijayaratne, NDT Agric (Hardy)
	Mrs N Jayawardene, Dip. Agric. (Bibile)
	S R D P C Peiris, BSc (SL)
	E A D N Nishantha, Dip. Agric. (Ratnapura)
Development Assistant	Mrs K M M E K Kulatunga, BSc (SL)
Clerk	Mrs W S P Amarasekera

Audio Visual Aids and Photographic Unit

Audio Visual Aids Production Officer	L W Amaratunge

Soils and Plant Nutrition

Head of Department	**Mrs M L A Samarappuli, BSc Agric (SL), MSc (California), PhD (SL)
Soils Chemist (Principal Research Officer)	R S Dharmakeerthi, BSc Agric (SL), MSc (SL), PhD (Canada)
Assistant Soils Chemists	*D N P Wickremasinghe, BSc (SL)
	Mrs R P Hettiarachchi, BSc (SL), MPhil (SL)
Experimental Officers	H D S P Perera, BSc (SL), MSc (SL)
	Mrs S D C K Maheepala
	S N Silva
	P Karunadasa, BSc (SL), MSc (SL), M I Biol. (SL)
	A H U Mitrasena
	A N Yakandawala
	T B Dissanayake
	Miss V U Edirimanne, BSc (SL)
	Miss A P Thewarapperuma
Technical Officers	P A C R Puhambugoda, NDT Agric (Hardy)
	J A Sarath Chandrasiri
	P D T C Gunatilleke
English Stenographer	Mrs K A D L Rupasinghe Perera

Biochemistry and Physiology

Head of Department	V H L Rodrigo, BSc Agric (SL), MSc (Essex), PhD (Wales)
Assistant Biochemists	* Mrs G V L Nilmini, BSc (SL)
	Mrs K V V S Kudaligama Wijesundera, BSc (SL), MPhil (SL)
Experimental Officers	D Ramawickrema
	P D J Rodrigo

Polymer Chemistry

Assistant Rubber Chemists	* Mrs A H L R Nilmini, BSc (SL)
	Mrs C J Wellappili, BSc (SL), MSc (SL), PhD (Cardiff)
Experimental Officers	H N K K Chandralal, BSc (SL), MSc (SL)
	Mrs D I R Denawaka, Dip. Rubber Tech. (PRI)
	Mrs W C M Kuruppu, Dip. Rubber Tech. (PRI), Certificate Rubber Tech. (Moratuwa)
	S S Warnapura

Experimental Officers	S L G Ranjith, Dip. Rubber Tech. (PRI)
	S M A Samarakoon, Dip. Agric. (Kundasale)
	Miss D M S Wijesekera, Dip. Rubber Tech. (PRI)
Clerk/Typist	Mrs R S Wijeratne

Raw Rubber and Chemical Analysis

Assistant Rubber Chemist	Miss A P Attanayake, BSc (SL)
Experimental Officers	Mrs L Wanigatunga
	Mrs H V K Gamage
	Mrs C S Lokuge
	L P P Vitharana
	K R N Karunatilleke, Dip. Rubber Tech. (PRI)
	B Gunasiri
	W D Wimaladasa
Research and Development Assistant	Miss G M Priyanthi Perera, BSc (SL), MSc (SL)
Clerk	Mrs I Wijesinghe

Electronic Instruments Repair Unit

Instrument Technician	L G P Lelwela

Rubber Technology and Development

Acting Head of Department	Mrs D G Edirisinghe, BSc (SL), MSc (SL), MPhil (UK)
Rubber Chemist	* Mrs M M Jayasuriya, BSc (SL), MSc (SL)
Assistant Rubber Chemist	Miss G D D Galpaya, BSc (SL)
Experimental Officers	Mrs H S Weeraman, Certificate, Rubber Tech. (Moratuwa)
	Mrs M K Mahanama, Dip. Rubber Tech. (PRI)
	Mrs S I Yapa, Dip. Rubber Tech. (PRI)
	Mrs P C Wettasinghe
	P L Perera
Technical Officer	T A A I Siriwardene

Raw Rubber Process Development and Chemical Engineering

Acting Head of Department	S Siriwardene, BSc (SL), MSc (Australia), PhD (Malaysia)
Assistant Rubber Chemist	P H Sarath Kumara, DPRI, MSc (SL)
Research Assistant	*R M U N Ratnayake, BSc (SL)
Experimental Officers	Mrs W K C Nalinie, Dip. Rubber Tech. (PRI)
	T A S Siriwardene

Experimental Officers	E C D Senanayake
	Mrs U M S Priyanka, BSc (SL), MSc (SL)
Technical Officers	Miss V C Rohanadeepa
	A K D W Prasad
Store Keeper	Mrs L Rukmanie
Clerk	Mrs S A Paranavithana

Biometry Section

Biometrician	Mrs B W Wijesuriya, BSc Agric (SL), MPhil (SL), PhD (SL)
Assistant Biometrician	H M L K Herath, BSc Agric (SL)
Experimental Officer	Mrs H K D C S Munasinghe, NCT Polymer (Moratuwa), Dip. Rubber Tech. (PRI), Dip. Computer Science (IDM)
Technical Officer	O V Abeyawardene, Dip. Agric. (Kundasale)

Adaptive Research Unit

Agronomist	S M M Iqbal, BSc Agric. (SL), MPhil (SL), PhD (Essex)
Research Assistants (Adaptive Research)	W A D D S Wettasinghe
	Mrs E S Munasinghe, BSc Agric (SL)
	Mrs B M D C Balasooriya, BSc Agric (SL)

Polgahawela Sub-Station

Experimental Officer	E A T Senadeera
Development Assistant	R Handapangoda, BSc Agric. (SL)

Library and Publications Unit

Librarian	S U Amarasinghe, BSc (SL), MA (SL), ASLLA
Library Assistant and Assistant Publications Officer	Mrs R M Amaratunga, Intermediate; Library Science, Documentation & Information (SL)
Clerk/Typist	P M P Jayantha

ADMINISTRATION DEPARTMENT

Assistant Medical Practitioner	M Subasinghe
Chief Clerk	Mrs M D P Mandalawatta
Clerks (Special Grade)	Mrs R S Amarasekera (up to 23.12.2006)
	Mrs W Paul
	R G D Sakaraja (up to 14.04.2006)

Clerk	Mrs P W Neelamanie
	Mrs K P R Gunasekera
Clerk/Typists	Mrs J A D Wijayanthi
	Miss B D Niranjala
English Stenographer	Mrs J A H S Kumarie
Apprentice Translator	Mrs D N Senevirathna, BSc (SL)
Telephone Operator	Mrs J A D C Preethika
Pharmacist	S Lankeshwara

Internal Audit Unit

Internal Auditor	Mrs M S I Senadheera, IFA, IPFA, IRCA
Internal Audit Officer	K C Fernando
Clerk/Typist	Mrs S N Munasinghe

Works Section

Resident Engineer	L L D W Jayatilleke, BSc (SL) (up to July 2006)
Electrical Foreman	W D Ratnasinghe
Building Foreman	M A D K Jayasumana
Transport Officer	U L D R L Gunasinghe
Chief Clerk	S A L Chandrawansa (up to February 2006)
Clerk	Miss M Gunawathie Silva
Clerk/Typists	Mrs J A S Dharshanie (Dip. in Management)
	Mrs K C S Wickremasinghe
Work Supervisor (Electrical)	T M R P Tennakoon

Accounts Section

Senior Accountant	W B Herath, ASCMA, MAAT (up to March 2006)
Accountant	W Kularatne
Accounting Assistant	D D R Lankatilaka, BCom (SL)
Accounts Clerks	Mrs C C Silva
	Mrs Irene Perera
	Mrs M Gunawardene
	Mrs K Kapuge
	Mrs W A C Weeramanthrie
	Mrs R Handungoda
	Miss G P Kukulewithana
Clerks	A V Nandasena
	Mrs K J M C R Fernando
Cashier Clerk	Mrs G A D D Jayawardena

Junior Clerks	Mrs C Dissanayake
	A K D A Wickremasinghe
Store-Keeper	D C P Pothmitiyage
Assistant Purchasing Officer	K D Sumanasena

DARTONFIELD GROUP

Estate Superintendent	Jehan Perera
Senior Clerk	K K P Gunawardena
Junior Clerks	Mrs S I K Pathirage
	Mrs O W D Namalie Udayanthi
Factory Officer	D S K Ranaweera
Assistant Factory Officer	W D D Senanayake
Field Officers	S K S de Silva (upto October 2006)
	T Somaratne
	H M J Premalal

Kuruwita Sub-Station

Visiting Superintendent	Anusha S Perera, Dip. in Personal Management (NIBM), AMIPM
Assistant Estate Superintendent	S A R Samarasekera
Junior Clerk	D S Jayasinghe

ADVISORY SERVICES DEPARTMENT

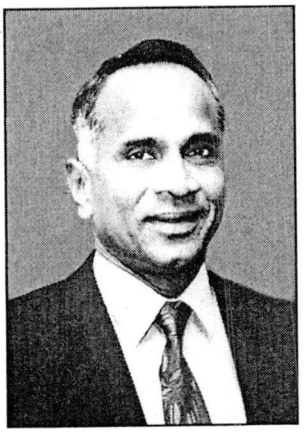
Head of Department	D M A P Dissanayake, BSc Agric (SL), PhD (Aberdeen)
Regional Advisory Officers	D D Dasanayake, BA (SL), MSc (UK), MSc (SL)
	A H Kularatne, BSc Agric (SL), MSc (Reading), MSc (Sri Lanka)
	R D D P Rajapaksha, BSc Agric (SL)
	P K K S Gunaratne, BSc Agric (SL)
	L P L Gunaratne, BSc Agric (SL)
Divisional Rubber Extension Officers	D Podimahathmaya
	G S Ratnayake (upto March 2006)
	R A D Ranawaka
	I Kiridena
	L L A Samarawickrama
	U L R A Perera
	R L R U S Bandara
	H H Jayasinghe

Rubber Extension Officers	D Weerasekera
	W D T C Muniratne
	K V Nandanakumara
	D R A M G Abeydissanayake
	R M S Ratnayake, NDT Agric (Hardy)
	D E P M Nanayakkara, Dip. Agric. (Aquinas)
	W D Chandrasiri
	M Dharmadasa, BSc (SL), MSc (SL)
	J A Jayaweera Perera
	E G U Dhanawardena
	Nihal Gamage, Dip. Agric. (Angunakolapelessa)
	U N Jayasuriya
	G D N Seneviratne
	K P Jayasinghe
	W C Siriwardena
	S G G Wijesinghe
	N G Yasaratne
	D M Mahindapala
	I P L Kithsiri
	W M A S L Wanigasuriya, Dip. Agric (Aquinas)
	S B S Silva
	M G N Gunaratne
	N L Dharmasena
Assistant Training Officer	P P S Perera
Clerk (Special Grade)	Mrs M A P P Seneviratne
Clerk	Miss M K Wijetilleke
	Mrs L Somawathi
	Miss Chitra Gunatilleke
	Mrs J N R Jayasinghe
	Mrs S K Hadunge
	Mrs S Nakandala
Clerk/Typist	Mrs S M Kaluarachchi

* On study leave overseas

** On no pay leave

RETIREMENT



Dr. L. M. K. Tillekeratne retired from the post of Director of the Rubber Research Institute on 01.09.2006 after serving the organization for 35 years. He served the institute as the Director for a period of 16 years, *i.e.* from 1990 to 2006 during his career at the Institute.

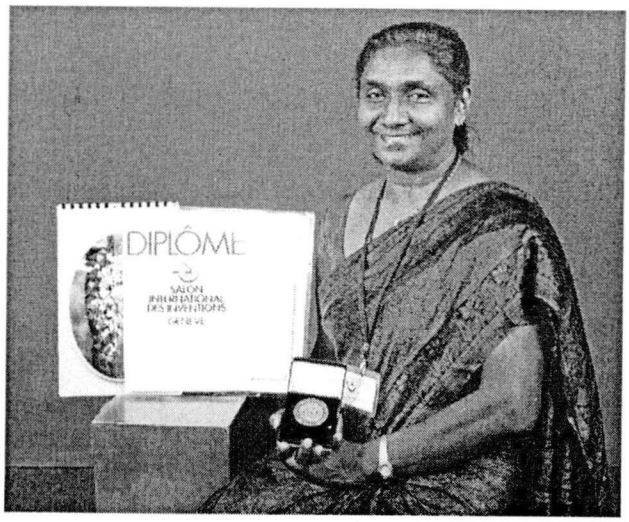
He obtained a degree in Chemistry from the University of Colombo and joined the Institute in 1971 as a Research Assistant of the Chemistry Department. He read for his PhD at the University of Aston in UK and rose to the position of the Head of the Specification and Analysis Department in 1989. Dr. Tillekeratne was appointed to the post of Director in 1990.

During his period in office as Director the institute was able to meet the challenges of the industry effectively and efficiently. His contribution to the industry especially the raw rubber and rubber products manufacturing sector is much recognized and appreciated by the industry. Development of a water soluble bleaching agent for the crepe rubber manufacture gave him both national and international recognition.

During his career at the Institute he won the Institute of Chemistry Gold Medal in 1985, Presidential Award for Invention in 1985, Silver Medal at International Inventors Exhibition in 1996 and GRC Award of the Sri Lanka Association for Advancement of Science in 1997.

He has published over 100 scientific papers, most of them on Rubber Chemistry and his research and development efforts on Rubber Chemistry has made him an internationally recognized expert in this field of natural rubber industry.

International Inventors Exhibition – 2006
Bronze Medal



Mrs M.K. Mahanama, Experimental Officer attached to the Rubber Technology and Development Department of the RRISL was awarded the Bronze Medal for her invention of natural rubber latex based flowers for floral décor, at the 34th International Inventors Exhibition held in Geneva, Switzerland in April, 2006.

RUBBER RESEARCH INSTITUTE OF SRI LANKA

DIRECTOR'S REVIEW

A Nugawela

The Rubber Research Institute of Sri Lanka continued its Research and Development programme successfully during the year. Some highlights of the said programme are briefly discussed below.

Commercial yields of RRISL 200 and 2000 series clones recently introduced to the recommended list continued to show vigorous growth and yields. Open pollinated seedling progenies of clones RRIC 100, PB 260, RRIC 121 also behaved similarly. In the annual hand pollination program 9567 pollinations were done.

With the objective of popularizing novel clones among growers more than 10,000 authentic plants of newly recommended clones were issued to establish budwood nurseries for both plantation and smallholder sectors. In order to improve the quality of planting material used by growers all RPC, Government and private commercial nurseries were inspected and around 2.5 million plants were certified as good for planting.

Pest problems were on the increase and the insecticide chloropyrophous was recommended to control them. Resistant Gene Analog (RGA) technique was developed to identify the resistance of rubber clones to *Corynespora* leaf fall disease.

Establishment of the cover crop a year prior to uprooting was found to be suitable to minimize soil erosion. Dolomite was effective as a Mg fertilizer from the first year of planting. High Grade Eppawala Rock Phosphate (HERP) was found to be a good source of P for young budding nurseries. Studies have also shown that frequency of fertilizer application could be brought down to once in four weeks by doubling the quantity per application which could address the issue of shortage of labor.

A ready reckonar was developed to overcome the temperature effect of latex/water mixture on the metrolac reading.

It is evident that buffing dust could be treated chemically and used in tyre tread compounds with no loss in technical properties. Preliminary studies indicate that heavy metals could be used to reduce allergic proteins in latex. Development of a suitable binder for saw dust and a TMTD free latex preservative system were identified.

Initial studies indicate that air dried sheets could be used in rubber tyre tread compounds with no adverse effect on performance. 362, 259, 443 and 162 samples of TSR, raw rubber, latex and chemicals were tested and more than 10 shipping and 500 testing reports were issued during the year.

A bronze medal was awarded at the International Inventors exhibition in Geneva for the innovation on NR latex based flowers.

Dipped product wastes could be used to produce multi-colored shoe soles having different surface designs. Five new products/compounds were developed and technology transferred to the industry. A highly effective room temperature curing system for cast/dipped products was developed. It is apparent that properties of natural rubber latex films could be improved by blending with polyvinyl acetate.

RRISL participated in many exhibitions held all over the country and won the first place at the Viskam Dakma exhibition held at Thakshila Viddyalaya, Horana.

Initial data on field establishment and early growth rates indicate that rubber could be successfully established in the intermediate zone of the Eastern Province.

About 60 training programmes were conducted covering more than 2800 smallholders in all aspects of rubber agronomy and raw rubber processing. Further, programmes were conducted to enlighten rubber growers on the Forest Stewardship Council (FSC) certification project.

The National Rubber Production in the country has to be increased to meet the increasing demand for this raw material. Therefore apart from the technology development programmes emphasis was given to technology transfer as well.

In order to further facilitate technology transfer activities the Polgahawela Sub-Station was opened during the year. Further, work on the Monaragala Sub-Station was commenced. Monaragala Sub-Station will be used to expand cultivation of rubber into non- traditional areas. This is one other important strategy to enhance the national rubber production. With regard to planting of rubber in non-traditional areas suitable clones and agronomic practices have been developed to cultivate rubber above the current ceiling of 300m above mean sea level (msl), *i.e.* upto 750m above msl. Further as stated above studies are underway to develop technology to cultivate rubber in the intermediate zone of the Eastern Province of the country.

Institute received Rs.43,218,369.20 through the Rubber Cess Fund. These funds were utilized for purchasing of scientific equipment, development activities in the Sub-Stations and improvement of transport facilities of the Institute.

Trends in the natural rubber industry

Sri Lanka

The natural rubber production in the country increased up to 109.2 thousand MT during the year. This is a 4.6% increase over the 2005 production of 104.4 thousand MT. As per latest figures on the total rubber extent of the country, *i.e.* 119,500 ha and assuming 80% of the extent as mature rubber the national productivity level is around 1150kg of rubber per hectare per annum. The national productivity is showing an increasing trend since the increases in natural rubber prices. This is a clear indication that investments on both replanting and adopting correct agronomic practices are mainly driven by the natural rubber prices and further if recommended technology is adopted the productivity levels in both plantations and smallholdings could be increased.

The annual replanting and new planting extents have increased significantly. Anyhow the growers should bear in mind that such new plantings should be capable

of yielding over 2000kg hectare annum. This is necessary to sustain the current level of return on investments in the future as well in an environment of increasing costs. In the current mature extent there is room for further improvements in productivity through adopting technology to over come shortage of skilled tappers, improving quality of tapping, minimizing losses of tapping days through rainguards and correct use of fertilizer. This will enable the rubber growers to get the maximum from the current high prices whilst contributing to enhance the total rubber production in the country.

As per the reports of International Rubber Study Group (IRSG) the monthly average price for RSS1 ranged for Rs.183 to 307 per kg in 2006, whilst it ranged from Rs.138 to 206 during 2005. Therefore the rubber prices have been favorable in 2006 than in 2005 and it is predicted to remain high in the coming years as well. The demand and supply situation of Natural Rubber and high crude oil prices that prevailed in 2006 would has resulted in the relatively high NR prices in 2006 than in 2005

Global

The world natural rubber production increased up to 9.37 million metric tons from the previous year's production of 8.884 million metric tons. This is a 5.5% growth in production and is higher than the national production increase of 4.6%. The world natural rubber consumption for years 2005 and 2006 was 8.999 million MT and 8.970 million MT respectively. Hence the consumption had shown a very marginal drop despite of an increased production. However, the synthetic rubber consumption had increased from 12.00 million MT to 12.53 million MT, an increase of 4.4% for the same period.

OVERSEAS VISITORS

Tanja Timmemann, Germany
Ulike Eleis, Germany
Ros Constable, UK
S Wrathmell, UK

GENETICS AND PLANT BREEDING

P Seneviratne

SUMMARY

The yield data of estate collaborative clone trials (ECTS) consisting of clones RRISL 201, RRISL 203, RRISL 206, RRISL 208, RRISL 211, RRISL 216, RRISL 217, RRISL 219, RRISL 223, RRISL 226, RRISL 2000 and RRISL 2001 continued to show promising results.

Selected open pollinated seedling progenies of clones RRIC 100, RRIC 121 and PB 260 have given high initial yields.

Post tapping girth data of clones RRISL 201 and RRISL 217 proved to be highly stable in all rubber growing areas tested under genotype environmental interaction trials.

Small scale clone trials established from 1995 and 1996 hand pollination selections, which are crosses of germplasm clone GPS 1, showed promising results.

Molecular characterization of 22 recommended clones of RRISL 200 series and RRISL 2000 series and 78 HP progenies were done with six RAPD primers. CLS disease resistant and susceptible individuals were selected using three primers.

DETAILED REVIEW

Staff

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

Meetings and Workshops

The department staff attended the following meetings and workshops;

Officer	Subject	Organization
K K Liyanage	Work shop on familiarization of Jenway Instruments	Prabano Intra Traders Ltd.
K K Liyanage	Work shop on Proposal Writing.	National Science Foundation
S P Withanage	Scientific Committee Meetings	Rubber Research Institute of Sri Lanka
S P Withanage & K K Liyanage	Short course on Molecular Markers for Plant Breeding	Sri Lanka Council for Agricultural Research Policy

Research students

- Ms E A D D Edrisinghe a student from the faculty of Agriculture and Plantation Management of Wayamba University carried out her research project on "Investigation on Random Amplified polymorphic DNA markers for the *Corynespora* Leaf fall Disease Resistance in Rubber (*Hevea brasiliensis*) for a period of 4 months at the department.

LABORATORY INVESTIGATIONS

Molecular biology of *Hevea* GPB/MM/97

Sixteen *Hevea* genotypes belong to RRISL 200 series and 78 Hand Pollination progeny along with the standard resistant and susceptible clones RRIC 100 and RRIC 103 respectively were analyzed with six random primers, in order to identify reliable RADP markers for CLF resistance. A total of 51 bands showed polymorphism. Nine selected bands clearly separated the RRIC 103 and its most related two genotypes from the rest. Same study was started with 13 genotypes of 2005 HP progeny (S P Withanage and K K Liyanage).

FIELD EXPERIMENTS

Hand pollination (HP) programme – 2006(GPB/BST/HP/01)

The annual hand pollination programme was carried out at RRISL Sub station at Nivitigalakele, Matugama where the G&PB department is situated. The crosses were selected mainly to cross RRII 105 and GPS 1 and also to study the inheritance of *Corynespora* leaf disease in RRIC 100 series clones. The crosses attempted, the number of pollinations done in each cross, number of pods harvested and seedlings obtained in each cross are given in Table 1. Although the pollination success was good some of the seeds got infected due to an unknown reason. The final fruit set success during the year was 2.59

Evaluation of hand pollinated progenies

Small scale clone trials

The list of the Small scale clone trials monitored by the department during the year under review is given in Table 2.

Table 1. *Details of 2006 hand pollination programme*

Cross	No. of pollinations	No. of fruits collected	No. of Seedlings
RRIC 100 2nd self progeny	1438	18	41
GPS 1 × RRIC 100	1542	08	-
GPS 1 × RRIC 121	526	08	-
RRIC 100 × RRIC 105	4148	109	160
RRIC 100 × uncertain	14		22
RRIC 103 2nd Self progeny	102	02	03
RRIC 100 1st self × RRII 105	709	55	21
RRIC 100 1self × uncertain		01	-
RRIC 100 1st self × RRIC 103 1st self	323	09	-
RRIC 100 2nd self progeny	779	05	01
Total	9567	229	248

(P Seneviratne, S P Withanage, K K Liyanage, K B Karunasekera, T M S K Gunasekera and I D M J Sarath kumara).

Table 2. *Details of small scale clone trials*

HP year	Site	Planting date	Current status
1986	Kuruwita	May 1990	8th year of tapping
1987	Clyde- Kethhena	May 1993	8th year of tapping
1988	Dartonfield	July 1993	6th year of tapping
1990	Kuruwita	July 2002	Immature
1991	Pallegoda	August 2000	Immature
	Vogan	November 2000	Immature
1995	Sorana	June 1998	2nd year of tapping
1996	Kuruwita – I & II	May 1999	1st year of tapping
1997	Clyde - I & II	June 2000	1st year of tapping
1998	N'Kele I, II & III	June 2001	Immature
	Kuruwita I, II &III	July 2001	,,
1999	Kuruwita I,II & III	June 2002	,,
2000	Arappalakande, I- III	May 2003	,,
	Dalkeith I & II	June 2003	,,
	Elston I & II	July 2003	,,
	Nivithigalakele I & II	July 2003	,,
2001	Paiyagala 1	June 2006	,,
	Kuruwita sub station II	July 2006	,,

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

Duncan multiple range test results for 15th year girth measurements and yield data relevant to the 8th year of tapping based on seven test tappings are given in Table 3a and 3b. The highest girth was obtained from clone 86- 21 and the highest yield was obtained from the control clone RRIC 121 followed by the new clone 86-87.

Table 3a. *Mean girth (15th year) of promising 1986 H.P. clones*

Clone	Mean girth (cm) and DMRT grouping
86-21	97.35 A
86-77	95.46 A
RRIC 121	92.86 AB
86-56	77.36 ABC
86-24	77.13 A BC
86-87	74.56 ABCD
86-82	74.33 BCD
RRIC 100	73.96 BCD

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

Clone	Yield (g/t/t) and DMRT grouping
RRIC 121	60.52 A
86 – 10	39.90 AB
86-74	39.74 AB
RRIC 110	39.19 A BC
86-87	34.10 BCD
86-11	32.78 BCD
86-77	32.37 BCD
86-25	29.90 BCDE
RRIC 100	29.66 BCDEF

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

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

Results of the Duncan's Multiple Range Test for 14th year girth are given in Table 4a. 8th year yield data based on three test tappings are given in table 4b. Very high bark consumption rates were observed in this clearing perhaps due to high frequency tapping.

Table 4a. *Mean girth and the results of DMRT of the 1987 H.P. Selections*

Clone	Girth in cm and DMRT grouping
RRIC 121	84.80^{A}
87-370	78.70^{B}
87-364	70.50^{C}
RRIC 100	69.89^{C}
87-372	67.03^{cD}
87-386	64.31^{D}
RRIC 102	64.14^{D}
87-375	63.00^{D}

Table 4b. *Mean yield and the results of DMRT of the 1987 H.P. Selections*

Clone	Yield (g/t/t) and DMRT grouping
RRIC 121	48.76^{A}
87-370	44.56^{A}
87-364	39.45^{AB}
87-372	37.53^{AB}
87-386	35.95^{BC}
RRIC 100	33.63^{CD}

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

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

The 13th year girth measurement was taken and the mean girth of clones were grouped using the Duncan's Multiple Range Test. Clones that are better than the control clones are given in Table 5a. Mean yields and the DMRT grouping of some selected clones based on ten test tapings in the 6th year are given in Table 5b along with control clones.

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

The 4th year girth measurements were taken at a height of 120 cm. The HP entries which performed better than the best control clone are shown in Table 6.

Table 5a. *Mean girth in cm of the 1988 HP progeny*

Clone	Mean girth and DMRT grouping
88-28	83.50^{A}
88-31	$79.26^{A\ B}$
88-32	$77.14^{A\ BC}$
88-14	$73.66^{B\ C\ D}$
88-36	$73.43^{B\ CD}$
88-16	$73.32^{BC\ D}$
88-15	70.50^{BCDE}
88-40	69.96^{CDEF}
RRIC 100	68.00^{DEFG}

Table 5b. *Mean yield (g/t/t) of the 1988 HP progeny*

Clone	Mean yield and DMRT grouping
RRIC 102	45.95^{A}
88-26	45.16^{AB}
88-14	39.27^{ABC}
88-50	38.26^{ABC}
88-10	37.53^{ABC}
88-20	37.08^{ABC}
88-16	35.95^{ABCD}
88-28	34.56^{ABCDE}

(P Seneviratne, S P Withanage, K K Liyanage and L S Kariyawasam)

Table 6. *Mean girth (cm) of selected HP entries of the 1990 HP progeny planted at Kuruwita Sub station*

Clone	Mean girth and DMRT grouping
90-10	37.12^{A}
90-11	35.56^{AB}
90-20	35.37^{AB}
90-7	35.25^{AB}
90-27	34.50^{AB}
90-21	34.18^{AB}
90-23	33.81^{AB}
90-6	32.06^{ABC}
90-28	31.81^{ABC}
90-4	31.68^{ABC}
RRISL 205	31.68^{ABC}

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

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

The seventh year girth measurements were taken at 120 cm from the two trials. Some of the best HP entries and control clones from trail 1 and trial 2 are shown in Table 7. Tapping commenced in the Pallegoda trial at the end of the year and arrangements were made to measure yield.

Table 7. *Mean girth of selected HP entries in cm of the 1991 HP progeny planted at Pallegoda and Vogan estates*

Mean girth (cm) from 91-01 trial (Pallegoda)		Mean girth (cm) from 91-02 trial (Vogan)	
Clone	**Girth**	**Clone**	**Girth**
RRISL 205	65.50^{A}	97-62	64.26^{A}
91-29	61.40^{AB}	RRISL 205	60.73^{AB}
RRIC 121	60.23^{BC}	RRIC 121	57.90^{BC}
91-19	58.83^{BCD}	91-63	57.45^{BCD}
91- 13	58.46^{BCDE}	91- 71	56.85^{BCD}
91- 5	58.37^{BCDE}	97-58	56.43^{BCD}

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

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

The 7^{th} year (post tapping) girth measurement (cm) and the second year yield data (g/t/t) based on three test tappings are given in Table 8 (grouped using Duncan's Multiple Range Test).

Table 8. *Mean girth in cm and yield (g/t/t) of the 1995 HP progeny*

Clone	Mean girth and DMRT grouping	Clone	Mean yield and DMRT grouping
RRIC 121	66.60^{A}	95-13	57.66^{A}
95-50	66.06^{AB}	95-21	55.76^{AB}
95-55	64.95^{ABC}	95-55	52.55^{ABC}
95-48	64.25^{ABC}	95-47	46.92^{BCD}
95-11	63.33^{ABCD}	95-19	44.52^{CDE}
95-47	63.04^{ABCD}	95-12	43.59^{CDEF}
95-29	61.82^{BCDE}	95-33	42.24^{CDEF}
95-26	61.43^{BCDEF}	95-23	42.03^{CDEF}
95-53	61.24^{CDEFG}	95-29	41.05^{DEFG}
95-51	61.10^{CDEFG}	95-1	40.34^{DEFGH}
95-45	60.89^{CDEFG}	RRIC 121	37.12^{DEFGHI}

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

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

In both trials sixth year girth measurements (at a height of 120 cm) of the clones are grouped using Duncan's multiple range test (DMRT) and some of the superior genotypes are shown in table 9. Tapping commenced in these trials at the latter part of the year.

Table 9. *Mean girth at 120 cm of the 1996 HP progeny*

Mean girth (cm) from 96-1 trial		Mean girth (cm) from 96-2 trial	
Clone	**Girth**	**Clone**	**Girth**
96-59	70.16^{A}	RRIC 121	68.50^{A}
96-15	62.50^{AB}	96-37	62.00^{AB}
96-14	62.16^{AB}	96-45	61.50^{AB}
96-31	62.07^{AB}	96-54	60.45^{ABC}
96-17	61.06^{ABC}	96-47	59.40^{ABCD}
96-3	60.69^{ABC}	96-44	58.80^{ABCDE}
RRIC 121	60.25^{ABC}	96-26	58.03^{BCDEF}
96-58	59.90^{ABCD}	96-39	56.35^{BCDEFG}
RRISL 205	59.16^{ABCDE}	96-40	$55.32^{BCDEFGH}$

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

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

The sixth year girth measurements were taken at a height of 120 cm in both trials. The best HP entries of both trials are shown in Table 10. These two trials were opened or tapping during the latter part of the year (S P Withanage, K K Liyanage, T M S K Gunasekera and K B Karunasekera).

Table 10. *Mean girth in cm of the 1997 HP progeny planted at Clyde estate*

Mean girth (cm) from 97-01 trial		Mean girth (cm) from 97-02 trial	
Clone	**Girth**	**Clone**	**Girth**
97-9	60.60^{A}	97-55	60.15^{A}
97-2	59.23^{AB}	RRISL 205	59.07^{AB}
97-19	58.67^{ABC}	97-61	57.26^{ABC}
97-10	57.36^{ABCD}	97-67	57.10^{ABC}
97-26	57.33^{ABCD}	97-44	55.30^{BCD}
RRISL 205	57.23^{ABCD}	97-74	55.30^{BCD}
97-22	56.80^{ABCD}	97-79	54.89^{BCD}

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

Fifth year girth measurements were taken from the above six trials. Girth data analysed using Duncan's multiple range tests for each experiment and some of the best HP entries and control clones are given in tables 11a and 11b.

Table 11a. *Mean girth of selected HP entries in cm of the 1998 HP progeny planted at Nivitigalakele Sub station*

Mean girth (cm) from trial 98-01		Mean girth (cm) from trial 98-02		Mean girth (cm) from trial 98-03	
Clone	**Girth**	**Clone**	**Girth**	**Clone**	**Girth**
98-88	53.84^{A}	98-132	53.19^{A}	RRISL 205	51.21^{A}
98-147	49.31^{B}	98-96	50.67^{AB}	RRIC 121	50.46^{AB}
98-134	47.14^{BC}	98-159	49.34^{B}	98-151	50.34^{AB}
98-180	47.12^{BC}	98-129	48.85^{B}	98-255	49.96^{AB}
RRIC 121	46.45^{BCD}	RRIC 121	47.40^{BC}	98-281	49.50^{ABC}
RRIC 130	45.90^{BCD}	98-53	44.63^{CD}	98-204	49.21^{ABC}
RRISL 205	45.43^{BCD}	RRIC 130	43.96^{CDE}	98-133	49.20^{ABC}
98-115	45.25^{BCD}	98-259	43.75^{DEF}	98-197	49.18^{ABC}
98-119	45.00^{BCD}	RRISL 205	43.65^{DEF}	98-280	48.46^{ABC}

Table 11b. *Mean girth of selected HP entries in cm of the 1998 HP progeny planted at Kuruwita Sub station*

Mean girth (cm) from trial 98-04		Mean girth (cm) from trial 98-05		Mean girth (cm) from trial 98-06	
Clone	**Girth**	**Clone**	**Girth**	**Clone**	**Girth**
98-230	50.53^{A}	98-68	51.21^{A}	98-223	51.66^{A}
98-98	50.21^{AB}	98-58	49.20^{AB}	RRISL 205	48.92^{AB}
98-276	50.06^{ABC}	98-80	48.50^{ABC}	98-154	48.83^{AB}
98-11	49.09^{ABCD}	98-51	47.75^{ABCD}	98-30	47.28^{ABC}
98-84	48.34^{ABCDE}	98-62	45.35^{BCDE}	98-19	47.21^{ABC}
98-219	47.28^{ABCDEF}	98-41	44.75^{BCDEF}	RRIC 121	46.18^{BCD}
RRISL 205	47.00^{ABCDEF}	98-07	44.20^{CDEF}	98-196	44.33^{BCDE}
98-89	$46.03^{ABCDEFG}$	RRISL 205	43.93^{CDEF}	98-278	43.41^{CDEF}
98-124	$44.93^{BCDEFGH}$	98-44	43.50^{DEFG}	98-23	42.53^{DEFG}

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

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

Results of the fourth year girth measurements were taken from each trial and the HP entries which performed better than the best control clone are shown in Table 12.

Table 12. *Mean girth of selected HP entries in cm of the 1999 HP progeny planted at Kuruwita Sub station*

Mean girth (cm) from trial 99-01		Mean girth (cm) from trial 99-02		Mean girth (cm) from trial 99-03	
Clone	**Girth**	**Clone**	**Girth**	**Clone**	**Girth**
99-55	33.62^{A}	99-157	42.75^{A}	99-189	43.64^{A}
99-61	33.06^{AB}	99-47	37.07^{AB}	99-216	38.25^{B}
99-71	32.37^{ABC}	99-167	34.81^{BC}	99-230	35.37^{BC}
99-43	32.25^{ABC}	99-265	34.68^{BC}	RRISL 205	33.68^{BCD}
99-67	31.62^{ABCD}	RRISL 205	34.00^{BCD}	RRIC 121	33.35^{BCDE}
99-80	31.50^{ABCDE}	99-178	33.75^{BCD}	99-44	33.31^{BCDE}
99-73	30.91^{ABCDEF}	99-272	33.43^{BCDE}	99-166	33.25^{BCDE}
99-139	30.87^{ABCDEF}	99-159	33.37^{BCDEF}	99-192	33.14^{BCDEF}
99-48	$30.43^{ABCDEFG}$	99-137	32.85^{BCDEFG}	99-120	33.12^{BCDEF}
99-119	$30.33^{ABCDEFG}$	99-246	$31.62^{BCDEFGH}$	99-195	33.00^{BCDEF}
99-81	$30.31^{ABCDEFG}$	99-242	$31.50^{BCDEFGH}$	99-63	32.75^{BCDEFG}
99-74	$30.21^{ABCDEFG}$	99-204	$31.50^{BCDEFGH}$	99-78	$32.43^{BCDEFGH}$
RRISL 205	$29.35^{ABCDEFGH}$	99-194	$30.68^{BCDEFGHI}$	99-133	$32.43^{BCDEFGH}$

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

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

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

Each block contains 364 genotypes in completely randomized single tree plots, derived from 11 families. Third year girth measurements are given with the families in Table 13.

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

In this trial a total of 258 genotypes derived from eight families are tested in a completely randomized single tree plot design. Family means derived from third year girth measurements are given in Table 14.

Table 13. *Mean girth (cm) and DMRT grouping of families of the 2000 HP progeny Trial I. planted at Arappalakande estate*

Family	Mean girth and DMRT grouping
RRIC 121 × PB 235	31.43^{A}
PB 235 × PB 260	31.41^{A}
BPM 24 × PB 235	31.19^{A}
BPM 24 × PB 260	30.61^{AB}
PB 235 × RRIC 121	30.52^{AB}
BPM 24 × RRIC 121	29.50^{ABC}
PB 260 × RRIC 121	28.88^{BCD}
BPM 24 × GP 36-104	28.36^{CD}
RRIC 121 × PB 260	27.99^{CDE}
PB 260 × PB 260	26.85^{DE}
RRIC 121 × GP 36-147	26.25^{E}

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

Table 14. *Mean girth (cm) of families of the 2000 HP progeny Trial. II planted at Arappalakande estate*

Family	Mean girth
BPM 24 × PB 260	30.47
BPM 24 × RRIC 121	30.41
RRIC 121 × PB 260	28.79
PB 235 × RRIC 121	28.65
RRIC 121× GP 36-147	28.41
PB 235 × PB 260	28.33
PB 260 × RRIC 121	27.53
PB 260 × PB 260	24.62

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

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

This trial has 90 genotypes derived from a single family BPM 24 × PB 235 in a completely randomized design with four single tree plots per clone. Third year girth measurement were taken and some of the genotypes and their DMRT ranking are shows in Table 15.

Table 15. *Mean girth (cm) of vigorous genotypes and their DMRT ranking in 2000 HP progeny Trial III planted at Arappalakande estate*

Clone	Girth
2000-103	38.00^{A}
2000-149	36.62^{AB}
2000-192	36.37^{ABC}
2000-121	35.62^{ABCD}
2000-59	35.50^{ABCD}
2000-130	34.62^{ABCDE}
2000-48	34.62^{ABCDE}
2000-64	34.37^{ABCDEF}
2000-105	34.33^{ABCDEF}
2000-191	34.25^{ABCDEF}
2000-42	34.25^{ABCDEF}

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

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

In this trial, 112 genotypes derived from two families (RRIC 121 × PB 235 & PB 235 × RRIC 121), 56 from each family were planted in a completely randomized design with three single tree plots per clone. Results of the third year girth measurements shows that about 42 genotypes have achieved over 25.50 cm. mean. Girth measurements were taken at 120cm from the bud union (P Seneviratne, S P Withanage, K K Liyanage, K W Rupatunge and K B Karunasekera).

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

In this trial, 98 genotypes from two families (BPM 24 × PB 260 (53) and RRIC 121 × PB 260 (45) have been planted in a completely randomized design with three single tree plots per clone. Third year girth measurements of some of the vigorous genotypes and their DMRT ranking are shown in Table 16.

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

In trial VI, 46 genotypes from one family with three single tree plots in a completely randomized design are being tested. In Trial VII 193 genotypes have been included from a single family with three single tree plots in a completely randomized design. Family mean, Variance, Minimum and Maximum derived from the third year girth measurements are given in Table 17.

Table 16. *Mean girth(cm) of vigorous genotypes and their DMRT ranking in 2000 HP progeny Trail V planted at Dalkeith estate*

Clone	Girth
2000-553	30.75A
2000-611	30.50AB
2000-229	29.66AB
2000-198	29.50ABC
2000-1199	29.00ABC
2000-254	28.16ABC
2000-333	28.00ABCD
2000-245	27.83ABCDE
2000-275	27.66ABCDE
2000-274	27.50ABCDE

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

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

In trial VI, 46 genotypes from one family with three single tree plots in a completely randomized design are being tested. In Trial VII 193 genotypes have been included from a single family with three single tree plots in a completely randomized design. Family mean, Variance, Minimum and Maximum derived from the third year girth measurements are given in Table 17.

Table 17. *Mean (cm), minimum, maximum and variance of two families planted at Nivitigalakele (2000 hand pollination progeny) trials VI and VII.*

	Results of the trial VI (BPM 24 × RRIC 121)	Results of the trial VII (PB 260 × RRIC 121)
Mean	25.42	29.26
Minium	13.00	15.00
Maximum	36.5	44.00
Variance	25.01	27.75

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

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

In trial VIII, 103 genotypes from one family (PB 235 × RRIC 121) with three single tree plots in a completely randomized design are being tested. In Trial IX, 52 genotypes have been included from 11 families with six single tree plots per genotype in a completely randomized design. Results of the third year girth measurements

shows that about 48 genotypes have achieved over 25.5cm in trial VIII. Table 18 shows the family means calculated from the third year girth measurements in trial IX.

Table 18. *Mean girth (cm) and variance of families planted Elston estate trial IX.*

Parentage (Family)	Mean girth in cm	Variance
BPM 24 × GP 36-104	26.87	18.45
BPM 24 × PB 235	30.19	10.30
BPM 24 × PB 260	28.07	23.26
BPM 24 × RRIC 121	29.24	14.56
PB 235 × PB 260	29.38	28.97
PB 235 × RRIC 121	26.64	20.46
PB 260 × PB 260	25.47	18.24
PB 260 × RRIC 121	26.98	28.00
RRIC 121 × GP 36-147	26.42	20.74
RRIC 121 × PB 235	30.37	23.65
RRIC 121 × PB 260	28.14	18.46

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

Genotype Environment Interaction (G × E) studies (GPB/GE/98)

Annual girth measurements and yield data were collected during the year. Analysis of variance of the girth (eighth year) showed the presence of highly significant differences in growth between clones, sites and the presence of significant genotype × environment interaction effect. Table 19 shows the mean girth and the variance of the clones in the eight sites under study. The highest mean girth, over all sites were recorded by RRISL 201, RRISL 205 and RRISL 206 and GPS 1 registered the lowest girth.

It was not possible to carry out test tappings in these trials regularly due to rain interferences and also due to unavoidable circumstances, especially in sites located in distance areas *i.e.* Kegalle, Muwankanda, Palmadulla, Ganepalla and Bibile. Therefore it was impossible to carry out data analysis and to make any comments about the yields in different environments.

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

The sixth year girth measurements were taken. Table 20 shows the mean girth of each treatment, *i.e.* control monoclone plots and plots of Bi – and Tri - clonal mixtures. Analysis of variance of the sixth year girth showed that there is no significant difference in growth among treatments. Trees of this trial were opened for tapping at the end of the year.

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

Clone	Ganepalla	Muwan kanda	Atale	Palm Garden	Pelma dulla	Badde gama	Bibile	Sorana	Clone mean	Variance
RRISL 201	64.0	69.9	63.6	61.9	63.9	65.2	62.3	66.0	64.6	6.40
RRISL 205	67.6	71.6	66.0	63.8	59.0	66.7	63.1	73.9	66.46	22.47
RRISL 206	56.8	65.1	64.0	60.8	56.4	62.8	62.8	65.6	61.78	12.47
RRISL 210	57.8	56.6	58.8	54.0	53.3	56.0	53.9	58.5	56.11	4.75
RRISL 215	55.7	59.4	54.5	52.9	56.1	57.1	52.3	57.1	55.63	5.51
RRISL 217	54.6	56.0	56.2	51.5	54.6	56.5	56.8	59.8	55.75	5.57
RRISL 218	56.0	66.5	65.4	53.2	54.2	56.0	56.7	66.9	59.36	34.07
RRISL 220	54.1	57.6	50.8	40.1	51.1	58.7	46.6	41.6	50.07	47.45
GPS 1	43.0	42.6	38.5	34.7	37.0	39.7	42.0	38.9	39.55	8.39
RRII 105	54.0	55.5	57.2	49.0	53.7	56.9	53.1	53.3	54.08	6.74
RRIM 712	46.3	47.7	47.0	37.4	46.7	49.2	47.5	36.9	44.87	23.51
RRIC 130	52.8	51.9	50.7	52.2	57.0	52.8	48.5	50.3	52.02	6.15
Heiken 2	45.5	51.7	49.9	38.1	46.1	45.7	50.7	41.0	46.08	22.49
PB 260	49.6	53.4	57.1	54.3	54.2	53.7	49.6	54.6	53.31	6.49
Site Mean	54.16	57.49	56.09	50.53	53.09	55.67	53.34	55.00		

(P Seneviratne, S P Withanage, K K Liyanage, K W Rupatung, I D M J Sarath kumara, H P Peris and K B Karunasekera).

Table 20. *Mean girth of each treatment*

Treatment	Mean girth (cm)
RRIC 102/RRIC 133	62.15
RRIC 121	60.28
RRIC 102/RRIC 121	59.63
RRIC 133	59.41
RRIC 133/RRIC 121	59.30
RRIC 102/RRIC 133/RRIC 121	57.95
RRIC 100/RRIC 133/RRIC 121	57.56
RRIC 100/RRIC 133	57.38
RRIC 100/RRIC 102/RRIC 121	57.15
RRIC 100/RRIC 121	57.06
RRIC 100	56.51
RRIC 102	56.32
RRIC 100/RRIC 102/RRIC 133	56.14
RRIC 100/RRIC 102	55.53

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

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

Sixth year girth measurements were recorded from this trial and are shown in Table 21.

It shows that seedlings too achieved the tappable girth in the sixth year as well as budded stumps. Tapping commenced in this trial at the end of the year.

Table 21. *Sixth year girth measurements obtained from seedlings and budded plants*

Budded plants	Girth (cm)	Selected seedlings	Girth (cm)	Unselected seedlings	Girth (cm)
PB 86	44.55	PB 86	57.07	PB 86	55.74
RRIC 121	55.74	RRIC 121	54.68	RRIC 121	58.23
PB 28/59	52.71	PB 28/59	51.98	PB 28/59	51.60
RRIC 100	53.30	RRIC 100	60.25	RRIC 100	59.89
PB 260	54.63	PB 260	61.65	PB 260	60.31

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

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

Annual girth measurements were taken from all the trials. Table 22 shows the girth measurements for the year under review and for the two previous years with the information on planting.

Yields from ECTs

GPB/BST/ECT/95/01

The estate yields obtained from ECT trials are given in Table 23. Clone, year of tapping, DRC, g/t/t and yield/tree/annum are included.

Table 22. *Annual girth measurements (cm) of ECTs*

Clone	Site	Year of planting	Girth in cm		
			2004	2005	2006
RRISL 201	Tempo	1996	62.8	65.5	68.08
	Moralioya	1996	63.7	69.4	75.14
	Kuruwita	1994	64.0	67.0	69.87
	Salawa	1999	50.5	58.8	64.11
RRISL 202	Moralioya	1996	58.1	61.7	67.82
	Kuruwita	1994	56.5	59.8	62.12
RRISL 203	Galewatta	1987	69.3	71.2	72.51
RRISL 205	Pallegoda	1995	64.2	67.9	69.4
	Vogan	1997	68.5	73.5	75.6
RRISL 206	Pallegoda	1995	57.7	61.8	63.5
	Vogan	1997	59.2	62.7	65.27
	Salawa	1999	49.7	53.9	55.5
RRISL 207	Dosertdivision*	2004		9.9	14.5
RRISL 208	Dartonfield	1994	62.7	64.16	65.33
RRISL 211	Dartonfield	1994	62.8	63.7	64.53
	Siriniwasa*	2001	28.46	38.76	46.40
RRISL 208	Dartonfield	1994	62.7	64.16	65.33
RRISL 214	Dosertdivision*	2004		9.18	12.79
RRISL 215	Salawa	1999	52.0	57.9	59.8
RRISL 216	Dartonfield	1994	59.6	60.8	62.48
RRISL 217	Kuruwita	1995	53.4	56.7	58.49
	Vogan	1997	54.1	58.6	59.98
RRISL 219	Dartonfield	1994	62.0	63.5	65.16
RRISL 220	Salawa	1999	45.10	49.37	52.1
RRISL 221	Salawa	1999	45.9	52.6	56.23
RRISL 223	Galewatte	1994	61.44	63.1	64.25
RRISL 225	Nivitigalakele*	2002	21.65	34.5	47.20
RRISL 226	Salawa	1999	47.5	52.5	54.46
	Siriniwasa*	2001	26.0	37.2	42.86
RRISL 2000	Pallegoda	1998	54.25	60.5	62.65
	Nivitagalakele*	2001	30.6	43.6	52.17
	Dosert division*	2004		8.68	15.32
RRISL 2001	Pallegoda	1995	58.7	61.0	63.10
	Nivitigalakele*	2001	24.7	36.9	46.60
	Dosert division*	2004		9.25	16.25
RRISL 2002	Dosert division*	2004		8.43	13.93
RRISL 2003	Dosert division*	2004		8.73	14.71
RRISL 2004	Dosert division*	2004		8.24	15.13
RRISL 2005	Dosert division*	2004		12.24	17.46
RRISL 2006	Dosert division*	2004		11.55	16.76
RRII 105	Pallegoda	1998	47.2	52.3	54.1

* Immature fields

Table 23. *Commercial yields obtained from ECT trials*

Clone	Year of tapping	No. of tapping days	Average g/t/t	Yield/tree/annum (Kg)
RRISL 201	3	170	32.14	5.46
RRISL 203	13	79	68.7	5.42
RRISL 205	5	58	36.06	2.12
RRISL 206	5	100	43.5	4.35
RRISL 208	4	53	43.46	2.30
RRISL 211	4	50	43.0	2.15
RRISL 216	5	52	37.28	1.93
RRISL 217	5	108	48.01	5.18
RRISL 219	4	53	39.46	2.09
RRISL 223	2	113	35.38	2.43
RRISL 2001	5	90	36.18	3.25

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

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

Fifth year girth measurements were taken from these trials (Table 24). All three clones planted under this programme showed vigorous growth. In Kegalle site clones RRISL 201 and RRISL 203 have reached tappable girth in the fifth year.

Table 24. *Mean girth of the SRT trials planted in 2001*

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

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

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

Fourth year mean girth of the four clones obtained from three sites planted in year 2002 and third year girth of clones planted in year 2003 are given in Table 25. Fertilizer applications for the period were completed.

Table 25. *Mean girth of the trials planted in 2002 and 2003*

Clone	Site/Expt. No.	Year 1	Year 2	Year 3	Year 4
RRIC 201	Kalutara (SRT/02/02)	6.98	17.8	26.38	40.48
	Kalutara (SRT/02/03)	6.04	13.5	20.18	29.86
	Ratnapura (SRT/02/04)	6.98	11.3	17.92	33.9
	Kaburupitiya (SRT/03/01)	10.0	20.7	33.75	
	Radawela (SRT/03/02)	7.3	16.0	30.12	
RRIC 205	Kalutara (SRT/02/02)	5.9	16.6	27.34	42.07
	Kalutara (SRT/02/03)	6.44	14.7	22.06	31.59
	Ratnapura (SRT/02/04)	6.17	12.3	20.9	31.21
	Kaburupitiya (SRT/03/01)	8.8	18.2	30.81	
	Radawela (SRT/03/02)	7.7	15.6	29.0	
RRIC 206	Kalutara (SRT/02/02)	6.82	19.0	30.03	42.98
	Kalutara (SRT/02/03)	6.69	15.98	26.22	35.71
	Ratnapura (SRT/02/04)	6.2	12.15	20.76	33.7
	Kaburupitiya (SRT/03/01)	9.18	19.75	31.86	
	Radawela (SRT/03/02)	8.51	16.9	30.37	
RRIC 121	Kalutara (SRT/02/02)	5.21	12.9	20.16	30.91
	Kalutara (SRT/02/03)	6.19	12.6	18.67	27.07
	Ratnapura (SRT/02/04)	6.18	9.6	16.7	27.12
	Kaburupitiya (SRT/03/01)	9.91	17.9	27.98	
	Radawela (SRT/03/02)	8.1	17.2	29.5	

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

ECT trials were established at Kuruwita sub station and Paiyagala estate from selected genotypes 12-93, 22-137 and 44-24 to monitor their performance. Repainting of all the genotype numbers was continued and minimum maintenance work was possible due to lack of funds (P Seneviratne, S P Withanage, K K Liyanage and I D M J Sarathkumara).

New plantings

Two small scale clone trials were established to test 2001 hand pollination selections.

- Trial 1 – Paiyagala Estate - 25 HP selections with two control clones (RRISL 203 and RRISL 221) were planted in a randomized block design in 4 replicates with 5 tree plot per clone.
- Trial 2 – Kuruwita Sub station - 17 HP selections with two control clones (RRISL 203 and RRISL 221) were planted in a randomized block design in 4 replicates with 5 tree plot per clone.

Estate/RRI collaborative clone trials were established at Kuruwita sub station and Paiyagala estate to test the following clones (Table 26).

Table 26. *Details of Estate/RRI collaborative clone trials*

Clone	Site
92-358	Paiyagala Estate
RRISL 210	,,
44-24 (Germplasm selection)	,,
22-137 (Germplasm selection)	,,
78-278	Kuruwita Sub Station
78-510	,,
78-534	,,
78-759	,,
78-770	,,
78-873	,,
78-878	,,
12-93 (Germplasm selection)	,,

(P Seneviratne, S P Withanage, K K Liyanage, K B Karunasekera, I D M J Sarathkumara, L S Kariyawasam, T M S K Gunasekara and H P Peries).

PLANT SCIENCE

P Seneviratne

SUMMARY

Rejuvenating the budwood plants in source bush nurseries to enhance the growth rate of budded plants during their immature phase has indicated that this technique can be used to revitalize the budwood in order to achieve the desired goal. Certain trunk and crown combinations of crown budding trials are giving encouraging yields. However, further monitoring of yields is necessary. A correlation exists between the girth of the two whorl nursery plants and the girth of them in the field up to tapping. Out of three different branch induction techniques tested, the leaf cap method continues to give the highest girth of the trees.

Growth and yield parameters of the trees planted at 500, 600, 700 and 800 per hectare have indicated a significant decrease with the increase of planting density. Girth and individual g/t/t were highest at low densities in a trial conducted with 350, 425, 500 and 575 trees per hectare, irrespective to the clone. Planting rubber in areas above 300m elevation in the mid country wet zone has given successful results. However, clone selection is critical. Growing long term perennial crops such as Durian, Rambutan and Jack trees with rubber in wider row systems improves the growth of rubber crop.

The post harvest girthing is comparable in clones RRIC 102 and RRIC 121 but low in RRISL 211. Although g/t/t was highest in d_6 tapping YPH was comparable with d_2, d_3 and d_4 tapping systems. A survey carried out on tapping panel dryness has indicated a gradual increase in the incidence of TPD with age of tree.

An extensive irrigation system was successfully installed in the government rubber nursery at Moneragala, covering over eight hectares. The system has 2500 sprinklers and is the largest in a rubber nursery in Sri Lanka. Budwood of new clones from the nurseries at Dartonfield and Nivithigalakele were used extensively in budgrafting programmes throughout the year in order to increase the usage of them. Budwood nurseries at Dartonfield were expanded and preliminarily work was done at the nursery at the Moneragala sub-station.

All rubber nurseries were visited regularly by the relevant officers and reports were forwarded to the Rubber Development Department for necessary action. The total number of plants certified from nurseries under Regional Plantation Companies (RPCs) was 893,150 while about 1.5 million plants were certified from Government nurseries. A clear improvement in the quality of plants was noticed in almost all nurseries under the management of RPC's, partly due to regular monitoring. However, the adherence to the recommendations which contributes to the quality improvements of plants is rather low in both government and private sector nurseries.

DETAILED REVIEW

Staff

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

Mr A Wickramaratne and Mr N M C Nayanakantha, Assistant Botanists continued their postgraduate studies abroad.

Mr M N de Alwis was granted no pay leave for a period of one year to do his higher studies in the UK from 12.09.2006.

Mr L S S Pathiratna, Botanist who was in the Plant Science Department for over 37 years retired on 11.12.2006. His main area of research was intercropping and his valuable contribution towards the betterment of the rubber industry is greatly appreciated.

Mr S Wilbert, Experimental Officer, who served in the department for about 36 years helping the research activities and conducting awareness programmes for stake holders retired on 06.09.2006.

Research students

- Mr P K R Chanushka Eranga Munasinghe, from University of Wayamba completed his final year project on "Assessment of possible reasons affecting the production of good quality budded plants in rubber nurseries owned by Government, Regional Plantation Companies and Private Sector in Sri Lanka" under the supervision of Dr (Mrs) P Seneviratne.

- Mr H V J L Priyadarshana, a student of Hardy Advanced Technological Institute at Ampara, completed his four months training from 16th March, 2006 under the supervision of Dr (Mrs) P Seneviratne.

- Mr Samindika Manampery a student of Hardy Advance Technological Institute at Ampara, completed his four months training in the Plant Science Department.

- Miss W W L L Sandamali, from University of Ruhuna completed her final year project on "Possible causes for the variation in yield among individuals of clonal rubber" under the supervision of Dr (Mrs) P Seneviratne.

- Miss N A Amali Shurmila Nallaperuma from University of Peradeniya started her final year project on "Yield determination through growth and physiological parameters" under the supervision of Dr W Senevirathna.

Seminars/Conferences/Meetings/Workshop attended

Officer	Subject	Organization
P Seneviratne and A M W K Senevirathna	Scientific Committee Meeting	RRISL
P Seneviratne	A presentation on nursery practices and planting material production	Planters' Association
	Nursery Development and Monitoring	MPI
	Investigation meeting	RDD
A M W K Senevirathna	Work shop for grantees	NSF
	10th Anniversary	PGIS
	Research Management	CARP
S A de Silva	Advances in micro irrigation	University of Peradeniya

Training programmes

Client	Subject	No. of programmes
Plantation Sector	Tapping	13
Plantation Sector	Budgrafting	14
Plantation Sector	Planting & Upkeeping	4
Plantation Sector	Rainguards	2
NIPM/Universities	Tapping , Budgrafting	4
RDD	Planting , Tapping and Rainguards	1

Advisory visits

Client	No. of visits
Plantations	11
Smallholders	01

LABORATORY INVESTIGATIONS

Tissue culture

***Propagation of clonal* Hevea**

The officer in charge of the tissue culture laboratory was in India, doing his postgraduate studies and therefore new experiments were not conducted during the year under review. However, the cultures were maintained by sub culturing in to new media (N M C Nayanakantha, P Seneviratne and G A S Wijesekera).

FIELD EXPERIMENTS

Clonal propagation

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

Rooting of cuttings to produce plants was done throughout the period with a low success rate. The origin of the shoot specially the maturity factor, appears to be the most important issue for rooting ability (P Seneviratne and G A S Wijesekera).

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

Bud grafted plants of high yielding individuals were maintained in the budwood nursery to harvest shoots to produce plants through rooting them. The low success rate in root induction was the bottleneck for the plant production. Plants of clones RRIC 121, RRIC 130 and PB 28/59 were maintained in the field (P Seneviratne, G A S Wijesekera and R K Samarasekara).

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

Seedlings have been planted consecutively, from the year 2001 and observations on wintering, flowering and growth rates are being collected. Seedling too as budded plants seems to enter the mature phase after 5-6 years (P Seneviratne and G A S Wijesekera).

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

The root systems of seedlings and cuttings produced by splitting the seedling and rooting the cutting taken from one half of the seedling was used in this experiment. Morphology of the root systems when sampled showed that the both systems are equally good. In some pairs of plants the tree girth was better in the rooted cutting than their seedling (P Seneviratne and G A S Wijesekera).

Budgrafting

Successive grafting - BG/1999/1 - Dartonfield

A new generation was produced by using the budwood of the last generation of plants. Eight generations have been produced accordingly (P Seneviratne and G A S Wijesekera).

Rejuvenation of budwood plants - Egaloya rubber nursery

Two more budgrafting passages were done during the year on top of the three passages completed by previous year (P Seneviratne and G A S Wijesekera).

Crown budding

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

Mean girth of RRIC 110 trees crown budded in 1997 with RRIC 100, 102,

117, 130 and *H. spruciana* at Padukka estate are given in Table 1. As shown in Table 1, RRIC 121 shows a significantly higher girth and *H. spruciana* crown budded trunks show the lowest girth. For this years girth measurements in both clearings namely Menerigama and main division all the crown budded trees in the field were taken except for trees affected with brown bast.

Table 1. *Mean girth and* ***Average yield*** *of RRIC 110 plants crown budded with different clones (The SEM is given within brackets)*

Clearing	Crown	No. of Trees	Girth (cm)	Average yield (g/t/t)
1995 RRIC 110	RRIC 100	183	61.67 (±) 0.59	26.31
Menerigama	RRIC 102	110	66.09 (±) 0.82	36.98
Division	RRIC 117	136	64.02 (±) 0.69	33.6
	RRIC 121	41	79.78 (±) 1.16	71.4
	RRIC 130	43	60.64 (±) 1.2	34.5
	H. spruciana	97	51.53 (±) 0.68	5.52
1993 RRIC 110	RRIC 100	113	54.3 (±) 0.67	14.6
Main Division	RRIC 102	55	54.9 (±) 1.1	20.9
	RRIC 117	99	55.87 (±) 0.8	15.4
	RRIC 110 (control)	43	74.76 (±) 1.7	26.8
	H. spruciana	*13*	*57.05* (±) 2.14	30.4

Yield data of the two trials are given in Table 1. Yield is high in trees crown budded with RRIC 121 when compared with other crown budded trunks (P Seneviratne, M N de Alwis and R K Samarasekera).

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

Mean girth of trees with different crowns are given in Table 2.

Table 2. *Mean girth and yield of trees with different crown clones*

Crown	No. of Trees	Mean girth cm (± SEM)	Average Yield (g/t/t)
RRIC 100	49	67.02 (±) 1.48	22.74
RRIC 121	36	66.5 (±) 2.25	16.14
H. pauciflora	19	60.80 (±) 2.76	17.35
RRIC 100 + *H. pauciflora*	4	70.25 (±) 4.67	13.43
RRIC 100 + RRIC 121	9	72.7 (±) 4.54	28.73
RRIC 121 + *H. pauciflora*	3	78.43 (±) 4.68	15.78
RRIC 100 + 121 + *H. pauciflora*	1	82.0	19.66

Trees crown budded with RRIC 100 + RRIC 121 + *H. pauciflora* have given the highest growth, where as those budgrafted with *H. pauciflora* show the lowest. RRISL 224 trees which failed crown budding eventually died due to repeated attacks of *Corynespora.* Yield data of trees with different crowns are given in Table 2.

Highest yield has been given by trees crown budded with RRIC 100 and RRIC 121 in combination. However the yields are rather low in this trial (P Seneviratne, M N de Alwis and R K Samarasekera).

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

Details of the experiment were published in the Annual Review for 2001. The clone RRIC 121 shows the highest girth whilst it is lowest in clone PR 305. As far as trunk and crown combinations are concerned, RRIC 121 crown on RRIC 130 trunk shows the highest girth (Table 3).

Table 3. *Mean girth and average yield of trees with different crown/trunk combinations*

Treatment	Trunk	Crown	Mean girth			No. of trees	Average yield g/t/t
1	PR 305	Control	47.39	±	1.09	3	25.95
	PR 305	RRIM 717	36.93	±	1.54	19	26.80
	PR 305	Pollarded	46.52	±	0.98	13	24.92
2	RRIM 717	Control	48.39	±	0.80	22	23.54
	RRIM 717	PR 305	36.7	±	1.03	-	-
	RRIM 717	Pollarded	44.7	±	2.5	8	14.42
3	BPM 24	Control	46.07	±	1.34	4	26.14
	BPM 24	PB 260		-		-	-
	BPM 24	Pollarded	41.83	±	1.99	4	25.33
4	PB 260	Control	51.81	±	1.71	7	25.01
	PB 260	BPM 24	39.87	±	1.87	1	12.8
	PB 260	Pollarded	51.00	±	-	-	-
5	RRIC 121	Control	56.75	±	2.07	9	19.41
	RRIC 121	RRISL 217	44.30	±	1.47	3	33.54
	RRIC 121	Pollarded	53.20	±	1.76	3	21.61
6	RRISL 217	Control	51.00	±	1.31	11	15.68
	RRISL 217	RRIC 121	42.55	±	1.09	-	-
	RRISL 217	Pollarded	46.40	±	0.98	7	15.62
7	RRIC 121	Control	55.36	±	1.45	13	26.82
	RRIC 121	RRIC 130	36.86	±	5.38	3	24.0
	RRIC 121	Pollarded	56.46	±	1.85	13	31.46
8	RRIC 130	Control	54.44	±	1.20	19	37.66
	RRIC 130	RRIC 121	55.05	±	2.11	4	32.46
	RRIC 130	Pollarded	53.80	±	1.51	17	32.05

Highest average yield has been given by clone RRISL 217 whilst it is lowest in clone BPM 24. RRISL 217 crown on RRIC 121 trunk shows the highest yield (P Seneviratne, L Zoysa and R K Samarasekera).

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

Girth measurements and yield records of RRIC 130 trees crown budded with RRIC 133, BPM 24, RRII 105 and RRIC 102 control trees at N'kele are given in Table 4.

Table 4. *Average yield and Mean girth of RRIC 130 plants crown budded with different clones (The SEM is given within brackets).*

Clearing	Crown	Average yield (g/t/t)	Mean Girth (cm)	
1999	RRIC 133	19.53	51.79 ±	1.48
	BPM 24	20.85	50.52 ±	0.972
	RRII 105	17.2	49.194 ±	1.426
	Control (RRIC 102)	22.75	55.47 ±	2.326

As shown in Table 4 control trees (RRIC 102) show a significantly higher girth. Girth of other crown budded clones are also comparable.

Highest yield has been given by the control trees (RRIC 102) partly due to higher girth of them (P Seneviratne, M N de Alwis and R K Samrasekera).

Budwood nurseries

Budwood availability

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

Budwood nurseries were expanded according to the clone requirement and also availability of other resources (Table 5). Budwood of almost all the clones were used for budgrafting programmes specially to issue for the purpose of establishing budwood nurseries. A large quantity was transported to Moneragala also for the same purpose.

BN/2006 Moneragala

Preliminary work of the budwood nursery proposed at the sub station at Moneragala was completed during the year under review. Plants were budgrafted at the government nursery in Moneragala and one of the RPC nurseries at Unugalla to plant in this nursery, once the land is fenced (P Seneviratne, P D Pathirane and L Zoysa).

Table 5. *Number of budwood plants available from each clone*

Clone	BN/2000/DF	BN/2000/Olikanda	BN/2002/Olikanda
RRISL 200	14	9	
RRISL 201	29	11	-
RRISL 202	21	4	-
RRISL 203	28	17	-
RRISL 205	12	15	-
RRISL 210	18		-
RRISL 215	31	4	-
RRISL 217	44	96	-
RRISL 218	23		-
RRISL 219	20		-
RRISL 2000	-	-	66
RRISL 2001	-	-	69
RRISL 2002	-	-	-
RRISL 2003	-	-	39
RRISL 2004	-	-	42
RRISL 2005	-	-	36
RRISL 2006	-	-	22
PB 260	-		51
PB 235	-		
BPM 24	-		
RRIM 712	-		
Total	**240**	**156**	**325**

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

Plant certification programme

The aim of this exercise is to guarantee the high quality of budded plants produce in nurseries in Sri Lanka. In order to achieve this objective, each nursery is inspected four rounds during the 8-10 months of the nursery period. The condition of the nurseries under the management of Regional Plantation Companies has been improved to a greater extent in general. However, the nurseries in the private sector, being profit making units, need regular and thorough monitoring throughout. Government nurseries continue to produce about 80 – 90 % of the country's planting material requirement. The productivity and the quality of the plants produce in different nurseries are different owing to the differences in the management.

The nurseries inspected during the year are given in Tables 6 and 7.

Table 6. *RPC nurseries (established in 2004 January 2005 August and 2006 January)*

Company	Number of estates	Number of Nurseries	No. of plants establish	Plants certification - 2006		
				Young budding	Bare roots	Total
Agalawatta	7	14	201,195	119,016	34,000	153,016
Balangoda	4	7	53,552	36,250	0	36,250
Elpitiya	2	3	40,000	300	11,900	12,200
Hapugastenna	2	2	13,900	6,000	0	6,000
Horana	4	4	100,100	8,700	41,950	50,650
Kahawatta	1	2	120,000	55,000	13,200	68,200
Kegalla	9	13	137,979	80,775	0	80,775
Kelani Velley	11	14	233,500	126,713	0	126,713
Kotagala	9	13	159,660	100,350	2,244	102,594
Lalan	1	1	149,000	100,000	0	100,000
Malwatta Velly	5	6	165,998	110,526	0	110,526
Pussellawa	5	8	89,557	30,409	15,817	46,226
Total	**60**	**87**	**1,464,441**	**774,039**	**119,111**	**893,150**

Planting techniques

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

Mean girth and the girth increments are shown in the Table 8 for the two types of planting materials and for the five different treatments tested. As it is shown in the Table 8, there aren't significant differences among treatments or the planting materials. Girth increment is higher in the young buddings with compared to that of the polybag plants. This is due to the fact that both clearings are in tapping and the post harvest girth of RRIC 121 being very high with compared to that of PB 260.

Table 7. *Government nurseries (established in 2005 January, 2005 August, and 2006 January nurseries)*

Name of Government nursery	Nurseries inspected	No. of plants established	Number of plants certified		
			YB	BR	Total
Egaloya	05-AUG-YB	250,000	84,800	0	84,800
Egaloya	06-Jan-YB	217,000	120,000	0	120,000
	Total	**467,000**	**204,800**	**0**	204,800
Gurugoda	05-AUG-YB	300,000	104,000	0	104,000
Gurugoda	06-Jan-YB	250,000	150,000	0	150,000
	Total	**550,000**	**254,000**	**0**	**254,000**
Karapinche	05-AUG-YB	200,000	83,000	0	83,000
Karapinche	06-Jan-YB	170,000	0	0	0
	Total	**370,000**	**83,000**	**0**	**83,000**
Meregama	05-Jan-GN	70,000	0	19,000	19,000
Meregama	05-AUG-YB	300,000	181,000	0	181,000
Meregama	06-Jan-YB	250,000	140,000	0	140,000
	Total	**550,000**	**321,000**	**19,000**	**340,000**
Monaragala	05-JAN-GN	100,000	0	46,060	46,060
Monaragala	05-AUG-YB	200,000	86,000	0	86,000
Monaragala	06-Jan-YB	242,000	50,000	0	50,000
	Total	**442,000**	**136,000**	**46,060**	**182,060**
Walikadamulla	05-Jan-GN	150,000	0	39,000	39,000
Walikadamulla	05-Jan-YB	240,000	5,000	0	5,000
Walikadamulla	05-AUG-GN	200,000	0	80,000	80,000
Walikadamulla	05-AUG-YB	250,000	110,000	0	110,000
Walikadamulla	06-Jan-YB	275,000	160,000	0	160,000
Total		**725,000**	**275,000**	**119,000**	**394,000**
Grand Total		**3,104,000**			**1,457,860**

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

Table 8. *Mean girth, girth increment and SEM of the plants (RRI 121 and PB 260) of different treatments*

Treatment	Young budding RRIC 121 1999 N/E		Poly bag PB 260 1999 S/W	
	Mean girth (cm)	Girth increment (cm)	Mean girth (cm)	Girth increment (cm)
T1 - With the poly bags	54.470 (±1.160)	2.940 (±0.378)	50.620 (±1.199)	0.650 (±0.121)
T2 - Base of the bag removed	54.363 (±1.596)	3.042 (±0.333)	54.240 (±1.518)	0.790 (±0.179)
T3 - Base of the bag removed + four silts	56.065 (±1.288)	3.050 (±0.375)	55.189 (±1.895)	0.778 (±0.178)
T4 - four silts only	56.847 (±1.461)	3.058 (±0.390)	54.150 (±1.213)	0.975 (±0.185)
T5 - bag removed as recommended	57.182 (±1.386)	3.147 (±0.353)	58.720 (±2.000)	1.000 (±0.220)

(P Seneviratne and U S Weerakoon).

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

Details of the experiment are given in Annual Review for 2001. Girth and the girth increment of the plants are given in the Table 9 and 10. The average girth of the plants grown in three types of planting holes and the girth increments are not significantly different. Girth of the plants in good soil conditions is significantly higher with compared to those grown in poor soil conditions though the differences are small. A correlation exists between the initial girth and the girth measured up to the year under review. As it can be seen from the data given, the correlation is high with better soil conditions indicating that the effect of the quality of the plants are shown better when the field conditions are favourable for the growth.

Table 9. *Girth of plants grown in three types of planting holes*

Soil condition	Girth (cm)	Girth increment
Bad	45.46 (± 0.104)	6.06
Moderate	45.65 (± 0.695)	6.10
Good	47.04 (± 0.379)	6.17

Table 10. *Correlation of girth increment and initial girth*

	Girth (cm)		
	Bad	**Moderate**	**Good**
Correlation coefficient (r)	0.41106	0.57151	0.58230
P value	< 0.0001	< 0.0001	< 0.0001
Sample size (n)	139	84	253
STDEV	5.412	6.372	6.034
SEM	0.104	0.695	0.379

(P Seneviratne and L Zoysa).

Cultural practices during immature phase

Branch induction – CP/2001/1 – Pallegoda

Different branching treatments were tested in this experiment to see the most effective one. As it can be seen from the data in Table 11. Leaf cap method has shown the highest girthing in both mixed and RRIC 121 blocks. Though the differences are not significant in clone RRIC 121, significant difference is seen among treatments in the mixed clonal area.

Table 11. *Girth of the trees of different branch induction treatments*

	Girth (cm)	
Treatment	**RRIC 121**	**Mixed clones**
T1 - Leaf cap	74.072 (±1.588)	64.360 (±1.617)
T2 - Leaves cut	72.203 (±1.294)	59.071 (±2.174)
T3 - 3" long apex removed	73.632 (±1.429)	60.311 (±2.033)
T4 – Control	72.965 (±1.182)	54.980 (±3.029)

(P Seneviratne and U S Weerakoon).

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

Details of the experimental layout are given in the Annual Review for 1992. Growth and yield parameters of the clones tested under four different densities are given in Table 12. Generally, growth and yield parameters of rubber, as indicated in Table 12 (a), significantly decreased with the increase in planting density resulting in lower levels of tree yield (g/t/t) in high densities, Table 12 (b). At present % trees in tapping was generally higher in higher planting densities.

Yield per hectare has increased, with increase in planting density, though the differences are not significant.

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

(a)

Density	RRIC 100				RRIC 110				RRIC 121			
	Girth (cm)	Bark thickness (mm)	% Trees in tapping	Tappable trees/ha	Girth (cm)	BT (mm)	% Trees in tapping	Tappable trees/ha	Girth (cm)	BT (mm)	% Trees in tapping	Tappable trees/ha
500	64.15	7.70	72.78	364	58.74	6.69	72.05	360	72.59	7.43	80.68	403
600	62.44	7.82	76.46	459	53.97	6.37	60.05	360	68.62	7.40	87.52	525
700	58.30	7.64	80.52	564	51.82	6.38	47.91	335	67.42	6.94	80.00	560
800	58.25	7.52	75.73	606	51.80	6.28	52.18	417	65.21	6.81	82.27	658

(b)

	RRIC 100		RRIC 110		RRIC 121	
Density (tree/ha)	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	21.91	1137	20.88	1076	39.75	2252
600	22.58	1613	21.47	1110	33.83	2508
700	17.28	1346	18.74	876	33.84	2668
800	19.20	1643	17.47	1053	28.32	2640

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

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

This experiment was established to study the effect of density on the growth and the yield. Details of the experiment was reported in the Annual Review for 1996. Effective trees in each block at Nivitigalakele were marked and arrangements were made to record daily yield data. Girth measurements at 5' height from the graft union were recorded at the end of year 2006. According to the data collected, girth decreased with increasing planting density irrespective of the clone. Individual clone g/t/t was highest at the lowest density (Table 13).

Table 13 . *Effect of planting density on growth and yield parameters of rubber*

Density /ha	RRIC 100			RRIC 121			RRIC 133			PB 260		
	Girth (cm)	g/t/t	YPH (kg)	Girth	g/t/t	YPH (kg)	Girth	g/t/t	YPH (kg)	Girth	g/t/t	YPH (kg)
350	81.8	33.4	818.3	81.6	35.7	918.7	83.8	34.7	850.1	77.3	36.1	1263.5
425	78.6	33.1	984.7	77.5	34.8	1035.3	79.0	32.8	975.8	74.3	34.3	1020.4
500	70.25	31.3	1095.5	72.6	33.1	1158.5	75.4	32.9	1151.5	67.2	34.0	1190.0
575	67.4	29.2	1175.3	72.6	30.6	1231.6	68.5	30.0	1207.5	67.3	30.7	1235.6

Number of tapping days recorded in the year 2006 was 70.

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

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

The trial is now completed and the maintenance of the clearings is done by the estate. The trial indicated that rubber can be grown successfully in high elevations up to about 600m provided that the clone selection is done judiciously in order to prevent from common foliar diseases (A Nugawela, in collaboration with all biology departments).

Exploitation

Low frequency tapping

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

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

Details of the LFT systems together with stimulation schedule are given in Table 14.

Table 14. *Tapping systems and the stimulation schedule for the treatments*

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

One tapping block from each clone was allocated for the experiment. In each block 25 trees each were allocated to T_1 & T_3 treatments and the rest of the trees in the block were tapped according to the T_2 treatment.

Daily latex yields were monitored using volumetric measurements of latex and metrolac measurement for DRC %. For three clones (*i.e.* RRIC 100, RRIC 121 and RRIC 130), yield records on d/3 tapping were obtained from estate records (An additional tapping block was not available for RRIC 102).

Table 15. *Summary of the yield parameters of low frequency tapping systems*

Treatment	Clone	g/t/t	Tapping days (10 months)	STD	YPH (10 months)	Average DRC (%)
T_1 - ½ S d_2	RRIC 100	55.2	105	500	2898.0	32
	RRIC 102	51	103	500	2626.5	34
	RRIC 121	49.3	103	500	2538.9	38
	RRIC 130	47.6	106	500	2522.8	38
T_2 - ½ S d_4	RRIC 100	57.2	55	500	1573.0	34
2.5% ET	RRIC 102	63.9	51	500	1629.4	36
	RRIC 121	54.9	51	500	1399.9	38
	RRIC 130	57.6	53	500	1526.4	40
T_3 - ½ S d_6	RRIC 100	72.7	32	500	1163.2	30
2.5% ET	RRIC 102	67.8	27	500	915.3	34
	RRIC 121	63.3	30	500	949.5	38
	RRIC 130	58.3	35	500	1020.0	36
T_4 - ½ S d/3	RRIC 100	35.8	92	500	1646.8	30
2.5% ET	RRIC 102	-	-	-	-	-
	RRIC 121	54.8	87	500	2383.8	38
	RRIC 130	44.1	90	500	1984.5	38

Although g/t/t was higher in d_6 tapping YPH was comparable among the tapping systems (Table 15). Stimulation showed no adverse effect on DRC which was generally over 30% (V H L Rodrigo, A Wickramarathne and R K Samarasekera).

Girth at opening (TG/99/1)

The objective of this trial to develop tapping systems to harvest optimum yields of new clones while minimizing immature period and cost of tapping. Details of the experiment are given in Annual Review for 2001. Yield data collection was not done during the year under review and the clearing was tapped under 1/2S d3 + 2.5 Eth. by the estate. All untapped trees too were open for tapping in February 2006. The girth and the girth increment of different clones are given in Table 16 and 17.

Table 16. *The girth increment of three clones and the three girth classes along with uptapped treatment*

Clone	Mean girth increment				
	G_{40}	G_{45}	G_{50}	Clone	Untapped tapped from March 2006
RRIC 102	1.33	0.86	1.16	1.11	1.38
RRIC 121	1.33	1.36	1.34	1.35	2.54
RRIC 211	0.57	0.92	1.25	0.8	1.01

Table 17. *Mean girth of the treatment for all three clones under different tapping systems*

Clone	Mean girth				
	G_{40}	G_{45}	G_{50}	Clone	Untapped tapped from March 2006
RRIC 102	59.73	59.52	61.01	60.09	81.6
RRIC 121	66.13	67.5	67.1	66.9	77.63
RRIC 211	49.69	55.72	54.32	53.24	60.4

(P Seneviratne and R P Karunasena)

Tapping panel dryness

Survey on tapping panel dryness (TPD/2002/01) (CARP funded Project – 12/478/358)

The results of the survey indicated the importance of avoiding shallow/ water logging areas in planting, use of good quality planting material, better immature upkeep and low frequency tapping in minimising the TPD disorder. Please refer the final report of the project listed under the list of references for more details (A M W K Senevirathna, S Wilbert and S Wijesinghe).

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

This was discontinued due to malpractices in tapping (A M W K Senevirathna, S Wilbert and S Wijesinghe).

Continuous monitoring of TPD (TPD/2002/03)

Summary of the results of ten tapping blocks monitored in RRIC 100, 102, 121 and RRIC 130 clones are shown in figures 1 and 2. According to the figure 1, the incidence of TPD (fully and partially dry) has been increased gradually with time. In RRIC 130, % TPD has been increased rapidly from *ca.* 10 to 40% at the end of three years of tapping and then dropped to *ca.* 25%. Such higher values are mainly due to the high intensity of tapping over the recommendation in some sites. After 4 years of tapping in RRIC 100, there was a sudden increase in TPD and then backed to *ca.* 10% through a fluctuation (Fig. 1). Such fluctuations are mainly due to the recovery of some affected trees with re-opening after a period of rest. Figure 2 shows the changes in different categories of TPD (P- partial dry, F- fully dry, P to F conversion and Recovered trees) at the end of the reporting year. Generally in any clone *ca.* 15-20% recovery of TPD and *ca.* 25% of conversion from partial to full (P to F) were observed. On average about 40% of dry trees were fully dry throughout (A M W K Senevirathna, S Wilbert, S Wijesinghe, R K Samarasekara and K A G B Amaratunga).

Biochemical analyses (TPD/2002/04)

Analysis of bark sugars using HPLC showed that sucrose content of TPD affected trees are high compared with healthy trees. Analyses of bark proteins did not

reveal distinct patterns among clones or the type of trees (affected/unaffected). The final report mentioned in the section *TPD/2002/01* above has more details (A M W K Senevirathna in collaboration with Biochemistry Department).

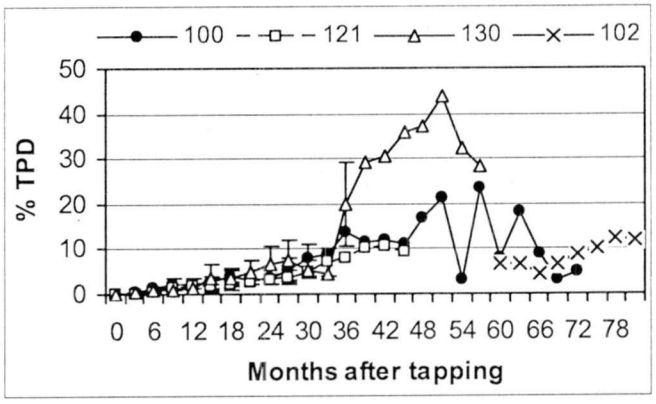


Fig. 1. Changes in % TPD (partial + full) of clones RRIC 100,102,121 and 130 with time monitored regularly

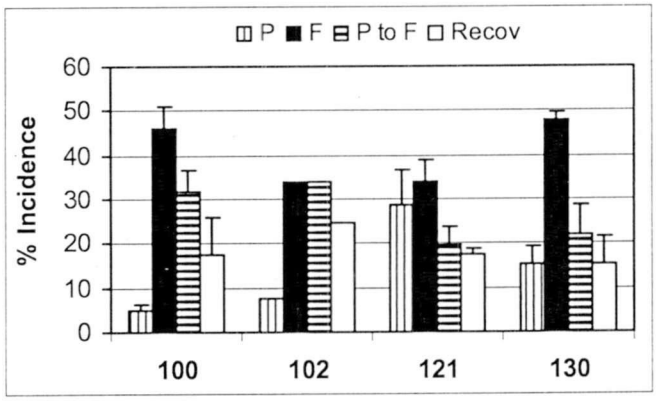


Fig. 2. Changes in different categories of TPD (P- partial dry, F- fully dry, P to F conversion and recovered trees) of clones RRIC 100,102,121 and 130 monitored regularly

In addition to these, tappers involved in the survey were interviewed for the collection of local knowledge incorporated in TPD. Most of tappers pointed out that tapping on panels when they are wet and tapping in rainy weather cause the high intensity of TPD (A M W K Senevirathna, S Wilbert, S Wijesinghe, R K Samarasekara and K A G B Amaratunga) (CARP funded Project – 12/478/358).

Testing of Siva's Formulation (TPD/2006/01)

A sample of Siva's Formulation (SF) given to the RRISL was test in the field during the middle part of the year. Only one tapping block of RRIC 121 planted in 1987 in Dartonfield estate was selected for the experiment due to the smaller size of the SF sample. 10 TPD affected trees were treated with SF at a rate of 1g per tree at 10 day intervals for 10 treatment cycles. Another 10 affected trees and five healthy trees were kept as controls without treating. All the selected trees were tapped at ½ Sd_2 intensity and latex flow rate and volume per tree were taken for each tapping throughout the period of treatment and afterwards 50 ml pooled samples from each treatment were taken from each tapping and oven dried to estimate the g/t/t. Data taken up to the end of the year are summarised in the Table 18.

Table 18. *Summary of the results of the treatment of Siva's Formulation (SF) for TPD*

	During the period of treatment			After the treatment (3 months)		
	Flow rate ml/min	Volume/ tree/tap	Yield (g/t/t)	Flow rate ml/min	Volume/ tree/tap	Yield (g/t/t)
Treated	0.5 ± 0.1	39.2 ± 3.7	14.2 ± 1.5	0.1 ± 0.0	9.0 ± 0.8	4.2 ± 0.3
Non-treated	1.2 ± 0.1	38.6 ± 2.1	14.4 ± 1.2	0.9 ±0.0	26.2 ± 1.1	10.1 ± 0.6
Healthy	4.4 ± 0.1	95.2 ± 3.4	35.0 ± 1.5	2.6 ± 0.1	73.0 ± 2.4	29.3 ± 1.3

(A M W K Senevirathna and S Wilbert)

Rubber and oil palm (2006)

The National Science Foundation of Sri Lanka granted 1.13 million rupees to study the 'comparative growth, photosynthetic rate and water use of rubber (*Hevea brasiliensis* Muell. Arg.) and oil palm (*Elaeis guineensis* Jacq.) grown in existing plantations in Sri Lanka' (RG/2005/AG/13).

Experimental site was selected from the Culloden estate, Neboda which belongs to the Agalawatta Plantations Ltd. For the study, oil palm planted in 2001, 2003, 2004 and rubber planted in 2005 were selected. From each oil palm plantation three replicates of 12 tree plots and five replicates of 20 tree plots from rubber plantation were demarcated for the experiment.

Girth and leaf development of rubber and leaf development of oil palm were taken as regular growth measurements. Leaf photosynthesis, transpiration and chlorophyll fluorescence were also taken from both crops. In addition, daily weather data and regular soil moisture measurements were also taken (A M W K Senevirathna, W Karunathilake, H Jayaneththi and R P N P Sanjeewa).

Irrigation systems in Moneragala rubber nursery

This experiment on different irrigation methods was carried out in Monaragala rubber nursery to assess the most convenient and cost effective irrigation method over manual watering.

The experiment was carried out in the young budding rubber nursery, Monaragala during a dry period of year 2006.

Four methods of irrigation *i.e*, over head sprinkler, mini-sprinkler, Porus pipe and water jet irrigation systems have been installed in the poly bag nursery according to the Latin Squire Design (LSD), replicating each treatment four times and manual watering was the control. All systems were operated for half an hour which was sufficient for the plants.

Sampling was done in selective manner from each replicate of different treatments and data have been collected every month. Growth of the plants was determined by measuring stem diameter and height of the plant. Daily rainfall was measured using a rain gauge. Data was analyzed using SAS package.

Fig. 3 shows the effect of irrigation on diameter of the poly bag plants two months after irrigation. A significant effect is shown by all micro irrigation methods with compared to manual watering.

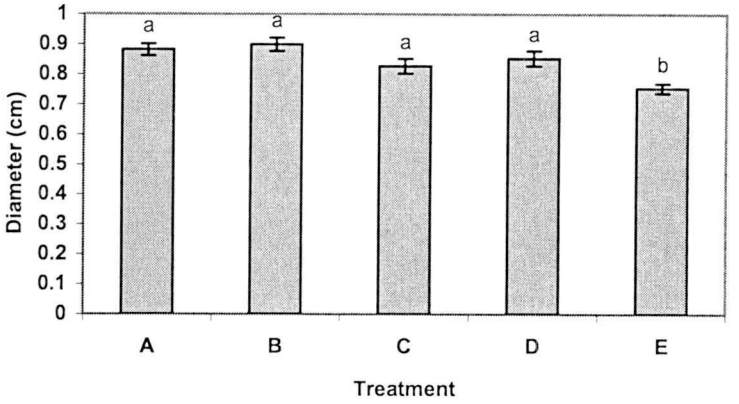


Fig. 3. Mean diameter of the plants in the poly bag nursery under different irrigation methods (After two months of irrigation) A- Overhead Sprinkler, B – Mini–Sprinkler, C – Porous Irrigation, D – Water jet sprayer method, E – Control.

Irrigated plants have shown better growth of plants with compared to manually watered plants and they became buddable earlier. Sprinkler irrigated plants have performed slightly better, through the differences are not significant (P Seneviratne and S A de Silva).

Irrigation systems for rubber nurseries

A large sprinkler irrigation system was successfully installed in Moneragala Government rubber nursery covering over eight hectares and having about 2500 sprinklers. It was the largest Sprinkler Irrigation system installed in a rubber nursery in Sri Lanka (P Seneviratne, S A de Silva and D Pathirana).

Inspection of irrigation systems

The irrigation systems which were installed under RPCs Capital Grant subsidy scheme were inspected by the staff of the department and the payments were recommended (P Seneviratne, S A de Silva and D Pathirana).

Intercropping

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

Details of experimental layout were reported in the annual review for 2002. Out of the three replicates, grafted Durian plants in replicate 1 and 2 completely died and infilling was done with grafted Jak plants and seedlings of Durian plants respectively. Growth measurements of rubber, rambutan and tea were taken at six month intervals. Harvesting of Cinnamon was continued through out the year 2006. Rambutan flowered in March and assessments on fruit set was done. Tea was harvested throughout the year. Growth of rubber in T_3 & T_4 *i.e.* wider within row systems was higher than that in other two systems (Table 19). Growth of Rambutan was comparable among treatments (Table 20).

Table 19. *Summary on the growth performance of rubber. Values for girth increment are given for a period of 12 months and measurements were taken at 150 cm height*

Treatments	Rubber			
	Planted in 2001		Planted in 2000	
	Girth (cm)	Girth increment (cm/year)	Girth (cm)	Girth increment (cm/year)
T1- (3mx3m) ×15m	42.74	6.26	43.04	6.95
T2 -(3mx3m) ×18m	42.77	6.57	42.88	6.27
T3-(3.5mx3.5m) ×15m	42.94	10.12	49.45	7.38
T4-(3.5mx3.5m) ×18m	44.83	7.65	46.96	6.04

Table 20. *Summary of the growth performance of Rambutan and yield performance of tea under different planting arrangements of rubber. Yield of tea is given as the mean fresh weight per bush per year.*

Treatments	Rambutan	Tea yield
	Girth (cm)	g/bush/year
(3m×3m) -15m	34.87	479
(3m×3m) -18m	33.76	528
(3.5m× 3.5m) - 15m	34.50	436
(3.5m× 3.5m) - 18m	32.54	563

(V H L Rodrigo and T U K Silva)

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

This trial investigating the possibility of intercropping indigenous species of Rattan under rubber was established in October 1996 and three indigenous species of

rattan were tested (Annual Review 1996). Most of the canes seem to have grown sufficiently and harvesting was done in November. Canes of *Calamus ovoideus* were larger than those of *Calamus zeylanicus* and 5499 m of canes at the rate Rs.7.77 were sold and an income of Rs.42,727.23 was obtained (L S S Pathiratna and M K P Perera).

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

This experiment was established in 1998 with financial assistance from CARP and details are given in Annual Review for 1998. The growth in girth of rubber trees was highest in the treatment with the widest inter row spacings with single rows of rubber. The growth of rubber in all treatments was comparable with the 8.4m inter row spacing treatment (Table 21).

Highest cinnamon bark yields were obtained in treatments with widest inter row spacings. The bark yields in the treatments with narrow inter row spacings continued to give low yields (Table 22).

Tapping commenced in January 2005 in this trial. The g/t/t yield of rubber was highest in wider inter row spacing treatments with single rows of rubber. Paired row treatments and the treatment with the 7.2m inter row spacing had the lowest yield but was comparable with the 8.4m inter row spacing treatment (Table 23).

Table 21. *The growth of rubber measured as girth in the 8th year*

	Inter row spacing treatments (m)										
	7.2	**8.4**	**9.6**	**10.8**	**12.0**	**13.2**	**13.2**	**14.4**	**15.6**	**16.8**	**18.0**
Girth (cm)*	58.1^{A}	61.1^{ABC}	60.8^{ABC}	62.6^{ABC}	64.0^{AB}	65.4^{AB}	59.7^{BC}	58.7^{BC}	59.8^{BC}	58.0^{C}	60.1^{ABC}

(Values with the same letter are not significantly different)

Table 22. *Cinnamon bark yield kg/ha.*

	Inter row spacing treatments (m)										
Bark yield	**7.2 S** 171.7	**8.4 S** 233.6	**9.6 S** 318.3	**10.8 S** 385.6	**12.0 S** 417.0	**13.2 S** 500.2	**13.2 P** 320.5	**14.4 P** 373.7	**15.6 P** 490.4	**16.8 P** 548.1	**18.0 P** 565.9

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

Table 23. *Rubber yield in grams /tree/tapping*

	Inter row spacing treatments (m)										
	7.2 S	**8.4 S**	**9.6 S**	**10.8 S**	**12.0 S**	**13.2 S**	**13.2 P**	**14.4 P**	**15.6 P**	**16.8 P**	**18.0 P**
Rubber yield g/t/t	31.8^{D}	33.1^{CD}	36.5^{BC}	39.3^{AB}	43.2^{A}	40.1^{AB}	28.9^{D}	29.0^{D}	30.9^{D}	31.1^{D}	30.1^{D}

(Values with the same letter are not significantly different)

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

PLANT PATHOLOGY AND MICROBIOLOGY

C K Jayasinghe

SUMMARY

The incidence of Oidium leaf fall was mild throughout the rubber growing areas. Operations on the management of white root disease was continued in smallholdings clearings as well as in company owned estates. Experiments on agronomic approaches were initiated with the view of minimizing the inoculum potential in the management of Corynespora leaf fall disease. Several floral arrangements have been constructed using partially decomposed rubber leaves. South West Monsoon was delayed and incidence of Phytophthora leaf fall and bark rot was moderate. A new caterpillar attack was detected on the leaves of young rubber plants and immediate steps were taken to manage the infestation by applying the insecticide, chlopyriphos.

DETAILED REVIEW

Dr C K Jayasinghe, Head of the Department, Dr (Miss) W P K Silva, Principal Research Officer, Dr K E Jayasuriya, Principal Research Officer, Mrs T H P S Fernando, Assistant Plant Pathologist and Mr W Amaratunge, Audio Visual Production Officer were on duty throughout the year.

Experimental Officers Mr E B Fernando, Mrs B I Tennakoon, Mrs D Siriwardena, and Mr C Wijeratne, Technical Officers Mr P Pieris, Mrs N Jayawardene and Mr E A D N Nishantha, Clerk Typist, Mrs P Amarasekera and Development Assistant Mrs M Kulatunge, continued to work in the Department.

Seminars/Conferences/Meetings/Workshops attended

Officer	Subject	Organization
Dr C K Jayasinghe	Pesticide Technical Advisory Committee	Dept. of Agriculture
Dr C K Jayasinghe	Specialist Committee on Plant Protection	CARP
Dr C K Jayasinghe	Research Committee Meeting at CRI	CRI
Dr C K Jayasinghe	IRRDB Annual General Meeting and International Conference, Vietnam	IRRDB
Dr C K Jayasinghe	Cambodian Rubber Conference, Cambodia	IRRDB
Dr C K Jayasinghe	Training Course on Corynespora leaf fall disease (as a resource personnel)	IRRDB
Mrs T H P S Fernando	Training on Corynespora leaf fall disease, India	IRRDB

Seminars/Training programmes conducted

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

Visits

The Department staff made 38 advisory, 200 experimental and 120 other visits during the year.

GENERAL

The wintering was uniform and all common canopy diseases were mild throughout the year. No new clones recommended for large scale planting succumbed to *Corynespora* leaf fall disease. White root disease caused by *Rigidoporus microporus* was detected in several new rubber clearings and the CARP funded project on management of white root disease was continued in smallholdings as well as in estates managed by companies. Dr C K Jayasinghe was appointed as the IRRDB Liaison Officer for the Plant Protection Specialist Group. This decision was taken at the IRRDB Annual General Meeting held in India and the Board considered the appointment as an honour to Dr C K Jayasinghe and the Rubber Research Institute of Sri Lanka.

LABORATORY AND FIELD INVESTIGATIONS

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

In vitro *screening of fungicides against* Rigidoporus microporus

A new fungicide containing Propiconazole called "Bumper" was screened in the lab against *R. microporus* and found that the efficacy was quite similar to that of Hexaconazol which is recommended. Field trials using Propiconazol were in progress (K E Jayasuriya, B I Tennakoon and E B Fernando).

Screening of new-generation fungicides to develop an integrated disease management system

In vitro screening of nine fungicides including several systemics against *Corynespora cassiicola* was completed. It was observed that the fungicides tebuconazole, hexaconazole, mancozeb, ridomil and carbendazim can inhibit the growth and germination of the conidia of the fungus.

The experiment is in progress to test chemicals under nursery conditions (C K Jayasinghe, T H P S Fernando and J V Rathnasinghe).

Biology of common pathogens (BCP/90/1)

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

This experiment will be commenced after purchasing a freeze dryer next year (C K Jayasinghe, W P K Silva and N Nishantha).

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

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

This method involved with the dipping of detached leaves into known quantities of crude toxin samples. The results showed (Table 1) that there is a variation in the behaviour of toxin on *Hevea* clones.

Table 1. *Effect of toxin on different clones – 18h. after inoculation by leaf wilt bio-assay*

	Isolate No.			
Clone	**Control**	**Pd15**	**B**	**Cory 14**
RRIC 121 field	-	+	+	+
RRIC 121 Polybag	-	+	-	+
RRIC 121 Budwood	-	++	+++	++
RRISL 223 field	-	+++	+++	+++
RRISL 2001 Budwood	-	+	+	+
RRIC 100 field	-	++	+	+++
RRIC 110 field	-	+++	+	++
RRIC 100 Budwood	-	+	+++	+++

- \- Normal position
- \+ Slight wilting
- ++ Moderate wilting
- +++ Severe wilting

The observations of the *in vitro* screening did not agree with the different degrees of susceptibility observed under field conditions. In the light of this situation further screening of clones using the crude toxin was terminated and it was decided that studies should be carried out to develop the clonal screening system using purified toxin of *C. cassiicola* (W P K Silva, C K Jayasinghe, N Nishantha and T H P S Fernando).

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

PCR was done with RGA (Resistant Gene Analog) markers and amplified fragments were separated using 5% polyacrylamide gel electrophoresis. A clear banding pattern could not be observed following silver staining procedure. Hence

radio isotopes were used to enhance the bands. There were some bands unique to resistant clones and some were unique to susceptible clones. These bands could be used to develop primers for the identification of resistant and susceptible clones for CLF disease (W P K Silva, C K Jayasinghe, N Nishantha, A Jayakody and E H Karunanayake. This is a collaborative project with the University of Colombo and partly funded by CARP).

Maintenance of nurseries established for screening purpose

Several visits were made to the above nurseries and pollarding and manuring were done. Screening of clones against Corynespora leaf disease was completed and none of the clones found to be affected with Corynespora leaf spot disease except the previously reported ones (C K Jayasinghe, W P K Silva, T H P S Fernando and C Wijeratne).

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

Biological control of white root disease

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

Biological control of rubber nursery diseases

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

Biological control of bark and stem diseases

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

MISCELLANEOUS

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

The field trial at Gallewatta division was in progress (K E Jayasuriya, C K Jayasinghe, E B Fernando and P Pieris)

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

Treatments were repeated whenever necessary and monitored for success rates (K E Jayasuriya, C K Jayasinghe, E B Fernando and B I Tennakoon).

Repellants against rodents and mammalian pests in rubber lands

Field trial in a small holding at Maggona was in progress. The formulation containing Chili and tobacco was tested using latex diluted at 1:4 used as the basal medium for application. A different formulation containing TMTD as the active ingredients was also tested at preliminary level (K E Jayasuriya, C K Jayasinghe, K M M E K Kulatunga, B I Tennakoon and E B Fernando).

Decorative handicrafts from partially decomposed rubber leaves

Several floral arrangements have been prepared and economics of the preparations of various floral arrangements have been calculated and it was shown that the cost vary from Rs.50.00 to 2000.00 depending on the type of creation. Several brands of pigments were tested for their colour lasting ability with a view of avoiding fading of floral arrangements (C K Jayasinghe and N Jayawardene).

Bark cracking disorder of rootstocks

An experiment was designed to test the effectiveness of three fungicides in controlling the above disorder. This experiment is in progress (W P K Silva, C K Jayasinghe and N Nishantha).

Improving management strategies in combating Corynespora leaf fall disease: project funded by Common Fund for Commodities (CFC)

Experiments on agronomic approaches to minimize the inoculum potential in the field were commenced.

Establishment of multiclonal clearings

Two multiclonal clearings were established with disease resistant and susceptible clones at Kuruwita substation, Ratnapura.

	:	Clones planted
Site 1	:	RRISL 203/RRISL 2001/RRISL 202
Site 2	:	RRISL 203/RRIC 121/RRISL 202

Growth parameters and the disease condition of the canopy is being monitored (C K Jayasinghe and T H P S Fernando).

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

Three fertilizer levels have been applied on RRISL 202, 201 and 217. *Corynespora* susceptible clones grown at RRISL substation, Kuruwita. Girth measurements, disease intensity of the canopy and other parameters were monitored (C K Jayasinghe, T H P S Fernando - collaborative with Soils and Plant Nutrition Department).

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

The above survey was carried out in all rubber growing areas in the island. It was found that none of the clones recommended for large scale planting was infected with this disease. Slight infections were found in two clones *viz.* RRISL 218 and RRISL 217. Clones RRISL 201, RRISL 208 had showed moderate infection (Table 2).

Table 2. *Disease intensity score of the clones in the RRISL recommendation list*

Clone	Average disease severity index
RRIC 100	0
RRIC 102	0
RRIC 121	0
RRIC 130	0
PB 217	0
PB 28/59	0
RRIC 117	0
RRIC 133	0.33
RRISL 203	0
RRISL 205	0
RRISL 206	0
RRISL 211	0
RRISL 215	0
PB235	0
PB 260	0
BPM 24	0
RRISL 201	1.19
RRISL 217	0.55
RRISL 204	0
RRISL 208	1.00
RRISL 218	0
RRISL 220	0
RRISL 221	0
RRISL 222	0
RRISL 226	0
GPS 1	0
PB 255	0
PR 255	0
RRII 105	0
RRISL 2000	0
RRISL 2001	0
RRISL 219	0

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

Occurrence of Septobasidium sp. on *Hevea brasiliensis*

Artificial inoculations proved that *Septobasidium* sp. is not parasitic on rubber. Growth of this fungus as entomopathogen is possible. Observations are in progress (C K Jayasinghe, T H P S Fernando and N Nishantha).

Cockchafer grub epidemic

In vitro experiments were continued with the view of developing a biological control system using the fungus, *Metarhizium anisopliae*. New epidemics were reported from few estates in Eheliyagoda and Ingiriya (C K Jayasinghe and M Kulatunga).

Caterpillar attack on young rubber plants

Leaf eating caterpillar attack was reported on young rubber plants in Eheliyagoda area. Young rubber leaves were entirely consumed and old ones were skelitanised. Severely affected two whorl plants showed die-back symptoms.

The attacking caterpillar was identified as the larval stage of *Tiracola plagiata* Moth. Further investigations revealed that *Mucuna bracteata* grown in the clearing as the cover was also affected by this caterpillar and the legume cover has provided the breeding grounds for the Moth. Immediate steps were taken to screen chemicals against leaf eating caterpillar and brought it under control by spraying the insecticide Chlopyriphos (C K Jayasinghe and M Kulatunge).

SOILS AND PLANT NUTRITION

R S Dharmakeerthi

SUMMARY

In order to minimize soil erosion losses during land preparation and field establishment periods, an effective cover crop management strategy was introduced. Establishment of *Mucuna* at least one year prior to uprooting will provide very good ground cover at the time of planting of rubber. Since the soil erosion loss is highest during the land preparation periods, adoption of this strategy will significantly reduce the rate of soil degradation during rubber replanting.

It was found that imported rock phosphate could be substituted with high grade Eppawala Rock Phosphate (HERP) in young budding nurseries. However, it was also found that the effectiveness of basal application of 50g of rock phosphate in young budding nurseries could vary with the soil condition.

Results from four field trials representing different soil conditions suggest that dolomite could be used as the Mg fertilizer during the first year after planting. The optimum quantity of dolomite and time of application needs to be determined. However, for Mg sensitive clones such as RRIC 102, it is advisable to apply kieserite as the Mg source during the first year.

More effective weedicides to control young and large Diyapara (*Womia triquestra*) plants in rubber plantations were identified. Spraying or application of concentrated Gramoxone and Cocktails of MCPA 60 and 2.4.D Amine on cut surfaces were found effective in controlling Diyapara.

The site-specific fertilizer recommendation programme for mature rubber provided fertilizer recommendations for 7500 hectares in the estate sector. Under the land selection programme for planting rubber 175 hectares in traditional and non traditional areas were surveyed. The department also analyzed approximately 250 different samples (1000 parameters) for outside organizations during the year.

DETAILED REVIEW

Staff

The Head of the Department, Dr (Mrs) Lalani Samarappuli was on duty until she went on no pay leave from August 01, 2006. Dr R S Dharmakeerthi, Soils Chemist and Mrs R Hettiarachchi, Assistant Soils Chemist, were on duty throughout the year. Assistant Soils Chemist, Mr D N P Wickramasinghe was served with vacated of post with effect from August 2006. Dr R S Dharmakeerthi was appointed as the acting Head with effect from August 15, 2006.

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

Research students

- Miss S H I T H Jayathilaka, an undergraduate student from the University of Peradeniya, completed her final year project on "Ammonia voilatilization from selected rubber growing soils fertilized with urea" under the supervision of Dr R S Dharmakeerthi.

- Mr T R Attygalle, an undergraduate student from the University of Peradeniya, completed his final year project on "Spatial variation of selected soil properties in a rubber plantation" under the supervision of Dr R S Dharmakeerthi.

Seminars/Conferences/Meetings/Work-shops addressed

Officer	Subject	Organization
R S Dharmakeerthi	National fertilizer day work shop on Fertilizer practices in plantation crop sector	Soil Science Society of Sri Lanka
R S Dharmakeerthi	Revised fertilizer recommendation for young budding nurseries	Scientific Committee Meeting, RRISL
R S Dharmakeerthi	International Natural Rubber Conference, Ho Chi Minh City, Vietnam	IRRDB and VRRI
R S Dharmakeerthi	Fertilizer application to rubber	Lalan Rubbers

Seminars/Conferences/Meetings/Work-shops attended

Officer	Subject	Organization
R S Dharmakeerthi	National Fertilizer Advisory Committee Meetings	National Fertilizer Secretariat
R S Dharmakeerthi	Annual Meetings, Soil Science Society of Sri Lanka 2006	Soil Science Society of Sri Lanka
R S Dharmakeerthi	Annual Meetings, Geo-Informatics 2006	Geo-Infomatics Society of Sri Lanka

Training programmes

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

Advisory visits

Client	No. of visits
Plantations	15
Smallholdings	9

LABORATORY AND FIELD INVESTIGATIONS

Soil fertility management

Ground cover management

Planting practices for tree legumes

Four field experiments are in progress, three in intermediate zone; at Nottinghill estate, Kahapathwela, Dammeria estate, Passara, Nalanda estate, Naula and the other experiment in wet zone; at Dorset division, Clyde estate, Tebuwana to study the performance of *Gliricidia sepium* as a successful tree legume species that can be grown between the rows of rubber plants which could provide wood material as energy for dendro power and leaf material as green manure. Growth measurements in three experiments are presented in Table 1 (Lalani Samarappuli, P Karunadasa, U Mitrasena and T Gunathilake).

Table 1. *Effect of different treatments on growth of rubber plants*

Treatments	Nottinghill 18 monthsGirth (cm)	Dameria 12 months Girth (cm)	Nalanda 12 months Diameter (mm)
Control	9.6 [A]	9.0 [A]	10.9 [A]
Mucuna	10.1 [A]	8.9 [A]	11.2 [A]
Gliricidia 450 sticks/ha (single row)	9.7 [A]	9.1 [A]	10.8 [A]
Gliricidia 900 sticks /ha (Double row)	9.1 [A]	9.7 [A]	11.2 [A]

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

New cover crop species

The experiment started to study the performance of *Mucuna bracteata* in different shade conditions under mature rubber is in progress at Payagala estate, Dartonfield estate, Salawa estate, Weniwella estate, and RRI sub station, Kuruwita. The biomass content of *Mucuna* was weighed at different shade conditions such as Low, medium and high at Kuruvita Sub station (Lalani Samarappuli, P Karunadasa, and U Mitrasena).

Weeds and weed control

Circle weeding

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

Integrated management of different weed species

Several field experiments were in progress to identify effective management practices to control *Wedelia trilobata* (Arunadevi), *Gleichenia linearis* (kekeilla), *Wormia triquetra* (Diyapara) and *Thanbargia* spp. in rubber plantations. Data collected in these experiments were being analyzed. It was found that both young plants and large trees of *Wormia triquetra* (Diyapara) can be controlled by application of concentrated paraquat and 2.4 D Amine. Spraying on young plants or application on cut surfaces in large trees were found effective (Lalani Samarappuli, A Thevarapperuma and T Gunatilake).

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

Mulching

Girth measurements in the two field experiments at Bibile estate, Bibile and Nottinghill estate, Kahapathwela to study the effect of mulching on growth of *Hevea* plants are given in Table 2 (Lalani Samarappuli, P Karunadasa, U Mitrasena and T Dissanayake).

Table 2. *Effect of mulching on girth of rubber plants*

Treatment	Bibile Girth (cm) 8 yrs	Kahapathwela Girth (cm) 7 yrs
No mulch	55.5 ^{B}	56.9 ^{B}
With mulch	58.7 ^{A}	61.2 ^{A}

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

The effectiveness of different mulching materials on growth of *Hevea* plants grown in comparatively drier areas are being studied in a field experiment (SMC-Ag/M/99/1) at Nottinghill estate, Kahapathwela. Effect of paddy straw, coir dust, paddy husk, and green manure on growth of rubber plants are given in Table 3. Test tapping was continued (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 3. *Effect of different mulching materials on growth of rubber plants*

Treatment	Girth (cm)
No mulch	55.7 ^{B}
Paddy husk	60.4 ^{A}
Coir Dust	58.8 ^{A}
Green manure	61.5 ^{A}
Paddy straw	60.9 ^{A}

(Means with same letter are not significantly different)

Ground cover management

The performance of *Mucuna bracteata* in comparison with *Pueraria phaseoloides* under dry agro-climatic conditions was studied in an experiment started in a 1998 replanting at Kumarawatta estate, Monaragala. In the same experiment the effect of different planting systems of *Crotolaria micans* and *Flemingia macrophylla* as successful tree legumes under dryer climatic condition was also studied. Girth at eight years after planting under two situations are given in Tables 4 and 5, respectively (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 4. *Effect of growing* Mucuna *on girth of rubber*

Species	Girth (cm)
Pueraria phaseoloides	52.9 ^{B}
Mucuna bracteata	57.3 ^{A}

(Means with same letter are not significantly different)

Table 5. *Effect of different planting systems of tree legumes on girth of rubber plants*

Treatment	Girth (cm)
Crotolaria micans	56.4 ^{A}
Flemingia macrophylla	57.6 ^{A}
Flemingia + Crotolaria	57.7 ^{A}

(Means with same letter are not significantly different)

Fertilizer practices for overcoming moisture stress

Effectiveness of potassium and mulching to overcome moisture stress and to improve growth of *Hevea* under two different agro-climatic conditions, comparatively intermediate and dry, was studied in two field experiments SMC-Ag/F/99/1 and SMC-Ag/F/98/1 at Nottinghill estate, Kahapathwela and Bibile estate, Bibile, respectively. Two K levels (recommended and double the recommended level) with and without a surface mulch were applied in these experiments. Test tapping was continued (Lalani Samarappuli, P Karunadasa and U Mitrasena).

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

The objective of this study is to highlight the potential of rubber plantations to carbon trading through carbon sequestration under Sri Lankan conditions. Uprooted trees of different ages and different clones were analyses to estimate Biomass accumulation in various parts of the trees. Average % dry matter partitioning in rubber trees of different clones and ages is presented in Fig. 1.

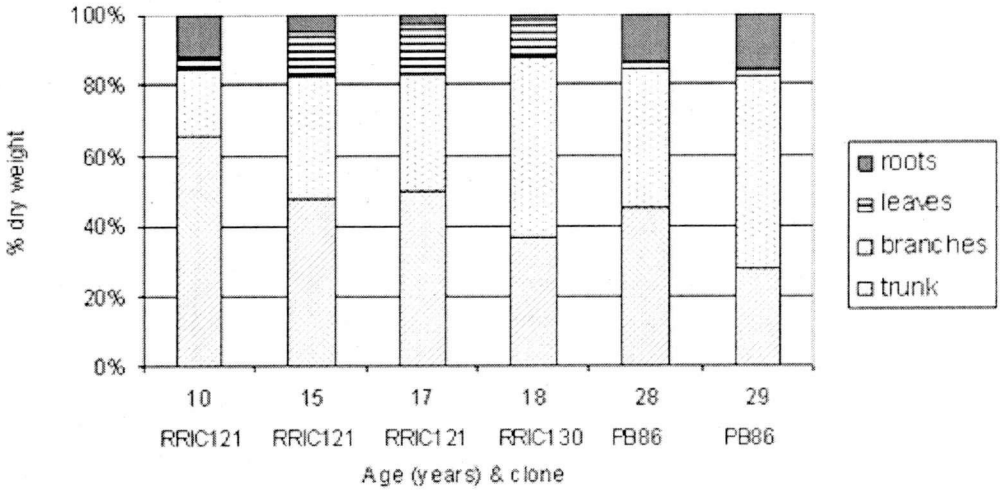


Fig 1. Dry matter partitioning of different clones

Further analyses are in progress and opportunities are being explored to submit proposals for carbon trading (Lalani Samarappuli, Wasana Wijesuriya, T Dissanayake, U Mithrasena and T Gunathilake).

Fertilizer use and plant nutrition

Fertilizers to nursery plants

Fertilizer use and plant nutrition

Fertilizers to nursery plants

Frequency of fertilizer application

An experiment was started at Galewatta Division, Dartonfield Estate, Agalawatta to further ascertain the possibilities of reducing fertilizer application frequency together with continuous application in young budding nurseries. Measurement on scion growth (Table 6) did not show any significant difference among current recommendation and continuous and/or reduced fertilizer application. Experiment is in progress (R S Dharmakeerthi, S Chandrasiri and V Edirimanne).

Table 6. *Effect of fertilizer application on growth of young budding plants at 14 weeks after planting*

Treatment	Diameter (mm)
Current recommendation	8.6 ^{A}
Biweekly & continuous	8.7 ^{A}
Monthly & continuous	8.5 ^{A}

(Means with same letter are not significantly different)

Urea as a source of N in young budding nurseries

Inconsistent observations had been made on scion growth when urea was used as the N source in young budding nurseries. Therefore another experiment was started at Sapumalkanda Group to study the effect of urea level, fertilizer application resumption stage (at cut back or 4-weeks after cut back) and frequency of fertilizer application (biweekly or monthly) on the growth of scion after cut back. Growth of scion at 8 weeks after cut back is given in the Table 7. It appears that none of the studied factors had negative effect on the scion growth.

Table 7. *Effect of N source, time and frequency of fertilizer application on scion diameter (mm) of young budding plants at 8weeks after cut-back*

N source	Biweekly		Monthly	
	At cut-back	4-wks after cut-back	At cut-back	4-wks after cut-back
1.0 SA	7.2 ^{A}	6.9 ^{A}	-	-
0.0 Urea	7.2 ^{A}	6.1 ^{A}	7.0 ^{A}	6.9 ^{A}
0.5 Urea	7.1 ^{A}	6.9 ^{A}	7.5 ^{A}	6.9 ^{A}
1.0 Urea	6.7 ^{A}	7.0 ^{A}	6.9 ^{A}	7.2 ^{A}
1.5 Urea	7.2 ^{A}	6.9 ^{A}	7.2 ^{A}	6.8 ^{A}

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

Effectiveness of basal P application in young budding nurseries

The study started at Dartonfield estate in 2005 to determine effectiveness of basal P source in young budding nurseries was continued. Data given in Table 8 indicates that although the application of P may not be required for the seedling growth during the first 3 months in this soil, DAP has significantly increased the scion growth particularly when there is no basal P source. Therefore, further studies are required to determine the effectiveness of basal P application using different soils (R S Dharmakeerthi, V Edirimanne and S Chandrasiri).

Table 8. *Effect of P on growth of young budding plants*

Treatment	Seedling diameter (12 wks after planting) mm	Scion diameter (8 wks after cut back) Mm
50g IRP as basal dressing + DAP in liquid formulation	6.8^{A}	6.2^{B}
50g IRP as basal dressing + No DAP in liquid formulation	7.1^{A}	6.1^{B}
No IRP as basal dressing + DAP in liquid formulation	6.9^{A}	7.0^{A}
No IRP as basal dressing + no DAP in liquid formulation	6.9^{A}	6.1^{B}
No fertilizer control	5.7^{B}	5.8^{C}

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

In an another experiment conducted using same soils to determine the effectiveness of high grade ERP (HERP) as a substitute to IRP similar observations was made. It was also observed that there was no significant difference between IRP and HERP on growth of young budding plants (Table 9).

Table 9. *Effect of different basal P sources on the growth and grafting success young budding plants*

Treatment	Parameter[§]				
	SLD (mm)	BD (%)	BS (%)	SP (%)	SCD (mm)
IRP	6.8^{A}	96^{A}	77^{B}	97^{A}	6.2^{B}
HERP	7.0^{A}	93^{A}	86^{A}	98^{A}	6.2^{B}
No basal P	6.9^{A}	90^{A}	89^{A}	90^{B}	7.0^{A}

[§] SLD – seedling diameter at 12 wks after planting; BD – budded ; BS – bud grafting success; SP – sprouting; SCD – scion diameter at 8 wks after cut back;

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

Fertilizers to immature rubber

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

Fertilizers to immature rubber

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

Four field experiments were in progress to study the feasibility of using Dolomite as a substitute to kieserite during the first year of planting. These experiments were at Sapumalkanda estate (*Homagama* series), RRISL Sub station at Kuruwita (*Ratnapura* series), Pitiyakanda estate, Mawathagama and Bibile estate, Bibile. Residual effects of treatments on girth of rubber plants are presented in Table 10. From 2nd year onwards the Mg source and rate are same for all treatments as per the RRISL recommendations. It appears that kieserite could be substituted with dolomite during the first year without any negative effects on the growth of the clones tested in these trials (Lalani Samarappuli, P Karunadasa, T Gunathilake and U Mitrasena).

Table 10. *Residual effect of different Mg treatments on girth of rubber plants*

Mg application During the 1st year	Pitiyakanda Girth (cm)	Sapumalkande Girth (cm)	Kuruwita Girth (cm)	Bibile Girth (cm)
75g kieserite in 2 applications (Control)	36.7^{A}	13.5^{AB}	18.1^{A}	16.3^{AB}
25g kieserite + 75g dolomite	34.8^{A}	13.9^{AB}	19.9^{A}	15.6^{AB}
50g dolomite + 75g dolomite	35.3^{A}	13.5^{AB}	19.6^{A}	14.7^{A}
75g dolomite only (planting hole)	36.6^{A}	14.3^{A}	20.6^{A}	19.4^{A}
75g dolomite (planting hole) + 25g kieserite	36.0^{A}	13.8^{AB}	17.6^{AB}	13.6^{B}
100g dolomite (planting hole) + 25g kieserite	35.5^{A}	14.0^{AB}	16.9^{AB}	15.9^{AB}
50g dolomite (planting hole) + 75g dolomite	34.5^{A}	13.3^{AB}	19.3^{A}	15.0^{AB}
75g dolomite (planting hole) + 25g kieserite	34.0^{A}	13.1^{AB}	17.8^{A}	15.0^{AB}
100g dolomite only (planting hole)	36.1^{A}	12.8^{B}	18.9^{A}	14.8^{AB}
150g dolomite only (planting hole)	35.2^{A}	13.3^{AB}	19.9^{A}	15.2^{AB}

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

Method of fertilizer application

Two field experiments started at Nottinghill estate and Dorset division, Clyde estate, to study the effect of cutting fertilizer pits on growth of *Hevea* under comparatively wet and dry agro-climatic conditions were in progress. Treatments consisted of two distances from the tree (1 ft. and 1½ ft), two application frequencies (4 and 2 per year) and a control. Growth measurements at six months after planting are presented in Table 11 (Lalani Samarappuli, P Karunadasa, U Mitrasena and T Gunathilake).

Table 11. *Seedling diameter (mm) after 6 months after planting*

Treatments	Nottinghil	Dorset
Control	11.5 [A]	12.7 [A]
4 applications /yr & 1 ft. away	12.9 [A]	14.2 [A]
4 applications /yr & 1½ ft. away	13.5 [A]	14.5 [A]
2 applications /yr & 1 ft. away	12.9 [A]	14.7 [A]
2 applications /yr & 1½ ft. away	13.1 [A]	14.7 [A]

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

Fertilizer requirement of rubber under different densities

Experiment at Mucalana division, Sirikandura estate (SMC-Ag/D/96/1) to study the fertilizer requirement of rubber under different densities was in progress. Treatments consisted of four different densities (500, 600, 700 and 800 trees/ha) and three fertilizer treatments (recommended level, reduced level and 1st three years recommended level and thereafter reduced level). Residual effect of different fertilizer treatments on yield of rubber was monitored. Statistical analysis on monthly test tapping data revealed that fertilizer × density interaction as well as residual fertilizer effects were not significant. (Lalani Samarappuli, P Karunadasa and T Dissanayake in collaboration with the Plant Science Department).

Fertilizer use in mature rubber

Fertilizer application during mature stage on yield

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

Nutrient requirement of new* Hevea *clones

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

217) to fertilizer during the mature phase was studied in a trial conducted at RRISL substation, Kuruwita in a clearing established in 1997. Test tapping data for the year 2006 (Table 12) indicated that there were significant differences among clones while the differences among fertilizer treatments were not statistically significant (R S Dharmakeerthi, S N Silva and C K Maheepala).

Table 12. *Effect of fertilizer level and clone on average yield during the 9th year after planting*

Fertilizer Level	g/t/t	Clone	g/t/t
No fertilizer	32.7 ^{A}	RRISL 201	29.9 ^{B}
100% Current recommendation	32.3 ^{A}	RRISL 202	28.9 ^{B}
200% Current recommendation	35.4 ^{A}	RRISL 217	45.5 ^{A}

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

Trials conducted in Moneragala

An experiment was started in 2004 at Muppanavalley division, Kumarawatta estate, Moneragala to determine the effectiveness of four fertilizer mixtures R/U/12:14:14 and R/U/15:15:7, with and without a Mg source on the growth of RRIC 121 and RRISL 203 clones at three different fertilizer levels (0, 1 and 2 times the currently recommended levels for traditional rubber growing areas). Growth measurements made two year after planting indicated statistically significant differences in fertilizer levels and clone (Table 13). The differences observed in different fertilizer mixtures as well as all higher order interactions were not statistically significant (R S Dharmakeerthi, S N Silva and C K Maheepala).

Table 13. *Effect of clone, fertilizer mixture and level on the growth of* Hevea *after 2 years of planting in Monaragala*

Fertilizer Mixture	Girth (cm)	Fertilizer Level	Girth (cm)	Clone	Girth (cm)
R/U 12:14:14 + Mg	7.1 ^{A}	No fertilizer	6.1 ^{C}	RRISL 203	7.1 ^{A}
R/U 15:15:7 + Mg	6.2 ^{A}	100% Current recommendation	6.7 ^{B}	RRIC 121	6.2 ^{B}
R/U 12:14:14	6.4 ^{A}	200% Current recommendation	7.2 ^{A}		
R/U 15:15:7	6.7 ^{A}				

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

Organic fertilizers

Planting stage

Field experiment in Pitiyakanda estate, Mawathagama to study the effect of application of different organic materials (paddy straw, poultry litter, cow dung, green manure, EM treated compost and burned paddy husk) into the planting hole was continued and the girth at 3½ after planting is presented in Table 14 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 14. *Effect of different treatments on growth of rubber plants after*

Treatment	Girth (cm)
Nil (control)	30.7^{BC}
Paddy straw	29.3^{C}
Poultry litter	30.2^{BC}
Cow dung	33.7^{ABC}
Green manure	34.1^{AB}
EM treated compost type 1	34.7^{AB}
EM treated compost type 2	35.8^{A}
Burned paddy husk	34.4^{AB}

(Means with same letter are not significantly different)

For the experiment in 2003 replanting in Lowmont division, Payagala estate, Dodangoda applied paddy straw, poultry litter, cow dung, green manure, compost, coir dust, paddy husk, tea dust and saw dust to the planting hole. Girth at 3½ years after planting is presented in Table 15 (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 15. *Effect of different treatments on growth of rubber plants*

Treatment	Girth (cm)
Nil (control)	28.5^{A}
Paddy straw	31.0^{A}
Poultry litter	30.6^{A}
Cow dung	27.0^{A}
Green manure	30.8^{A}
Compost	29.1^{A}
Coir dust	25.5^{A}
Paddy husk	28.5^{A}
Tea dust	27.5^{A}
Saw dust	26.2^{A}

(Means with same letter are not significantly different)

Immature stage

A field experiment (FPN-Org/An/01/1), is in progress at Pembroke division, Payagala estate to study the effect of poultry litter as an organic manure for rubber. Treatments consisted of (T1) No organic manure (control), (T2) Organic manure to

planting hole + 1st to 6th year, (T3) Organic manure to planting hole + 2nd year + 4th year + 6th year (Level 1), (T4) Organic manure to planting hole + 2nd year + 4th year + 6th year (Level 2), (T5) Organic manure to planting hole + 3rd year + 6th year (T6) Organic manure to 3rd year + 5th year. Effect of treatments on girth at the end of 5½years is given in Table 16 (Lalani Samarappuli, P Karunadasa, U Mitrasena and T Dissanayake).

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

Treatment	Girth (cm)
T1	47.3^{B}
T2	50.7^{A}
T3	50.8^{A}
T4	51.3^{A}
T5	51.7^{A}
T6	50.7^{A}

(Means with same letter are not significantly different)

Two more experiments are in progress at Pitiyakanda estate, Mawathagama in a 2003 replanting and at Bibile estate, Bible in a 2004 replanting, respectively. Organic manures evaluated in these experiments are paddy straw, EM treated paddy straw, burned paddy husk, coconut husk, and green manure. Growth measurements and some soil properties at three years and six months after planting in experiment at Pitiyakanda estate and girth at two year after planting in experiment at Bibile estate are presented in Tables 17 and 18, respectively (Lalani Samarappuli, P Karunadasa and U Mitrasena).

Table 17. *Effect of different treatments on growth of rubber plants*

Treatment	Girth (cm)	Soil pH	Organic Carbon %
Nil (control)	33.87^{A}	5.3^{B}	1.02^{B}
EM treated paddy straw	36.02^{A}	6.5^{A}	1.34^{A}
Burned paddy husk	35.10^{A}	5.4^{AB}	1.02^{B}
Coconut husk	35.27^{A}	5.1^{B}	1.09^{B}

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

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

Treatment	Girth (cm)
Nil (control)	8.02^{A}
Burned paddy husk	8.87^{A}
Paddy straw	9.20^{A}
Green manure	9.60^{A}

(Means with same letter are not significantly different)

An experiment is in progress to develop a sustainable and comercially 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". Girth data of this experiment is given in Table 19 (Lalani Samarappuli, P Karunadasa and T Dissanayake).

Table 19. *Effect of different treatments on girth of rubber plants*

Treatment	Girth after planting (cm)	
	8 ½ years	9 ½ years
Chemical fertilizer only	56.3	64.6
Organic fertilizer only	55.9	63.0

Spatial variability of rubber growing soils and the growth of rubber

Spatial variability of some properties of rubber growing soils

Soil samples collected according to a geostatistical design from a small holder rubber field (30% slope) were analyzed for organic C (OC), clay, gravimetric water content (WC), pH, and nutrient availability. The variation in some soil properties along the slope in this field is given in Figure 2. The lowest OC and WC appears to around the middle of the slope length (R S Dharmakeerthi, S P Perera, S N Silva and S Chandrasiri).

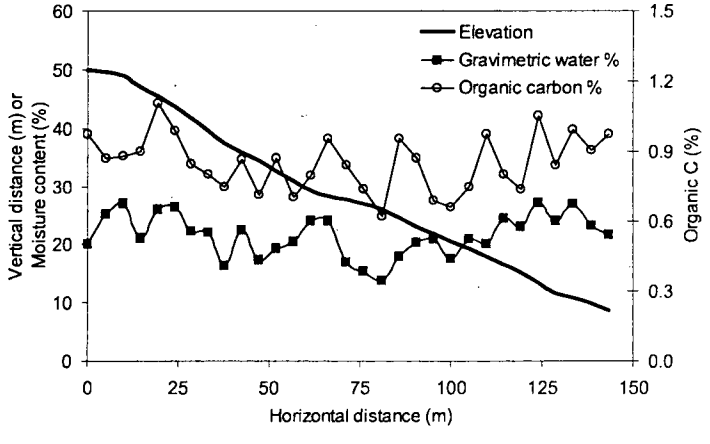


Fig.2. Variation in organic C and gravimetric water content along the slope

Site-specific fertilizer recommendation by soil and foliar survey program

Under this programme about 7500 hectares of mature rubber fields were surveyed and fertilizer recommendations were given for the next three years (L Samarappuli, R S Dharmakeerthi and all the staff of the department).

Land selection and suitability for rubber cultivation

Under the routine land selection programme 75ha. of land in the traditional rubber growing areas and 100ha. in the Hambantota district were surveyed for the suitability of rubber cultivation (L Samarappuli, R S Dharmakeerthi and all the staff of the department).

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

This is a collaborative study with the Biometry section and Advisory Services Department together with Ruhuna and Wyamba Universities. The soils and Plant Nutrition Department is responsible for assessing the land suitability in rubber growing areas of Moneragala and adjacent parts of Badulla and Ampara districts. Two sites in Badalkumbura AGA division were sampled in December, 2006 and the results are presented in Table 20.

Table 20. *Indicators of land suitability in two sites of the Moneragala district*

Site	Slope %	Depth to water table (cm)	Soil depth (cm)	Bulk density (g/cm^3)	Horizon	pH	Organic Carbon content %
Lunugala Kolaniya	0-15	>130	>165	0-15 cm	O	5.46	0.82
				1.51	A	5.52	0.72
				15-30 cm	B	5.79	0.57
				1.57	C	5.08	0.05
					(Composite)	6.43	1.01
Karawila	20-25	>150	>150	0-15 cm	O	5.85	0.96
				1.25	A	6.08	1.15
				15-30 cm	B	5.79	0.53
				1.22	C	5.61	0.13
					(Composite)	6.00	1.45

The team working on soil aspects of this project is as follows (L Samarappuli, P Karunadasa, U Mithrasena, Anoma Thewarapperuma and T Gunathilake).

Analytical services

The Department analyzed approximately 250 samples (1000 parameters) for outside organizations (L Samarappuli, R S Dharmakeerthi and all the staff of the department).

BIOCHEMISTRY AND PHYSIOLOGY

V H L Rodrigo

SUMMARY

Emphasis was given to develop a new ready-reckoner to correct the error in metrolac dry rubber determination associated with temperature variation. In the same time, special attention was given to the preliminary investigations required to develop a digitized electronic appliance to measure the dry rubber content in latex.

The waste oil based rainguard sealant developed by the Department recently, was applied in large scale and assessments were done throughout the year.

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

DETAILED REVIEW

Staff

Dr V H L Rodrigo, Head and Mrs K V V S Kudaligama, Assistant Biochemist, were on duty through out the year. Mrs G V L Nilmini, Assistant Biochemist obtained study leave overseas for four years with effect from 21st, August as she left the country to pursue her PhD programme in the University of Maine, USA. Experimental Officers, Mr P D J Rodrigo and Mr D Ramawickrama, were on duty through out the year.

Seminars/Conferences/Meetings/Workshops attended

Officer	Subject	Organization
V H L Rodrigo	Workshop on exploitation	Planters' Association
	Rubber cultivation in Eastern province	National Science Foundation
	Workshop on Bioinformatics	University of Colombo
	CDM workshops	Ministry of Forest and Environment
	Scientific Committee Meetings	RRISL, Colombo Office
	Workshop on exploitation	Kegalle Planations Ltd.
	IRRDB Conference	Vietnam
	Ecosystem Conference	National Science Foundation
	Workshop to smallholders	RRISL, at Padiyatalawa
	Forestry symposium	University of Jayawardenapura
K V V S Kudaligama	Scientific Committee Meeting	Colombo Office

Training programmes

Client	Subject	No. of programmes
School teachers	G.C.E.(O/L) rubber syllabus	3
Rubber Development Officers	Tapping and Rainguards	1
Trainee from Vocational training Authority	Computer training	1
NDT (Agriculture) students	Vocational training	1
Planters	Today's challenges in rubber industry	1
Smallholders	Tapping	1
Hardy Institute students	Latex analysis	1
Planters & Field Officers	Low frequency tapping	1
Field Officers and Tappers	Rainguards	1

Advisory visits: 10 advisory visits were made during the year.

LABORATORY AND FIELD INVESTIGATIONS

Extraction of Quebrachitol from rubber serum

BCP/Q&RS/2002/1

Finding a suitable method for the extraction of Quebrachitol from rubber serum was temporarily discontinued due to lack of laboratory facilities and staff (G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama).

Biochemical studies of Tapping Panel Dryness (TPD)

BCP/TPD/2002/2

This project attempts to identity possible causes for the TPD which is considered to be a physiological disorder. Analyses were carried out with the extractions of bark samples taken from affected and healthy trees for sugar content and the protein pattern using HPLC and SDS-PAGE, respectively. Sugar analysis of bark extracts using HPLC showed a clear increase in sucrose content in the affected trees compared to that in the healthy trees in two clones, RRIC 100 and RRIC 121. However, bark proteins showed no clear difference in both affected and healthy trees of any clone tested, *i.e.* RRIC100, RRIC121, RRIC102 and RRIC130 (Fig. 1) (G V Lakmali Nilmini, K V V S Kudaligama, P D J Rodrigo, D Ramawickrama in collaboration with the Plant Science Department - This project was funded by the Council for Agricultural Research Policy).

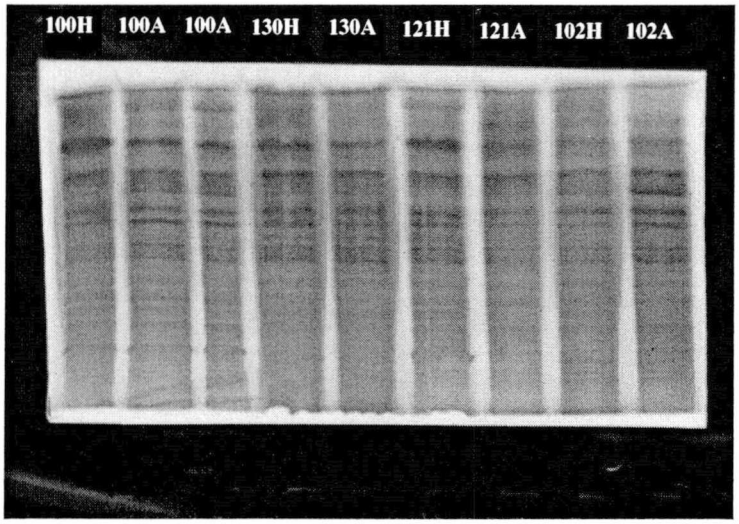


Fig. 1. Protein banding patterns of healthy (H) and TPD affected (A) barks of RRIC 100, 102, 121 and 130 clones of rubber subjected to the SDS-PAGE

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

Variation of non-rubber constituents present in latex was investigated in 4 clones, *i.e.* RRIC 100, RRIC 121, RRIC 130 and RRIC 102. Latex samples were collected from two tapping blocks of each clone and were processed in to lace crepe. They were analysed for dry rubber content, total solid content, acetone extractable non rubber, nitrogen content, Po, PRI and Mooney viscosity (VR). DRC% and TSC% in the latex of RRIC130 and RRIC121 were significantly higher when comparing with those in RRIC102 and RRIC100. Acetone extractable non rubber content was high in RRIC121 and RRIC102. With compared to the specifications given for Lankaprene, the ash content was lower and N% was slightly higher in all four clones. Initial plasticity was high in RRIC130 and RRIC121. Among all four clones, PRI value was lowest in RRIC130. In all four clones tested VR value was higher than the expected standard value (Table 1).

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

This research project aims to solve the temperature associated problem in measuring dry rubber content of latex with the metrolac which is generally reported in high elevation areas. A ready reckoner chart based on both metrolac reading and temperature was developed (Table 2) and thereafter sample testing began to investigate the effectiveness of this temperature based ready-reckoner chart in the determination of % DRC in latex (G V Lakmali Nilmini, K V V S Kudaligama, V H L Rodrigo, P D J Rodrigo and D Ramawickrama).

Table 1. *Raw rubber properties and non rubber constituents in four major* Hevea *clones (Values in parenthesis represent the Standard Error of means)*

Clone	DRC (%)	TSC (%)	Acetone extractable non rubber (%)	Ash (%)	N (%)	Po	PRI	Mooney Viscosity ML(1+4) @100°C
RRIC130	40.08 (±0.20)	42.39 (±0.19)	2.74 (±0.09)	0.14 (±0.005)	0.36 (±0.005)	49 (±0.50)	66 (±1.0)	97 (±1.0)
RRIC121	40.56 (±0.19)	43.18 (±0.20)	3.07 (±0.09)	0.14 (±0.005)	0.37 (±0.004)	49 (±0.5)	71 (±1.0)	94 (±1.0)
RRIC102	38.36 (±0.26)	41.18 (±0.25)	3.15 (±0.06)	0.14 (±0.006)	0.38 (±0.005)	45 (±0.5)	70 (±1.3)	90 (±1.3)
RRIC100	38.32 (0.24)	40.76 (±0.23)	2.84 (±0.05)	0.15 (±0.005)	0.40 (±0.005)	43 (±0.5)	69 (±1.0)	87 (±1.2)
Specifications for Lankaprene	-	-	-	0.25(max.)	0.35(max.)	35-50	70-85	70-80

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

Table 2. *Modified ready-reckoner chart to assess the dry rubber content in latex. Values are given as the proportion of dry rubber in latex*

Metrolac reading	Temperature (°C)																		
	20	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	
50	0.29	0.28	0.27	0.26	0.25	0.24	0.23	0.22	0.21	0.20	0.19	0.18	0.17	0.17	0.16	0.15	0.14	0.13	**50**
60	0.31	0.30	0.29	0.28	0.27	0.26	0.25	0.24	0.23	0.22	0.21	0.20	0.19	0.19	0.18	0.17	0.16	0.15	**60**
70	0.33	0.32	0.31	0.30	0.29	0.28	0.27	0.26	0.25	0.24	0.23	0.22	0.21	0.21	0.20	0.19	0.18	0.17	**70**
80	0.35	0.34	0.33	0.32	0.31	0.30	0.29	0.28	0.27	0.26	0.25	0.24	0.23	0.23	0.22	0.21	0.20	0.19	**80**
90	0.37	0.36	0.35	0.34	0.33	0.32	0.31	0.30	0.29	0.28	0.27	0.26	0.25	0.24	0.24	0.23	0.22	0.21	**90**
100	0.39	0.38	0.37	0.36	0.35	0.34	0.33	0.32	0.31	0.30	0.29	0.28	0.27	0.26	0.25	0.24	0.24	0.23	**100**
110	0.41	0.40	0.39	0.38	0.37	0.36	0.35	0.34	0.33	0.32	0.31	0.30	0.29	0.28	0.27	0.26	0.25	0.25	**110**
120	0.43	0.42	0.41	0.40	0.39	0.38	0.37	0.36	0.35	0.34	0.33	0.32	0.31	0.30	0.29	0.28	0.27	0.26	**120**
130	0.45	0.44	0.43	0.42	0.41	0.40	0.39	0.38	0.37	0.36	0.35	0.34	0.33	0.32	0.31	0.30	0.29	0.28	**130**
140	0.47	0.46	0.45	0.44	0.43	0.42	0.41	0.40	0.39	0.38	0.37	0.36	0.35	0.34	0.33	0.32	0.31	0.30	**140**
150	0 49	0.48	0.47	0.46	0.45	0.44	0.43	0.42	0.41	0.40	0.39	0.38	0.37	0.36	0.35	0.34	0.33	0.32	**150**
160	0.51	0.50	0.49	0.48	0.47	0.46	0.45	0.44	0.43	0.42	0.41	0.40	0.39	0.38	0.37	0.36	0.35	0.34	**160**
170	0.53	0.52	0.51	0.50	0.49	0.48	0.47	0.46	0.45	0.44	0.43	0.42	0.41	0.40	0.38	0.38	0.37	0.36	**170**
180	0.55	0.54	0.53	0.52	0.51	0.50	0.49	0.48	0.47	0.46	0.45	0.44	0.43	0.41	0.40	0.39	0.38	0.37	**180**
190	0.57	0.56	0.55	0.54	0.53	0.52	0.51	0.50	0.49	0.48	0.47	0.46	0.45	0.43	0.42	0.41	0.40	0.39	**190**
200	0.59	0.58	0.57	0.56	0.55	0.53	0.53	0.52	0.51	0.50	0.49	0.47	0.47	0.45	0.44	0.43	0.42	0.41	**200**
210	0.61	0.60	0.59	0.58	0.57	0.55	0.55	0.54	0.53	0.52	0.51	0.49	0.49	0.47	0.46	0.45	0.44	0.43	**210**
220	0.63	0.62	0.61	0.60	0.59	0.57	0.57	0.56	0.55	0.54	0.53	0.51	0.50	0.49	0.48	0.47	0.46	0.45	**220**

(Dilution; 1part of latex to 2 parts of water)

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

This project was designed to develop new rainguard sealants with desired characteristics such as easy application and reduced cost, particularly with industrial wastes. With the final formulation, apron type rainguards were fixed in nine tapping blocks in Dartonfield, Gallewatta and Kuruwita. Gutter type raingurds were fixed in six tapping blocks in Gallewatta.

The apron type rainguards performed well for *ca.* six months initially with *ca.* 90% of the rainguards been fixed successfully. However, the rate of leakages increased thereafter. In gutter type rainguards, the sealant performed well with no leaking (Table 3). Further developments of the sealant were in progress.

Table 3. *Performance of rainguards in three different sites rainguards were fixed in Feb – March 2006*

	Gallewatta		Dartonfield	Kuruwita
	Apron type	Gutter type	Apron type	Apron type
No. of rain guards fixed	650	1400	650	700
No. of leaking trees as at May, 2006	78	0	82	39
No. of leaking trees as at September, 2006	256	0	320	218

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

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

Assessment on RRIMFLOW exploitation trials was continued for one year period in six tapping blocks in Gallewatta with two control blocks. DRC%, latex volume and scrap weight were monitored daily in each block and a detailed investigation of the bark abnormalities on tree basis was carried out at monthly intervals. RRIMFLOW experimental blocks in eight other estates were also monitored.

All RRIMFLOW blocks initially showed high yields and gradually declined with time. In most occasions, RRIMFLOW blocks tapped downward showed low yields comparing to the upward tapped blocks. DRC% of RRIC 121 blocks showed lesser sensitivity to gas stimulation. In RRIC 100 RRIMFLOW blocks, DRC% was lower than the control block. DRC% of the downward tapped block increased after June as that blocked was not gassed thereafter. RRIC 100 blocks initially showed high g/t/t values and then declined with the time (Fig. 2) (V H L Rodrigo, K V V S Kudaligama, P D J Rodrigo and D Ramawickrama in collaboration with the Plant Science Department).

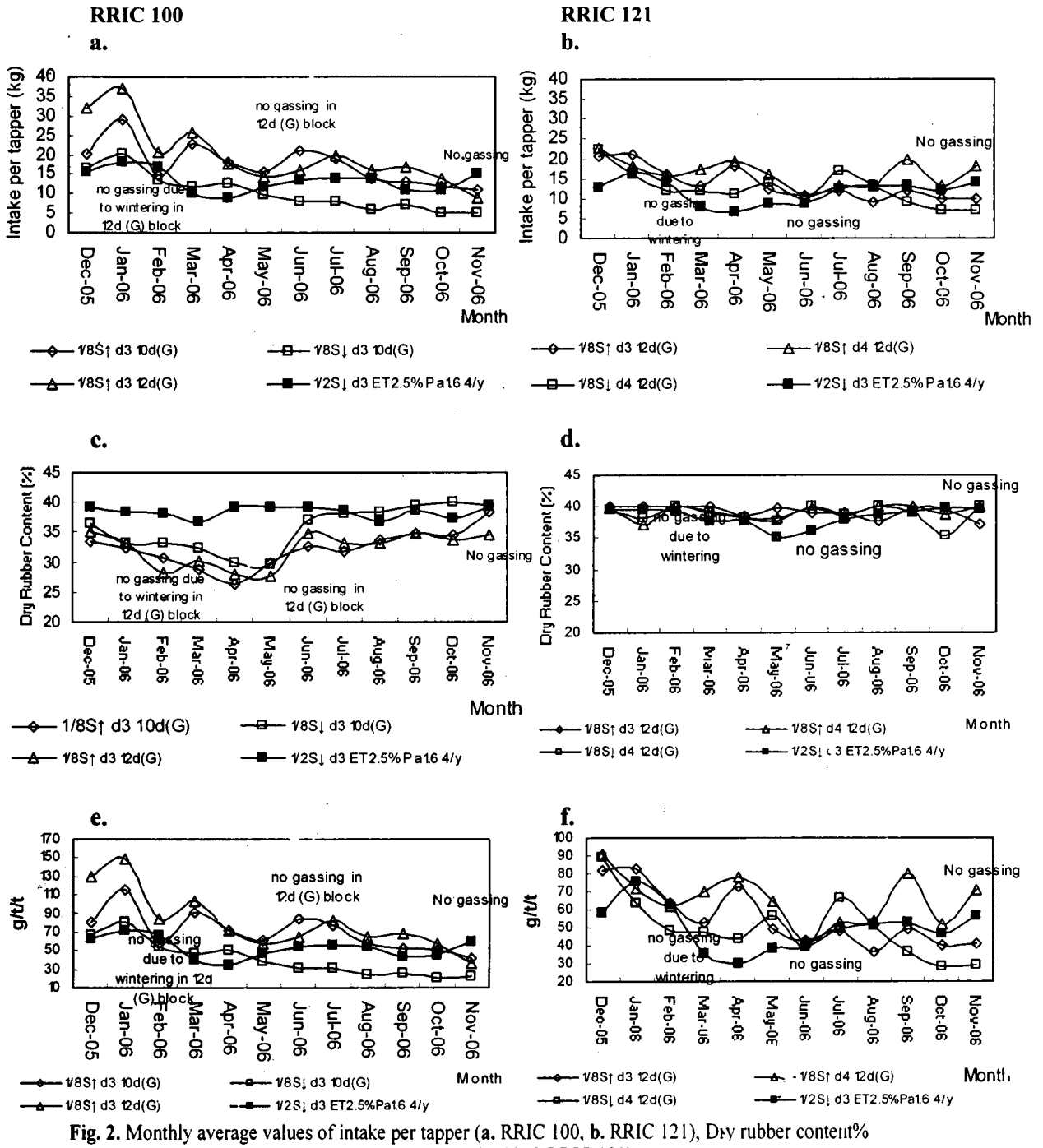


Fig. 2. Monthly average values of intake per tapper (**a.** RRIC 100, **b.** RRIC 121), Dry rubber content% (**c.** RRIC 100, **d.** RRIC 121) and g/t/t (**e.** RRIC 100, **f.** RRIC 121)

Possibility of using acetylene gas as a yield stimulant

A mini scale research project was started in order to investigate the possibility of using acetylene gas as a yield stimulant. Of RRIC 100 planted in 1986, 25 health trees were selected for this experiment. RRIMFLOW gas jackets was fixed on these trees and tapped 1/8S upward cut at d3 frequency. Gassing was done in every ten days as per the recommendation for RRIMFLOW. There was no any clear yield increase due to acetylene stimulation (Fig. 3).

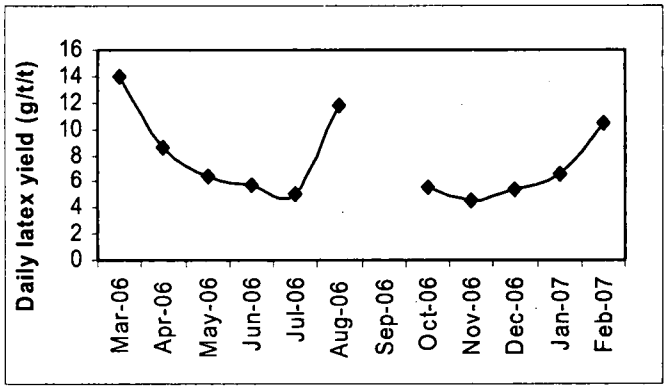


Fig. 3. Daily latex yield (g/t/t) of experimental block stimulated with acetylene gas

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

The research project was commenced to investigate the possibility of developing an electronic appliance to measure the dry rubber content of latex digitally. Also, it is expected to address the temperature associated problems in latex weighing in the development of this instrument Latex samples were tested to identify the relationship between temperature, density and dry rubber content (Fig. 4). Ministry of Plantation Industries has agreed to provide Rs.100,000 initially from the Cess for the project.

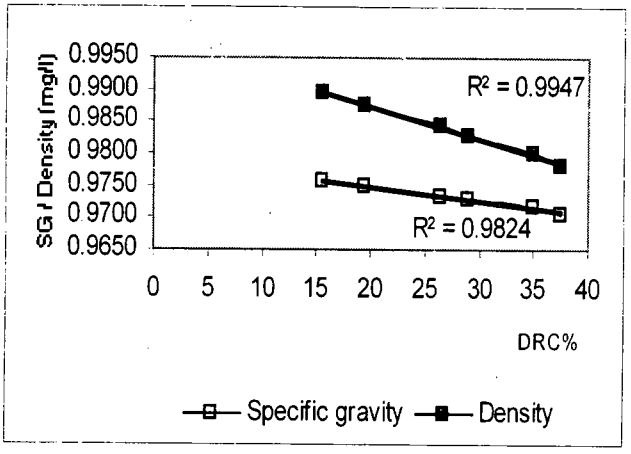


Fig. 4. Relationship of dry rubber content with specific gravity (SG) and density of latex

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

Low frequency tapping with liquid stimulation
BCP/LFT(L)/2006/1

This project aims to sustain the productivity of rubber lands using Low Frequency Tapping systems with ethephon based liquid stimulants whilst addressing the problems of tapper shortage and high tapping cost. Low frequency tapping systems with d/4 and d/6 frequencies are tested in this project. Experimental blocks were selected from Gallewatta division of Dartonfield estate, Udapola estate in Deraniyagala, Kuruwita sub station of the RRISL and Notinghill estate in Mawathagama. A three year research grant has been provided by the National Science Foundation for large scale and systematic testing of these systems (V H L Rodrigo, K V V S Kudaligama, G V L Nilmini, P D J Rodrigo and D Ramawickrama).

ADVISORY SERVICES

A Dissanayake

SUMMARY

Several extension and collaborative research projects were identified and carried out at national and regional level to increase the productivity of the rubber smallholder sector.

Five different types of farmer training programmes were designed according to the stakeholder requirements and conducted 51 programs covering all rubber growing areas. Two thousand five hundred and forty one (2541) smallholders directly benefited from these training programmes. Training and skill development of rubber tappers, as a solution to the tapper shortage, was considered as a priority project under these training programmes.

Participatory studies were conducted in Monaragala and Colombo districts, to collect information on knowledge levels and adoption rates of RRI recommendations by rubber growers. The aim of this study was to identify training and organizational needs of farmers and effectively plan extension programmes.

ASD was selected as a key stakeholder in the 'Forest Stewardship Council (FSC) Certification Project', which is launched by the FSC secretariat of IUCN, Sri Lanka and Export Development Board to register 20000 ha. of rubber lands under FSC certification project. Under this project six awareness programmes were conducted by the officers of ASD covering all rubber growing regions, and attracted 692 medium scale rubber growers as beneficiaries in the first phase of the project.

The ASD staff was also involved in carrying out special projects namely introduction of *Mucuna* as a cover crop, rehabilitation of substandard rubber holdings in the first three years of growth, transfer of technologies for construction and rehabilitation of rubber processing centers.

DETAILED REVIEW

Staff

The head of the department, five Regional Advisory Officers, 22 Rubber Extension Officers and the Assistant Training Officer were on duty throughout the period.

Mr G S Ratnayaka, Divisional Rubber Extension Officer (Warakapola), retired from services with effect from 30th March 2006. Gampaha, Kosgama, Homagama and Warakaopola ranges were re-demarcated and Mr R A D Ranawaka, Divisional Rubber Extension Officer was transferred to the Warakapola range.

Mr A H Kularathna, Regional Advisory Officer, completed a Postgraduate Degree in Management, MSc (Management) at the University of Sri Jayawardanapura.

Research students

- Mr T A C Prasad, Faculty of Agriculture, University of Ruhuna conducted his final year project on "Analysis of cost of production of smallholder rubber production in Sri Lanka" under the supervision of Dr A Dissanayake.

National level committees

- Dr A Dissanayaka Head/ASD has been appointed as a member of the national steering committee of the project "Forest Stewardship Certification (FSC) and establishment of national standards for Sri Lanka".

Seminars/Conferences/Workshops/Meetings

Officer	Subject	Organization
A Dissanayake	International natural rubber conference	Ho Chi Minh city, Vietnam
A Dissanayake	Meetings of the National Steering Committee of the "Forest Stewardship Certification" (FSC) Project	FSC secretariat of the IUCN, Sri Lanka
A Dissanayake	Scientific Committee Meetings	Rubber Research Institute
A Dissanayake, RAOO, REOO	District level awareness raising Campaigns of the FSC project	Advisory Services Department in Collaboration with IUCN and EDB
A Dissanayake	Research coordination meeting (RCM) of the Coordinated Thematic Research Programme (CTRP)	National Science Foundation (NSF)
RAOO, REOO	Residential workshop on training stake holders of the FSC project.	IUCN
A Dissanayake, RAOO, REOO	Monthly Progress review meetings	RRISL
RAOO, REOO	Regional/range level farmer training programmes to increase the adoption rates of RRI recommendations	RRISL

Advisory visits

RAOO and REOO attended to various specific requests of rubber growers in the form of Advisory visits.

SERVICES

Farmer training

Knowledge dissemination and improvement of skill levels to increase land productivity of rubber growers in traditional as well as in non-traditional rubber growing areas, were considered as the "thrust" area of activities of the ASD. A selected team of REOO was appointed as resource personnel to identify area specific training needs of rubber growers. Accordingly, five different types of training programmes were designed for farmers in traditional rubber growing areas. Specific curriculum and training schedules were developed for each type and 51 training programmes were successfully completed (Table 1).

Other special farmer training programmes

- **FSC group certification for rubber growers**
  ASD was selected as a key stakeholder in the Forest Stewardship Council (FSC) certification project, which is launched by the FSC secretariat of IUCN, Sri Lanka and Export Development Board to register 20000 ha. of rubber lands under the FSC Certification project. Under this project six awareness training programmes were conducted by the officers of ASD covering all rubber growing regions, to enlighten the rubber growers on the benefits of FSC certification and attracted 692 medium scale rubber growers to the project.

- **Extension and advisory services in non-traditional rubber growing areas**
  In the non-traditional areas three technology transfer programmes were conducted by the ASD to increase the adoption rates of RRI recommendations on planting and immature up keep, targeting new rubber growers in Haldummulla, Nikapotha, Badalkumbura and Medagama areas of the Monaragala district.

- **Participatory studies on adoption of RRI recommendations**
  Participatory studies were conducted by the ASD in Monaragala and Colombo districts to collect information on knowledge levels and adoption rates of RRI recommendations by rubber growers. The aim of this study was to identify training needs of farmers and effectively plan training programmes. Results of this study is shown below Table 2.

Table 1. *Farmer training programmes conducted in traditional rubber growing areas*

Name	Objective/s of training programmes	Programme duration	No. of Programmes	No. of Participants
1. Rubber Cultivation and tapping training schools	To increase the knowledge and skills levels of all rubber cultivation and processing aspects	10 half days	09	250
2. Skill development of unskilled rubber tappers	1. To improve the tapping and processing skills of rubber tappers. 2. To introduce correct yield exploitation principles	03 half days	13	314
3. Awareness raising on RRI recommendations for productivity improvement	1. To identify adoption rates and adoption problems of farmers 2. To raise awareness on RRI recommendations	01 full day	24	1587
4. Training of Agricultural production and Research Assistants of Agrarians Services Department on rubber cultivation and processing	To share knowledge and to improve interaction between parallel Agricultural development organizations.	02 full days	02	125
5. Transfer of technologies to rubber growers in Monaragala District	To increase the knowledge levels in rubber cultivation aspects of new rubber growers in the Monaragala District.	01 full day	03	267
Total			51	2543

N.B. Each awareness raising programme was conducted after testing and analyzing the adoption rates of RRI recommendations by participants

Table 2. *Levels of awareness of farmers on important recommendations of rubber cultivation and processing aspects in Colombo and Monaragala districts*

Target area	Percentage awareness of farmers	
	Colombo district	Monaragala district
Recommendations on planting and related activities	80	48
Recommendations on soil fertility management	83	28
Recommendations on disease control	64	31
Recommendations on tapping and yield exploitation system practices	52	Not studied
Recommendations on RSS processing	48	50
Recommendations on intercropping and mixed cropping systems	90	54

The above study revealed that awareness levels of rubber growers in Colombo district in relation to planting and related activities, soil fertility management and intercropping systems are high while the awareness levels of processing and yield exploitation systems are on the average. On the other hand awareness levels of farmers in Monaragala District in both cultivation and processing aspects were found between average and below average levels. This study is in progress in other regions.

Other national level projects

Rehabilitations of substandard holdings

A special extension programme was carried out to identify immature substandard rubber holdings in relation to stand per hectare and growth levels with the objective of providing necessary extension and advisory support services to rehabilitate. Nearly, 1,358.52 ha. of Rubber holdings planted in year 2005 and 2006 were identified as substandard and 244.14 ha of rubber holdings were rehabilitated (Table 3).

Table 3. *Extent of substandard rubber holdings rehabilitated by REOO*

Region	Identified as substandard extent (ha)	Extent rehabilitated by REOO (ha)
Kegalle	680.68	19.08
Colombo/Gampaha	50.00	12.52
Galle/Matara	62.80	58.02
Kalutara	408.82	114.41
Ratnapura	159.20	40.11
Total	**1,358.52**	**244.14**

The poor achievement (18%) was mainly due to unavailability of authenticated planting materials.

Introduction of* Mucuna *as a cover crop

Demonstration programmes and advisory and training activities together with other support services such as organizing nurseries and facilitating supply of materials etc. were continued to popularize *Mucuna* as a cover crop in the smallholder rubber sector. REOO identified farmers owing 984.36 ha rubber holdings for introduction of *Mucuna* as cover crop but only 236.86 ha of immature rubber holdings could be successfully established with *Mucuna*, achieving only 24.05% of success rate Table 4.

Table 4. *Introduction of* Mucuna *as cover crops*

Region	Extent selected for the introduction of *Mucuna* (ha)	Extent established with *Mucuna* (ha)
Kegalle	396.60	41.78
Colombo/Gampaha	38.00	12.30
Galle/Matara	20.00	40.01
Kalutara	198.96	93.70
Ratnapura	357.80	49.07
Total	964.36	236.86

The low success rate was mainly due to poor rooting ability of *Mucuna* cuttings and unavailability of rooted poly bagged plants.

Tapping panel marking and correction of tapping panel markings

To promote the successful adoption of recommended yield exploitation systems, training and demonstrations programmes to educate farmers on tapping panel marking and correction of panel markings, were conducted for selected groups of farmers identified from each REOO range. REOO assisted to mark new tapping panels in 523.42 ha and corrected incorrectly marked panels in 448.05 ha during the year (Table 5).

Table 5. *Extent of rubber holdings marked for tapping and correction of tapping panel markings*

Region	Extent marked for tapping (ha)	Extent corrected for tapping (ha)
Kegall	291.45	274.48
Colombo/Gampaha	35.8	15.10
Galle/Matara	19.81	17.80
Kalutara	60.8	92.47
Ratnapura	117	48.2
Total	523.42	448.05

Provision of advisory services to construct and repair rubber processing centres

As one of the major functions of the department, advisory services were rendered to transfer relevant technologies to construct new rubber processing centers and repair substandard processing centers, with the aim of increasing the production efficiency of smoke houses and quality improvement of RSS.

Accordingly services were rendered to construct 40 new processing centers and to up grade 47 substandard Rubber Processing centers Table 6.

Table 6. *Number of Rubber Processing Centers Constructed and repaired as per advice of REOO*

Region	No. of new processing centers constructed	No. of processing centers repaired
Kegalle	10	13
Colombo/Gampaha	4	3
Galle/Matara	2	2
Kalutara	18	20
Ratnapura	6	9
Total	40	47

Collaborative research projects

Role of institutions in global environmental change

This project was conducted with the collaboration of Energy and Resources Institute (teri) of India and Environment and Public Health Organization (ENPHO) of Nepal. The other departments/sections participated in this project from RRISL are Soils and Plant Nutrition and Biometry. Head/ASD involved as a team member of this project. The aim of this project is to educate people on the adverse impacts of climate change and adaptation measures to minimize the impact on rubber plantations.

An examination of profit inefficiency of smallholder rubber producers in Sri Lanka

The objectives of this project is to assess the Natural Rubber (NR) production in Sri Lanka compared to other NR producing countries in the world, to derive a statistical measure of profit (economic) inefficiency of rubber farmers in the three major rubber-growing districts. During the year under review, REOO of Kegalle, Kalutara and Ratnapura districts were involved in conducting the questionnaire survey. Head/ASD is involved as a team member of this project.

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

This project is funded by NSF under the theme "environmental protection and sustainable management" of the Coordinated Thematic Research Programme (CTRP). Biometry section, soils and plant nutrition and advisory services department are involved from RRI together with Ruhuna and Wayamba Universities. The overall

objective of this project is to improve the smallholder rubber sector in the Moneragala and adjacent parts of the Badulla and Ampara districts through sustainable management of environmental, socio-economic, technological and institutional aspects. Some results with respect to extension needs, collected from several villages are presented below.

Sum of ranks together with their priority obtained for each area of awareness during the immature stage is given in Table 7, 8, 9 and 10. The smallholders in both villages considered land preparation and planting and disease management as important. The smallholders have given least priorities for weeding and intercropping.

Table 7. *Sum of ranks and priorities for different awareness activities during the immature stage of rubber*

Activity	Sum of ranks* & priority for villages	
	Karandagama	Lunugala colony
1. Land preparation and planting	133 (1)	100 (1)
2. Maintenance of soil conservation practices & cover management	211 (3)	150 (3)
3. Disease management	197 (2)	133 (2)
4. Fertilizer application	222 (4)	153 (4)
5. Weeding	296 (6)	165 (5)
6. Intercropping	285 (5)	178 (6)

*Highest priority for the lowest rank sum, given in parentheses

Smallholders have considered marking of tapping panels, correct tapping methods and disease control as important areas for awareness raising as evident from sum of ranks given in Table 8. The smallholders considered fertilizer application and weeding as less important areas for awareness raising.

Table 8. *Sum of ranks and priorities for different awareness activities during the mature stage of rubber*

Activity	Sum of ranks* & priority for villages	
	Karandagama	Lunugala Kolaniya
1. Marking of tapping panels	168 (1)	103 (1)
2. Correct tapping methods	178 (2)	110 (2)
3. Fertilizer application	194 (4)	135 (4)
4. Weeding	231 (5)	141 (5)
5. Disease control	187 (3)	120 (3)

*Highest priority for the lowest rank sum, given in parentheses

According to the results given in Table 09, Recommended practices and low cost methods were the most important areas to be addressed in awareness programs in rubber processing. Smallholders in these villages have not considered maintenance of smoke houses and machinery as important.

Table 9. *Sum of ranks and priorities for different awareness activities for processing of rubber*

Activity	Sum of ranks* & priority for villages	
	Karandagama	Lunugala Kolaniya
1. Recommended practices	120 (1)	73 (1)
2. Maintenance of smoke houses	177 (3)	111 (3)
3. Maintenance of machinery	201 (4)	130 (4)
4. Low cost methods	142 (2)	106 (2)

*Highest priority for the lowest rank sum, given in parentheses

The most preferred area of dissemination was workshops as depicted by lowest sum of ranks (Table 10). Least preference was given for radio and TV programmes, newspaper supplements, video documentary and films as dissemination media in both villages.

Table 10. *Sum of ranks and priorities for different dissemination media*

Activity	Sum of ranks* & priority for villages	
	Karandagama	Lunugala Kolaniya
1. Lectures & leaflets	152 (2)	81 (2)
2. Workshops	104 (1)	66 (1)
3. Video documentary/films	173 (3)	137 (4)
4. Newspaper supplements/Radio/TV	211 (4)	136 (3)

*Highest priority for the lowest rank sum, given in parentheses

Area specific projects

Different training and institutional needs of rubber growers identified by RAO and REOO on specific issues at regional level, related to field management practices, processing, marketing and other related issues were addressed successfully.

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

a. Organizing repair works of rubber rolling units
b. Control of irrational use of chemicals on tapping panels
c. Training on yield stimulation techniques.
d. Introduction of intercropping and mix cropping system
e. Introduction of alternate fire wood sources to reduce cost of production of RSS

RUBBER TECHNOLOGY AND DEVELOPMENT

Dilhara Edirisinghe

SUMMARY

Work on a short term project based on NR/SBR/reclaimed rubber blends for tyre tread compounds was completed. NR latex based flowers developed by the Department won a bronze medal at the International Inventor's Exhibition held in Geneva, Switzerland. NR/PVAc blends with high strength properties were developed and the results were presented at Asia Rubtech Expo' 06. Several trials were carried out to produce flame retardant NR latex foam and masks out of NR latex foam. Also, a novel creature required to produce a space movie was successfully developed out of NR latex foam. A highly effective room temperature curing system for manufacture of cast/dipped products was developed and the work was presented at the International Rubber Conference held in Vietnam. A large scale plant trial using a rubberized bitumen emulsion, for road construction work was also successfully completed. A rubber ring compound with improved properties and a rubber boot compound using low cost materials were developed and improvement of the quality of a garden mat was carried out on request from an industry. Research work on Interpenetrating Polymer Networks was successfully completed at the Loughborough University, UK. Two new research projects on NR/SBR/BR and NR/EPDM blends were initiated. Trials carried out to incorporate GRT into NR latex for production of RSS sheets were successful. The department provided rubber compound and product testing services and handled number of industrial problems at the request of various rubber product industries. Further, the staff was actively involved in training students, entrepreneurs, etc and organizing stalls at exhibitions and job fairs organized by several ministries. The RRISL stall won first place in the competition held among exhibition stalls at the "Viskam Dakma" exhibition and trade fair held in Horana.

DETAILED REVIEW

Staff

Mrs D G Edirisinghe, Acting Head of the department was on duty throughout the year. Mrs M M Jayasuriya, Rubber Chemist completed her postgraduate studies leading to a PhD degree at the Loughborough University, UK. Miss G D Dilini Galpaya, Assistant Rubber Chemist was on duty throughout the year.

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

Research students

- Miss Pradeepa Gunaratnam, MSc (Polymer Science and Technology) student from the University of Sri Jayawardenapura completed her research work at the department.
- Miss W A D Nilukshi, a BSc (Chemistry Special) undergraduate student from the University of Kelaniya, Sri Lanka completed her six weeks vacation training.
- Mr A D J Dharmadasa and Mr Ramesh Karunagaran, MSc (Polymer Science and Technology) students from the University of Sri Jayawardenapura commenced their research work at the department.
- Mr Thushara Samaraweera, a MSc (Polymer Science and Technology) student from the University of Sri Jayawardenapura completed the research work and carried out writing-up of his thesis.
- Mrs Gayanthi Alahapperuma, a MSc (Polymer Technology) student from the University of Moratuwa continued her research work and writing-up of her thesis was initiated.
- Miss Geethamala Jayawardena, a BSc (Chemistry Special) undergraduate student from the University of Sri Jayawardenapura, Sri Lanka carried out a short term research project during her vacation training period.
- Mrs D G Edirisinghe served as the external examiner to evaluate the theses of three MSc students of the University of Sri Jayewardenepura and one MSc student of the University of Moratuwa.

Seminars/Conferences/Meetings/Workshops

Officer	Subject	Organization
Mrs D G Edirisinghe	First and Second Working Group Meetings on "Bicycle Tyres and Tubes"	Sri Lanka Standards Institution
Mrs D G Edirisinghe and Miss G D D Galpaya	Workshop on "Research Findings and Postgraduate Opportunities	The Scientific Staff Officers' Association of RRISL
Miss G D D Galpaya	Workshop on "Research Proposal Preparation & Report Writing"	Sri Lanka Council for Agricultural Research Policy
Mrs D G Edirisinghe	Sectoral Committee Meeting on "Chemical and Polymer Technology"	Sri Lanka Standards Institution
Mrs D G Edirisinghe	Scientific Committee Meetings	Rubber Research Institute of Sri Lanka
Mrs D G Edirisinghe and Miss G D D Galpaya	Seminar on "Tyre Machinery"	Ceyexxe Ltd.

Officer	Subject	Organization
Miss G D D Galpaya	Workshop on "Effective Proposal Writing"	National Science Foundation
Miss G D D Galpaya	Seminar on "Applications and Challenges of Nano-technology in Polymers and Coatings"	National Science Foundation
Miss G D D Galpaya	Training Programme on "ISO 17025"	Sri Lanka Accreditation Board
Miss G D D Galpaya	"Monitoring & Evaluation of Research Projects"	Sri Lanka Council for Agricultural Research Policy
Mrs D G Edirisinghe	Asia Rubtech Expo'06 Conference, Kochi, India	Indian Rubber Institute
Mrs Priyanthi Perera	International Rubber Conference, Vietnam	IRRDB
Miss G D D Galpaya	Study tour/training programme to the International Center for Chemical Sciences, University of Karachi, Pakistan	NASTEC, Young Scientists Forum
Miss.G D D Galpaya	INFORM workshop at PGIA, University of Peradeniya	Sri Lanka Council for Agricultural Research Policy

Training programmes

Client	Subject	No. of programmes
Students of the Plastics and Rubber Institute	(i) General properties of NR latex and latex technology (ii) Manufacture of RSS, crepe and TSR - Diploma Course in Rubber Technology	1
Students of the Plastics and Rubber Institute	(i) Structure and property relationship of polymers (ii) Compounding ingredients (dry rubber and latex) (iii) Processing techniques (latex) - Basic Course in Rubber Technology	1
BSc (Polymer) students of the University of Sri Jayewardenepura	Degradation and stabilization of polymers	1

Client	Subject	No. of programmes
MSc (Polymer Science and Technology) students of the University of Sri Jayewardenepura	a). Degradation and stabilization of polymers b). Practical training on "Rubber Technology"	1 1
MSc (Polymer Technology) students of the University of Moratuwa	Latex technology	1
Planter Trainees (Induction Course) of the National Institute of Plantation Management	Tests for raw rubber and their relevance	1
BSc (Architecture) students of the University of Moratuwa	Practical training on production of "foam rubber"	1

Industrial visits

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

Officers	Industry
Mrs D G Edirisinghe Miss G D D Galpaya Mr Sarath Kumara	Lalan Rubbers (Pvt.) Ltd., Seethawaka, Avissawella
Dr W M G Seneviratne Mrs D G Edirisinghe Miss G D D Galpaya	Suyamas International (Pvt.) Ltd., Horana
Dr W M G Seneviratne Mrs D G Edirisinghe Miss G D D Galpaya	Carnival World Ko-Lanka (Pvt.) Ltd, Katana
Mrs D G Edirisinghe Miss G DD Galpaya Mrs S I Yapa	Nippon Nature Foams International (Pvt.) Ltd., Bandaragama
Mrs M K Mahanama	Nippon Nature Foams International (Pvt.) Ltd., Bandaragama

LABORATORY INVESTIGATIONS

Latex technology

Blends of natural and synthetic rubber latices

NR/PVAc blends for dipped products

The objective of this research was to improve strength and ageing properties of natural rubber latex films. Cast films of the composition of 87/13 NR/PVAc latex

blends with different doses of curing ingredients initially in the two polymer phases were prepared as per different blending techniques. The films were vulcanized at 70°C, leached in water and dried at room temperature. The films exhibited a glossy surface finish. Modulus, tensile strength and tear strength of the 87/13 NR/PVAc blend compound prepared according to blending technique 2 [mixing PVAc with the soap (until the pH reaches that of the NR latex) and adding the mixture to NR latex followed by dilution of the whole mixture] and by adding a greater proportion of curing agents initially into the

NR phase (Sample No.2) were higher than those of the other 87/13 NR/ PVAc blend compounds and the unblended NR compound (Fig. 1 and 2). Further, the cast films were aged at 70°C for 168 hours and same properties as above were evaluated. Resistance to ageing of the films produced out of blends of NR and PVAc latices were found to be excellent. Therefore, the 87/13 NR/PVAc blend compound developed as per the special blending technique is suitable for the manufacture of latex based products which require, excellent strength, in particular and ageing properties.

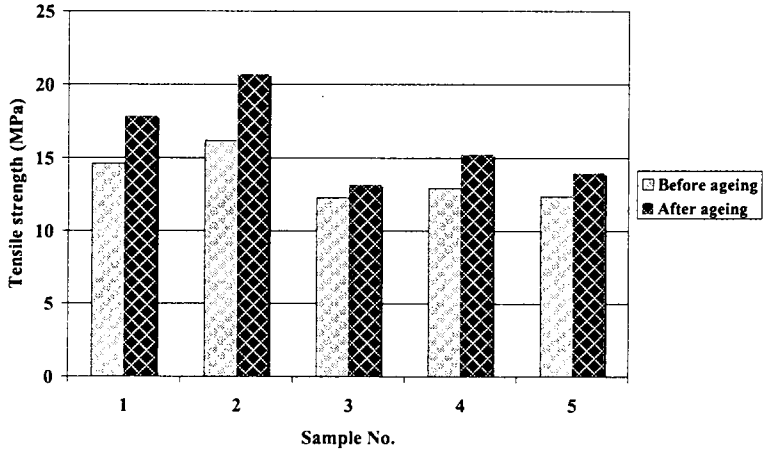


Fig 1. Variation of tensile strength of the samples produced as per different compounding techniques

The research paper on the above work titled "Improvements in Properties of NR Latex Films by Blending with Polyvinyl Acetate" was presented at the Asia Rubtech Expo'06 which took place in Cochin, India from 23rd -25th November 2006 (D G Edirisinghe, Poson Wettasinghe and Priyanthi Perera).

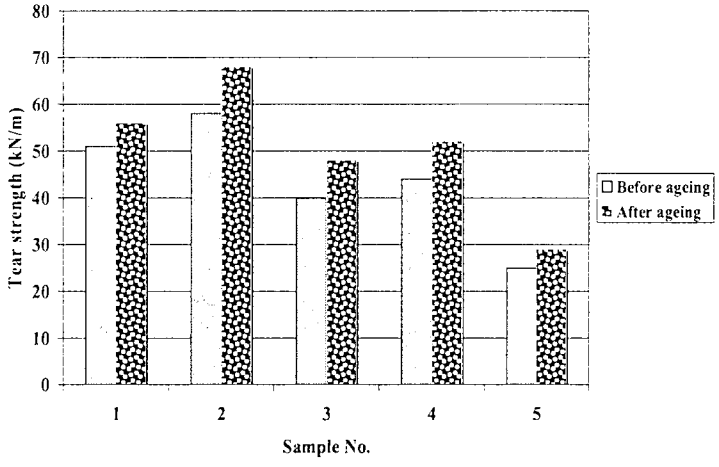


Fig 2. Variation of the tear strength of samples produced according to different compounding techniques

Development of NR /NBR blends for dipped products

The above project was initiated on a request made by Industrial Clothings (Pvt.) Ltd. The aim of replacing part of NBR latex with NR latex was to enhance strength properties and reduce cost of gloves produced at the company. The research was completed and writing–up of the MSc research project was carried out during the year (D G Edirisinghe, S Siriwardena, Thushara Samaraweera - MSc student, University of Sri Jayawardenapura and Priyanthi Perera).

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

The second set of blends of NR/CR and NR/NBR cast films was produced by varying the composition of each component in the blend and irradiation dose, for confirmation of the results which were previously obtained with the first set of samples. Some interesting results on tensile properties and tear strength of the films were noted (D G Edirisinghe, S Kulatunge – Atomic Energy Authority of Sri Lanka, S L G Ranjith, A I Siriwardena and P L Perera).

NR latex foam

Development of flame retardant NR latex foam

Several NR latex foam samples were prepared using different combinations of flame retardant chemicals, on a request made by Richard Pieris Natural Foams Ltd., Seethawaka, Avissawella. The flame resistance of these samples was tested according to a simple method using the Bunsen burner and compared with those of the samples prepared without flame retardant chemicals and with a blend of 80:20 NR/neoprene latices. However, the comparison did not reveal promising results as the

test employed was not a standard method (W M G Seneviratne, D G Edirisinghe, G D D Galpaya, S I Yapa and C Kuruppu).

Development of masks and toy animals

Several trials were carried out to produce NR latex foam suitable for masks, at the request of Carnival World Ko-Lanka, Katana. At present these masks are being produced at the above factory using the conventional casting technique. Replacement of direct latex casting with foam casting is expected to yield better facial expressions and reflections, comfort of wear and lower cost as foam requires lower quantity of compounded latex compared to direct casting. The thickness of the masks produced was greater than the required level and the foam structure indicated air trapping. Hence, the formulation was modified to produce foam suitable for filling the mould using an injecting device in order to minimize air trapping. Also, trials were initiated to produce toy animals out of NR latex foam using plaster of Paris moulds. Trials have shown that the use of good quality moulds with facilities to release entrapped air is quite important to produce products of required quality (W M G Seneviratne, D G Edirisinghe, G D D Galpaya and S I Yapa).

Development of a novel creature

A novel creature more or less similar to a dinosaur was produced by pasting the parts of the creature made separately out of NR latex foam using plaster of Paris moulds. This development was carried out at request made by the Department of Architecture, University of Moratuwa. Painting of the creature, one of the characters required for production of a space movie was carried out by university students. These students were also given a training on production of NR latex foam (D G Edirisinghe, S I Yapa and Sanjaya Vithana, University of Moratuwa).

Development of articles from foam waste/rejects

Several trials were conducted to produce pillows, table mats, etc. from foam waste/rejects at the request of Nippon Nature Foams International (Pvt.) Ltd. and some of the trials were successful. Further work is in progress (D G Edirisinghe and M K Mahanama).

Natural rubber latex based flowers for floral décor

Development of natural like flowers based on NR latex compounds led to a highly innovative discovery and this invention which won a Presidential Merit Award in 2003 was chosen for the International Inventors Exhibition. Several beautiful floral arrangements were produced and these were presented at the "34th International Inventors Exhibition" held in Geneva, Switzerland from 5th – 9th April and won third place in the "Industrial" category. This was awarded with a bronze medal and a certificate.

Rubberized bitumen emulsions in road construction

The developed rubberized bitumen emulsion was supplied to Sonex Lanka (Pvt.) Ltd. in large quantities to carry out factory scale trials. A large scale plant trial carried out in collaboration with Sonex Lanka (Pvt.) Ltd was successfully completed. Also, a sample of the developed emulsion was handed over to the RDA for analysis. Further trials are being carried out in order to reduce the cost of the product (M M Jayasuriya, S L G Ranjith and S I Yapa)

Development of a room temperature curing system for cast/dipped products

Development of a room temperature curing system for cast/dipped product was carried out in the department as a short term project. The overall aim of this research was to develop a highly effective room temperature curing system for natural rubber (NR) latex based compounds thus the energy consumption for vulcanization at elevated temperatures will be eliminated. Small scale rubber product manufacturers engaged in cottage industries will be specially benefited by this due to the reduction in the cost of production of the articles.

A series of NR latex based compounds (S1 – S12) was prepared by varying the amounts of accelerators in the sulphur vulcanizing system. Twelve different combinations of the three accelerators ZDC, ZMBT and DPG were tried out. The compounded latex samples thus prepared were poured into glass plates and the time taken for vulcanization of the films at room temperature was determined. Cross-link formation was assessed by swelling measurements. Mechanical properties of the room temperature vulcanized films were evaluated. The results revealed that the time required to vulcanize at room temperature can be minimized by using the sulphur vulcanizing system with the accelerator ratio ZDC : MBT : DPG = 1 : 1 : 0.5 (Table 1, sample S7) as it is the fastest accelerator combination among the twelve combinations studied. Also, this combination exhibited excellent tensile properties (Fig. 3) and tear strength (Fig. 4). As such the vulcanizing system with the accelerator ratio as mentioned above can be regarded as a highly effective room temperature vulcanizing system in terms of rate of vulcanization, cost and strength properties for NR latex based compounds used in the manufacture of cast products, dipped products, rubberized-coir products, latex foam, *etc.*

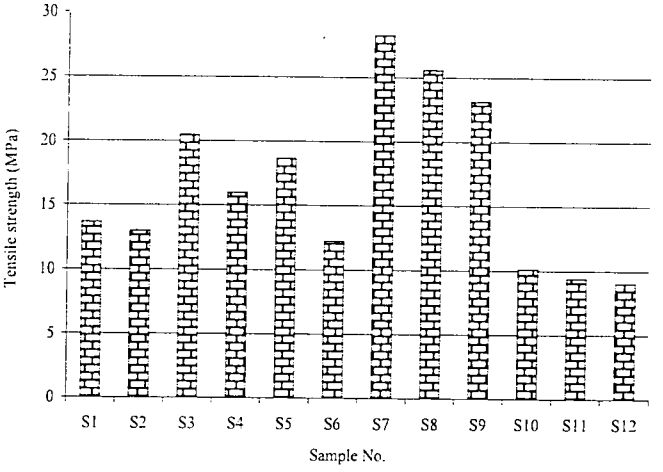


Fig. 3. Variation of tensile strength of the samples

Table 1. *Vulcanization time of the samples at room temperature*

Sample No.	Vulcanization time (hours)
S_1	28
S_2	30
S_3	24
S_4	27
S_5	26
S_6	30
S_7	**18**
S_8	20
S_9	22
S_{10}	48
S_{11}	49
S_{12}	49

The research paper on the above work titled "Development of a highly effective room temperature vulcanizing system for natural rubber latex based compounds" was presented at the International Rubber Conference - 2006 held in Vietnam from 13^{th} – 17^{th} November, 2006 (D G Edirisinghe, Priyanthi Perera and W A D Nilukshi, BSc (Chemistry Special) undergraduate student from the University of Kelaniya).

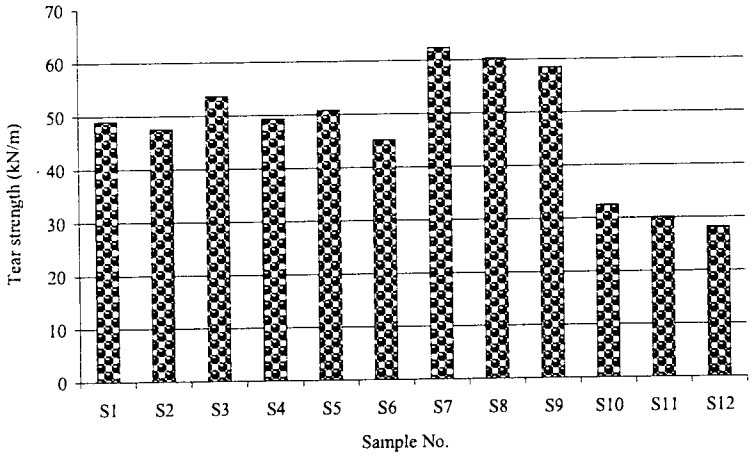


Fig. 4. Variation of tear strength of the samples

Interpenetrating polymer networks (IPNs)

Several series of sequential interpenetrating polymer networks using natural rubber and poly (methylmethacrylate) were prepared. Three types of IPNs known as semi-1 IPNs, semi-2 IPNs and full IPNs were prepared at various compositions. In addition, blends of natural rubber and poly (methylmethacrylate) were prepared for comparison. These materials were characterized by dynamic mechanical thermal analysis (DMTA), modulated-temperature thermal differential scanning calorimetry (MDSC), stress-strain analysis and some soxhlet extraction studies. The effects of composition and cross-linking of NR component and/or PMMA component on the physical and dynamic mechanical properties were evaluated.

All types of IPN and the blends produced in this study were phase separated. However, the blends exhibited considerable amounts of mixing of components resulting most probably from grafting PMMA chains on to natural rubber. In addition, incorporation of PMMA into the natural rubber matrix rendered high tensile strength and modulus which tended to increase with increasing PMMA content. Cross-linking of the natural rubber and the PMMA component improved the extent of mixing and physical properties to a significant level.

Attempts were been made to improve the compatibility between the natural rubber and poly (methylmethacrylate) components by incorporating epoxidised natural rubber (ENR) into this system. Incorporation of ENR-45 and ENR-60 improved the extent of mixing of natural rubber component as was evident from the prominent shift of the NR glass transition to the higher temperature. With increase of the epoxidation level to a 60 mole %, the miscibility between the ENR component and PMMA component was increased when compared to the ENR with 45 or 50 mole %. Apart from this, the physical properties such as tensile strength and tear strength increased with incorporation of ENR.

The above research was completed at the Institute of Polymer Technology and Materials Engineering, Loughborough University, UK and Mrs M M Jayasuriya obtained her PhD degree (M M Jayasuriya and D J Hourstan).

Development of rubber products for bio-medical applications

The imported rubber products provided to the department by the Bio-medical Engineering Services, Department of Health were initially analyzed for the identification of type of rubber using the FTIR instrument. One such product is the "Chest Bulb" made out of rubber. This is used for obtaining ECG's. This rubber bulb should be non-toxic and it should not have any adverse effect on the patient's skin and should not react with the electrode gel. Cost of this product should be less than Rs.600/= and the service life should be more than three months. Trials were initiated to develop a suitable rubber compound (D G Edirisinghe and Priyanthi Perera).

Latex/GRT masterbatches for production of RSS sheets

Trials were conducted to incorporate GRT into NR latex in order to produce RSS sheets with the aim of reducing environmental pollution and energy consumption during banbury mixing of GRT with rubber. Different percentages of GRT were incorporated into latex according to a novel technique with subsequent coagulation with 2% formic acid. The RSS sheets thus produced were uniform in colour and in texture. A study on the processability and properties of the developed RSS sheets is in progress (D G Edirisinghe, S Siriwardena and S L G Ranjith).

Dry rubber technology

Dry rubber blends

NR/SBR/reclaimed rubber blends for tyre retreads

Analysis of abrasion patterns on the Akron abraded test pieces was carried out using the Scanning Electron Microscope (SEM). As expected, generally the results indicated a reduction in the mechanical properties such as tensile properties; tear strength and resistance to abrasion with increasing amounts of reclaim in the blend. However, some of the developed blend systems containing reclaim showed good resistance to abrasion. Introduction of a combination of two types of carbon black instead of a single type did not improve the properties probably due to poor distribution of the same in the blends. SEM photographs revealed that the reclaim rubber is distributed in the NR/SBR blends as discrete particles and this is probably the cause for the reduction in mechanical properties with the increase of reclaim levels. Discrete reclaim rubber particles appears to be weakly bonded to NR and SBR phases and as a result there is a high possibility of removal when abraded. Therefore, attempts have to be made to improve bonding between reclaim and the other virgin rubbers in the blend for enhanced mechanical properties (W M G Seneviratne, D G

Edirisinghe, Pradeepa Gunaratnam - MSc student, University of Sri Jayawardenapura, P C Wettasinghe and M K Mahanama).

Optimization of mechanical properties of NR/SBR /BR blends used in tyre treads

A project was initiated in collaboration with Loadstar (Pvt.) Ltd. to optimize mechanical properties of NR/SBR/BR blends used in tyre treads. Incorporation of a small percentage of polybutadiene rubber (BR) into NR/SBR blends is expected to improve tread wear, reduce hysteresis and groove cracking. A series of tri-blend compounds were prepared by varying the composition of the three rubbers in the blend. Mechanical property testing of the compounds was carried out and some of the tri-blend compounds showed improved properties over the other compounds. Further work is in progress (D G Edirisinghe, G D D Galpaya and A D J Dharmadasa, MSc (Polymer Science and Technology) student of the University of Sri Jayewardenepura).

Enhancement of mechanical properties of ozone resisting NR/EPDM blends

A series of NR/EPDM blend compounds was produced by varying the percentage composition of EPDM in the compound, amount of antiozonant and by combining two types of antiozonants. Individual rubber compounds via NR, EPDM and their blends were tested for ozone resistance and mechanical properties. Some interesting results on ozone resistance were noted. Further work is in progress (D G Edirisinghe, H N K K Chandralal, Ramesh Karunagaran – MSc (Polymer Science and Technology) student, University of Sri Jayewardenepura and S L G Ranjith).

Property improvement of an EPDM rubber compound

A study was initiated to improve the tensile strength and compression set of the EPDM rubber compound which is currently being used at J.S. Enterprises, Panadura to produce lip type rubber rings. A trial was performed by replacing 20% of the EPDM with natural rubber and by varying the proportions of sulphur and the accelerators. Physical properties of the blend were evaluated and compared with those of the EPDM rubber compound. Subsequent trials have shown that it was possible to improve ageing resistance of the compound when EPDM rubber is blended with another grade of EPDM having different diene content. The developed formulations were forwarded to the company (D G Edirisinghe and S L G Ranjith).

Quality improvement of a garden mat

Garden mat developed by Encore Technologies (Pvt.) Ltd. was prone to discolouration on exposure to sunlight for 24 hours and sought RRISL advice to overcome this shortcoming of the mat. This was found to be due to migration of ingredients on exposure to light. In order to prevent this, compound made out of chlorobutyl rubber was sandwiched between the bottom layer prepared out of GRT and the top green colour layer prepared out of natural rubber and vulcanized at 140°C.

The intermediate cholorobutyl layer prevented migration of ingredients which was expected to cause the discolouration and the final outcome was satisfactory (W M G Seneviratne, G D D Galpaya, D G Edirisinghe and P L Perera).

Use of scrap crepe in tyre retread compounds

Since the initial work on this project revealed that 20% of the RSS in tyre tread compounds can be replaced with scrap crepe without any significant reduction in mechanical properties, the 80/20 RSS/scrap crepe formulation was chosen for further work. It is known that the masterbatch mixing technique usually results in improved properties compared to that of single-stage mixing technique. Hence, the carbon black distribution in the two natural rubber phases was varied by incorporating 80%, 65% and 50% of carbon black (N 330) initially into the RSS and the remaining amount of black into the scrap crepe. Mechanical properties of the three compounds were evaluated. There was a significant difference between the mechanical property results of the three compounds which indicate that carbon black does not transfer from one natural rubber-carbon black masterbatch to the other. Tensile strength, modulus, hardness and abrasion resistance of the rubber compounds prepared by incorporating 80% (compound A) and 65% (compound B) of carbon black initially into the RSS were very much higher than those of the other. The tensile strength and the abrasion volume loss of compound A were 15 MPa and 103 mm^3 respectively and these values are in accordance with the required values (Shantha Maduluwage and Prof. K Subramanium, University of Moratuwa, D G Edirisinghe, Gayanthi Alahapperuma – MSc student, University of Moratuwa and Priyanthi Perera).

Development of a boot compound using low cost materials

The natural rubber (NR) used in the boot formulation was replaced partially by reclaim rubber at the request of Sinwa Holdings (Pvt.) Ltd. in order to reduce the cost of the product. Tensile properties, tear strength and resistance to flex-cracking of the compound made with reclaim rubber were within the required level. Further, a compound was prepared by partially replacing NR with NBR powder. Tensile properties of this compound were almost similar to those of the reclaimed rubber compound, but there was a reduction in the tear strength (D G Edirisinghe and A I Siriwardena).

Development of a door mat using scrap crepe rubber

Few compound formulations were tried out to produce a mat with good physical properties using scrap crepe at the request of a scrap crepe manufacturer. Mechanical properties of one of the compounds were in accordance with the required levels and the comprehensive report was handed over to the entrepreneur to set up a factory (D G Edirisinghe, P C Wettasinghe and P P Jayasinghe).

Comparison of mechanical properties of bicycle tyre treads compounds made out of different rubbers and their blends

A series of bicycle tyre tread compounds were prepared out of NR, SBR, reclaimed rubber and their blends at the DSI factory, Mahara in consultation with the RRISL on a request made by the SLSI. Determination of mechanical properties was carried out both at DSI and RRISL laboratories in view of revising the existing SLS standard for bicycle tyres. Further, bicycle tyres were produced out of selected compounds in the series in order to evaluate their performance on roads (D G Edirisinghe and S L G Ranjith).

Shoe soles out of dipped products waste/rejects

Multi coloured shoe-soles with different surface designs were produced solely out of dipped products waste/rejects to make use of them for a useful product application. This was presented at the Presidential Awards Competition. The results of the competition are yet to be announced (D G Edirisinghe and M K Mahanama).

Industrial extension

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

Service	No. of companies
Physical properties of rubber compounds	10
Testing of rubber products	2
Testing of reclaimed rubber	1
Tensile properties of gloves	1
Tensile properties of cast films	1
Testing of latex based adhesives	1
Hardness of sole crepe samples	3

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

Officers in the department participated /assisted at the following exhibitions/job fairs

Mrs D G Edirisinghe, Miss G D D Galpaya, Mr P L Perera and Mr H N K K Chandralal were actively involved in organizing the RRISL stall and carrying out demonstrations on rubber products manufacture at the "Thambapanni Navodaya" exhibition and fair held at Hindu Vidyalaya, Puttalam from March 17th to 19th, organized by the Ministry of Plantation Industries.

The staff of the department assisted the RRISL stalls by conducting demonstrations on rubber products manufacture and providing advice on setting up mainly latex based cottage industries, at the Job Fairs held at Pelmadulla, Dankotuwa

and Piliyandala organized by the Ministry of Labour Relations and Foreign Employment.

Mrs D G Edirisinghe, Miss G D D Galpaya, Mr P L Perera and Mr H N K K Chandralal were actively involved in organizing the RRISL stall and carrying out demonstrations on rubber products manufacture at the "Viskam Dakma" exhibition and trade fair held at Thakshila Vidyalaya, Horana from 8th to 12th April. **The RRISL stall won first place in the competition held among exhibition stalls.** The RRISL was awarded a certificate and a trophy.

Mrs D G Edirisinghe, Miss G D D Galpaya, Mr P L Perera, Mr H N K K Chandralal, Mrs Priyanthi Perera, Mrs M K Mahanama and Mr A I Siriwardena were actively involved in organizing the RRISL stall and providing advice and assistance to entrepreneurs mainly on rubber machinery required for setting up rubber based industries at the "International Machinery Exhibition and Trade Fair 2006" held at the Sri Lanka Exhibition and Convention Centre, Colombo from September 08th to 10th. This exhibition was organized by the Small and Medium Enterprise Developers and the Ministry of Rural Industries and Self Employment Promotion.

Mrs D G Edirisinghe, Mr P L Perera, Mrs M K Mahanama and Mr S L G Ranjith were actively involved in organizing the RRISL stall at the exhibition and fair held at Medankara Vidyalaya, Horana from October 18th to 20th.

Mrs D G Edirisinghe, Mrs M K Mahanama, Mr S L G Ranjith and Mrs Priyanthi Perera were actively involved in organizing the RRISL stall at the "Mahapola Exhibition and Trade Fair" held in Ratmalana from December 14th to 19th.

Mrs M K Mahanama served as one of the Judges in the competition among inventions held in the Kurunegala and Anuradhapura districts organized by the Sri Lanka Inventors Commission jointly with the Ministry of Education.

POLYMER CHEMISTRY

Champa Wellappili

SUMMARY

NR latex compound was modified by the addition of styrene/acrylic copolymer. The films prepared from 10-20% copolymer in the latex blend exhibits higher tensile strength than 100% NR film. The tensile properties decrease at higher loadings of the copolymer in the blend. Styrene/acrylic copolymer /NR blends show better ageing properties when compared with 100% NR films.

Nitrosamine free phenolic type bactericide was investigated as a new preservative system for NR latex. The effect of preservation was evaluated by VFA No and a new bactericide resulted in a lower VFA in latex when compared with the conventional system.

Effectiveness of metal ions such as Al^{3+} on NR latex proteins was investigated to denature the antigenic proteins in NR latex. It was found that the introduction of metal ions before centrifuging, improved the deactivation rather than addition of metal ions prior to its vulcanization.

Improvement of the physical properties was achieved of the blends of NR containing NR glove cuttings treated with fatty acids compared with NR blend containing untreated glove waste.

Calibration curves for different types of lattices and dry rubber blends were carried out using FTIR in view of obtaining reference standards for quantitative analysis of rubber blends and compounds.

A workshop on rubber wood treatment was conducted for some students from a rehabilitation camp.

DETAILED REVIEW

Staff

Dr (Mrs) Champa Wellappili, Rubber Chemist was on duty throughout the year. Ms Nilmini Liyanage, Assistant Rubber Chemist, left for UK, on the 30th April 2006 for her postgraduate studies at the University of Cardiff in Wales.

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

Research students

- Mr Chamila Kadigamuwa, a BSc (Chemistry Special) undergraduate student of the University of Kelaniya, and Mr Dammika, a BSc (Chemistry Special) undergraduate student of the University of Sri Jayawardanapura conducted their research projects at the department

The staff of the department involved in conducting practical classes for the students following the NDT course in Polymer Technology at the University of Moratuwa.

Seminars/Conference/Meetings/Workshops/Lectures

Officer	Subject	Organization
Champa Wellappili	Nanotechnology	National Science Foundation
Champa Wellappili	Bio technology	Chamber of Commerce and National Science Foundation
Champa Wellappili	Monitoring and evaluation of research projects and programme	Council for Agricultural Research Project (CARP)

Training programmes

Client	Subject	No. of programmes
NIPM Induction course for planter trainees	Delivered lectures on "Composition of NR Latex"	1
University of Sri Jayawardanapura BSc General Degree course	Served as a visiting lecturer on "Polymer surface coatings"	1
Students from rehabilitation camp, Elpitiya	Conducted a workshop on "rubber wood treatment"	1

LABORATORY INVESTIGATIONS

Natural rubber latex/Styrene acrylate emulsion blends

Blends of NR with suitable elastomers and polymers have been tried to improve certain properties like tensile strength, thermal stability, wear and tear resistance etc. Therefore, NR latex compounds were modified by the addition of a styrene/acrylic copolymer. Fig 1 shows tensile strength values of unaged and aged latex blends as a function of blend ratio. It shows the 90/10 NR/copolymer blend yields optimum tensile properties in comparison with the other blending ratios.

Reduction of tensile strength of NR and its blends were observed after performing the aging test at 100°C which phenomenon is quite normal. The NR

shows the lowest value. This was probably because of an oxidative degradation of the NR at elevated temperature in the presence of oxygen. In contrast, tensile strength of the NR/copolymer blends did not show significant change between aged and unaged samples in comparison with NR alone (Champa Wellappili, Chitra Kuruppu and Chamila Kadigamuwa- Kelaniya University).

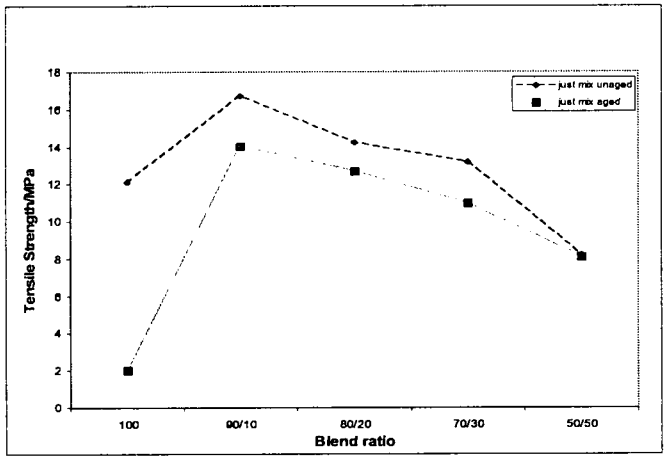


Fig 1. Variation of tensile strength of NR blends as a function of polymer ratio

Development of new preservative system for NR latex

Low ammonia TMTD/ZnO preservative system was replaced with a new nitrosamine free phenolic type bacteriaside which is commonly used in the leather processing industry.

The effect of preservation was evaluated by VFA analysis. As shown in Fig. 2, low VFA value was obtained with new phenolic type bactericide when compared with the conventional system.

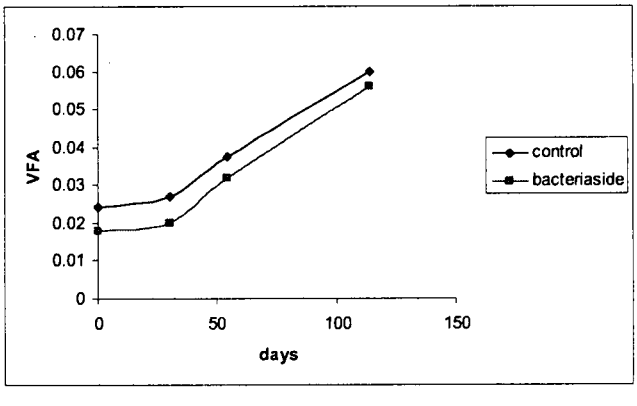


Fig 2. Variation of VFA No as a function of no of days

Further investigations on comparisons of physical and curing properties of these two systems are in progress. Evaluation of the optimum concentration for the bactericide is also in progress (Champa Wellappili, H N K K Chandralal and Ananda Samarakoon).

Effect of metal ions on natural rubber latex proteins

Significant conformational changes of the proteins are reported to be accompanied with the interactions of metal ions (such as Cu^{2+}, Ni^{2+}) with peptide bonds in proteins. As such, experiments were initiated with chemical compounds such as Al^{3+} with different compositions, to denature the antigenic protein in NR latex expecting reduction of the total protein levels. Metal ions were added prior to centrifuging of latex in one set of experiment while the other was carried out prior to vulcanizing of compounded latex. The project will be continued (Champa Wellappili, Ananda Samarakoon and K K K D Priyashantha - Sri Jayawardanapura University).

Development of a dispersion medium for a natural fungicide

A suitable mineral oil emulsion was developed as a medium to spray a natural fungicide as requested by TRI to use on a commercial scale in Tea plantation industry. This newly prepared emulsion can be applied within larger coverage of plantation than what is being used currently, which will reduce the chemical cost (Champa Wellappili and H N K K Chandralal).

Utilization of used and rejected natural rubber gloves in rubber products industry

The project aimed to investigate the possibilities of blending chemically treated waste NR gloves, as a cheap reinforcing filler with virgin Natural Rubber (NR) in view of obtaining improved properties. A series of experiments were carried out with two types of blends - namely NR with untreated waste gloves and waste gloves treated with Fatty Acid (FA). Improvement of physical properties was further enhanced through a blending process where waste gloves were first treated with a FA, before the actual blending with NR compound was carried out. FA based activator seems to improve the miscibility of the two phase through possible plasticizing action and thereby improving the physical properties of the end product. FA is a cheaper alternative to improve the dispersibility of the blend.

Physical properties such as tensile, hardness and tear properties of the blends with varying proportions of the waste glove content are depicted in Figures 3- 7 (Champa Wellappili and Indra Denawaka).

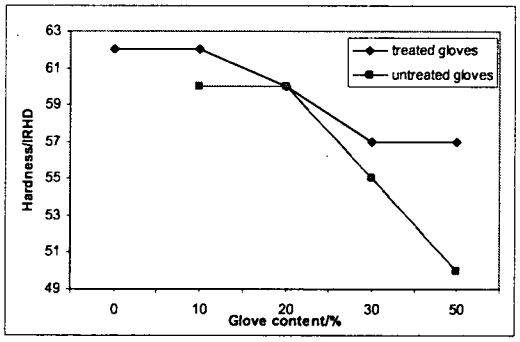


Fig 3. Variation of Hardness as a function of glove content with treated and untreated gloves

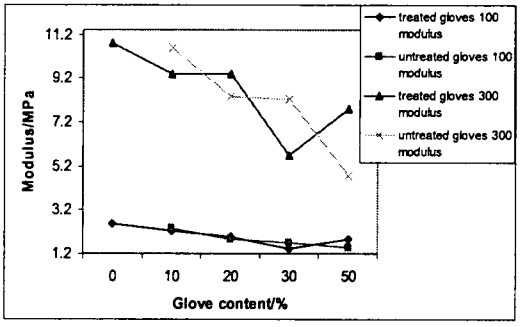


Fig 4. Variation of 100% and 300% modulus as a function of glove content

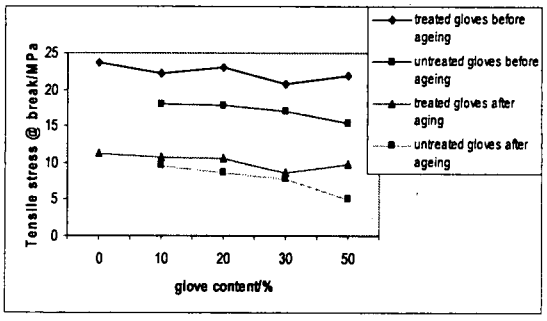


Fig 5. Variation of tensile stress @ break as a function of glove content with treated and untreated gloves for before and after ageing

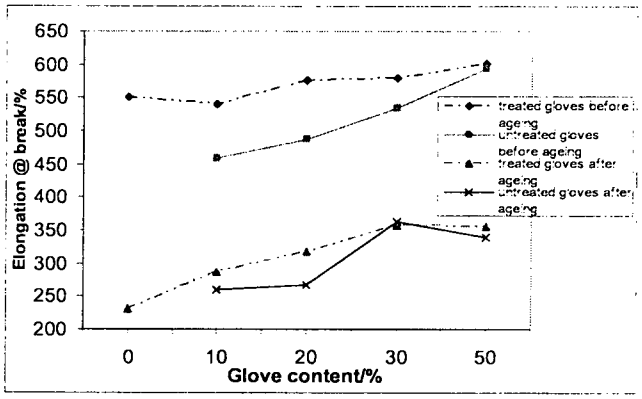


Fig 6. Variation of Modulus (before and after ageing) as a function of glove content with treated and untreated gloves

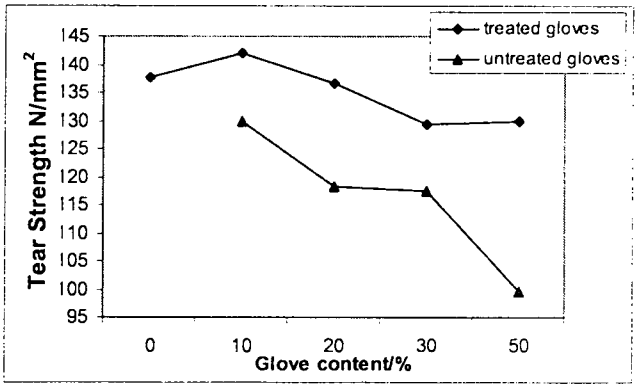


Fig 7. Variation of tear strength as a function of glove content

Investigation of rheological behaviour of compounded NR latex in the presence of associative thickeners as a function of pH

Viscosity of Natural rubber latex compound is an important processing parameter for the dipped NR latex products to obtain the desired thickness. As such viscosity modifiers are commonly used to improve the viscosity.

This project was initiated to study the effect of associative thickeners on the viscosity and the colloidal stability of NR latex compounds at different pH ranges. Initial trials were conducted using available thickeners such as Carboxy Methyl Cellulose (CMC), Hydroxy Ethyl Cellulose (HEC). Further improvements and to maintain the viscosity of compounds at specified pH levels are in progress. Variation

of viscosity of compounded latex as a function of HEC and CMC concentration is shown in Fig. 8 (Champa Wellappili, H N K K Chandralal and S S Warnapura).

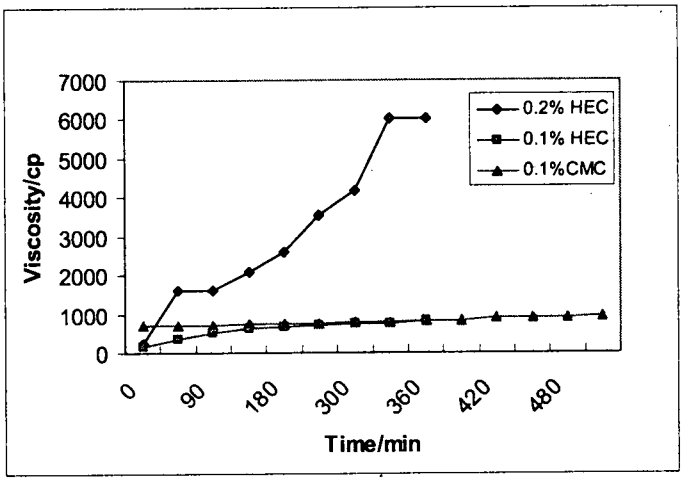


Fig 8. Variation of viscosity as a function of HEC and CMC concentration

Preparation of plasticized PVC

Several trials were conducted on a request made by Ms. Shore to Shore Company at Katunayake Free Trade Zone, to prepare compounds out of plasticized PVC for the manufacture labels to be affixed in traveling bags. The trials were conducted with different types of plasticizers such as Phthalates. Different conditions and concentrations were tried out to achieve the product in compliance with company requirements (Champa Wellappili, H N K K Chandralala and Ananda Samarakoon).

Construction of polymer library

Different ratios of lattices and dry rubber blends such as NR/EPDM, NR/SBR, NR/NBR were used to obtain spectrographs using FTIR. A calibration curve was plotted by taking into consideration of the appropriate/relevant peaks of the main polymers. This can be used as reference standards to quantitative analysis of rubber blends and compounds (Champa Wellappili and Indra Denawaka)

Industrial extension and testing samples

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

Company	Analytical services
Water Board	Analysis of polymer composition of 'O' rings
Malindu Timber,	Testing of timber for moisture Developed a suitable binder to prepare partition boards
Richard Pieris	Analysis of polymer composition of rubber mat
Samson compounds (Pvt) Ltd.	Analysis of polymer composition of rubber products
Sinwar Holdings	Analyze the solvents by distillation
Associated Motorways	Analyze the purity of chemicals by melting point
Jay Sea Foods Processing (Pvt) Ltd.	Analyze the adhesive
Latex Green (Pvt) Ltd.	Analysis of polymer composition of foam rubber

Exhibitions

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

- "Viskam Dakma" exhibition and trade fair held at Thakshila Vidyalaya, Horana from 8th to 12th April.
- "Mahapola Exhibition and Trade Fair" held in Ratmalana from December 14th to 19th
- "International Machinery Exhibition and Trade Fair 2006" held at the Sri Lanka Exhibition and Convention Centre, Colombo from September 08th to 10th.

RAW RUBBER AND CHEMICAL ANALYSIS

Anusha Attanayake

SUMMARY

A total number of 362 raw rubber analytical certificates of TSR samples were issued after testing the samples for raw rubber properties for grading and shipping purposes. 259 samples of different grades of other forms of processed raw rubber were tested for raw rubber analysis for quality assessment for both export and local consumption purposes. Several rubber chemicals were tested for their percentage purity assessments. The department was also involved in testing of rubber products such as rubber gloves for sodium pentachlorophenate content and powder content, rubber content in vulcanized products, contamination of metal ions in dipped products.

In addition to the above routine testing and analytical work, department engaged in the following research projects.

i. Quality assessment of latex by monitoring the volatile fatty acid number and mechanical stability parameters
ii. Estimation of Technical parameters for low grades of rubber
iii. Evaluation of the latex quality parameters of centrifuged latex preserved with latex preservatives prepared using conventional ball milling and pearl milling techniques.

DETAILED REVIEW

Staff

Ms A P Attanayake, Assistant Rubber Chemist was in Charge of overall activities of the department through out the year.

Experimental Officers, Ms H S Weeraman, L Wanigatunga, H V K Gamage, C Lokuge, L P Vitharana, M Wijesekera, B Gunasiri, N Karunatilaka, W Vithanage and Clerk Mrs I Wijesinghe were on duty through out the year.

Instrument Technician Mr L G P Lelwela, was on duty through out the year.

Seminars/ Conferences/Meetings/Workshops attended

Officer	Subject	Organization
Mrs A P Attanayake	Effective writing of project proposals	National Science Foundation
Mrs A P Attanayake	Laboratory Management System ISO/IEC 17025	Sri Lanka Accreditation Board

Training programmes

Client	Subject	No. of programmes
Culloden Estate R Ranasinghe, P A Luxman Saman Kumara	TSR analysis	1
Glenross Estate S Galpaya, G D Trimal, S H Wahalatha	Latex analysis	1
Latex Green (Pvt) Ltd Isira Samarasinghe	Latex analysis	1
Kelani Valley Plantation Kiriporuwa Estate	Latex analysis	1
A I Dayalatha, W S Jayakody	Latex analysis	1
S.L.R.M.C - V S Maddigoda	Latex analysis	1
Ceymac Rubber Company D L M Rupasinghe	Raw rubber analysis	1
N.D.T. a Group of students University of Moratuwa	Raw rubber analysis	1
MSc Polymer science a group of students, University of Jayawardanapura	Latex/Raw rubber analysis	1
NIPM Plantation Management Training course for Planter Trainees	Lecture on significance of latex testing & practical demonstration	1
Lalan Centrifuging factory Staff	Lecture on sampling of latex	1

Industrial visits

Officer	Subject	Industry
S Weeraman L P Vitharana	Advisory visit on TSR processing	Sandagiri Block Rubber Factory, Dompe
S Weeraman	Skim rubber project.	Glenross Rubber Company, Neboda.
W Wimaladasa	Factory Inspection, data collection and samples drawn	Hewij Rubber Company, Lewwanduwa Le Fern Laboratories, Getahetta Lalan Rubbers Ltd, Warakapola
Nilmini Liyanage H N K K Chandralal S Weeraman	To carry out a process Audit	Ceyesta Factory Maharagama
S Weeraman L Wanigatunga C Lokuge	Advisory Visit	Lalan Rubbers (Pvt) Ltd, Bulathsinhala
P H SarathKumara S Weeraman	Inspection visit to grant subsidy under CESS scheme	Lalan Rubbers (Pvt) Ltd, Biyagama

LABORATORY INVESTIGATIONS

Services

Fixing of rainguards

Assistance was given for the preparation and fixing of rain guards at Bellana Victoria Estate initiated by Advisory Services Department (A Dissanayake, Nimal Karunatilaka and Wimaladasa Vithanage).

Calibration of latex tanks

Calibration of latex tanks were carried out at SRMC Mawanella centrifuged latex factory, RRI Kuruwita sub station and Dartonfield Estate, Agalawatta, Parambe estate, Kegalle, Rambukanda Estate, Ratnapura, Galatura Estate, Galatura as requested by those companies for accurate measurements of the quantity of latex (A Attanayake and L P Vitharana).

Production control by trace metal ion contamination in bleaching agent

A number of samples were tested for trace metal ion (Copper, Iron) contamination in bleaching chemical in order to streamline the production control system at Mackwoods Company, one of the manufacturers of bleaching agent used in the manufacture of crepe rubber (S Siriwardena, A Attanayake and L Wanigathunga).

Evaluation of the methods of preparation of dispersions by using Pearl mill and the Ball mill on the viscosity of LATZ latex

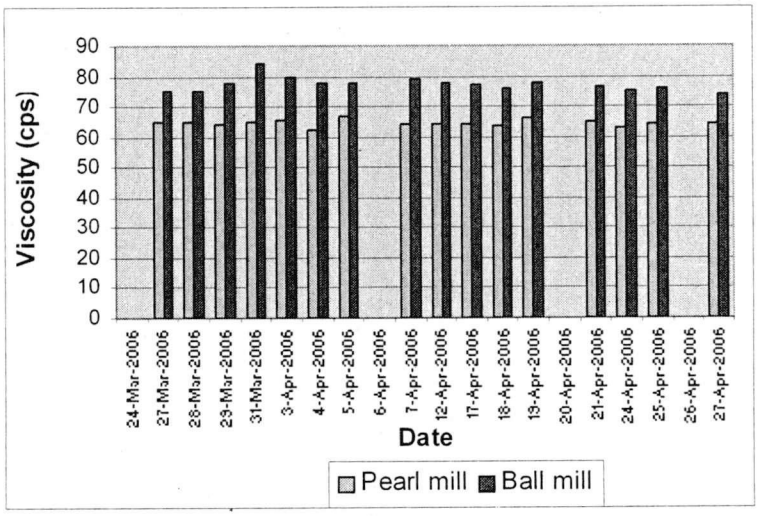


Fig 1. Comparison of viscosity of latex preserved with preservatives prepared using ball milling and Pearl milling

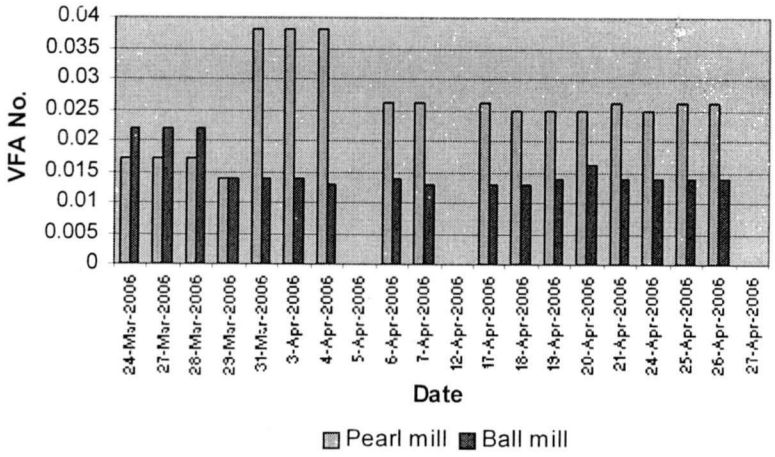


Fig 2. Comparison of VFA of latex preserved with preservatives prepared using ball milling and Pearl milling

Viscosity of latex is one of the major quality control parameters in ascertaining the quality of latex in the latex manufacturing industry and maintaining its consistency is quite vital for dipped product manufacture. Extent of latex preservation has a direct impact on the viscosity and it is believed that the extent of dispersibility of latex preservatives in latex may play a vital role in the viscosity consistency. This project was initiated on a request made by an industrialist.

Two sets of LATZ latex were prepared by the addition of chemical preservative dispersions of TMTD and ZnO prepared by means of pearl milling and conventional ball mixing. Whereas particle size of the Pearl mill dispersion was less than 1 micron and the particle size of the Ball mill dispersion was found to be in the range of 2-5 microns. Comparison of the results shows that the viscosity of latex preserved with ball milled chemicals varies between the acceptable range of 70- 80 cps while the latex preserved with Pearl milled chemicals varies in the range of 60 -70 cps as shown in Fig. 1.

The VFA No of latex preserved with ball milled chemicals maintained at comparatively lower level and does not show any significant fluctuations where as the VFA No of latex preserved with pearl milled chemicals remained at a higher level with batch to batch variations as shown in figure 2 may be due to the reagglomoration of particles is higher with smaller particles thereby reducing the effectiveness of preservation as reported in literature (A Attanayake, C Lokuge and W Vithanage).

Issuing of laboratory inspection report to Lalan Rubbers - Warakapola

A comprehensive report detailing the additional facilities required to be

installed in comparison with a standard latex testing laboratories was submitted to the company in view of standardizing the laboratory test results (A Attanayake, S Weeraman, C Lokuge and V Gamage).

Technical parameters for low grades of natural rubber

Due to the escalating price of rubber, the centrifuge latex factories were interested in producing superior quality skim rubber by adopting different manufacturing methods. This has made the RRI to embark on a grading system for lower grades of rubber including skim rubber to meet the demand of the product manufacturers and minimize the trade disputes.

Data collected and technical analysis was carried out on the samples drawn from different skim rubber factories. Statistical analysis has been carried out in view of stipulating average limits of skim rubber (S Siriwardena, S Weeraman, S Priyanka, W Vithanage and N Karunathilaka).

Study on the factors affecting the mechanical stability time in natural rubber latex

This project was initiated as an attempt to study the factors affecting the MST of latex based on an industrial request made by Lalan Group of Companies. Dependence on the temperature, adulteration, amount of preservatives added, clone and processing conditions on the variation of MST were aimed at in this study. Effect of variation of MST on temperatures 20, 25, 40, 45^{0}C is shown in figures 3-6. At lower temperatures MST shows a higher value which implies latex is more stable as expected. Studies on the other parameters are in progress (A Attanayake and M Wijesekara).

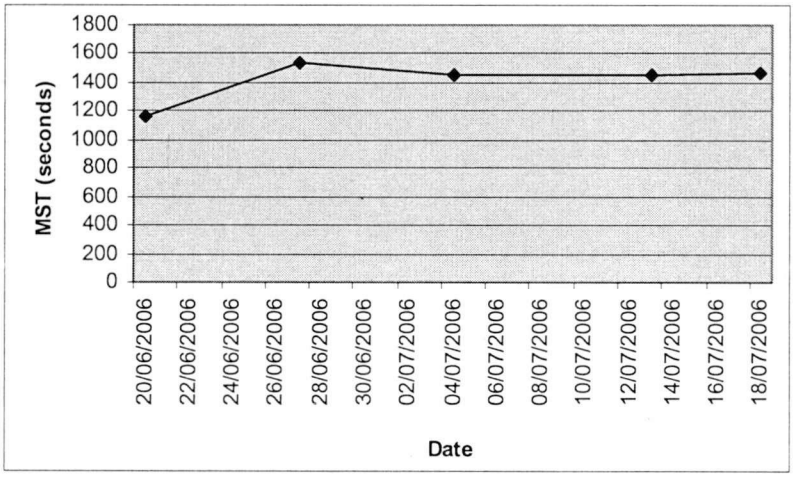


Fig 3. Variation of MST on maturation at 20^{0}C

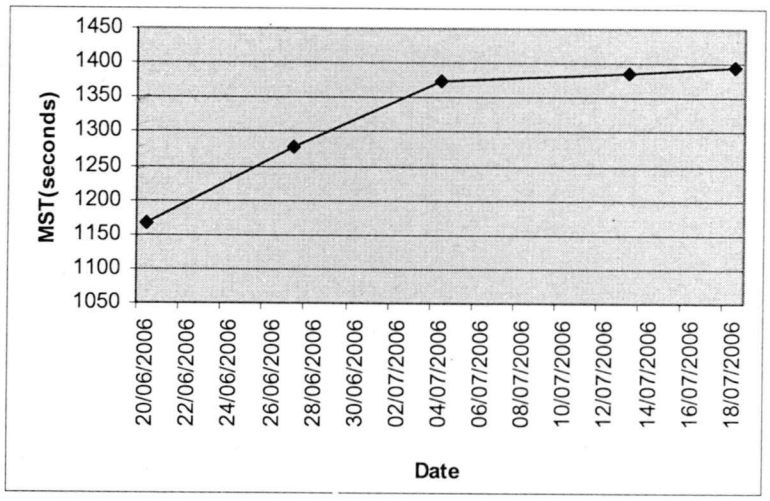


Fig 4. Variation of MST on maturation at 25^0C

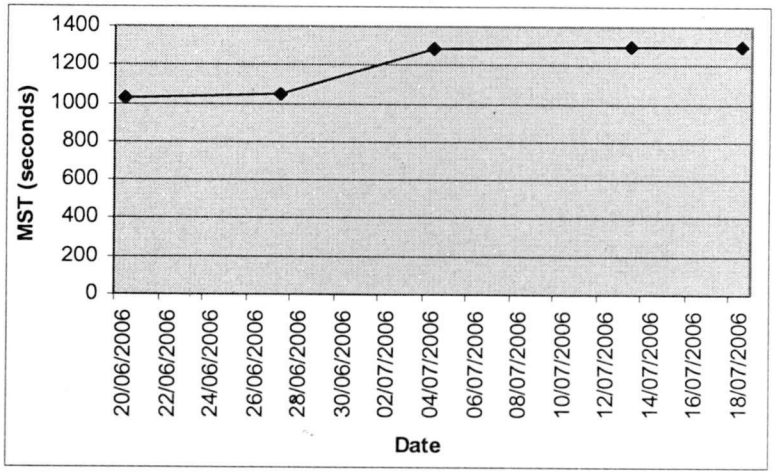


Fig 5. Variation of MST on maturation at 40^0C

Maintenance of quality consistency in centrifuged latex with special reference to MST and viscosity

This project was initiated on a request made by Lalan Rubbers (Pvt) Ltd., in order to study the variations of latex quality parameters such as MST and Viscosity of the centrifuged latex produced from field latex obtained from various suppliers. The objective of the project is to maintain the consistency of the centrifuged latex

produced as far as possible by way of segregating the batches of field latex which possesses similar qualities from different sources and processing them together subsequently.

Figure 7 shows the MST variation of Centrifuged latex with time preserved with preservatives prepared using ball milling and pearl milling. As expected, ball milled preservatives appeared to be more effective in preservation of latex. MST becomes more or less constant approximately after a period of one month on storage, which is quite normal under general storage conditions.

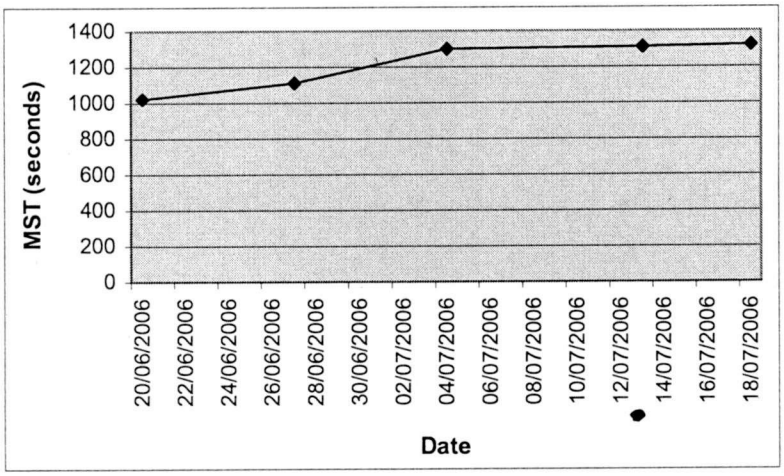


Fig 6. Variation of MST on maturation at 45^0C

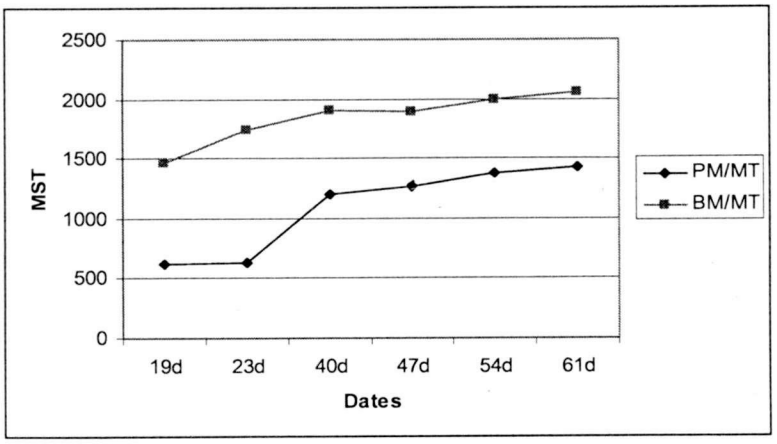


Fig 7. MST variation of centrifuged latex with time

During the period of storage VFA graph shows similar pattern which is shown in figure 8.

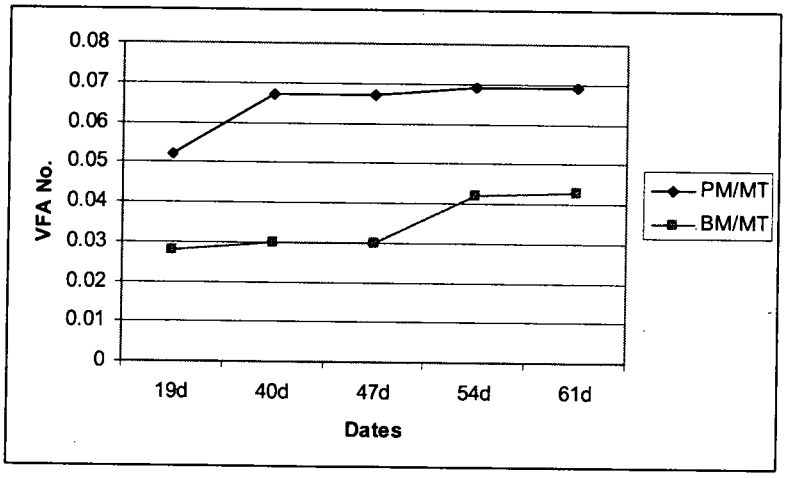


Fig 8. VFA variation of centrifuged latex sample with time

The Viscosity of the centrifuged latex appeared to be decreased slightly with maturation and eventually became constant attaining a value of approximately between 65 – 66cpi shown in Fig. 9.

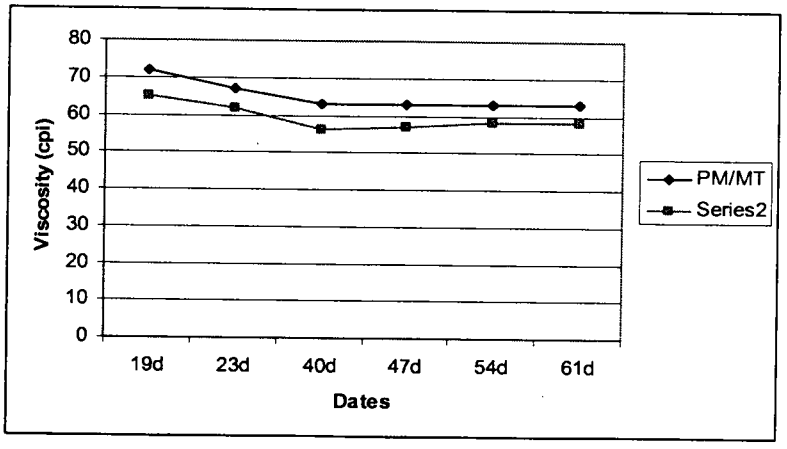


Fig 9. Viscosity variation of centrifuged latex with time

The project is to be pursued with the continuation of similar studies with different batches of latex from various other sources (W M G Seneviratne, G D D Galpaya, Champa Lokuge, G S P D C Ariyaratne and P G B J Ranaweera - University of Wayamba).

Trouble shooting activities

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

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

Analytical services

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

Service	No. of samples
TSR Factory	
1. Sandagiri Rubber Mills Dompe	302
2. Le-Ferne Block Rubber Factory, Getahetta Nathupana	60
Miscellaneous	
Raw rubber samples	259
Latex samples	443
Chemical samples	48
Bleaching agent	114
Glove samples	36
Polythene	21
Shipping certificates	10
Testing certificates	500

RAW RUBBER PROCESS DEVELOPMENT AND CHEMICAL ENGINEERING

S Siriwardena

SUMMARY

Discolouration of crepe rubber was reported from several estates in the latter part of the year and investigations revealed that this was mainly due to the problems in the collection network and processing problems caused by acceptance of latex for processing beyond factory capacities.

A total number of 56 visits were made to the rubber factories and other industries for advisory and consultancy work on requests and complaints made by the industries for factory development, waste water disposal and other related problems in raw rubber processing industry. Rubber factories numbering 35 were also visited in order to inspect the refurbishments carried out under the rubber factory development subsidy scheme.

Investigations carried out on the performance of vulcanisates prepared with different grades of rubber, viz. ADS, RSS, completely sundried sheets and partially sundried and subsequently smoked sheets, revealed that there is a potential for ADS to be used in tyre tread compounds.

Results of preliminary experiments showed that high VFA centrifuged latex could be blended with low VFA centrifuged latex at certain blend ratios to fall within the required specifications without seriously affecting other latex properties.

Poly ethylene glycol 400 diacrylate (A 400) was found to be the best polyfunctional monomer (PFM) to give the best compromise of physical properties of irradiated composites of NR/EPDM/CB and the optimum irradiation dose was found to be 80 kGy.

DETAILED REVIEW

Staff

Dr Susantha Siriwardane, Principal Research Officer was confirmed in the post of Head of the department on the 13th of May. Mr Upul Rathnayake, Assistant Rubber Chemist continued his postgraduate studies at University of Loughborough, UK. Mr P H Sarath Kumara, Assistant Rubber Chemist and Mr P P Jayasinghe, Research Assistant, were on duty throughout the year.

Messrs Chandana Senanayake, T A S Siriwardane, A K D Warnajith Prasad, Mrs Chandrika Nalini, Mrs S M S Priyanka and Mrs C Rohanadepa, Experimental Officers, Mrs Ruckmani Liyanage, Store Keeper and Mrs Anusha Paranavithana, Typist/Clerk, were on duty throughout the year.

Research students

- Mr G D Dinesh Krishantha, Temporary Research Assistant recruited to work on the research project on "Development of irradiated natural rubber (NR) and Ethylene - Propylene - diene ter polymer (EPDM) based composite materials for outdoor applications" was also on duty throughout the year.

- Mr M R Punsara Prasanjith, Temporary Technical Officer recruited on 15 November 2005 to work on the research project on "water pollution from rubber industries" funded by South Asian Network for Development of Environmental Economics (SANDEE)" was also on duty throughout the year.

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

- Miss N U Samarawickrema, fourth year Chemistry Special student of University of Ruhuna completed her research project titled "Preparation and characterisation of carbon black filled NR/EPDM ternary composites" under the supervision of Dr Susantha Siriwardena.

- Mr N D Seneviratne, fourth year Chemistry Special student of University of Colombo commenced his final year research project on "Preparation and properties of sheet rubber using NR latex/silca masterbatches" in August under the supervision of Dr. Susantha Siriwardena and Dr S Hewge, Department of Chemistry, University of Colombo.

- Miss Thushari Illangamge, fourth year Chemistry Special student of University of Sri Jayawardenapura commenced her final year research project on "studies on the effects of Mg^{2+} content on the quality of centrifuged latex and tensile properties of latex films" in November under the supervision of Dr Susantha Siriwardena and Dr S Liyanage, Department of Chemistry, University of Sri Jayawardenapura.

Seminars/Conferences/Workshops/Meetings

Officer/s	Subject	Organization
A K D Warnajith	Participated at the "Viskam Dekma Exhibition and Trade Fair"	Thakshila Vidyalayaya, Horana
T A S Siriwardane & A K D Warnajith Prasad	Attended a seminar on "Water Purification"	Royal Palm Hotel, Kandy

Officer/s	Subject	Organization
W M G Seneviratne	ANRPC Committee meeting on Natural Rubber Statistics (CNSR) Production and Marketing Strategies (CCPMS) 4-6 December	Trans Asia Hotel, Colombo
W M G Seneviratne	Indo -Lanka Wastewater Conference organized by ICTAD	Institute of Engineers
W M G Seneviratne	Participated as member of the Protein allergy group meeting and the workshop (May 29th -30th May) And member of the Sri Lankan Representative in the NR as a environmentally friendly raw material workshop (1st June – 2nd June 2006) organized by the ANRPC	Rubber Research Institute, Kottayam, India
W M G Seneviratne	Seminar on Energy Solutions by Ms. Thermax Ltd India organized by Lalan Group of Companies July 2006	Taj Samudra Hotel., Colombo
W M G Seneviratne	Technology Management Seminar organized by patent office and WIPO August 2006	Patent Office, Colombo
W M G Seneviratne	Speech on wastewater treatment processes for scrap rubber processing industry for scrap millers Organized by Chamber of Commerce	CEA Training Centre, Pinnawala, Kegalle
W M G Seneviratne	International conference on S&T Policy Research and Statistical Indicators organized by NSF November 2006	Galle Face Hotel, Colombo
W M G Seneviratne	International Natural Rubber Conference organized by the IRRDB and RRI, Vietnam 13-14 IRRDB Annual General Meeting	Ho Chi MinH City, Vietnam
W M G Seneviratne	Participated as a member of the drafting committee of the MPI Policy document in nine meetings	MPI Auditorium and Agrarian Research Institute
W M G Seneviratne	Three Cess committee meetings	MPI Auditorium
W M G Seneviratne	Eight committee meetings of the executive committee of Management and ten Educational and Educational development sub committee meetings	PRISL, Rajagiriya
W M G Seneviratne	Four Ceyesta Board meetings as a member of the Board of Management	Ceyesta House, Colombo
W M G Seneviratne	Eight SRMC Board meetings as a member of the Board of Management	SRMC, Mawanella

Training programmes

Client	Subject	No. of Programmes
Lalan Group- Staff of the Centrifuged latex factories	Waste reduction measures in centrifuged latex manufacture Tests on latex and their implications on quality of final products Preservation of latex and metrolac weighing	1
Plantation Managers workshop organized by the Planters' Association	Achieving quality consistency in crepe rubber manufacture" Cost reduction measures in crepe rubber manufacture Defects in crepe rubber and causes	1
Plantation Managers Namunukula Plantations Ltd.	Waste water treatment technology Quality Assurance in crepe rubber manufacture Defects in crepe rubber and causes Quality Assurance of field latex and weighing of latex using metrolac	1
Rubber Extension Officers	Refresher training programme on rubber manufacture	1
Undergraduates from Wayamba University	Demonstrations on processing of raw rubber at Glenross latex centrifuged factory and Dartonfield rubber factories	1
Tappers, Poranuwa estate, Pelmadulla.	Awareness programme on metrolac weighing.	1
Factory staff of Balangoda Plantations Ltd.	Awareness programme on Correct practices in crepe rubber manufacture for Factory and Field staff	
Scientific Committee Members 14th SCM	Presentation on Weighing of field latex and maintaining quality	1
Scientific Committee Members 14th SCM.	Presentation on Discoluration of crepe rubber	1
Field and factory staff Lalan Centrifuged Latex Factory, Bulathsinhala	Maintenance of quality of field latex and centrifuged latex	1
Public Lecture at Institute of Engineers	Energy involvement in the rubber industry	1
MSc students in Polymer Science and Technology, University of Moratuwa	Lecture programme in Kinetics of polymerization	1
BSc Students in Microbiology University of Wayamba, Makandura	Lecture programme on Waste water treatment and management	1
DPRI Students of PRI	Lectures on Nature and structure of polymers and molecular characterization	1

Advisory visits

Sample collection

Type of industry	No. of factories
Rubber Industries	7
Non Rubber Industries	1

Factory development

Service provided	No of factories
Inspection for subsidy recommendations for infrastructure development under CESS funds allocation	37
Advisory on process and quality improvements	13

Wastewater treatment and disposal

Service provided	No of factories
Inspection visits for upgrading the existing plants	3
Submission of site specific designs of treatment plants after inspection visits	10
Inspection visits to streamline the operation of treatment plants installed during the year	3

Field visits

Lalan centrifuged latex manufacturing factory – Warakapola

A team of officers from the department carried out a thorough inspection of the operational procedures at the above factory on a request made by the company. The objective of the exercise was to identify the shortcomings and the possible improvements. A detailed report was submitted with recommendations to rectify the shortcomings and suggestions for further improvements (Susantha Siriwardane, P H Sarath Kumara and U M S Priyanka).

Experimental visits

42 raw rubber processing factories were visited to collect data and other information with regard to waste water treatment facilities, their maintenance and associated health problems of the neighbourhood. This project titled "water pollution from rubber industries" was funded by South Asian Network for Development of Environmental Economics (SANDEE)".

Table 1. *Sample testing and certificates issued*

Samples tested	Number of samples				
	1 Quarter	2 Quarter	3 Quarter	4 Quarter	Year total
Waste water	15	30	64	20	129
Processing water	03	01	07	05	16
Certificates issued	**Number of certificates**				
	1 Quarter	2 Quarter	3 Quarter	4 Quarter	Year total
Waste water	15	15	21	20	71
Processing water	02	Nil	02	05	09
"Certificate of epidemic prevention"	17	07	11	07	42

LABORATORY AND FIELD INVESTIGATIONS

Mechanization of crepe rubber manufacturing process (Project No. RRPD/D/MCM/2006/01)

A coagulum partitioning unit was fabricated and trials were conducted to study the effectiveness of this unit in the mechanized system for crepe rubber manufacture. The results of raw rubber properties of crepe rubber prepared employing this system, indicated that there was no adverse effect on the properties by switching over to this system.

Investigation of discrepancies of DRC estimated by Metrolac and lab test (Project No. RRPD/L/DMR/2006/03)

This project was started after a complaint made by Udapolla estate, Deraniyagala that there are discrepancies in the metrolac DRC when compared with lab DRC in different tapping blocks in the same division. Investigations into this problem were carried out at this estate. Similar investigations were carried out at Delkeith estate and Dartonfield estate after selecting different clones. Any conclusion could not be arrived at, from the results so far obtained. A questionnaire was circulated among rubber estates to collect information with regard to the nature of the problems associated with metrolac estimation. Similar problems were not reported from any other estate.

The effect of ammonia on metrolac reading of fresh field latex during maturation was also investigated. It was found that there was no any effect on metrolac reading on storage of field latex ammoniated to the recommended levels of 0.2% and 0.4% for preservation in the manufacture of LA and HA centrifuged latex respectively (P H Sarath Kumara, A K D Waranajith, U M S Priyanka and C Rohanadeepa).

Characterisation of non-conventional grade of NR (Project No. RRPD/D/CNR/2006/06)

A collaborative research project with Raw Rubber and Chemical Analysis Dept. was commenced to establish average values for raw rubber properties of selected low grades of NR. Samples of skim and scrap rubber from various sources were collected and tested for raw rubber properties. The results for raw rubber properties of skim rubber are shown in Tables 2 and 3.

Table 2. *Distribution of dirt, ash and VM distribution of skim rubber*

Dirt		Ash		VM	
Range	**No. of samples**	**Range**	**No. of samples**	**Range**	**No. of samples**
0 – 0.02	01	0 – 0.2	01	0-0.5	1
0.021 – 0.04	04	0.21 – 0.4	13	0.51-1.0	1
0.041- 0.06	10	0.41- 0.8	38	1.01-1.5	2
0.061-0.08	12	0.81-1.0	03	1.51-2.52	34
0.081-0.1	07	1.1-2.0	04	2.51-3.5	23
0.11-0.5	27	> 2.1	03	>3.5	04
>0. 0.5	04				
Total	**65**		**62**		**65**

Table 3. *Distribution of nitrogen content, plasticity (Po) and plasticity retention index of skim rubber*

Nitrogen		P_0		PRI	
Range	**No. of samples**	**Range**	**No. of samples**	**Range**	**No. of samples**
0-0.2	0	0-35	0	0-5	6
0.21-0.5	0	36-40	3	5.1-10	22
0.51-1.0	0	41-45	6	10.1-20	5
1.01-2.0	12	46-50	29	20.1-30	8
2.01-4.0	48	51-55	27	30.1-40	5
	1			40.1-50	2
				50.1-60	8
				60.1-70	2
				>70	5
					2
Total	**61**		**65**		**65**

These results are being statistically analysed by the Biometry department. Another batch of scrap and yellow fraction rubber was collected and they are being

tested for raw rubber properties (Susantha Siriwardane, W M S Priyanka, Sriyanthi Weeraman, Wimaladasa Vithanage and Chandrika Nalini).

Comparison of the performance of different types of rubber in tyre compounds. (Project No. RRPD/D/CPR/2006/10)

Four types of rubber sheets were manufactured using different drying methods. Their Wallace plasticity number and Wallace plasticity retention index match the standard limits for conventional RSS grades used in tyre industry (Table 4). Further, smoke drying has improved PRI of rubber sheets. It was also found that drying method does not influence the cure time. However, exposure to sunlight may facilitate the procesability of the compounds (Table 5). No marked variations in the mechanical properties of vulcanisates observed in sheet rubber dried with different drying methods and conventional RSS sheets. Only a slight increase in abrasion resistance was recorded for smoked sheets (Table 6). Therefore, these results show that there is no distinct advantage of smoking sheets over sun drying to be used in tyre tread compounds. The mechanical properties of all the compounds were almost within the industrial norms and properties did not vary to any appreciable degree. In fact, compounding formulae could be adjusted to optimize the performance of tyre tread compounds prepared with sun dried sheets. Therefore, there is a promising potential for the use of completely or partially sun-dried sheets in tyre tread compounds replacing traditionally used RSS sheets. Field trials are, however, required to be carried out before any firm recommendation is made.

Table 4. *Raw rubber properties of rubber sheets*

Type of sheets	Wallace plasticity number(P_0) [min. 30]	Plasticity retention Index(PRI) [min. 60]	% volatile matter [max. .80]	Mooney viscosity (ML (1+4) @100°C))	Total nitrogen (% w/w)	Dirt (% w/w) [max. 0.05]
RSS	47	83	0.48	87.00	0.39	0.033
ADS	55	72	0.94	88.50	0.45	0.121
CSDS	53	65	0.48	98.00	0.41	0.135
PSDS	51	83	0.46	91.50	0.43	0.047

Table 5. *Cure characteristics of compounds prepared using sheets dried at different drying conditions*

Type of sheets	Scorch time (t_{10}) (min)	Cure time (t_{90}) (min)	Max. torque (Nm)
RSS	1.43	5.52	83
ADS	2.05	5.21	90
CSDS	1.48	5.08	76
PSDS	1.05	4.56	57

Table 6. *The Mechanical properties of the vulcanisates*

Type of sheets	Tensile strength (MPa)	Elongation at break (%)	300% Modulus (MPa)	Tear strength N/mm	Hardness (Shore A)	DIN Abrasion volume loss (mm^3)
RSS	23.2	459	10.5	79.65	61	126
ADS	21.7	470	11.3	88.97	59	153
CSDS	22.7	448	10.2	100.08	59	153
PSDS	22.7	432	9.7	104.47	60	132

Study of quality of field latex and centrifuged latex under different treatment conditions (Project No. RRPD/L/QLT/2006/14)

This project was started towards the end of the year and the first phase was completed. It was observed that the quality in terms of VFA No. remained constant throughout the test period (*i.e.* 7 days) provided that alkalinity was maintained at the specified level. The variation of Mg^{2+} content on storage also was studied by the titrimetric method, but the results were not consistent. Variation of VFA No., KOH No., MST (mechanical stability time) and Mg^{2+} content was studied in blends of high VFA and low VFA centrifuged latex at different proportions. It was found that high VFA latex can be blended with low VFA latex at certain blend ratios without any adverse effect on other properties and hence safe to use in product manufacture. This will be repeated to confirm the results and vulcanisate properties of the films will also be studied (P H Sarath Kumara, A K D Warnajith Prasad and C Rohanadeepa).

Preparation of silica masterbatches incorporating silica at latex stage (Project No. RRPD/L/PSM/2006/15)

This project was assigned to a final year student from University of Colombo. Stable silica slurry with different concentrations was prepared. They were incorporated into field latex and was processed into sheet rubber. The rubber samples were dried and physical tests on vulcanisates prepared by compounding the rubber samples according to a standard formulation were carried out (Susantha Siriwardane, Gamini Ranjith, U M S Priyanka and N D Seneviratne).

Development of irradiated natural rubber (NR) and Ethylene - Propylene - diene ter polymer (EPDM) based composite materials for outdoor applications (NSF-RG/2004/C/03)

The properties of NR/EPDM/CB composites with three grades of carbon black varying the filler loading were evaluated and N-220 grade of CB with filler loading 30 phr gave the best compromise of properties.

Four different types of mixing sequences were tested and it was found that FNEP method (Blending of two polymers followed by incorporation of carbon black) was the best among the candidate sequences, to give overall properties of both aged and unaged composite. The composite thus prepared using this particular method was irradiated with different doses. The results are shown in Table 7. The optimum properties were recorded at an irradiation dose of 100 kGy.

Table 7. *The effect of radiation dose on the mechanical properties of the composites*

Radiation dose (kGy)	Tensile strength (MPa)	Elongation @ Break (%)	Modulus @ 300% (MPa)	Tear strength (N/mm)	Hardness (Shore A)	DIN Abrasion volume loss (mm^3)
0	14.08	476	4.25	79.65	59	123
40	14.57	467	4.76	88.97	59	127
80	17.40	454	5.85	100.08	60	130
100	18.00	423	6.61	104.47	59	128
120	17.39	472	5.78	100.99	60	129
160	16.12	439	5.71	87.36	60	139

Physical properties of the blends, irradiated at 40, 80 and 100 kGy, prepared by FNEP method incorporating poly functional monomers (PFM) were then studied. Among the PFMs tested, poly ethylene glycol 400 diacrylate (A 400) was found to be the best PFM which gave the best performances at an irradiation dose of 80 kGy. Thus, the PFM (A 400) was incorporated into the composite at different concentrations before irradiation. The results are being evaluated to select the optimum concentration of A 400 (Susantha Siriwardena, Dilhara Edirisingha, Priyanthi Perera, Laleen Karunanayake, Samantha Sooriaarchchi and Dinesh Krishantha).

Wastewater treatment and disposal (RRPD/EFF/1998/02)

Treatment plants installed in a number of raw rubber processing factories based on RRISL developed anaerobic coupled aerobic treatment process were found be quite satisfactory as seen from the routine analysis of the quality of treated discharge from these plants. Development and modifications of the process was carried out in three treatment plants installed few years back. Redesign of clarifier, Filter tank and the introduction of newly developed submersible aerator for improved aeration, methodology of incorporation of rubberized coir are among some of the modifications carried out in those plants. Introduction of chemicals such as Alum and Flocculant (NALCO series, a Polymer based material) at the clarifier was done for centrifuged latex effluent plant to improve the clarification of aerated liquor.

Construction of one new plant for crepe rubber processing factory and one for centrifuged latex processing factory were completed during the year and are due to commence operation.

Designs were submitted for installation of treatment plants for three crepe rubber processing factories, two latex centrifuging factories, three latex product manufacturing plants (Latex foam), and two scrap and skim processing factories (W M G Seneviratne, S Siriwardane and P Warnajith).

ADAPTIVE RESEARCH

V H L Rodrigo and S M M Iqbal

SUMMARY

Growth and physiological yield parameters of rubber plants in smallholdings showed the potential success of rubber cultivation in the Intermediate zone of Eastern province and in total, 52.5 acres of rubber were established in 52 smallholdings. A collaborative project with the University of Ruhuna and Department of Agriculture was commenced to popularize bee keeping among rubber smallholders in Kegalle and Ratnapura regions. Development activities of the RRISL's substation in Polgahawela continued and the office building of the substation was inaugurated by the Hon. Minister of Plantation Industries and Hon. Minister of Media and Information. The 50 acre land allocated to the RRISL from the Kumarawatta estate to set up the Monaragala substation was officially transferred to the RRISL by a MOU and the construction of the office building complex commenced. Flower production in the "Tropical Red" Anthurium variety was successful under mature rubber. A study revealed that quality of tapping in smallholdings in Kalutara region was very poor. Glyphosate was found to be effective in controlling weeds in *Cinnamon* and it had no detrimental effect on the photosynthetic apparatus of the crop.

DETAILED REVIEW

Staff

Dr V H L Rodrigo coordinated the activities of this unit. Dr S M M Iqbal (Agronomist), Mr W A D D S Wettasinghe (Research Assistant), Ms B M D C Balasooriya (Research Assistant), Mr E A T Senadeera (Experimental Officer) and Mr R Handapangoda (Development Assistant) were on duty throughout the year. Ms E S Munasinghe resumed her duties with effect from 26th July after being on maternity leave. Mrs C Weeramanthree, Account Clerk was transferred to RRISL sub station with effect from 03.07.2006.

Research student

- Mr K M R Dissanayake, an undergraduate student from the University of Wayamba, completed his third year project on "Effectiveness of different herbicides in Rubber – Cinnamon intercropping fields" under the supervision of Dr V H L Rodrigo and Ms B M D C Balasooriya.

Seminars/Conferences/Meetings/Workshops attended

Officer	Subject	Organization
S M M Iqbal V H L Rodrigo	Attended National Workshop on Bio-Informatics	School of Computer Studies, University of Colombo
S M M Iqbal V H L Rodrigo	Presented a paper on Feasibility of rubber (*Hevea brasiliensis* Mull. Arg.) cultivation in the Eastern Province of Sri Lanka; a non traditional area for rubber. International Natural Rubber Conference-2006	International Rubber Research and Development Board, Rubber Research Institute of Vietnam
V H L Rodrigo S M M Iqbal	Presented a paper on 'Rubber (*Hevea brasiliensis* Mull. Arg.) cultivation in the Eastern Province of Sri Lanka with alleviation of rural poverty and increase in the forest cover: a feasibility study. International Conference on Humid Tropical Ecosystem	National Science Foundation
E S Munasinghe V H L Rodrigo	Presented a paper on potential carbon sequestering capacity of mature rubber plantations with genotypic differences. International Conference on Humid Tropical Ecosystem	National Science Foundation
E S Munasinghe V H L Rodrigo	Presented a paper on Assessment on timber and carbon in rubber plantations with special reference to the wet zone of Sri Lanka. International Symposium on Forestry and Environmental Science.	University of Sri Jayawardenepura
B M D C Balasoooriya V H L Rodrigo	Presented a paper on Effect of free range poultry system on land use efficiency and floral diversity in rubber plantations. International Symposium on Forestry and Environmental Science	University of Sri Jayawardenepura

Seminars/Conferences/Meetings/Workshops conducted

Officer	Subject	Organization
S M M Iqbal	Delivered lectures on Intercropping under Rubber to the Rubber Development Officers at RDO Training Programmes	RRISL
S M M Iqbal	Delivered a lecture on intercropping under rubber at the workshop conducted for medium scale rubber growers	RRISL

Officer	Subject	Organization
D S Wettasinghe, V H L Rodrigo, S M M Iqbal	Conducted smallholder workshops on bee-keeping for the bee keepers in Ratnapura and Kegalle districts.	RRISL
V H L Rodrigo, S M M Iqbal, E A T Senadheera	Conducted a field day programme and tapping system for the staff of Edella estate	Polgahawela Sub-station Edella Estate
V H L Rodrigo, S M M Iqbal , E S Munasinghe	Conducted smallholder workshops on agronomic practices in rubber cultivation for the smallholders in Padiyathalawa.	RRISL/NSF
S M M Iqbal E A T Senadheera	Conducted a smallholder awareness programme on "Planting and fertilizer application of rubber" to the smallholders of Polgahawela area.	Polgahawela Sub-station
V H L Rodrigo B M D C Balasooriya	Delivered a lecture on "Tapping : Ways and means to address the present day challenges" at the workshop conducted for the Managers and Asst. Managers of the Kegalle Plantation	Polgahawela Sub-station/ Kegalle Plantation Ltd.
E A T Senadheera	Delivered lectures on "Pest and disease control in Rubber Plantation/ Diseases in rubber bark" at workshops conducted for smallholders in Kegalle Region.	RDD Kegalle

Advisory visits

135 experimental and 6 advisory visits were made.

FIELD INVESTIGATIONS

Adaptive Research Programme

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

Beekeeping in the estate sector

Bee honey was collected from the colonies set up in Dartonfield and Kuruwita estates during the period of January to April 2006. Yield was considerably low due to the heavy rainfall prevailed during the nectar production period of rubber with that only an average of 1036ml of bee honey was collected per colony (Table 1).

Table 1. *Yield of honey*

Site	No. of colonies harvested	Volume of honey (ml)
Dartonfield	9	7890
Kuruwita	6	7650

Awareness programmes on beekeepers in rubber smallholders

Workshops on beekeeping under rubber plantation were held in Kegalle and Ratnapura regions jointly with Agriculture Department of Sabaragamuwa province. Bee keepers in rubber small-holdings and number of colonies presented in these two regions are showed in Table 2. Dr R W K Punchihewa/University of Ruhuna has participated in the work-shops and introduced a new clay bee pot to the rubber smallholders.

Details and potential advantage of the clay bee pot:

- 3 detachable sections
- Easy to manufacture by potters (Rs.400/=/pot approx).
- Natural place for swarming bees to settle down
- Extractor is not needed to collect honey
- The upper potion of the pot could be removed without disturbing the main colony to collect the honey.
- No supplementary feeding is required.
- Could be kept aboveground in rubber area with the support of three stones or fixed on branches of the rubber plant

Table 2. *Number of bee colonies found in two rubber regions*

District	No. of small-holders	No. of bee colonies present
Kegalle	37	86
Ratnapura	36	45

In total 72 pots were distributed to bee keepers in these regions and 32 pots were also installed at RRISL research stations (Table 3).

Table 3. *Distribution of bee clay pots*

Station	No. of clay boxes installed
RRISL Agalawatta	8
Nivithigalakele Sub-station	5
Kuruwita Sub-station	15
Polgahawela Sub-station	4
Smallholders (Kegalle & Ratnapura)	72

(W A D D S Wettasinghe, S M M Iqbal, V H L Rodrigo in collaboration with Ruhuna University).

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

Details of this experiment are given in Annual Review 2004. A detailed growth analysis of rubber plants was performed with non-destructive measurements

and values obtained for plant girth are summarized in Table 4. Rubber planted in 2003 showed a girth increment rate of 7.26cm/year whilst that in 2004 had only 5.02 cm girth expansion per year (Table 4). Rubber planted in November 2005 showed a mean girth of 8.52 cm.

Table 4. *Growth of rubber in smallholding in Eastern province. Mean girth values are given with ± standard error of means*

Small holdings No.	Village	Year of planting	Mean girth as at December 2006 (cm)
01	Komana	2003	23.52±0.583
02	Komana	2003	18.04±0.373
03	Komana	2004	20.34±0.395
04	Komana	2004	14.74±0.364
05	Komana	2004	15.01±0.528
06	Komana	2005	8.64±0.395
07	Komana	2005	9.37±0.235
08	Komana	2005	10.66±0.221
09	Hela Komana	2004	12.61±0.246
10	Hela Komana	2004	8.33±0.279
11	Hela Komana	2004	10.18±0.283
12	Hela Komana	2005	9.20±0.211
13	Hela Komana	2005	5.25±0.202
14	Hela Komana	2005	8.01±0.271

The photosynthetic performance of rubber leaves was assessed. It showed that the both light saturated rate of photosynthesis (A_{max}) and the apparent quantum yield of rubber (ϕ_{app}) were comparatively lower in the afternoon than in morning hours. This situation was common to all age categories and the mean differences were 2.55μmol $m^{-2}s^{-1}$ and 0.143 for A_{max} and ϕ_{app}, respectively. Nevertheless, trees planted in 2003 showed highest values in both A_{max} and the ϕ_{app} (Table 5)

Table 5. *The apparent quantum yield (ϕ_{app}) and maximum light-saturated rate of photosynthesis (A_{max}) for rubber planted in 2003, 2004 and 2005. Values are given as the mean of two replicates with ± standard error*

Year of planting-rubber	Time of measurement	Mean apparent quantum yield (ϕ_{app})	Mean A_{max} ($\mu mol\ m^{-2}\ s^{-1}$)
2003	Morning (0900-1000h)	0.0626 ± 0.0060	17.35 ±2.350
	Afternoon (1500-1600h)	0.0485 ± 0.0064	13.55 ±0.750
2004	Morning (0900-1000h)	0.0585 ± 0.0068	15.20 ±0.1414
	Afternoon (1500-1600h)	0.0385 ± 0.0061	12.20 ±0.2828
2005	Morning (0900-1000h)	0.0511 ± 0.0029	13.05 ±0.5303
	Afternoon (1500-1600h)	0.0422 ± 0.0030	12.20 ±0.9546

Leaf chlorophyll a fluorescence emission *(Fv/Fm)* was measured by using a Plant Efficiency Analyser (PEA, Hansatech Instruments Ltd., England. UK). Measurements were confined to seven leaves in two plants (Fig. 1). The results illustrate that the F_v/F_m ratio was greater in the afternoon than in morning, however the absolute difference was marginal with the values above 0.7.

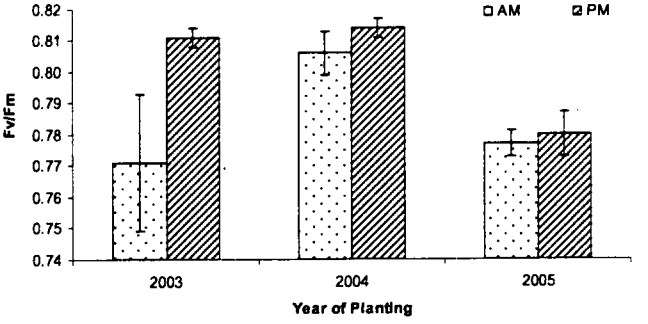


Fig. 1. Diurnal variation of leaf chlorophyll *a* fluorescence emission (Fm/Fv ratio) of rubber planted in year 2003, 2004 and 2005. Values are means of 7 replicate measurements and error bars represent ± Standard Error of Mean.

(S M M Iqbal, V H L Rodrigo, R S Dharmakeerthi, K B A Karunasekera and A Nugawela. This project was funded by NSF under the RG/2005/AG14 grant).

***Polgahawela Sub-station* (ARU/RCWP/2005/1)**

Expansion of Rubber cultivation to Wayamba region (North western Province)

Key involvements

- Construction of the office building was completed and the function of the office was inaugurated by the Hon. Minister of plantation Industries, Mr. Melroy Fernando and Hon. Minister of Media and Information Mr. Anura Priyadharshana Yapa .
- Immature upkeep of rubber in 3ha
- Rubber was planted in four ha. with clones RRIC 121 and RRISL 2001 and seedlings of RRIC121 and RRIC 100.
- Pineapple was planted in one ha under coconut.
- Field day programmes were conducted to the managers and Asst. managers of the Kegalle Plantation Ltd and smallholders in North Western Province.

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

***Monaragala substation* (ARU/RCMR/2006/1)**

Monaragala sub-station will be established at Kumbukkana Division of Kumarawatta estate to facilitate and develop new technologies and refine existing technologies for rubber cultivation in the targeted area of Uva, and Eastern provinces.

Key involvements

- Twenty (20) ha from the Kumbukkana Division of Kumarawatta estate was surveyed and MOU was signed to transfer the land to the RRISL.
- Foundation stone of the office bearing complex was laid by the Hon.Minister Plantation Industries, Hon. Minister of Child Development and Women Empowerment and the Chairman, Rubber Research Board and the construction were in progress.

(V H L Rodrigo, S M M Iqbal and C K Jayasinghe in collaboration with all departments).

***Mixed clonal system for smallholder sectors* (ARU/MCS/2004/1)**

Experimental details appeared in the Annual Review 2004. Field trial established in Kegalle was maintained with the estate/smallholder collaboration. However, the smallholder trials at Monaragala were terminated due to the poor collaboration (S M M Iqbal, V H L Rodrigo and K B A Karunasekara).

***Anthurium culture under mature rubber* (ARU/AC/2004/1)**

This trial was in progress in Kuruwita and Dartonfield estates. Production and growth performance were assessed in Anthurium. Flowering in the variety of "Tropical Red" was successful compared to that in Gauthamala variety (Table 6 & 7).

Table 6. *Production of the flowers during the 2nd year of planting of Anthurium*

Estate	No of plants	No of flowers harvested
Dartonfield	2500	2616
Kuruwita	145	648

Table 7. *Percentage of plants that produced flowers in the Anthurium varieties*

Months after planting	Gauthamala	Tropical red
6	1.33	2.44
9	0.33	16.52
12	0.00	17.04
15	0.00	12.40
18	2.66	52.24
21	10.00	58.96
24	1.66	65.88

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

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

Details of the study were given in the Annual Review 2005.

Routine maintenance of the system and data collection was carried out up to June. Because of the security problem in the Dartonfield estate, poultry setup was transferred to the Kuruwita Sub-station.

Egg production and effect of poultry on groundcover in terms of Summed Dominance Ratio (SDR) value (floral distribution) were assessed. Hen House Average value for the egg production was 30%. SDR value shows that the population of *Paspalum conjugatum*, *Adiantum spp.*, *Syngonium podophylium* and *Commelina indehiscens* decreased with time and no significant impact on the *Pueraria phaseoloides*, the traditional cover crop (B M D C Balasooriya, S M M Iqbal, V H L Rodrigo in collaboration with VRI).

***Assessments of different tapping systems practiced in the smallholder sector* (ARU/TSPSH/2005/2)**

This study was commenced to assess the performance of recommended clones under different tapping systems practised under smallholder conditions. Twenty one sites from Kalutara district were selected and their social information was collected using a questionnaire. Eighteen sites were assessed for the quality of tapping systems (Table 8).

In all sites, the rate of bark consumption was very high. Farmers only in four sites had used a stencil to mark tapping guidelines. Correct tapping length was maintained only in five sites. Tapping angle was found to be correct in twelve sites. The depth of tapping cut is reasonably good in fifteen sites. Although the cup hangers were available, their placement was not in order.

Yield record sheets were distributed among farmers to collect data on yield performance.

Table 8. *Summary of the tapping quality assessment in smallholdings in Kalutara district (If a minimum of 80% trees followed the standard recommendation, then it was considered as good).*

Status of the quality of tapping system	Guide line	Tapping angle	Depth of the cut	Length of cut	Bark consumption	Cup hangers	Placement of cups
Good	4	12	15	5	0	11	2
Poor	14	6	3	11	18	7	16

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

Interplanting of rubber lands with tea

***Productivity in rubber/Tea systems – Kuruwita* (ARU/TRIC/1990/1)**

Rubber was infected with white root disease (WRT) and the tea crop by live-wood termites (LWT) and stem canker infestation. This experiment was terminated due to the heavy casualties found in both tea and rubber (S M M Iqbal, S Wettasinghe and R Handapangoda)

***Productivity in rubber/Tea systems - Gallewatta/Dartonfield* (ARU/TRIC/1990/2)**

Details of the experiment were given in the Annual Review 1990.

Yield of tea was collected throughout the year (Table 9) and there was no statistical difference in tea yields among treatments.

Table 9. *Made tea yield (MTY) in rubber/tea system*

System	Mean MTY Kg/bush
1.Tea only (100%)	0.073^{A}
2. Rubber 8'×27' (100%) + Tea	0.067^{A}
3. Rubber 8'×32' (85%) + Tea	0.055^{A}
4. Rubber 8'×36' (75%) + Tea	0.067^{A}
5. Rubber 8'×40 (70%) + Tea	0.070^{A}
6. Rubber 8'×44' (65%) + Tea	0.059^{A}

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

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

This experiment comprised with three levels of rubber fertilizers and two planting systems of rubber with tea. However the fertilizer program had not been carried out as per the experimental design for last two years. Therefore, this trial did not comply with the design hence terminated (S M M Iqbal and R.Handapangoda).

***Effectiveness of different herbicides in Rubber/Cinnamon intercropping fields* (ARU/EHRC/2006/1)**

This trial was initiated in early March 2006 in immature Rubber/Cinnamon intercropping fields at Polgahawela Sub-station. This consisted of five treatments with three replicates.

Treatments were;

1. Diuron after clean weeding
2. Glyphosate (100ml/16l)
3. Diuron and Glyphosate (tank mixture)
4. Split application of Diuron and Glyphosate
5. Manual weeding

Treatments were applied to 4m x 4m plots. Following measurements were collected in three weeks interval.

a. Dry weight of weeds
b. Distribution of weed species
c. No of shoot per Cinnamon plant
d. Height of the Cinnamon plant

Table 10. *Dry weight of weeds (g)*

Treatment	Time		
	3 weeks	6 weeks	9 weeks
1. Diuron after clean weeding	3.415	12.207	42.413
2. Glyphosate	18.487	45.410	80.437
3. Diuron and Glyphosate (tank mixture)	2.130	16.887	86.623
4. Split application of Diuron and Glyphosate	12.263	23.510	65.910
5. Manual weeding	34.927	73.010	56.593

Table 11. *Height of Cinnamon plants (cm)*

Treatment	Time			
	4 weeks	8 weeks	12 weeks	16 weeks
1. Diuron after clean weeding	53.26	62.99	68.41	77.74
2. Glyphosate	54.32	60.16	66.19	74.29
3. Diuron and Glyphosate (tank mixture)	56.38	61.06	66.37	75.41
4. Split application of Diuron and Glyphosate	57.08	62.47	66.18	72.78
5. Manual weeding	53.87	56.80	60.23	65.10

Table 12. *Number shoots per cinnamon plant*

Treatment	Time			
	4 weeks	8 weeks	12 weeks	16 weeks
1. Diuron after clean weeding	5	5	5	5
2. Glyphosate	4	4	4	4
3. Diuron and Glyphosate (tank mixture)	5	5	5	5
4. Split application of Diuron and Glyphosate	4	4	4	4
5. Manual weeding	4	4	5	5

Dry weight of weeds, height of cinnamon plants and number of shoots per cinnamon plant were statistical comparable among the five treatments at the end of the experimental period.

The value of Summed Dominance Ratio (SDR) was calculated using data collected on the distribution of weed species. It shows that Verbinaceae was the most dominant family of weeds available after three weeks of Glyphosate applied and manual weeded plots whilst Rubiaceae in all other plots. However at twelve weeks after the application of treatments, Leguminosae was the most dominant family in all herbicide applied plots except in split application of Glyphosate and Diuron. Verbenaceae was dominant in manual weeded plots.

Leaf chlorophyll a fluorescence emission (expressed as the ratio of variable to maximum fluorescence Fv/Fm) was measured in four treatment plots (diuron, glyphosate, Tank mixture of diuron and glyphosate and manual weeding) in two component crops to assess the effect of herbicide on photosynthetic apparatus. In general, photosynthetic apparatus of both component crops was not affected by the herbicide application with values above 0.7 for the Fv/Fm ratio. However in the rubber crop, a significant but slight decline in the Fv/Fm ratio was observed in the afternoon over the values recorded in the morning after seven days of diuron applications. No significant effect of any chemical on photosynthetic apparatus of cinnamon was recorded (B M D C Balasooriya, V H L Rodrigo, S M M Iqbal and E A T Senadheera).

Competition on the immature upkeep of rubber clearings 2005 (Kahawatta Plantations) **(ARU/CRNC/2006/1)**

A protocol was developed and used to select the best rubber clearing among Pelmadulla, Poranuwa, Opatha and Hunuwala estates (two clearings each) in Kahawatta Plantations Limited. The following parameters were considered in the marking scheme. Girth, stand per hectare, elephant foot, branching, bark damage, nutrient deficiency, soil conservation, weed management and fencing (D S Wettasinghe and V H LRodrigo).

BIOMETRY

Wasana Wijesuriya

SUMMARY

Providing necessary research support to other research departments, maintenance of databases, conducting research falling into the discipline of Biometry and involving in collaborative research in the rubber sector are among the major activities of the Biometry section in the year under review. Research support in various aspects; *viz.* experimental design, analysis and interpretation of results were provided to research departments, trainees and University students attached to the research departments. Databases were satisfactorily maintained during the year under review on meteorological data collected at the Meteorological station at Dartonfield and information on research personnel and projects of RRI.

The staff of the Biometry section is in a routine process of upgrading their knowledge through a focus on research to develop appropriate statistical methods for the rubber sector. Statistical quality control, multivariate statistical forecasting, analysis of participatory studies and on-farm trials, are among the research focuses of the Biometry section. Biometry section in collaboration with the Advisory Services Department and Soils and Plant Nutrition Department has successfully completed the project "Role of institutions in global environmental change" funded by Asia Pacific Network (APN) for global change research during this year.

DETAILED REVIEW

Staff

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

Seminars/Conferences/Meetings/Workshops attended

Officer	Subject	Organization
Wasana Wijesuriya and Keminda Herath	International natural rubber conference	Ho Chi Minh city, Vietnam
Wasana Wijesuriya and Keminda Herath	Research coordination meeting (RCM) of the Coordinated Thematic Research Programme (CTRP)	National Science Foundation (NSF)
Wasana Wijesuriya	23rd International Biometric Conference	McGill University, Montreal, Canada
Wasana Wijesuriya	Scientific committee meetings	Rubber Research Institute

Officer	Subject	Organization
Wasana Wijesuriya	Technical Advisory Committee of the centre for Climate Change Studies	Department of Meteorology
Wasana Wijesuriya	Steering committee of the Young Scientists' Forum	National Science and Technology Commission (NASTEC)
Wasana Wijesuriya	Executive committee of the Applied Statistics Association of Sri Lanka	University of Peradeniya
Wasana Wijesuriya	The National Capacity Needs Self Assessment for Global Environmental management (NCSA) project	Ministry of Environment

Services

Statistical analysis and interpretation

Research support was provided to other Research Departments and students attached to them in designing of experiments, statistical analyses and interpretation of experimental results (W Wijesuriya and K Herath).

Database management

Meteorological

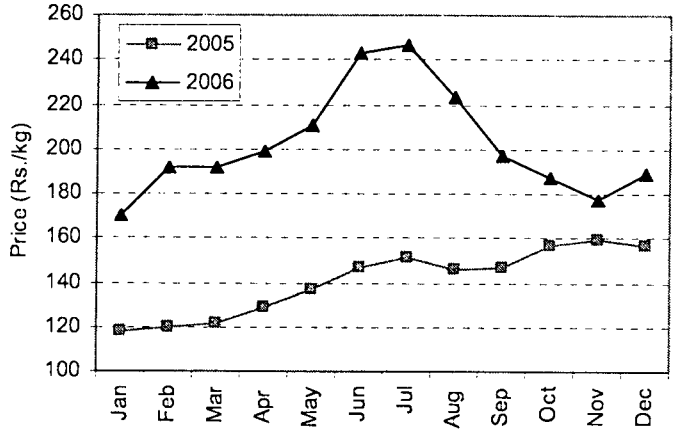
The database with daily meteorological data collected in the Dartonfield meteorological station was properly maintained. Monthly reports were prepared from this daily database and sent to the Central Meteorological Station, Colombo and the Natural Resources Management Centre (NRMC), Peradeniya. These data were made available to researchers and organizations on request (K Herath, W Wijesuriya, C Munasinghe and V Abeywardene).

Auction prices of rubber

The database on auction prices of different rubber grades was updated for 2006. Some important information derived from this database is given below.

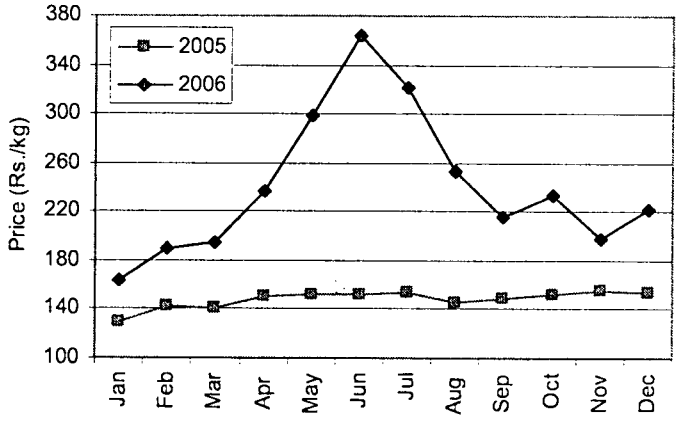
Prices of Ribbed Smoked Sheets (RSS)

The prices of RSS1 in 2006 reached the maximum of Rs.246.90 in July. Monthly averages for this grade were above than that of 2005 in all months as given in the figure below. The prices of RSS grades increased by 42-44% from 2005 to 2006 compared to 10-12% from 2004 to 2005.

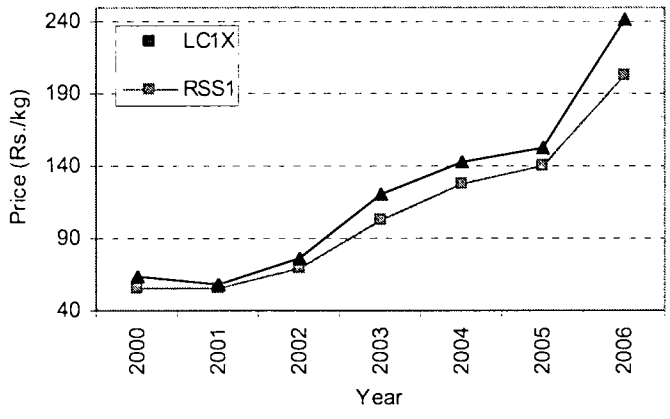


Prices of Latex Crepe (LC)

The prices of LC1X in 2006 were always above the 2005 prices and the gap was found to be more during the middle of the year as depicted in the figure below. This increase accounted for 56-58% for LC grades.

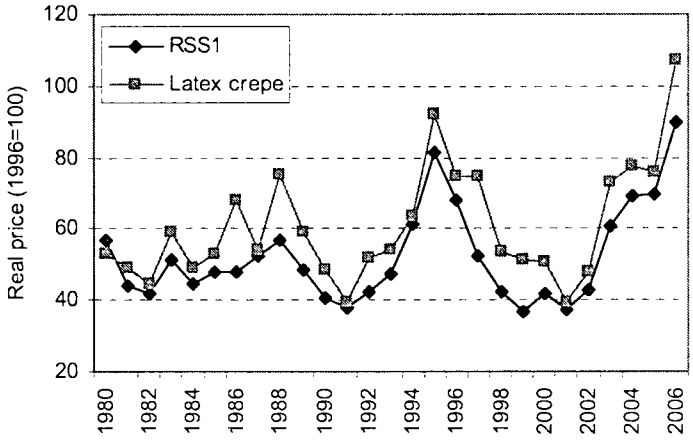


The changes in annual average prices for RSS1 and LC1X are presented below and the price hike in the middle of the year in both grades was responsible for the increase of average prices, which accounted for nearly 44 and 58%, respectively for RSS1 and LC1X grades.



Changes in real prices for the rubber grades

The real prices of 2006 have exceeded the peak observed in 1995 (Rs.72.45 for RSS1 and Rs.82.08 for LC1X in nominal terms) after the slight reduction in real prices observed in 2005 as depicted in the following figure.



Note: Prices transformed by GDP deflator

RESEARCH

Studies completed in year 2006

Role of institutions in global environmental change

This was a collaborative project between RRI with Energy and Resources Institute (teri) of India and Environment and Public Health Organization (ENPHO) of Nepal. The aim of this project was to educate people on the adverse impacts of

climate change and to suggest adaptation measures to minimize the impact on rubber plantations. During the year under review, one-day capacity building workshops were conducted during March in Haldummulla in the Badulla district, Badalkumbura and Medagama in the Moneragala district (Wasana Wijesuriya, Anura Dissanayake, Lalani Samarappuli, Keminda Herath, Jagath Edirisinghe (Wayamba University) and Vidura Abeywardene).

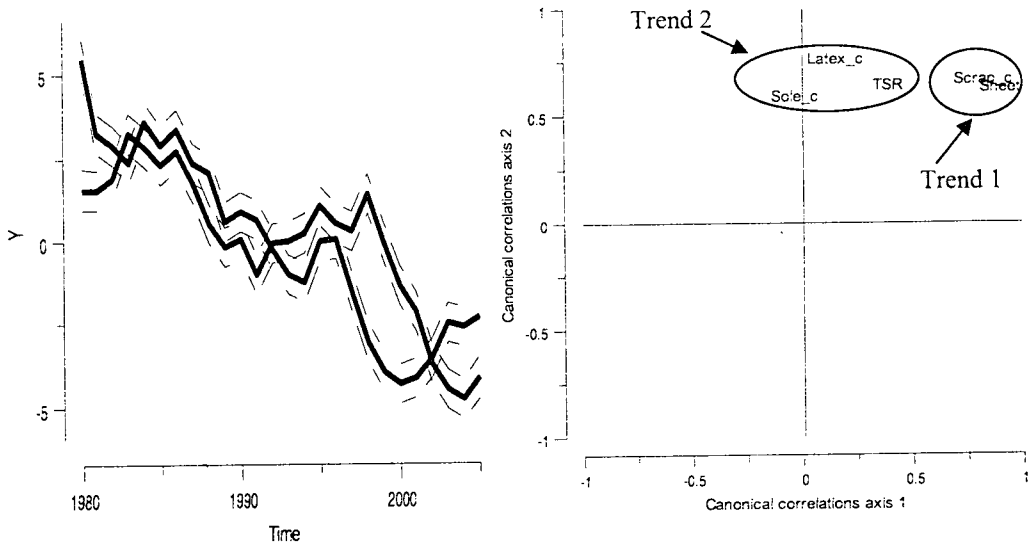
Identifying common trends and forecasting in multivariate time series using Dynamic Factor Model technique: Application in rubber economic data (CARP contract 12/572/433)

This is a collaborative research study with Faculty of Agriculture, University of Peradeniya funded by CARP. Analyses were carried out during this year for rubber production, exports, yield and prices. The dynamic factor model is ideal for identifying common trends of several time series. For instance, common trends of production of rubber by type and impacts of other economic variables can be identified effectively through this technique.

Following models were fitted to production time series of different types of rubber using the software, Brodgar version 2 and the best-fit model was selected on the basis of AIC and log likelihood ratio.

Model (observations = M common trends + Noise)			Measures of fit	
No	No of common trends	Error covariance matrix	AIC	Log likelihood
1	*2*	*Symmetric, non- diagonal*	*367.606*	*-145.803*
2	2	Diagonal	373.303	-163.651
3	3	Symmetric, non-diagonal	372.758	-144.379
4	3	Diagonal	373.611	-159.805

Model No. 1 has the best fit and the identified common trends and biplots of canonical variates are given in the figure below. Trends of latex crepe, sole crepe and TSR production for the period 1980 to 2005 are common (Trend 2) while scrap crepe and RSS production have a different common trend (Trend 1) over time. The important feature of Dynamic Factor Model (DFM) is that explanatory variables on rubber production can be included in the models to assess their impact on the dependent variable, rubber production. The relevant further analyses are in progress [Keminda Herath and S Samita (University of Peradeniya)].



An examination of profit inefficiency of smallholder rubber producers in Sri Lanka (CARP contract 12/636/479)

The objectives of this project were to assess the Natural Rubber (NR) production in Sri Lanka compared to other NR producing countries in the world, to derive a statistical measure of profit (economic) inefficiency of rubber farmers in the three major rubber-growing districts, to relate the household attributes and other socio-economic variables to the inefficiency and to derive suitable policy implications for improving efficiency in rubber farming. During the year under review, the questionnaire survey was completed in the three major rubber growing districts *viz.*, Kegalle, Kalutara and Ratnapura. Data entering of this survey is in progress [Wasana Wijesuriya, Jagath Edirisinghe (Wayamba University), D M A P Dissanayake and C Bogahawatta (University of Peradeniya)].

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

This project is funded by NSF under the theme "Environmental protection and sustainable management" of the Coordinated Thematic Research Programme (CTRP). The overall objectives of this project is to improve the smallholder rubber sector in the Moneragala and adjacent parts of the Badulla and Ampara districts through sustainable management of environmental, socio-economic, technological and institutional aspects. It is expected to generate knowledge and integrate them through information tools such as GIS and decision support systems in a user-friendly interface for effective policy making and planning.

The project will look into land availability and suitability for rubber cultivation and related issues. Under environmental and economic concerns, it was planned to improve awareness on the environmental benefits of rubber farming and combating adverse environmental impacts and also to explore the possibility on CDM

proposals for this area. Technological concerns focus on awareness and adoption of recommendations on rubber planting and processing and supply of essential inputs to the farmers. Social acceptance of rubber farming, income status of farmers, livelihood conditions and ways to improve them, labour availability/scarcity and perceptions of rubber farmers will be studied under socio-economic concerns.

This project falls into different disciplines. The departments, soils and plant nutrition and advisory services and the Biometry section are involved from RRI together with Ruhuna and Wayamba Universities. The results under different disciplines are presented in respective departmental reviews.

The project commenced during the 4th quarter of 2006 and the following activities were done during this year.

Activity	Target group	No. participated	Duration and date
Participatory workshop at Karawila, Badalkumbura	Smallholder farmers	196	One full day 18-10-2006
Workshop on Participatory Rural Appraisal (PRA) at RRI, Ratmalana	ASD officers	20	One full day 26-10-2006
Participatory workshop at Karandagama, Badalkumbura	Smallholder farmers	92	One full day 02-11-2006
Participatory workshop at Lunugala kolaniya, Badalkumbura	Smallholder farmers	83	One full day 02-11-2006

Results of Participatory Rural Appraisal (PRA)

Major issues raised by the smallholder farmers

Issues related to planting material were common to all areas and were among the highest priority issues of rubber farmers in Moneragala. Poor awareness on rubber cultivation, nursery maintenance and disease control were also among the major issues.

Village/AGA division	Issues in the order of priority
Karawila/ Badalkumbura	1. Scarcity of plants 2. Non availability of plants at the required time 3. Poor quality planting material
Karandagama/ Badalkumbura	1. Poor quality plants 2. Poor knowledge on nursery maintenance & disease control 3. Non availability of plants at the required time
Lunugala Kolaniya/ Badalkumbura	1. Poor quality plants (without lateral shoots) 2. Non availability of plants at the required time 3. Problems with ownership 4. Poor knowledge on cultivation of rubber

Suitable crops identified by matrix ranking exercise at Lunugala Kolaniya

Rubber crop was given the highest marks for 4 different criteria as shown in the table below. Rubber was ranked as the best, followed by banana and coconut. The same sequence was observed by ignoring the criteria No. 4, which is biased towards rubber. It is important to note that the farmers have given lowest marks for rubber for the criteria No.9, knowledge of the crop. It highlights the importance of organizing awareness programmes in these areas.

Criteria	Chena crops	Cowpea/ Mung beans	Corn	Chilies	Mango	Sugar cane	Lime	Rubber	Coconut	Banana	Paddy
1. High profitability	3	3	3	4	5	3	4	**11**	5	7	2
2. Income throughout the year	2	2	2	6	2	2	3	**11**	7	8	5
3. Easy to plant	2	2	4	4	6	1	4	8	5	**10**	4
4. Government sponsorship (subsidies)	0	0	0	0	5	0	0	**30**	8	0	7
5. Advices and services	0	2	2	2	6	4	0	**22**	7	0	5
6. Abundant supply of planting material and other inputs	7	7	5	5	2	3	2	3	2	**8**	6
7. Market facilities	6	6	6	5	4	2	2	4	4	**9**	2
8. Tolerant to droughts	2	2	2	2	**9**	5	6	8	6	6	2
9. Knowledge of the crop	**6**	**6**	**6**	**6**	3	5	4	1	3	4	**6**
Total	28	30	30	34	42	25	25	**98**	47	52	39
Rank	***8***	***7***	***7***	***6***	***4***	***9***	***9***	***1***	***3***	***2***	***5***

Seasonal involvement of in different activities by rubber farmers

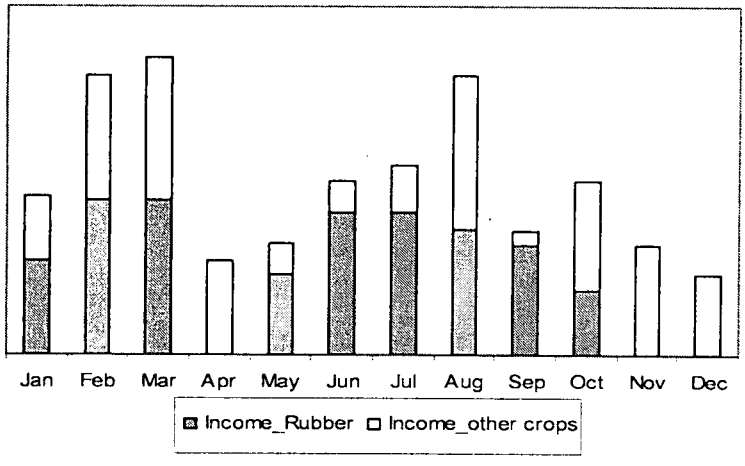
Farmers in Lunugala Kolaniya had come up with the following seasonal calendar and labour requirement for rubber planting. This kind of information is very important in planning effective extension programmes targeting specific issues in the planting cycle.

Month	Activity	Man days/acre
January	Fertilizer application	02
	Weeding (rubber and intercrops)	07
	Harvesting of intercrops	30
February	Harvesting of intercrops	30
March	Land preparation for intercrops (*Yala*)	20
	Planting of intercrops (*Yala*)	10

Month	Activity	Man days /acre
April	Fertilizer application (immature rubber)	03
	Fertilizer application (*Yala* intercrops)	02
May	Fertilizer application (mature rubber)	08
June	Planting bare roots received in poly bags	02
	Harvesting of intercrops	10
July	Mulching of immature rubber	07
	Fertilizer application for the nursery	02
August	Irrigation of immature rubber (once in 2 days)	30
September	Land preparation for new planting	10
	Lining	01
October	Holing	20
	Filling	05
	Fencing	10
November	Planting of intercrops (Banana *Maha* crop)	15
	Fertilizer application for intercrops/weeding	08
December	Planting of rubber	05

Seasonal variation of income from rubber and other crops

The hypothetical figure drawn by a group of farmers in Karandagama, Badalkumbura is given below. According to the farmers they do not receive any substantial income from rubber in April, November and December. October, November and December are the months with high rainfall in this area and as a result there is no income from rubber during November and December. Hence, the institutional responses need to be focused on possibilities to introduce rainguards to combat losses due to rainfall during the peak yielding months of the year.



([Wasana Wijesuriya, Lalani Samarappuli, Anura Dissanayake, Keminda Herath, D D Dasanayake, A H Kularatne, Lalaith Gunaratne, Kapila Gunaratne, Darshana Rajapakse, Shantha Perera, Vidura Abeywardene, P Karunadasa, U Mithrasena, Anoma Thewarapperuma, T Gunathilaka, Susith Rathnayake, R A D Ranawaka, L L A Samarawickreme, R L R U S Bandara, H H Jayasinghe, D R A M G Abeydissanayake, M Dharmadasa, Nihal Gamage, U N Jayasuriya from RRI], Mahinda Wijeratne from University of Ruhuna and Jagath Edirisinghe from Wayamba University)

LIBRARY AND PUBLICATIONS

S U Amarasinghe

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

- Maintaining, processing and publishing of Institute's regular publications
- Collecting and disseminating of NR and related areas
- Participation in AGRINET (Agricultural Information Network)

Staff

Mr S U Amarasinghe, Librarian and Publications Officer, Mrs R M Amaratunga, Library Assistant and Assistant Publications Officer, Mrs Irene Perera, Acting Library Assistant (Colombo Office), Mr P M P Jayantha, Clerk/Typist and two Library Attendants were on duty during the year.

Seminars and Workshops

Librarian and Publications Officer attended the followings:

- The AGM of the Sri Lanka Library Association at BMICH on 30th June
- Three AGRINET Librarian's meeting at CARP on 3rd March, 2nd June and 29th September
- The seminar for SLSTINET members on 20th July

Resource development activities

During the year, 87 books were added to the Library collection out of which 30 books were received as gifts. Due to high subscription costs, the library subscribed to a limited number of periodicals and twenty one received on exchange basis. Internet facility was received by the Library this year and this facility can be used to access the latest scientific publications.

Publications

The following publications were processed and published during the year.

- RRISL Bulletin Vol.46 (2005) (Special issue)
- RRISL Bulletin Vol.47 (2006)
- RRISL Journal Vol.87 (2005)
- Annual Review 2005
- Annual Report 2005

ILL Service

Twenty three articles were sent to various agricultural Libraries on their request and *vice versa* twelve articles were requested for RRISL Library users. Nearly nine literature surveys on rubber were done using CD-ROM databases available at CARP and PGIA Libraries.

Information services

Contents of the current periodical were distributed among users. Computerised data were sent to the CARP Library for the compilation of bibliographies on plant breeding and indigenous medicine.

Equipment

The following equipment were received by the Library during the year.

- Panasonic Photocopier DP – 1520P
- Laminator LP 35 (A3), M/No. 1301060365
- ALFA Writing Table
- UNISONIC computer Table

DARTONFIELD GROUP

J Perera

SUMMARY

Dartonfield Group consisting of Dartonfield and Gallewatte divisions at Agalawatta and Nivitigalakele respectively carries a total extent of 331.8 hectares. The area under rubber cultivation is 206.3 ha. of which 187.48 ha. in tapping during the year under review. The immature extent stood at 18.79 hectares.

The tapping system (1/2S d/3) introduced to Gallewatte division continued to be in existence reducing shortage of tappers to a large extent.

The actual tapping intensity (ATI) during the year in 100% and 67% areas were 50% and 63% respectively.

A total crop of 209,111 kg harvested for the year, an increase of 13% over the estimated crop of 184,900 kg.

The YPH recorded for the year was 1,115.4 kg. The crop and YPH increased by 23,204 kg and 167.6 kg respectively in comparison to last season.

According to the final accounts of the Group ending 31st December 2006, the Group Net Sale Average (NSA) and Cost of Production (COP) were Rs.209.76 and Rs.113.70 respectively, recording a profit of Rs.96.06 per kilo of made rubber. Thus, the Group was able to secure a profit of Rs.19,556,060.72.

All the agricultural practices of the estate came to a standstill during the 10 day island wide strike by estate workers demanding pay hike.

DETAILED REVIEW

Mr Jehan Perera, the Estate Superintendent, Mr K K P Gunawardena, Acting Chief Clerk, Mrs S I K Pathirage and Mrs O W Namali Udayanthie, Junior Clerks, Mr H M Jayantha Premalal, Field Officer - attending office duties, Mr D S K Ranaweera, Factory Officer, Mr W D D Senanayake, Assistant Factory Officer, Mr Somaratne Tennakoon, Field Officer, Mr Ajith Basil Nakandala, Mr B M Siriwardena, Mr Jagath Nakandala, Mr N L D Nihal and Mr K A Sarath Kumara, Junior Assistant Field Officers were on duty throughout the year.

- The demise of Mr S K S de Silva on 03/10/2006 Field Officer, attended to office duties is recorded with regret.

- Mr H M Jayantha Premalal, Field Officer in charge of Nivitigalakele division was transferred to the Estate Office with effect from 01.05.2006 to cover up the duties performed by Mr S K S de Silva.

The Group cadre stood as follows at the end of the year.

Senior staff	01
Assistant staff	14
Minor staff	02
	17

Hectarage summary - Dartonfield group

Hectarage summary of the Dartonfield Group is given in Table 1.

Table 1. *Land distribution (ha.) of Dartonfield group*

	Dartonfield division	Gallewatte division	Nivitigalakele division	Total
Mature area	39.02	138.46	10.00	187.48
Immature area	-	-	18.79	18.79
Budwood nurseries	- 6.54	-	1.25	7.79
Seedling nurseries	0.73		0.75	1.48
Uprooting areas			13.90	13.90
Abandoned areas		5.13	11.32	16.45
State land taken	0.27			0.27
Paddy/Deniya land		1.22	1.22	2.44
Waste land	0.19	0.18		0.37
Earth slipped area	3.01	1.26		4.27
Jungles	0.80		3.29	4.09
Rocky areas	2.14	4.74		6.88
Building	16.14	5.07	7.79	29.00
Roads	2.92	6.86	0.32	10.10
Building complex	2.53			2.53
Streams			2.17	2.17
Grand total	**74.29**	**162.92**	**70.80**	**308.01**

Rainfall

The annual rainfall recorded for the year was 4,260.9 mm of which 33% received during cropping months of the year. Moreover, rainfall distribution during the year had a negative impact on tapping activities.

Table 2. *Annual rainfall and wet days of the group for last five years*

	2002	2003	2004	2005	2006
Rainfall (mm)	3,618.7	4,454.1	4,349.7	4,129.0	4,260.9
Wet days	232	229	235	222	204

Crop

A total crop for 209,111kg was harvested against the estimated crop of 1,849,000 kg an increase of 24,211kg (13%) above the estimated and 23,204kg (12%) above previous year crop of 185,907 kg.

Table 3. *The crop and YPH (kg) Dartonfield group from 2002 to 2006*

Hect.	2002 186.59		2003 189.69		2004 184.71		2005 196.15		2006 187.48	
Division	**Crop**	**YPH**	**Crop**	**YPH**	**Crop**	**YPH**	**Crop**	**YPH**	**Crop**	**YPH**
Dartonfield	39780	1218	40951	1177	31394	850	33527	859	40278	1032
Gallewatte	109175	815	137910	1010	119433	872	144169	997	156863	1133
N'kele	15051	754	11252	613	8618	689	8211	656	11970	1197
Group total	164006	879	190113	1002	159445	863	1859	948	209111	1115
Group estimate	175950	943	187550	989	178124	964	169350	1001	184900	986

Tappers productivity

The average IPT during the last five years are given in Table 4.

Table 4. *The average IPT (kg.) of Dartonfield group from 2002 to 2006*

	2002	2003	2004	2005	2006
Dartonfield	7.1	6.6	6/4	6.8	7.1
Gallewatte	7.8	9.8	9.6	9.4	9.9
Nivitigalakele	4.4	4.6	5.9	5.7	6.3
Group average	7.6	8.4	8.7	8.9	8.9

The average IPT has increased over the previous year, an improvement made in tapper productivity. Average task of 100% intensity was 275 trees per block.

Tapping days

Monthly break down of normal tapping (NT), late tapping (LT), double tapping (DT), rainguard tapping (RT) and no tapping, of the group given in Table 5.

Table 5. *Average number of tapping days of Dartonfield group during last five years*

	2002	2003	2004	2005	2006
Normal tapping	252	261	168	190	199
Late tapping	36	24	12	06	35
Double tapping	(32)	-	-	(11))	(27)
No tapping	77	80	186	104	77
Rainguard tapping	-	-	-	65	54

Rainguard

82% of the total mature extent of Dartonfield group was rain guarded during the year. As a result of fixing rain guard, additional 52 and 56 tapping days were recorded in Dartonfield and Gallewatte divisions respectively. 11% of total crop harvested during the year was from rain guard area and additional income received from same was Rs.3,542,375.07.

Table 6. *Additional income generated by fixing rainguard (Rs./kg.)*

	Dartonfield division	Gallewatte division	Total
Hectarage (ha.)	39.02	115.28	154.30
Crop (kg)	5,437	17,556	22,993
Tappers	911	2,177	3,088
Tapping cost (Rs./kg)	47.83	35.40	38.34
C.O.M (Rs./kg)	19.20	19.20	19.20
Rain guard cost (Rs.)	31.75	31.75	31.75
Total cost (Rs./kg)	98.78	86.35	89.29
Income (Rs./kg)	209.76	209.76	209.76
Profit (Rs./kg)	110.98	123.41	120.47
Total profit (Rs.)	603,398.26	2,166,585.96	2,769,966.71
Profit per hectare (Rs.)	15,463.82	18,794.12	17,951.82
Additional tapping days	52	56	

Table 7. *Comparative statement of the mature extent profit per kg. and profit per hectare*

	Years				
	2002	2003	2004	2005	2006
Mature area (ha.)	186.59	189.69	184.71	196.15	187.48
Total profit (Rs.)	2,273,123.34	9,868,973.18	9,000,670.79	10,777,920.74	19,556,061.30
Profit per ha. (Rs.)	12,182.45	52,026.85	48,728.66	54,947.34	104,310.12

Profit per hectare was Rs.104,310.12 for the year under review, an increase of Rs.46,363.78 per hectare when compared with last year.

Cost of production and productivity

The cost of production has increased by Rs.29.40 per kg when compared with previous year.

Table 8. *Labour rates and break down of cost of production from 2002 to 2006(Rs./Kg.)*

	2002	2003	2004	2005	2006
1. Labour wages	147.35	147.35	178.75	216.25	285.50
2. Cost of production	54.25	57.16	74.50	86.84	116.24
2.1 Tapping	19.35	22.33	25.45	29.29	35.35
2.2 Manufacture	11.12	12.66	17.47	16.33	19.20
2.3 General charges	16.87	14.90	19.21	28.35	47.47
2.4 M/area upkeep	6.91	7.27	12.37	12.87	14.22
3. N.S.A.	68.11	109.07	130.95	144.34	209.76
4. Profit	13.86	51.91	56.45	57.50	93.52

Manufacture

Table 9. *Summary of grades manufactured during the year*

Grade	Quantity (kg.)	Percentage %
Latex crepe No.1		
Latex crepe No.2	154,941	86
Latex crepe No.3	26,038	14
Total	180,979	100
Scrap crepe No. 1	17,002	72
Scrap crepe No.2	5,955	25
Scrap crepe No.3	542	03
Total	23,499	100
RSS No.1	4,391	95
RSS No.2	242	
		05
Total	4,633	
		100
Grand Total	**209,111**	

KURUWITA SUB STATION

S A R Samarasekera

SUMMARY

A crop of 78,275kg was harvested during the year which is an increase of 34% over the estimated crop for the same period.

The actual yield per hectare (Y.P.H.) and the average intake per tapper were 1,610.2kg and 9.4kg respectively.

The annual rainfall was 4,100.3mm with 132 wet days during the year.

The average number of normal, late, rain interference, double tapping and no tapping days were 306, 20, 9, 2, 30 respectively.

The cost of production and the net sale average for the year were Rs.78.99 and Rs.165.82 per kg respectively. The profit per kg was Rs.86.83 and profit made for the year was Rs.6,796,618.25. The total profit inclusive of sundry income was Rs.7,537,935.48.

DETAILD REVIEW

The Visiting Superintendent Mr Anusha S Perera over looked the activities of the Sub Station throughout the year.

Mr S A R Samarasekara, Assistant Estate Superintendent, Mr D S Jayasinghe Clerk, Mr J R C Jayalath, Assistant Field Officer and Mr V G D N Gunaseela, Mr N V U S V Kumara, Junior Assistant Field Officers were on duty throughout the year.

The estate cadre stood at 05 at the end of the year made as follows.

Intermediate staff	- 01
Assistant Staff	- 01
Minor Staff	- 03

Hectarege

A summary of the hectarage is given in Table 1.

Table 1. *Land distribution (ha.) in Kuruiwta Sub Station*

Land type	Extent (ha.)
Mature area	48.61
Immature area	31.50
Nurseries	2.25
Tea area	2.25
Fruit plantation	2.00
Paddy area	1.00
Building, gardens and roads	8.54
Water tank	.01
Proposed replanting area 2007	3.00
Unsuitable for planting	.84

A total crop of 78,275kg was harvested from an extent of 48.61 hectares during the year. When compared with the actual of the last year this is an increase of 9,179kg. The yield per hectare (YPH) for last 5 years is given in the Table 2. The average yield per hectare of the estate has increased by 11% from that of the previous year. Also it was higher than the estimate of the year.

Table 2. *Yield per hectare (kg.) recorded for the last five years in the Kuruwita estate*

	Year				
	2002	2003	2004	2005	2006
Estimate	819.0	1,080.0	1,197.7	1,200.0	1,200.0
Y.P.H.	1,357.7	1,371.5	1,393.9	1,451.2	1,610.2

Table 3. *Y.P.H. (kg.) recorded for each month during the year*

Month	Y.P.H. (kg)
January	183.9
February	153.0
March	92.2
April	60.1
May	101.8
June	129.4
July	151.5
August	138.7
September	129.8
October	147.0
November	140.0
December	182.1

Tappers productivity

The average intake per tapper at the end of the year was 9.4kg. This is an increase of 0.7kg over the last year.

Table 4. *The average I.P.T. (kg.) for the last five years*

	Year				
	2002	**2003**	**2004**	**2005**	**2006**
Intake per tapper	9.6	9.4	8.5	8.7	9.4

Vacant blocks

The No. of vacant blocks recorded for the last 2 years in the estate are given in Table 5.

Table 5. *Vacant blocks and percentage*

Year	No. of vacant blocks	Percentage
2005	477	5.66
2006	195	2.27

Tapping

When compared with the last year there is an increase in both normal and late tapping days. 335 tapping days were recorded during the year. This was possible merely due to the application of rain guards.

Table 6. *The No. of the tapping days, average intake per tapper and Y.P.H. for the last five years*

	Y ear				
	2002	**2003**	**2004**	**2005**	**2006**
1 Tapping days	290	280	327	336	335
1.1 Normal	252	258	306	302	306
1.2 Late	36	14	14	18	20
1.3 Rain interference	02	08	07	16	09
1.4 Rain guard	(70)	(32)	(92)	(88)	(122)
1.5 Double	(32)	(46)	(11)	(04)	(02)
2 No tapping	75	85	39	29	30
3 Ave. intake per tapper	9.6	9.4	8.5	8.7	9.4
4 Y.P.H. (kg.)	1,357.7	1,371.5	1,393.9	1,451.2	1,610.2

Rainguard

The performance of rain guards in the estate for the last 2 years are given in Table 7.

Table 7. *Additional income generated by fixing of rain guards*

	Year	
	2005	**2006**
Hectarage	31.25	33.66
No of rainguards fitted	13,143	15,680
Total cost per rain guards (Rs.)	15.51	19.08
Additional income from rainguards (Rs.)	1,036,719.84	1,853,376.00
Additional profit per hectare (Rs.)	32,677.96	61,500.82
Profit per tree	78.88	118.20
Additional tapping days	88	122

Rainfall

Rainfall figures for the last two years are given below in Table 8.

Table 8. *Rainfall (mm) distribution during 2005 and 2006*

	Year	
Month	**2005**	**2006**
January	97.2	162.9
February	192.5	181.3
March	367.3	243.5
April	394.6	324.6
May	342.3	479.7
June	302.5	450.1
July	235.4	188.0
August	152.1	418.9
September	428.4	298.9
October	576.5	645.0
November	652.0	458.2
December	162.2	149.1
Total	3,903.0	4,000.3

The annual rainfall figures and the number of wet days for last five years of the estate are given in Table 9.

Table 9. *Annual rainfall and the No. of wet days during the last five years*

	Year				
	2002	**2003**	**2004**	**2005**	**2006**
Rainfall in mm	2,743	3,981	4,556	3,903	4,100
Wet days	70	89	120	103	132

Tapping cost

The tapping cost of the estate has increased by 9.9% over the last year.

Table 10. *A break down in total tapping cost for the last five years*

Cost item	Cost/kg. (Rs.) and year				
	2002	2003	2004	2005	2006
Tapping	14.42	14.67	21.10	24.31	26.39
Double tapping	.47	1.33	.54	.17	.09
Overtime on tapping	.11	.18	.22	.28	.36
Over kilos	.68	.48	.31	.33	.54
Extra pay to Kangany	.02	.03	.03	.03	.02
Scrap pay	.22	.36	.39	.61	.88
Incentive pay to field staff		.09	.20	.22	.25
Total tapping cost (Rs.)	15.92	17.14	22.79	25.95	28.53

Cost of production and productivity

The cost of production has increased by Rs.18.68 per kg when compared with the previous year.

Table 11. *Labour rate (Rs.) and a break down of the cost of production (Rs./Kg.)*

	Year				
	2002	2003	2004	2005	2006
Labour rate	109.0	109.0	125.0	125.00	170
C.O.P.	31.94	34.25	55.11	60.31	78.99
Tapping	16.43	17.91	23.54	27.17	29.64
General charges	12.37	11.39	23.20	23.52	37.09
Upkeep	3.14	4.95	8.37	9.62	12.26
N.S.A.	53.93	83.12	104.89	120.58	165.82
Profit per kilo	21.99	48.87	49.78	60.27	86.83

Labour rate per day for the year was Rs.170/= plus an additional incentive of Rs.90/= per day depending on the attendance.

Table 12. *Comparative statement of the mature extent profit per kg. and profit per hectare*

	Year				
	2002	2003	2004	2005	2006
Mature extent (ha.)	48.83	48.83	44.25	47.61	48.61
Total profit (Rs.)	1,437,640.23	3,272,921.64	3,070,281.06	416,4415.92	6,796,618.25
Profit per ha. (Rs.)	12,853.24	29,441.74	67,026.86	69,384.88	139819.34

During the year 2006 a profit of Rs.86.83 on a kilogram and Rs.139819.34 per revenue hectare were recorded.

Tea

A crop of 21,439 kg was harvested during the year. The cost of production and the net sale average for the year were Rs.22.66 and Rs.26.09 per kg. respectively.

The profit per kg was Rs.2.67 and the profit made for the year was Rs.73,458.89.

Cinnamon

325kg of Cinnamon was sold during the year.

Rubber plants

No. of young budding plants of clone RRIC 121 were issued to the smallholders during the year.

Fruits

17,917 kg of Pine apple and 8,461.5 kg of Passion fruit were harvested from the fruit plantation during the year.

Reward

The selected best tappers were rewarded in this year in order to encourage tapping.

Fertilizer application

Fertilizer application for mature and immature fields were carried out as per the scheduled.

Meteorological Summary – 2006
Dartonfield Station

Wasana Wijesuriya

A total of 4261 mm of rain experienced during 2006. This was an increase of 136 mm, compared to the previous year. The departure from the long-term average, 4072mm was 189mm, which accounts for nearly 5%. Fig. 1 indicates that the distribution of rainfall during this year departed from the usual bimodal pattern. January and August, which are generally dry months, have exceeded 400 mm of rainfall per month.

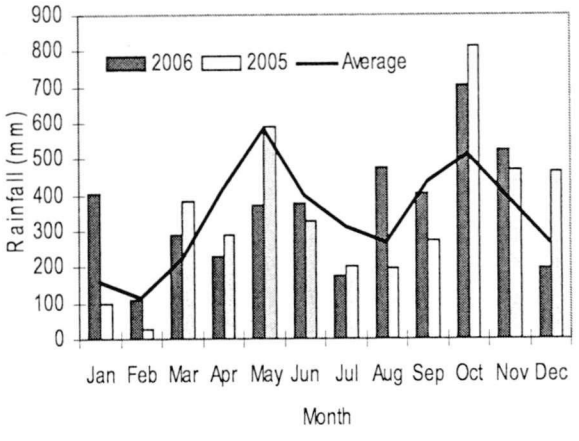


Fig.1 Monthly variation in rainfall

As in the previous year the highest rainfall was observed in October under the influence inter monsoons in the 2nd rain spell. In this year too, heavy showers were observed during October and November like in year 2005. Below average rainfall values were observed for the period from April to July and also during the month of December.

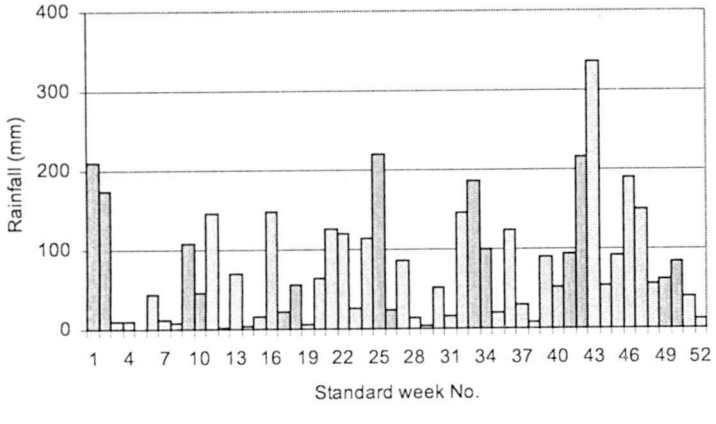


Fig. 2. Weekly variation in rainfall

The distribution of weekly rainfall is illustrated in Fig. 2. Eight dry weeks (a week having a total rainfall less than 10 mm) were observed during the year and it was 9 weeks in 2005. The highest weekly rainfall was observed during the 43rd standard week (Late October).

Start and end of monsoon rains

The successful start of the rains occurred by 29th March and 08th September in 80% of the years for Southwest (SW) and Northeast (NE) rains, respectively when the period from 1964 to 2003 were considered. For the year under review, SW rains commenced successfully by 01st of March, which was an early onset of rains compared to the 80% expected, but was very close to the start in 2005. The onset of NE rains in the year was 08th August, an early start by a duration of one month.

Rains have ceased generally by 14th August and 05th January for SW and NE rainy seasons, respectively (80% expected). For the year under review SW rains ceased by 06h July while NE rains ceased by 26th December. It was an early end in both occasions. The 1st rain spell lasted for127 days, which is shorter than the median, 139 days. The 2nd spell exceeded the median length of 122 days and lasted for140 days.

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 222, which is close to the long-term average of 220 days. Pan evaporation during 2006 was 751 mm (2.1 mm/day).

Other meteorological factors

Table 2 depicts the monthly values of some important meteorological observations together with averages for 1980 to 2005. The minimum temperature dropped below 20^0C in 6 days in January and 3 days in December during this year. The lowest mean minimum temperature was observed in the month of January. The minimum temperatures during May to July did not exceed 24^0C as in 2005. The highest mean maximum temperature of 33.4^0C was observed in February. The average morning RH was in the range of 83 to 91%. The monthly values of soil temperatures at 4 different depths are given in Table 3.

Table 1. *Monthly variation of rainfall and rainy days in 2006*

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	404.1	(156)	18	(11)	3	13	2	62.3
February	108.4	(114)	12	(09)	5	7	-	75.9
March	289.3	(222)	19	(13)	4	14	1	78.5
April	227.2	(415)	13	(18)	3	9	1	64.3
May	372.8	(584)	22	(24)	2	19	1	62.8
June	377.0	(398)	18	(23)	4	12	2	59.8
July	176.0	(313)	16	(22)	5	11	-	66.6
August	473.6	(268)	23	(20)	2	19	2	61.4
September	405.9	(436)	21	(22)	7	12	2	57.4
October	704.2	(513)	24	(23)	3	16	5	65.1
November	524.1	(387)	20	(20)	2	16	2	47.0
December	198.3	(266)	16	(15)	4	11	1	49.4
Total	4260.9	(4072)	222	(220)	44	159	19	750.5

* A rainy day is defined as a day with a rainfall ≥0.3 mm

** Average values for 1980-2005 are shown in parentheses

Table 2. *Variation of observed meteorological factors at Dartonfield – 2006*

Month	(Latitude 6° 32' N; Longitude 80°. 09' E Altitude 65.5m) Temperature (°C)				Sun shine hours	Relative humidity (%)			Mean wind speed ($kmhr^{-1}$)
	Mean Max	Mean Min	Mean	No. of days Min Temp <20		8.30am	No. of days 8.30am >90%	3.30pm	
January	32.0	21.5	26.8 (26.7)	06	5.2	91 (88)	20	72 (68)	1.60
February	33.4	22.5	28.0 (27.1)	-	6.0	90 (86)	17	62 (65)	2.00
March	33.1	22.7	27.9 (27.6)	-	5.6	91 (85)	19	70 (68)	1.30
April	32.5	23.7	28.1 (27.8)	-	5.4	87 (85)	11	69 (75)	0.70
May	31.7	23.8	27.8 (27.6)	-	4.6	86 (88)	09	74 (77)	1.40
June	31.6	23.7	27.7 (26.9)	-	5.2	90 (88)	15	69 (74)	2.10
July	30.6	23.5	27.1 (26.9)	-	5.1	88 (89)	12	74 (75)	2.80
August	30.8	22.9	26.9 (26.6)	-	5.3	90 (88)	18	75 (74)	2.00
September	31.3	23.2	27.3 (26.7)	-	4.6	83 (88)	11	74 (75)	1.90
October	32.0	22.7	27.4 (26.6)	-	6.0	83 (86)	09	74 (77)	1.30
November	32.3	22.5	27.4 (26.6)	-	4.0	90 (86)	11	80 (77)	0.40
December	31.5	22.4	26.6 (26.7)	03	3.4	91 (85)	19	79 (73)	0.40

Average values for 1980-2005 are shown in parentheses.

Table 3. *Soil temperatures recorded at different depths at Dartonfield – 2006*

Month	08.30 hrs				15.30 hrs			
	5cm	**10cm**	**20cm**	**30cm**	**5cm**	**10cm**	**20cm**	**30cm**
January	26.5	25.6	26.8	27.8	34.3	32.0	30.4	28.6
February	27.5	27.1	28.3	29.2	37.6	34.4	32.2	29.9
March	27.7	27.0	28.1	29.0	34.7	33.1	31.1	29.8
April	28.9	28.0	28.9	29.8	35.7	33.5	31.7	30.4
May	28.6	27.9	28.6	29.6	34.1	32.4	31.1	30.1
June	27.8	26.9	27.7	28.8	34.9	31.8	30.8	29.5
July	27.8	27.0	27.9	28.7	32.6	31.6	30.1	28.9
August	27.3	26.5	27.3	28.4	32.5	31.3	29.8	28.9
September	27.9	26.6	27.5	28.3	33.6	31.9	30.2	29.1
October	28.4	26.7	27.5	28.4	33.4	32.0	30.9	29.4
November	27.7	26.3	27.0	28.1	31.7	30.8	29.7	28.7
December	27.0	26.0	26.9	27.8	31.6	30.6	29.1	28.4

LIST OF PUBLICATIONS

Scientific Journals
(Bold type – Rubber Research Institute of Sri Lanka employees)

De Costa, W.A.J.M., Weerakoon, W.M.W., **Herath, H.M.L.K.,** Amarathunga, K.S.P. and Abeywardena, R.M.I. (2006). Physiology of yield determination of rice under elevated carbon dioxide at high temperatures in a subhumid tropical climate. *Field Crop Research* **96**, 336-347.

Dharmakeerthi, R.S., Kay, B.D. and Beauchamp, E.G. (2006). Spatial variability of in-season nitrogen uptake by corn across a variable landscape as affected by management. *Agronomy Journal* **98**, 255-264.

Dharmakeerthi, R.S., Silva, S.N., Yakandawala, A. and Jayasinghe, W.K. (2005). Nutritional status of rubber growing soils in the Moneragala district. *Journal of the Rubber Research Institute of Sri Lanka* **87**, 23-35.

Iqbal, S.M.M., Ireland, C.R. and **Rodrigo, V.H.L.** (2006). Analysis of the factors determining the decision of smallholder rubber farmers in Sri Lanka to intercrop tea with rubber. *Agricultural Systems* **87**, 296-312.

Jayasuriya, K.E. and Wijesundera, R.L.C. (2005). Variability in defence responses of rubber genotypes against *Phytophthora meadii* infections. *Journal of the Rubber Research Institute of Sri Lanka* **87**, 46-55.

Kay, B.D., Mahboudbi, A.A., Beauchamp, E.G. and **Dharmakeerthi, R.S.** (2006). Integrating soil and weather data to describe variability in plant available nitrogen. *Soil Science Society of America Journal* **70**, 1210-1221.

Karunanayake, L. and **Perera, G.M. Priyanthi** (2006). Effect of magnesium and phosphate ions on the stability of concentrated natural rubber latex – dipped products. *Journal of Applied Polymer Science* **99**, 3120-3124.

Kudaligama, K.V.V.S., Thurul, W.M. and Yapa, P.A.J. (2005). Effect of bio-brush medium: a coir based biomass retainer on treatment efficiency of an anaerobic filter type reactor. *Journal of the Rubber Research Institute of Sri Lanka* **87**, 15-22.

Pathiratna, L.S.S. and **Perera, M.K.P.** (2005).Rubber (*Hevea brasiliensis*) cinnamon (*Cinnamomum verum*) intercropping system: performance under standard inter row spacings of rubber. *Natural Rubber Research* **18**, 105-112.

Pathiratna, L.S.S. and **Perera, M.K.P.** (2005). Effect of competition from rubber (*Hevea*) on the yield of intercropped medicinal plants, *Solanum virginianum* Schrad., *Aerva Lanata* (L.) Juss. Ex. Schult and *Indigofera tinctoria* L. *Journal of the Rubber Research Institute of Sri Lanka* **87**, 36-45.

Pathiratna, L. S. S. and **Perera, M.K.P.** (2006). Effect of plant density on bark yield of Cinnamon intercropped under mature rubber. *Agroforestry Systems* **68**, 123-131.

Pathiratna, L. S. S., Seneviratna, P., Perera, M.K.P. and Balasooriya, C.K. (2006). Bark cracking disorder in the lower trunk region of seedling and in the root stock of bud grafted trees of *Hevea brasiliensis* Muell.Arg. *Ceylon Journal of Science (Bio Sci)* **35,** 79-86.

Pathiratna, L. S. S., Seneviratna, P., Waidyanatha, U. P. De. S. and Samaranayake, A. C. I. (2006). Effect of tree density on growth, yield and profitability in rubber *(Hevea)* plantations. *Ceylon Journal of Science (Bio sci),* **35**, 141-148.

Ratnayake, U.N. and Haworth, B. (2006). Polypropylene-clay nanocomposites: influence of low molecular weight polar additives on intercalation exfoliation behaviour. *Polymer Engineering and Science* **46**, 1008.

Wijesuriya, Wasana and Thattil, R.O. (2005). Analysis of ranking exercises in Participatory Rural Appraisal (PRA): a case study from the smallholder rubber sector. *Journal of the Rubber Research Institute of Sri Lanka* **87,** 7-14.

Withanage, S.P., Attanayake, D.P.S.T.G. and **Karunasekera, K.B.A.** (2005). Adaptability of recently recommended rubber clones for agro-climatic variability of Sri Lanka. *Journal of the Rubber Research Institute of Sri Lanka* **87**, 1-6.

Books/Theses

Jayasuriya, Madhupani Mekhala (2006). Interpenetrating polymer networks based on natural rubber and poly (methylmethacrylate). *PhD Thesis,* Loughborough University, UK.

Samarappuli, Lalani and **Wijesuriya, Wasana** (2006). Rubber in Sri Lanka: a prospective plantation crop to combat adverse impacts of climate change. **In**: *Multiple dimensions in global environmental change.* pp.557-577 (Ed. S. Sonak), Energy and Resources Institute, India.

Wijesuriya, Wasana, Thattil, R.O. and **Herath, Keminda** (2006). Tools and approaches for studies on global environmental change: a case study on quantifying casual maps using Bayesian networks to identify reasons for abandoning rubber cultivations in Sri Lanka. **In**: *Multiple dimensions in global environmental change*. 578-589. (Ed. S. Sonak), Energy and Resources Institute, India.

Bulletin/Conferences/Seminars/Workshops/Reports

අභයවර්ධන, විදුර (2005). කෘෂි ක්ෂේත්‍රයේ තිරසාර සංවර්ධනයක් උදෙසා සහභාගිත්ව ගැමි පිවිසුම (PRA) හි ඇති වැදගත්කම. *රබර් ප්‍රවෘත්*. **24**, 1-8.

Balasooriya, B. M. D. C., Rodrigo, V. H. L., Iqbal, S. M. M. and Gamage, D. V. S. de S (2006). Effect of free range poultry system on land use efficiency and floral diversity in rubber plantations. *Proceedings of International Forestry and Environment Symposium: Managing Natural Resources Towards Sustainable Development*. December 2006. Kalutara, Sri Lanka. 7.

Dharmakeerthi, R.S., Ranasinghe, R., **Silva, S.N., Yakandawala, A.** and **Maheepala, C.K.** (2006). Girth response of new *Hevea* clones to fertilizer in a red yellow podzolic soil in Sri Lanka. *Proceedings of the International Natural Rubber Conference.* 13-14 November 2006, Vietnam, 246.

Dissanayake, Anura, Wijesuriya, Wasana, Wijeratne, Mahinda, **Herath, Keminda** and Edirisinghe, Jagath (2006). Involvements in rural societies by smallholder rubber farmers in Sri Lanka. *Proceedings of the International Natural Rubber Conference.* 13-14 November 2006, Vietnam. 549-556.

Dissanayake, K.M.R., **Rodrigo, V.H.L.** and **Balasooriya, B.M.D.C.** (2006). Usage of commonly available herbicides for the weed control on rubber – cinnamon intercrop. *Proceedings of the Sixth Agricultural Research Symposium 2006.* Faculty of Agriculture and Plantation Management, University of Wayamba, Sri Lanka. 298-302.

Edirisinghe, D.G., Wettasinghe, P.C., Perera, G.M.P. and Wickramarachchi, D.N. (2006). Improvements in properties of NR latex films by blending with polyvinyl acetate. *Proceedings of Asia Rubtech Expo '06* Conference, 23 – 25 November, 2006, India. 100.

Fernando, Nishadi, **Wijesuriya, Wasana** and Wijeratne, Mahinda (2006). Application of quantitative techniques for PRA tools. *Proceedings 10th Anniversary International Symposium*, Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka. 26-36.

Fernando, Nishadi, **Wijesuriya, Wasana** and Wijeratne, Mahinda (2006). Application of statistical techniques for Participatory Rural Appraisal (PRA). *Proceedings Seventh Annual Research Session of Agricultural Graduates*. Faculty of Agriculture, University of Ruhuna, Sri Lanka. 15-17.

Herath, Keminda and **Wijesuriya, Wasana** (2006). Wealth ranking as a participatory tool in determining socio-economic status of rubber smallholders. *Proceedings of the International Natural Rubber Conference.* 13-14 November 2006, Vietnam. 548.

Iqbal, S.M..M. and **Rodrigo, V.H.L.** (2006). Feasibility of rubber (*Hevea brasiliensis* Mull. Arg.) cultivation in the Eastern Province of Sri Lanka; a non traditional area for rubber. *Proceedings of the International Natural Rubber Conference.* 13-14 November 2006, Vietnam. 571-584.

ඉක්බාල්, එස්.එම්.එම්., **රැළිගු, වී.එච්.එල්.**, **පෙරේරා, ඒ.එම්.ඒ.** සහ **වෙත්තසිංහ, ඩී.එස්.** (2005). රබර් සමඟ තේ වගාව, කුඩා වතුහිමියන් මෙන්ම විශාල වැවිලිකරුවන් සඳහාද යෝග්‍ය ක්‍රමයකි. *රබර් ප්‍රවත්* **24**, 13-16.

Jayasinghe, C.K. (2006). *Corynespora* leaf fall: success story of the management in Sri Lanka and future of the world's leading rubber clones. *Proceedings of the International Natural Rubber Conference.* 13-14 November 2006, Vietnam. 413.

Jayasuriya, K.E. (2006). Pesticides used in rubber cultivation and precautions on handling. *Bulletin of the Rubber Research Institute of Sri Lanka* **47**, 44-50.

ජයසූරිය, කේ.ඊ. සහ **වෙත්තසිංහ, ඩී.එස්.** (2005). රබර් සමඟ මිශ්‍ර භෝග වගාවේදී සුදුමුල් රෝගය හොඳින් පාලනය කිරීමේ වැදගත්කම්. *රබර් ප්‍රවත්* **24,** 17-21.

ජයසූරිය, කේ.ඊ. සහ **වෙත්තසිංහ, ඩී.එස්.** (2005). රබර් වගාවේදි පලිබෝධ නාශක ආරක්ෂාකාරී ලෙස භාවිතා කිරීම. *රබර් ප්‍රවත්* **24,** 47-54.

Krishantha, G. D. D., Kulathunge, S. S., **Edirisinghe, D. G.**, Karunanayake, L. **Siriwardena, S.** (2006). Modification of NR/EPDM/Carbon black composites by co-vulcanization through high energy γ-irradiation, *Asia Rub Tech Expo 2006*, 23-25 November 2006, Cochin, India, 115-116.

කුලතුංග, මේනකා (2005). වසංගත තත්වයෙන් පැතිරී යන කම්බිලි පණු ආක්‍රමණය: හඳුනා ගැනීම සහ පාලනය. *රබර් පුවත්* **24,** 55-58.

Muasinghe, E.S. and **Rodrigo, V.H.L.** (2006). Can rubber (*Hevea brasiliensis* Muell. Arg.) be grown as a timber crop*? Bulletin of the Rubber Research Institute of Sri Lanka.* **47**, 34-39.

Munasinghe, E. S. and **Rodrigo, V. H. L.** (2006). Potential carbon sequestering capacity of mature rubber plantations with genotypic differences. *Proceedings of the International Conference on Humid Tropical Ecosystems: Changes, Challenges, Opportunities,* December 2006. Kandy, Sri Lanka, 75.

Munasinghe, E. S., Rodrigo, V. H. L., Gunawardena, U. A. D. P., **Karunatilake, P. K.W.** (2006). Assessment on timber and carbon in rubber plantations with special reference to the wet zone of Sri Lanka. *Proceedings of the Eleventh International Forestry and Environmental Symposium.* December 2006, Department of Forestry and Environmental Science, University of Sri Jayawardenapura, Sri Lanka. 8.

Nugawela, A. (2006). Enjoy 2000 plus yields: adhere to basic agronomic practices. *Bulletin of the Rubber Research Institute of Sri Lanka* **47,** 70-74.

Nugawela, A. (2006). Stimulation of rubber trees for enhancing performance – the past, current practices and future trends. *Bulletin of the Rubber Research Institute of Sri Lanka* **47**, 75-79.

Pathiratna, L.S.S (2006). Management of intercrops under rubber: implications of competition and possibilities for improvement. *Bulletin of the Rubber Research Institute of Sri Lanka* **47,** 8-16

Pathiratna, L.S.S. (2006). Cinnamon for intercropping under rubber. *Bulletin of the Rubber Research Institute of Sri Lanka* **47,** 17-23.

Pathiratna, L.S.S. (2006). Some aspects of proliferation and distribution of fine roots in rubber (*Hevea). Bulletin of the Rubber Research Institute of Sri Lanka.* **47,** 59-64.

Pathiratna, L.S.S and **Perera, M.K.P.** (2006). Performance of rattan (*Calamus* spp.) inter planted under rubber (*Hevea*). *Bulletin of the Rubber Research Institute of Sri Lanka* **47,** 24-27.

Pathiratna, L.S.S and **Perera, M.K.P.** (2006). Intercropping medicinal plants under rubber (*Hevea*). *Bulletin of the Rubber Research Institute of Sri Lanka* **47**, 28-33.

Pathiratna, L.S.S. and **Wijesuriya, B.W**. (2006). A new systematic experimental design for tree crop research. *Bulletin of the Rubber Research Institute of Sri Lanka* **47**, 40-43.

Perera, G.M.P. and **Edirisinghe, D.G.** (2006). Development of a highly effective room temperature vulcanizing system for natural rubber latex based compounds. *Proceedings of the International Natural Rubber Conference.* 13-14 November 2006, Vietnam. 461-468.

පෙරේරා, එම්.කේ.පී. (2005). දේශීය වටිනාකමක් ඇති ඖෂධ ශාක රබර් සමඟ වගා කරමු. *රබර් ප්‍රවත්* **24**, 32-34.

පෙරේරා, එම්.කේ.පී. (2005). රබර් සමඟ අතුරු භෝග දැමීමේදී පැන නඟින ගැටළු. *රබර් ප්‍රවත්* **24**, 39-42.

Rodrigo, V.H.L and **Iqbal, S.M.M**. (2006). Rubber (*Hevea brasiliensis* Mull. Arg.) cultivation in the Eastern Province of Sri Lanka with alleviation of rural poverty and increase in the forest cover: a feasibility study. *Proceedings of International Conference on Humid Tropical Ecosystems: Changes, Challenges, Opportunities.* December 2006. Kandy, Sri Lanka. 72.

Rodrigo, V.H.L., Kudaligama, K.V.V.S. and **Samarasekera, R. K.** (2006). Response of some Sri Lankan rubber clones to gaseous stimulation in tapping: a preliminary investigation. *Proceedings of the International Natural Rubber Conference,* 13-14 November 2006, Vietnam. 74-87.

Sarath Kumara, P.H. (2006). DRC estimation of natural rubber latex using the metrolac – Sri Lankan experience. *Proceedings International Natural Rubber Conference.* 13-14 November 2006, Vietnam. 453-460.

Sarath Kumara, P.H. (2006). Methods of estimation of dry rubber content in natural rubber latex. *Bulletin of the Rubber Research Institute of Sri Lanka* **47**, 65-69.

Sarath Kumara, P.H. and **Warnajith Prasad, A. K. D**. (2006). Is metrolac weighing an accurate method for DRC estimation? *Bulletin of the Rubber Research Institute of Sri Lanka* **47**, 51-58.

Senevirathna, A.M.W.K. (2006). Identification of physical factors affecting tapping panel dryness (TPD) of rubber (*Hevea brasiliensis* Muell Arg.) and some biochemical changes at the onset of tapping panel dryness. *Terminal Report of CARP Project 12/478/358*, Rubber Research Institute of Sri Lanka. pp. 29.

Senevirathna, A.M.W.K. (2006). Current status of taping panel dryness in some Sri Lankan high yielding clones of rubber and associated factors. *Proceedings of the International Natural Rubber Conference,* Vietnam, 13-15 November 2006, 138.

Senevirathna, A.M.W.K. (2006). Incorporation of scientific and local knowledge in rubber farming systems: a useful tool. *Bulletin of the Rubber Research Institute of Sri Lanka* **47,** 1-7.

සෙනෙවිරත්න, වසන්ත (2005). ශ්‍රී ලංකාවේ රබර් නිෂ්පාදනය ඉහළ නැංවීම, තත්වයෙන් උසස් පැළයක් සිටුවීමෙන් අරඹමු. *රබර් පුවත්* **24**, 35-38.

සෙනෙවිරත්න, ප්‍රියානි සහ තිලකරත්න, එල්.එම්.කේ. (2005). රබර් වගා කිරීමේ ව්‍යාපෘති සඳහා පැල නිෂ්පාදනය. *රබර් පුවත්* **24**, 43-46.

Seneviratne, W.M.G. (2006). Performance of treatment of rubber process effluents by anaerobic-aerobic treatment plants in Sri Lanka. *Proceedings International Natural Rubber Conference.* 13-14 November 2006, Vietnam. 470-481.

Seneviratne, W.M.G., Chandrasekara, Kumudini, Samarakoon, S.M.G.M. and **Priyanka, U.M.S.** (2006). Issues of protein allergy of natural rubber lattices/products – techniques and methodologies of removal of allergenic proteins. *Proceedings of the International Natural Rubber Conference.* 13-14 November 2006, Vietnam. 469.

Siriwardena, S., Edirisinghe, D. G., Prasad, A.K.D.W., Rohanadeepa, V.C. and **Siriwardena, T.A.S.** (2006). The performance of different types of sheet rubber in a tyre tread compound. *Proceedings of the International Natural Rubber Conference.* 13-14 November 2006, Vietnam. 501.

Wellappili, Champa J., De Silva, Karnika, Dharmatilake, Malani and **Denawaka, Indra** (2006). Effect of chemically treated buffing dust on technological properties of tyre tread compounds. *Progress in Rub, Plast. and Recycling Tech.* **23**, 1-19.

වෙත්තසිංහ, ඩී.එස්. (2005). රබර් වගාවේ මී පැණි නිෂ්පාදනයෙන් අමතර අදායමක්. *රබර් පුවත්* **24**, 22-31.

වික්‍රමරත්න, එන්.ඒ.ඒ.බී., රැළිගු, වී.එච්.එල්. සහ තිලකරත්න, එල්.එම්.කේ. (2005). කිරි කැපීමේ නිර්දේශිත ගොඩනැඟි ඇති විද්‍යාත්මක පසුබිම. *රබර් පුවත්* **24**, 8-12.

Wijeratne, Mahinda, Edirisinghe, Sajini and **Dissanayake, Anura** (2006). Assessment of CBOS in rubber smallholdings sector through PRA techniques. *Proceedings of the International Natural Rubber Conference.* 13-14 November 2006, Vietnam. 522-528.

Wijeratne, Mahinda, Sanjeewani, M.K.M. and **Dissanayake, Anura** (2006). Present status and potential for rubber wood industry in Sri Lanka. *Proceedings of the International Natural Rubber Conference.* 13-14 November 2006, Vietnam. 612.

Wijesuriya, Wasana (2006). Role of institutions in global environmental change. Final report for APN project 2005-02-CMY-Sonak, Asia-Pacific Network for Global Change Research.

Wijesuriya, Wasana, Dissanayake, Anura, Wijeratne, Mahinda, **Herath, Keminda** and Edirisinghe, Jagath (2006). Participatory methods for development of the smallholder rubber sector in Sri Lanka. *Proceedings of the International Natural Rubber Conference.* 13-14 November 2006, Vietnam. 529-537.

Wijesuriya, Wasana, Riley, J. and Thattil, R.O. (2006). Improving interpretability of Participatory Rural Appraisal (PRA) through appropriate statistical methods: case studies form the smallholder rubber sector of Sri Lanka. *International Biometric Conference*, Montreal, Canada.