THE RUBBER RESEARCH INSTITUTE OF SRI LANKA

ANNUAL REVIEW FOR 1979

CONTENTS

RUBBER RESEARCH INSTITUTE OF SRI LANKA

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(As at 31st December, 1979)

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Mr. Daya Gunasekera

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Lawyers

Attorney-General's Department
(Corporations Division)
Hulftsdorp,
Colombo 12.

Auditors

Satchithananda, Schokman, Wijeratne & Co.
Chartered Accountants,
P. O. Box 918,
Colombo 1.

Bankers

Bank of Ceylon,
York Street, Colombo 1.
People's Bank, Matugama.

Registered Office Laboratories

Dartonfield, Agalwatta.

Colombo Office

Consisting of the:

Advisory Services Department & Economic Research Unit, Rubber Chemistry Department, Specifications Laboratory
Telawala Road,
Ratmalana,
Mt. Lavinia.

THE RUBBER RESEARCH INSTITUTE OF SRI LANKA

STAFF

(As at 31st December, 1979)

Director ... O. S. Peries, B. Ag. Sci. (Melb.), Ph. D. (Bristol), M.I. Biol.

Assistant Director ... D. M. Fernando, B.Sc. (Cey.), M.Sc. (McGill)

RESEARCH DEPARTMENTS

Botany

Head of Department ... L. B. Chandrasekera, B. Sc. (Cey.), Dip. Ag. Sci. (Cantab.)

Botanists ... U. P. de S. Waidyanatha, B. Sc. (Cey.), M.Sc. (Cey.), Ph. D. (Lond.), D.I.C.

R. Satchuthananthavale, B. Sc. (Madras), M.A. (Madras), Ph. D. (Sheffield)

Mrs. A. C. I. Samaranayake, B. Sc. (Cey.), Ph. D. (Lond.)

Research Assistant ... K. A. K. Jayatillake, B. Sc. (Cey.)

Experimental Officer ... Miss E. M. A. I. Ekanayake, B. Sc. (Cey.)

Senior Technical Officer ... W. G. V. Fernando

Technical Officers ... L. S. S. Pathiratne, L. I. Biol.
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W. A. Ariyaratne
D. K. Angammana
L. S. Kariyawasam
I. R. M. Amarakoon
K. A. G. Bandara
R. P. Karunasena

Senior Field Assistants ... M. C. Perera
R. B. Gunaratne

Field Assistants ... D. A. Brahmana
S. Kodikara
W. A. T. Silva
S. Wilbert
U.K. D. Lewis
N. L. D. Ruban

Genetics & Plant Breeding

Head of Department ... D. M. Fernando, B.Sc. (Cey.), M.Sc. (McGill)

Geneticist & Plant Breeder ... N. E. M. Jayasekera, B.Sc.Ag. (Cey.), Ph.D. (Birm.)

Senior Technical Officer	...	P. Samaranayake
Technical Officers	...	W. D. Gunadasa, B.A. (Cey.) K. B. A. Karunasekera K. W. Rupatunga
Senior Field Assistant	...	B. M. S. G. Peiris
Field Assistants	...	D. S. Gamage A. K. M. S. Senaratne

Plant Pathology

Head of Department	...	*A. de S. Liyanage, B.Sc. Ag. (Cey.), Ph.D. (Lond.)
Assistant Plant Pathologist	...	C. K. Jayasinghe, B.Sc. (Cey.), M.Sc. (Cey.)
Experimental Officer	...	Mrs. N. I. S. Liyanage, B. Sc. Ag. (Cey.)
Senior Technical Officers	...	*Z. E. Irugalbandara *D. M. Dantanarayana
Technical Officers	...	L. W. Amaratunga A. Dharmaratne W. A. D. D. S. Wettasinghe E. Bharath Fernando S. S. Warnapura Miss J. L. P. Chandrika E. A. T. Senadeera

Soils & Plant Nutrition

Head of Department	...	O. S. Peries, B. Ag. Sci. (Melb.) Ph. D. (Bristol), M.I. Biol.
Soils Chemists	...	C. G. Silva, B.Sc. (Cey.), M.S. (Hawaii) N. Yogaratnam, B.Sc. Ag. (Alhabad), Ph.D. (Lond.)
Assistant Soils Chemist	...	M. K. S. A. Samaraweera, B.Sc. (Cey.), M.Sc. (Bristol), Ph.D. (Bristol)
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Field Assistants	...	W. M. Abeysinghe M. A. Mendis K. S. A. C. Peiris K. A. J. Wijenayake

Rubber Chemistry & Technology

Head of Department	...	Vacant
Actg. Head of Rubber Chemistry Dept. & Chief Rubber Technologist	...	S. W. Karunaratne, B.Sc. (Cey.), M.Sc. (Aston), A. R. I. C., A. N. C. R.T., F. P. R. I., F. I. C.
Biochemist	...	P. A. J. Yapa, B.Sc. (Cey.), Ph.D. (Lond.)
Chemical Engineer	...	R. Tharmalingam, B.Sc. (Cey.), Dip. Chem. Eng. (U.C. Lond.), M. Phil. (Aston)
Rubber Chemists	...	*A. Coomarasamy, B.Sc. (Cey.), Ph. D. (Aston) A. M. A. Amarapathy, B.Sc. (Cey.), M.Sc. (Aston), Ph.D. (Aston) M. R. N. Fernando, M.Sc. (Moscow), M.Sc. (Aston), Ph. D. (Aston) W. S. E. Fernando, B.Sc. (Cey.), M.Sc. (Aston), Ph.D. (Aston)
Rubber Chemist/Specification Officer	...	L. M. K. Tillekeratne, B.Sc. (Cey.), M.Sc. (Aston), Ph.D. (Aston)
Research Assistant	...	M. C. S. Perera, B.Sc. (Cey.), M.Sc. (Cey.)
Asst. Development Officer	...	M. D. R. J. Gunatilleke, B.Sc. (Cey.)
Asst. Specification Officer	...	P. A. D. T. Vimalasiri, B.Sc. (Cey.)
Experimental Officers	...	L. B. K. Silva, B.Sc. (Cey.), L.P.R.I. P. W. Sedirishamy, B.Sc. (Cey.) T. S. Amarawansa, B.Sc. (Cey.) K. C. Croose, B.Sc. (Cey.)
Senior Technical Officers	...	A. S. Dekumpitiya D. D. Medagama P. P. Jayasinghe, L.P.R.I. S. Kasinathan, M.I. Biol.
Technical Officers	...	Mrs. N. A. Baduge, B.A. (Cey.) W. D. Dharmasena Mrs. H. S. Weeraman K. P. N. de Silva W. A. Lionel R. Surendrakumar B. P. H. R. Mendis K. A. R. M. Perera Mrs. D. Nirmala Miss M. G. M. Mangalika

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Clerk/Stores Assistant	...	R. L. Fernando
Specification Assistants (Special Grade)	...	T. M. Ahamadeen W. A. S. Wijesekera
Specification Assistants	...	K. S. Abeysundera G. Wanigatunga A. G. R. S. Perera T. A. S. Siriwardene Miss M. D. K. Peiris R. Wickremaratne

Statistical Section

Assistant Statistician	...	W. N. Wickremasinghe, B.Sc. (Cey.)
Technical Officers	...	L. T. Peiris R. A. P. Abhayapala Miss J. D. Nandanie

Advisory Services Department & Economic Research Unit

Head of Department	...	A. B. Dissanayake, B.Sc. Ag. (Cey.), B.A. (Cey.), M.Sc. (Cey.)
Deputy Head of Department	...	R. P. M. de Zoysa, B.Sc. (Cey.), M.Sc. (Oregon)
Asst. Agricultural Economists	...	*H. D. B. H. Gunasekera, B.Sc. Ag. (Cey.) N. K. Atapattu, B.Sc. (Cey.)
Regional Advisory Officers	...	A. Dahanayake, B.Sc.Ag. (Cey.) A. J. L. de Silva A. S. Widanapathirana, B.Sc.Ag. (Cey.)
Divisional Rubber Extension Officers	...	H. A. D. Ariyaratne K. I. Ariyaratna W. S. Dassanayake A. Sooriyaarachchi T. B. Herath R. P. D. J. Wijewardene M. C. Samarasekera K. Ekanayake W. A. S. Wijesekera M. P. V. P. S. Perera U. S. Wijepala H. R. Dias

Rubber Extension Officers ... K. A. S. Abeygunawardene
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M. Athauda
S. D. Athukorale
R. L. R. U. S. Bandara
D. D. Dassanayake
P. W. David
K. D. Dharmasena
H. A. V. V. S. Eratne
E. A. F. S. Fernando
S. S. K. Fernando
W. G. Galgamuwa Arachchige
D. G. L. Gunapala
M. G. N. Gunaratne
W. W. Gunasekera
U. D. V. Gunasinghe
R. K. Gunatilleke
G. Gunawardene
S. T. R. J. Gunawardene
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R. B. Heendeniya
D. Hettiarachchi
S. D. Hidellarachchi
D. P. P. Jayakody
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J. H. M. K. K. B. Jayasinghe
A. K. Jayatissa
L. S. Kasturiratne
D. Karunasekera
N. C. Katukurunda
I. Kiridena
K. S. Kodikara
D. D. Kotalawala
E. N. Liyanage
T. P. Liyanage, B.A. (Cey.)
W. E. W. de Mel
P. R. Nonis
D. Palihakkara
Mrs. G. N. P. Perera, B.A. (Cey.)
J. A. J. Perera
U. L. C. Perera
U. L. R. A. Perera
P. P. S. Perera
D. Podimahatmaya
A. W. Premasiri
S. A. Prematilleke
R. W. U. Rajapakse
S. C. Rajasinghe
R. M. B. Ranasinghe
G. Ranwalage
G. S. Ratnayake
J. S. Ratnayake
W. D. D. Rupasinghe
L. L. A. Samarawickrema
E. C. D. Senanayake

		S. R. R. B. Senanayake G. Senarath S. Senawickrema S. H. B. L. de Silva M. Sirisena W. C. Siriwardene J. Sumanasekera W. J. H. Swaris O. M. W. Tillekeratne S. S. Waidyakularatne S. Weerakoon K. W. N. B. Weragama C. Wickrematilleke V. Wijesinghe W. M. D. Wijesundera
Technical Officers	...	K. S. Peiris, B.A. (Cey.) I. H. S. L. Weerasinghe

Administration Department

Chief Administrative Officer & Secretary to the Board	...	D. S. Wijesiri, B.A. (Cey.)
Assistant Administrative Officer	...	G. M. R. Wimalaweera, B.A. Pub. Adm. (Cey.)
Office Assistant	...	T. H. Wijesena
Asst. Medical Practitioner	...	M. C. Peiris
Personal Assistant to the Director	...	P. Samarasinghe
Chief Clerk	...	W. D. Jayawansa
Clerks (Special Grade)	...	J. D. Gunaratne Mrs. D. F. Thambawita
Confidential Clerk/Stenographer	...	P. H. Seneviratne
Translator/Clerk	...	D. U. Kannangara
Clerk/Typists	...	R. G. D. Sakaraja Mrs. R. S. Amarasekera Mrs. W. Paul Miss W. S. P. Mendis Miss V. D. Nanayakkara Miss I. Jayasekara G. D. A. S. Abayaratne

Internal Audit Unit

(*This Unit functions under the Director*)

Internal Auditor	...	E. P. D. Roberts, F.C.B.I. (Lond.)

Graduate Assistants	...	B. A. D. A. S. Balachandra, B.A. (Cey.) K. D. Chandradasa, B.A. (Cey.) P. W. Karunaratne, B.A. (Cey.) A. Kalubowilage, B.A. (Cey.)

Administration Unit—
Colombo Office

Assistant Administrative Officer	...	W. J. P. Dias, B.Sc. (Cey.)
Office Assistant	...	A. L. Gunawardena
Chief Clerk	...	R. E. Perera
Clerk	...	G. P. A. I. G. Pathirana
Clerk/Typists	...	Mrs. M. A. P. P. Seneviratne Mrs. I. Swaris Mrs. H. B. Perera
Clerk (Accounts)	...	Mrs. L. J. C. Perera
Clerk/Translator	...	I. L. Sirisena
Artist Clerk	...	M. J. P. Lusena
Graduate Assistants	...	B. D. Cyril, B.A. (Cey.) Mrs. S. Jayasena, B.A. (Cey.) Mrs. Y. Sudasinghe, B.A. (Cey.) Mrs. J. N. de Silva, B.A. (Cey.) Mrs. L. Wijesuriya, B.A. (Cey.)
Telephone Operator/ Receptionist	...	P. Lakshman Perera

Library

Library Assistants & Assistant Publications Officers	...	Miss L. I. T. Ramanaden Miss V. S. Perera, B.A. (Cey.)
Library Clerk	...	D. C. Thambawita
Clerk/Typist	...	Mrs. D. T. Dantanarayana

Works Section

Works Engineer	...	Vacant
Senior Foreman	...	J. Weerakoon
Mechanical Foreman	...	M. M. Anderson
Building Foreman	...	W. S. J. Benjamin
Transport Assistant	...	B. D. Ponnamperuma
Clerk (Special Grade)	...	D. D. D. Adikaram

Clerk/Typist	...	N. Jayasekera
Graduate Assistant	...	D. P. K. Gamage, B.A. (Cey.)
Workshop Charge-hand	...	W. D. Dharmawardena

Accounts Department

Chief Accountant	...	M. E. A. Peiris, Dip. Acc. (Cey.), A.C.M.A.(Lond.)
Assistant Accountant	...	A. C. Swaris
Accounting Assistant	...	A. K. D. Amaradasa
Foreign Order Clerk	...	K. G. A. K. Dharmawardena
Book-Keeper	...	K. D. D. Navaratne
Accounts Clerk	...	A. L. Ratnayake
Clerk (Special Grade)	...	N. C. de Silva
Store-Keeper	...	P. D. Somadasa
Clerks	...	D. A. Rajapakse G. A. Kannangara G. S. Doolwela
Graduate Assistants	...	Mrs. G. K. Somasiri, B.A. (Cey.) Mrs. K. K. Jagoda, B.A. (Cey.)
Clerk/Typists	...	W. Kularatne Mrs. C. C. Silva Miss K. M. S. A. Siriwardena Miss S. Irene
Cashier	...	D. C. A. D. B. de Silva
Assistant Store-Keepers	...	P. L. R. A. W. Cooray D. C. P. Pothmitiyage

Estate Department

Estate Superintendent	...	R. G. Siriwardene
Chief Clerk	...	B. H. Rodrigo
Senior Assistant Clerk	...	U. D. Shelton Perera
Checkroll Clerk/Typist	...	A. A. Ariyaratne
Junior Assistant Clerks	...	K. K. P. Gunawardene K. D. Sumanasena

Field Officers	...	A. K. D. L. H. Samaranayake N. L. D. Piyadasa A. K. D. Hemapala
Factory Officer	...	D. C. C. Jayasekera
Assistant Factory Officer	...	D. S. K. Ranaweera
School Master	...	S. Nadarajah

Kuruwita Sub-station

Visiting Superintendent	...	R. C. Peries
Assistant Estate Superintendent	...	S. G. Fernando

*On study leave overseas.

DIRECTOR'S REVIEW

BY

O. S. PERIES

The highlight of the year was undoubtedly the visit of the President of Sri Lanka, His Excellency J. R. Jayewardene to the Institute on 12th October 1979. His Excellency spent a major part of his time at the Institute in discussions with the Research Staff, and took note of several new developments introduced by the Institute.

The President was accompanied by:

Hon. M. D. H. Jayawardena, Minister of Plantation Industries
Hon. Lalith Athulathmudali, Minister of Trade & Shipping
Hon. Gamini Dissanayake, Minister of Mahaweli Development
Hon. Wijeyapala Mendis, Minister of Textiles Industries
Hon. M. S. Amarasiri, Deputy Minister of Trade & Shipping
Hon. Indradasa Hettiarachchi, District Minister, Kalutara
Mr. Merril Kariyawasam, M. P., Agalawatte
Dr. Neville Fernando, M. P., Panadura,
Mr. Reginald Wijegooneratne, M. P., Matugama
Mr. O. S. Perera, M. P., Bulathsinhala

GENERAL

Price: The price of Natural Rubber (NR) was good throughout the year, with only a few dips, which are inherent hazards of the commodity. The price was on the up-swing towards the end of the year and no doubt the global problems, and particularly those in Iran, the Middle East and Afghanistan will tend to increase the prices still further. But, as always, a very high price for NR is not good for the industry as synthetic substitutes can compete from a certain point when the price curves approach each other.

The predictions of this Institute (see *Ann. Rev.* 1973 — 1978) that the price of NR will increase over the years, reaching a peak around 1980, have been vindicated. It is unfortunate that these predictions, and the more important plea to accelerate the replanting programme, were not acted on by the industry—the acreage replanted in 1976 was only about 7,000 acres. If the replanting rate had been increased, Sri Lanka would have another 50–60,000 acres of young high yielding rubber in production now, adding to the country's foreign exchange earnings.

Price stabilisation: An international commodity agreement to stabilise the world price of NR was concluded in October 1979, with the assistance of UNCTAD, thus ending 3 years of negotiations between fifty rubber-producing and consuming countries. Under the proposed pact, the World rubber price would initially be maintained between a ceiling of $ (US) 1.23 and a floor price of 68 cents (US) per kg.

The rubber price stabilisation agreement is the first in a series of similar pacts planned for commodities considered vital as income earners for developing countries. It is expected to reduce some of the complaints of poorer nations, who feel frustrated at the unsatisfactory results of several North-South conferences during the year. Dr. Gamani Corea, Secretary General of UNCTAD has described the rubber agreement as "a most encouraging step forward."

Mr. Lalith Athulathmudali, Sri Lanka's Minister of Trade, who has been a keen supporter of the price stabilisation agreement, has said that the agreement would set up an OPEC-style organisation. He even coined a name, OREC, the proposed Organisation of Rubber Exporting Countries, which would give a better deal to rubber producers of the Third World. However, he added a warning to producers not to push NR prices too high. If they did, industrialised countries would make special efforts to develop cheaper synthetic substitutes and NR's advantage would be lost.

Synthetics-Strength: At the Twentieth Annual Meeting of the International Institute of Synthetic Rubber Producers, the final paper was Clayton Ruebensaal's global review of synthetics. He forecast that the total synthetic world consumption in 1980 would be 10.22 million tonnes or 70.8 percent of all rubber used. This would rise to over 13 million tonnes in 1985, or 72.1 percent. Synthetic rubber could be expected to grow at the annual rate of 4.87 percent in the period 1978 to 1985 in the non-centrally planned economy countries. Referring to the share of the total world rubber market taken by natural rubber, he said that statistics showed that after a low 31 percent in 1973, it did gain slightly to 31.1 percent in 1975. Since then, it had continued to drop reaching 30.1 percent in 1978, the lowest level since World War II. He predicted a further loss of market share for natural, reaching 28 percent by 1985, despite a continued average annual growth rate in tonnage of about 3 percent per year. Even after allowing for appreciable gains in passenger radial tyres, natural rubber's share had improved only marginally in the tyre sector. There were four reasons for this: (*a*) as a high percentage of truck tyres in the US were still bias (about 90 percent), compounding around high-priced natural rubber had resulted in an increase in the percentage of synthetic rubber used. This would be reversed over the next several years as new radial truck tyre capacity came on stream; (*b*) a high rate of retreading, which used large amounts of SBR, was another contributing factor; (*c*) an increasingly higher percentage of radial tyre construction had moved from steel to fabric tyres. This move permitted the use of more synthetic rubber with higher levels of carbon black, (*d*) finally, the overall share of natural rubber in the US has continued to drop due to the extensive use of new speciality synthetics for the varied and demanding end uses of the non-tyre sector. This was where SR was really growing.

Synthetic-Problems: "Most synthetic rubber not used for internal purposes continues to be sold at prices that disregard both profit and long-term reinvestment needs," John Ong, President of BF Goodrich, told the 20th annual International Institute of Synthetic Rubber Producers conference in Vancouver, B.C. He also said that the current pricing situation in synthetic rubber has restricted the amount of capital available for modernizing plants, replacing outmoded equipment, consolidating operations and developing new processes and products with greater opportunities for profitability. He called such investments "essential to economic growth of any industry.," and said that if the Northern American synthetic rubber industry stays where it is, the future is clear: "Synthetic rubber will continue to be undervalued. By not receiving at least acceptable margins on its products the industry will be unable to generate adequate capital for improving its plants. The trend of closing plants, — five have been shut down during the past 12 years — will continue."

Alternative Sources of NR: The United States Department of Agriculture is reported to have found five species of plants that hold definite promise as natural rubber crops, according to an article published by *Farm Chemicals;* February, 1979. These are Pale Indian Plantain, Guayule (see *Ann. Rev.* 1978), Desert Milkweed, Rabbitbrush and Goldenrod. The USDA has been studying almost 300 plant species since 1976 to find alternative sources for oils and rubber.

According to the report, in the plants under study the hydrocarbons and other useful components are distributed throughout the plant. If the whole plant is harvested, agricultural production would be compatible with increased food and fibre production. The objective then would bring about a major increase in agricultural productivity by developing a large capability for producing industrial raw materials and fuels while increasing food and fibre production. The United States may eventually rely heavily on plants as sources of hydrocarbons in the face of increasing prices of petroleum and its decreasing availability.

Management of Smallholdings: Our *Annual Review* for 1978 (see p 3) made a suggestion for the management of Rubber Smallholdings in Sri Lanka, in the same manner as Estates, with a Superintendent in charge of a group of such holdings, so that proper management and agricultural inputs were applied at the required level at the desired time. Now it has been found that the Rubber Industry Smallholder Development Authority (RISDA) in Malaysia is also proposing to try out such a scheme. RISDA is proposing to experiment with "mini estates" in an effort to modernise the smallholder sector. The scheme combines three projects, a credit premium, guaranteed income and group replanting. *RISDA undertakes the necessary clearing and replanting work by contract*, and the smallholders can be employed by the contractors. When the estates become productive, RISDA will manage them, and perhaps turn them into a company.

Clearly, Malaysia has recognised that productive land is an asset no country can afford to let anyone neglect. If smallholders are not managing their land up to the standards that will give optimum results then, it is equally clear that the Government must step in and give them the necessary assistance, if the country is going to reap the maximum benefits from that land. Smallholders are good agriculturalists and know how to manage rubber lands, but very often they lack the resources to do so. It is all the more important to take note of this now, when input prices are escalating and rubber prices are the best they have been in decades. The country must maximise the income from rubber. As all the agricultural land in Sri Lanka has already been planted with various crops, there is little chance of expanding the area under rubber as other countries, particularly India, have done recently. But there is every chance of our increasing the crop from the land already planted, by better management. The most important and urgent factor here is replanting, which this Institute has pin-pointed over the last decade.

RESEARCH STUDENTS

The Institute accepted two Research Assistants through the National Science Council (NSC), for studies leading to M.Sc. degrees. The total number of NSC scholars at the Institute is 10 now, 8 of them reading for higher degrees in the scheme of training of young graduates for research appointments. This is the highest number of students we have ever had, undergoing training at the Institute and indicates the confidence, the Universities and the NSC has in this Institute's ability to train good Research Assistants.

RESEARCH

The details of research carried out by each of the Departments are summarised at the head of each Departmental Review. Therefore, these summaries will not be repeated here.

A new staff appraisal scheme was introduced at the request of the Rubber Research Board in order to assist Research Officers with an appraisal of their work at regular intervals.

A new Library Assistant & Assistant Publications Officer was appointed during the year. The new officer will provide a better library and a reference service to the Headquarters staff.

A new scheme of recording of all experiments was also introduced during the year. Files have been opened on every field and laboratory experiment, and details of all such experiments will be maintained in these files. This will ensure that there will be an on going record of the work being carried out at the Institute.

BOARD

Mr. H. G. R. de Mel was unanimously elected Chairman of the Rubber Research Board at its meeting held in January 1979. Mr. D. Jayasiri Perera, former Chairman of the R. R. Board continues to serve on the Board as a member. There were no other changes on the Board during the year.

STAFF

The Director, the Heads of Departments and all the Senior and Intermediate Staff Officers of the Institute were on duty throughout the year, except where reference is made below.

The Director visited Malaysia in December as the leader of the National Science Council team to attend the Workshop on Research Administration and Management, sponsored by the Commonwealth Science Council, U.K. After the Workshop he accompanied the Chairman, Rubber Research Board, on visits to various Institutions connected with the Rubber Industry in Malaysia.

Mr. R. Tharmalingam, Chemical Engineer attended the International Rubber Seminar held in Milan, Italy from 10 — 15th October, 1979.

Dr. U. P. de S. Waidyanatha, Botanist attended the International Symposium and Workshop on Genetic Resources of Forage Plants held at Peradeniya from 6th—11th May 1979, and sponsored by the Australian Government.

Dr. L. M. K. Tillakeratne, Rubber Chemist/Specifications Officer attended the International Standards Organisation for Technical Classifications (ISO/TC/45) Meeting in Ottawa, Canada from 11th to 20th October 1979.

Mr. H. D. B. H. Gunasekera, Assistant Agricultural Economist, continued his studies for the Master's degree in Agricultural Development Economics at the Australian National University.

Dr. A. de S. Liyanage, Head of the Plant Pathology Department, attended the workshop on South American Leaf Blight (SALB), organised by the Association of Natural Rubber Producing Countries, and held in Kuala Lumpur, Malaysia from 9—12 October. He proceeded to Trinidad on 17th November on a Fellowship to carry out studies on SALB, he will be away for approximately 9 months.

The services of Mr. C. G. Silva, Soils Chemist, were loaned to the Fertilizer Secretariat, for one year with effect from 1st May.

Dr. M. K. S. A. Samaraweera, Assistant Soils Chemist, returned to the Island on 21.6.1979, after completing his course of study and training in Analytical Chemistry and Plant Nutrition at the University of Bristol in U.K.

Dr. A. Coomarasamy, Rubber Chemist, left for the U.K., to carry out research and development work into thermoplastic natural rubber, on a special UNIDO financed project at the Malaysian Rubber Producers Research Association, U.K. He will be away for one year.

Mr. Z. E. Irugalbandara, Senior Technical Officer, Plant Pathology Department, is following a course of training in Plant Anatomy at East Malling Research Station, U.K. commencing 25.4.1979.

Mr. L. B. K. Silva, Experimental Officer, Rubber Chemistry Department returned to the Island after following a course of training in Care and Maintenance of Electronic Equipment at Bristol Polytechnic, U.K.

Mr. S. Kasinathan, Senior Technical Officer, Biochemistry Section of the Rubber Chemistry Department, returned to the Island after following a course of training in various techniques used in the study of the biosynthesis of latex in *Hevea* at the Rubber Research Institute of Malaysia.

Mr. D. M. Dantanarayana, Senior Technical Officer, Plant Pathology Department, is following a course of training in Fungal Identification at the Commonwealth Mycological Institute in U.K.

Mr. R. B. Gunaratne, Senior Field Assistant, Botany Department, returned to the Island after following a course of training in Plant Physiology at the Rubber Research Institute of Malaysia.

Mr. P. P. Jayasinghe, Senior Technical Officer, Rubber Chemistry Department, returned to the Island in October 1979, after undergoing training at the RRIM Technology Centre.

The salaried staff of the Institute at the end of the year was as follows:

Officers in Grades	I — VI	...	39
Officers in Grades	VII — XV	...	248
Officers in Grades	XVI — XIX	...	142
	Total		429

VISITORS

Visitors to the Institute included:

Miss Stella Hower, British Council, London
Members of the Rubber Master Plan Team
Dr. I. M. Haroon, Silk & Allied Products Development Authority
A Review Team from FAO Headquarters
Sir Charles Pereira, FRS, Head, Agricultural Research Council, U.K.
Mr. Alfred M. Forde, Joint Inspection Unit of U.N. Geneva
Mr. Antonio Donini, Joint Inspection Unit, U. N. Geneva
Dr. R. Belcher, University of Birmingham
Mr. Suriya Upatising, 15-1279, Thailand Road, Blenket, Thailand
Mr. Marko Voljo, World Bank, Washington, D.C.
Mr. F. M. Schorosch, World Bank, Washington, D.C.
Mr. G. B. Hayes, World Bank, Washington D.C.
Dr. J. H. Bradbury, Reader in Physical Chemistry, Australian National University, Canberra, Australia
Dr. I. D. Geard, Chief Plant Pathologist, Dept. of Agriculture, New Town Research Laboratories, Tasmania, Australia
Professor Dr. Chr. Pinazzi, University of Marine, Rte de Laval, Lemans, France
Mr. Osher Christon, Banonbhofsti, 145, Basle, Switzerland
Mr. Roberto Rodriguez, Campo Exp. El Palmer, Indiana, Mexico
Mr. J. Julien, Agricultural Engineer, French Embassy
Dr. Robert M. Pratt, International Executive Service Corp., U.S.A.
Mr. David Hooper, Vice President, World Bank, Washington & 20 others
Professor Richard Evans Schultes, Harvard Botanical Museum, Cambridge, Masso
Mrs. Dorothy McNeil Schultes, 78, Larchmont Rd., Melrose, Basso 2176.

REVIEW OF THE BOTANY DEPARTMENT

By

L. B. CHANDRASEKERA

SUMMARY

In large-scale yield stimulation trials on commercial estates, 5% Ethrel has given yield increases of 16 to 26 percent over the controls.

There have been indications that the two clones RRIC 52 and PB 86 could be exploited more intensively than on the S/2, d/2, 100% tapping system. In clone PB 86, tapping on the alternate daily half spiral system with additional recovery tappings to obtain in all 180 tappings for the year has resulted in high yields comparable with that for daily tapping (S/2 d/1 200%) and much higher than for the S/2 d/2 100% system. From the point of view of dry cuts, recovery tappings spaced out so that not more than six additional tappings are carried out per month appear to be better than recovery of lost tapping days by daily tappings. The yield response to puncture tapping appears to be a clonal character.

Yields of over 2000 kg per hectare have been recorded in large scale trials for the four clones RRIC 13, 48, 36 and RRIM 600. These four clones are therefore considered suitable for limited scale commercial planting with clone RRIC 36 confined only to the relatively dry districts. Of the two clones RRIC 100 and 101, the clone RRIC 101 has maintained higher average yields in all trials.

Clonal seed of PB 86 has been found to be satisfactory for use as rootstocks.

Intercropping rubber planted at spacings of 2.5 m x 9.0 m with crops such as banana, passion fruit, pineapple and coffee has so far not had any adverse effects on the growth of rubber, when carried out according to this Institute's recommendations. Whether coffee would continue to thrive under mature rubber and yield adequately has still to be resolved. In pineapple cultivation where weeding costs are high, the pre-emergent weedicide Diuron has given promising results. Among forage crops, *Panicum* species produced more dry matter than the *Brachiaria* species tested both when growing alone or in combination with a legume. *B. brizantha* and *P. maximum* depressed growth of *Hevea* significantly when grown alone or in combination with a legume when compared with *Pueraria* or natural covers. In terms of both dry matter and availability of nitrogen, a mixed pasture of grass and legumes appears to be beneficial.

Root differentiation was observed when *Hevea* calluses grown on a high auxin medium was transferred and grown on a low auxin medium with kinetin; low levels of cinnamic acid in the presence of kinetin also induced root differentiation.

Crown budding experiments indicate that growth of the trunk could be significantly affected by the nature of the crown. Green buddings have been found to be suitable for large scale planting in the Kalutara District.

DETAILED REVIEW

Staff

Mr. L. B. Chandrasekera, Head of the Botany Department, Dr. R. Satchuthananthavale, Botanist, Dr. (Mrs.) A. C. I. Samaranayake, Botanist, and Dr. U. P. de S. Waidyanatha, Botanist, were on duty throughout the year.

The Experimental Officer, Miss E. M. A. I. Ekanayake, the Senior Technical Assistant, Mr. W. G. V. Fernando, Technical Assistants, Messrs. I.R.M. Amarakoon, D. K. Angammana, W. A. Ariyaratne, K. A. G. Bandara, L. B. Chandrasena, L. S. Kariyawasam, L. S. S. Pathiratne, T. C. Weerasinghe, Miss C. W. Ranasinghe, Senior Field Assistants, Messrs. M. C. Perera and R. B. Gunaratne and Field Assistants, Messrs. D. A. Brahmana, S. Kodikara, U. K. D. Lewis, N. L. D. Ruban, W. T. Silva and S. Wilbert were on duty throughout the year.

Mr. K. A. K. Jayatilake joined the Institute as Research Assistant in the Botany Department in November 1979, but resigned his post at the end of December 1979.

Mr. R. P. Karunasena joined the Botany Department as technical Assistant on 8th March, 1979.

Research Grants and Students

The International Foundation for Science research grant, awarded to Dr. U. P. de S. Waidyanatha, Botanist, has been extended to the second year.

The three research students, Messrs. S. N. Dissanayake, M. H. Mendis and A. H. Ranjan continued their studies in the Department.

Visits

The technical staff of the Botany Department paid advisory visits to plantations and routine visits to experimental areas where necessary. The Head of the Department also carried out inspections of seedling and budwood nurseries for registration by the Rubber Control Department.

Meetings and Conferences

The Head of the Department and the Botanist, R. Satchuthananthavale, Mrs C. Samaranayake and U. P. de S. Waidyanatha lectured to two batches of Planter trainees from the Ministry of Plantations Industries on subjects relevant to their specialities.

The Research Staff also participated, during the period under review, in the following meetings and conferences.

Head of Department —

Talduwa Planters' Club and the Kalutara district Planters' Association—Intercropping.

R. Satchuthananthavale, Botanist—

Talduwa Planters' Club and the Tebuwana Club — The use of Ethrel as a yield stimulant for rubber under conditions in Sri Lanka.

Mrs. C. Samaranayake, Botanist —

J. E. D. B. Planters' Seminar at Talduwa—Planting techniques.

S.P.C. Planters' meeting at Morawakkorale—Use of plants grown in polythene containers.

U. P. de S. Waidyanatha, Botanist —

Planters' conferences at Talduwa and Deniyaya - Tapping.

Publications

1. Annual Review of the Botany Department, 1979.
2. Circular—Prospects for intercropping rubber lands in Sri Lanka: L.B. Chandrasekera.
3. Waidyanatha, U. P. de S. and Angammana, D.K. (1980): Early exploitation of *Hevea* rubber trees by puncture and short-cut tappings (Submitted for publication to *Experimental Agriculture*).
4. Samaranayake Chandra, V. Abeywardena, R. B. Gunaratne & K. A. G. Bandara: Effect of the rootstock & scion on bud emergence of *Hevea* budgrafts. *J. Rub. Res. Inst. Sri Lanka* (in press).

YIELD STIMULATION

Ethrel stimulation, PB 86, Eladuwa Estate — ET/71/1(F)

Ethrel at 10% concentration is applied six times a year on a 3.8 cm strip of scraped bark below the tapping cut and tapped on S/2 d/2 100% intensity in clone PB 86. In this trial the stimulated plots have continuously maintained increased yields over the control plots. During the 8 year period from 1971 to 1978, the average yields in grammes/tree/tapping recorded for the stimulated and the control plots were 51.3 and 32.5 repectively.

In 1979 the treatments were changed to the following:

1. In 6 plots a quarter spiral cut was opened as high panels above the low panels and tapped upwards alternate daily with 10 per cent Ethrel applied on a 3.8 cm strip of scraped bark above the cut once every two months.
2. In 12 plots a half spiral cut was tapped downwards alternate daily on low panels with Ethrel applied once a month on the tapping cut.
3. Six plots tapped S/2, d/2 100% on low panels to serve as controls.

The average yields in grammes per tree per tapping recorded in 1980 are given in Table 1 —(L.B. Chandrasekera & D. A. Brahmana).

Table 1. *Yields of trees under different treatments with Ethrel*

Treatment	*gms/tree/tapping*
1	55.1
2	33.3
3	22.0

Ethrel stimulation — Eladuwa Estate (ET/72/2/F)

This trial, details of which are given in the Annual Review for 1978, had been in progress for a continuous period of 8 years. The yields recorded from the various treatments in the 8th year are given in Table 2.

Table 2. *Mean yields of dry rubber for the various treatments*

Treatments	*Mean yield g/tree/tap*	*Mean yield as % of control*
Above cut or panel application		
1. S/2, d/2 unstimulated control	29.08	100
2. S/2, d/2 + Coconut oil	29.97	103.06
3. S/2, d/2 + 5% Ethrel	34.12	117.33
4. S/2, d/2 + 10% Ethrel	32.02	110.11
Below cut application		
1. S/2, d/2 unstimulated control	33.33	100
2. S/2, d/2 + Coconut oil	28.20	84.60
3. S/2, d/2 + 5% Ethrel	24.31	72.90
4. S/2, d/2 + 10% Ethrel	30.75	92.30

The above-cut application of stimulant has continued to give higher yields than the unstimulated control. There is some indication, though inconsistent that below-cut application has, for the first time, given yields less than the control. (R. Satchuthananthavale and I. R. M. Amarakoon).

Large scale Ethrel trials based on the Institute's recommendations

Three large scale trials were started at the end of 1978 and beginning of 1979 on Peenkande, Frocester and Elston Estates to test the latest recommendations of Ethrel usage.

Ethrel is applied at 5% concentration on the tapping panel, above the cut, immediately after the monsoon rains. To facilitate collection the stimulant is applied on a split task basis; that is, a tapping block is split into two sections and only one half is stimulated first and the other half two weeks later. The stimulated half is tapped first and latex collected last so as to give more time for latex flow therefrom. The yield data are recorded by the estates.

The yield data for the period August to November are given in Table 3a to 3c. Only one round of stimulation could be carried out for the period up to November because of prolonged rain this year.

Table 3a. *Ethrel stimulation trial, PB 86, 1960 Replantation. Frocester Estate*

	Control	*Stimulated*
No. of tapping tasks	16	19
Mean yield/tapper/day		
Latex drc	11.70 kg	14.79 kg
Scrap drc	1.67 kg	2.29 kg
Mean yield (latex) as % of control	100	126.4

Table 3b. *Ethrel stimulation trial, PB 86, 1960 Replantation, Elston Estate*

	Control	*Stimulated*
No. of tapping tasks	5	5
Mean yield/tapper/day		
Latex drc	9.41 kg	10.93 kg
Scrap drc	0.74 kg	0.91 kg
Mean yield (latex) as % of control	100	116.1

Table 3c. *Ethrel stimulation trial, PB 86, 1960 Replantation, Peenkande Estate*

	Control	*Stimulated*
No. of tapping tasks	12	15
Mean yield/tapper/day		
Latex drc	5.71 kg	6.96 kg
Scrap drc	0.81 kg	0.89 kg
Mean yield (latex) as % of control	100	121.8

Ethrel trials in Kegalle District

Three more Ethrel trials were started in the above District during December 1979, on Parambe, Atale and Kelani Estates. (R. Satchuthananthavale & I. R. M. Amarakoon).

TAPPING

Tapping Experiment, 1961 Replantation, Dartonfield (T 70/1/F)

Six tapping systems are compared on four clones, RRIC 7, RRIC 45, RRIC 52 and PB 86, each clone planted in separate unreplicated plots. Each treatment in clones RRIC 7, RRIC 45 and RRIC 52 is replicated eight times and in clone PB 86, six times. The design within each clone is randomised blocks.

This replantation was first tapped in March 1968 on S/2, d/2 100%. The various tapping systems were introduced in 1971. A summary of yield, girth increment and Brown Bast data for the period 1971 to 1979 are given in Table 4.

Table 4. *Yield, girth increment and Brown Bast data for 1971-1979*

Tapping System	*RRIC 45*			*RRIC 7*			*RRIC 52*			*PB 86*		
	Yield (kg/ha/yr)	*G.I. (cm)*	*% Brown Bast*	*Yield (kg/ha/yr)*	*G.I. (cm)*	*% Brown Bast*	*Yield (kg/ha/yr)*	*G.I. (cm)*	*% Brown Bast*	*Yield (kg/ha/yr)*	*G.I. (cm)*	*% Brown Bast*
S/2 d/2	1410.0	15.4	15	1337.0	14.2	27.5	1582.0	15.0	7.5	1776.0	15.5	10.0
S/2 d/1	2456.0	15.5	25	1838.0	10.3	37.5	2483.0	17.2	6.7	2924.0	14.5	10.0
S/1 d/3	1331.0	10.3	22.5	951.1	10.4	42.5	1438.0	10.0	2.5	1831.0	13.5	23.3
S/1 d/4	1017.0	14.1	30.0	811.6	9.9	22.5	1138.0	7.8	10.0	1294.0	12.3	10.0
2S/2 d/3	1328.0	11.6	15.0	1102.0	12.4	25.0	1406.0	10.0	10.0	1904.0	12.1	3.3
2S/2 d/4	1066.0	12.8	17.5	1002.0	11.8	25.0	1149.0	10.3	10.0	1695.0	15.4	10.0

All clones have yielded more with S/2 d/1 tapping than with S/2 d/2 tapping. This was exceptionally so for RRIC 45, PB 86 and RRIC 52. However the high incidence of Brown Bast with S/2 d/1 tapping on RRIC 45 and RRIC 7 shows that high intensity tapping is injurious and in the long run probably uneconomic for such clones. The numbers of dry trees for S/2 d/1 and S/2 d/2 tappings were low and comparable for PB 86 and RRIC 52 suggesting that these two clones could be exploited more intensively than on the S/2 d/2 system. Except PB 86 other clones have responded poorly to 2S/2 and S/1 tappings. The overall incidence of Brown Bast was strikingly higher for RRIC 45 and RRIC 7 than for PB 86 and RRIC 52.

This experiment was terminated in December 1979 due to high incidence of White Root disease. (U. P. de S. Waidyanatha & C. W. Ranasinghe).

Tapping Experiment, RRIC 45, 1965 Replantation, Nivitigalakele (T 75/2/F)

Five tapping treatments are being investigated on 5 tree plots, each treatment replicated 7 times on a randomised block design. The treatments commenced in July 1975. Yield, girth increment and Brown Bast statistics for 1979 are given in Table 5.

Table 5. *Yield (Y), girth increment (GI) and Brown Bast (BB) data for 1979*

Tapping system	*Yield (kg/ha/yr)*	*Girth increment (cm)*	*Brown Bast %*
S/2 d/2 100%	2334.8	1.87	5.7
S/2 d/1 200%	3091.6	1.93	5.7
S/2 d/2 (2x2d/4) 100%	1733.3	1.26	16.7
S/2 d/1 (2x2d/1) 200%	2772.6	0.96	11.4
2S/2 d/2 200%	2015.5	1.24	14.3

This year's data are consistent with the previous year's in that there is no advantage in alternating panels at each tapping of a tree both for daily and alternate daily systems. At 200% intensity, tapping of a half spiral daily appears to be better than tapping of two half spirals alternate daily. The incidence of Brown Bast is high in all treatments with two S/2 cuts. (U. P. de S. Waidyanatha & S. Wilbert).

Tapping Experiment, PB 86, 1963 Replantation, Nivitigalakele (T 75/3/F)

The treatments given in Table 6 were applied in August 1975 to 7 tree plots of clone PB 86, each plot replicated 5 times in a randomised block experiment.

Table 6. *Yield (Y), girth increment (GI) and Brown Bast (BB) data for 1979*

Treatment	*Yield (kg/ha/yr)*	*Girth (cm)*	*% Brown Bast*
S/2 d/2 100% (Control)	1676.5	1.02	5
* S/2 d/2 100% + recovery tapping	2304.9	1.44	12.5
** S/2 d/2 100% + recovery tapping	2314.2	0.72	7.5
S/2 2d/3 133%	2080.0	0.92	17.5
S/2 d/1 200%	2268.5	0.86	17.5

* Recovery of lost tapping days by daily tapping.

** Recovery tappings spaced out so that no more than 6 additional tappings per month.

S/2 d/2 + recovery tappings to obtain in all 180 tappings for the year have given yields comparable with that for daily tapping (S/2 d/1) and appreciably higher than for normal S/2 d/2 tapping. Lower yields for the S/2 2d/3 system than for the S/2 d/2 + recovery tapping system is inconsistent with the trend of the rest of the results in this experiment. Incidence of Brown Bast has been unusually high for S/2 2d/3 and S/2 d/1 tappings for PB 86 in this experiment.

Such a high incidence of brown bast however was not recorded for such tappings in other experiments on PB 86. (U. P. de S. Waidyanatha & S. Wilbert).

Tapping Experiment, RRIC 52, 1963 Replantation, Eladuwa (T 76/1/F)

Six tapping treatments (Table 7) replicated 5 times each were investigated in 12 tree plots on a randomised blocks design. An additional cut was introduced on the opposite panel at a height of 53 (H_1) or 106 cm (H_2) above the existing lower cut (L). Treatments commenced in May 1976.

Table 7. *Yield (Y) and girth increment (GI) data for three years (1976-1979)*

Treatment	*Yield (kg/ha)* L	H	*Total*	*GI (cm)*
S/2 d/2 100% (panel L)	2769	—	2769	1.08
S/2 d/1 200% (panel L)	4253	—	4253	1.00
S/2 d/1 (2x2d/2) 200% (panel L or H_1)	2678	1858	4536	0.89
S/2 d/1 (2x2d/2) 200% (panel L or H_2)	2797	1702	4499	0.99
2S/2 d/2 200% (panel L + H_1)	2645	1818	4463	0.88
2S/2 d/2 200% (panel L +H_2)	2714	1699	4413	1.14
	LSD (1%) 906			LSD (5%) 0.36

L = Lower (normal) panel

H_1 = 2nd panel, 53 cm above L and on opposite side

H_2 = 2nd panel, 106 cm above L and on opposite side

The trees of this experiment have not had Brown Bast to date. Daily tapping at an intensity of 200% had given very significantly higher yields for the three year period than tapping at 100%. There was no difference in yields amongst the various methods of tapping at 200% intensity.

There was no yield advantage in alternating panels at each tapping, over tapping the same panel continuously. Tapping daily and alternate daily at 200% intensity gave comparable yields. Alternate daily tapping should therefore be more advantageous because of the lower labour input.

In double cut tapping, the lower cut in each treatment has out-yielded the higher. There was however no yield difference between the two higher panels.

Girthing was significantly decreased by increasing the tapping intensity from 100 to 200%. (U. P. de S. Waidyanatha & M. C. Perera).

Tapping Experiment, RRIC 101, 1969 Replantation, Eladuwa (T 78/1/F)

The treatments given in Table 8 are being tested on 3 tree plots replicated 6 times in a randomised block experiment. Treatments commenced in April 1978.

Table 8. *Yield (kg/ha/yr) and Brown Bast data for 1979*

Treatment	*Yield (kg/ha/yr)* L	H	Total	*% Brown Bast* L	H
S/2 d/3 67%	1115	—	1115	11	
S/2 d/2 100%	2156	—	2156	17	
S/2 d/2 (2xY/2) 100% — 53 cm H↑	—	1510	1510	—	50
— do — 106 cm H↑	—	2060	2060	—	44
S/2 d/2 (2x2d/4) 100%— 53 cm H↑	952	998	1950	11	33
— do — H↓	1026	984	2010	28	17
— do — 106 cm H↑	977	987	1964	17	50
— do — H↓	951	995	1946	22	11
PT 1 M d/3 + E	—	—	2232	17	
		LSD (5%)	507		

H = Higher cut L = Lower cut

53 cm, 106 cm = distance between L and H cuts

tapped upwards↑ tapped downwards↓

PT 1 m d/3 + E = 1 metre band puncture tapped third daily with 5% Ethrel stimulation every 4-6 weeks.

On the whole S/2 d/2 tapping has significantly outyielded S/2 d/3 tapping. However there appears to be no advantage hitherto in tapping two panels alternatively at each tapping round or annually nor in separating the panels wider apart than 21". Interestingly, unlike in some other clones, there is no significant difference in yield between the lower and the upper cuts in any of the treatments. Puncture tapping gave higher yields than S/2 tapping, when both tappings are on the d/3 basis.

This field has a high incidence of Brown Bast. Inexplicably, the upper panels appear more prone to Brown Bast than the lower and strikingly a larger number of upper panels tapped upwards have dried compared to the same panel tapped downwards. (U. P. de S. Waidyanatha & M. C. Perera).

Tapping Experiment, RRIC 103, 1969 Replantation, Eladuwa (T 78/3/F)

The treatments given in Table 9 are applied to 5 tree plots each replicated 7 times. The design of the experiment is randomised blocks. Treatments commenced in April 1978.

Alternate daily tapping significantly outyielded third daily tapping of a half spiral. Tapping two consecutive days followed by one day's rest (2d/3) gave still higher yields, whether the same cut was tapped or two cuts were tapped alternatively at each tapping.

Table 9. *Yield (kg/ha/yr) for 1979*

Treatment	*Lower cut*	*Upper cut*	*Total*
S/2 d/3 67%	904	—	904
S/2 d/2 100%	1270	—	1270
S/2 2d/3 133%	1903	—	1903.7
S/2 2d/3 (2x4d/6) 133%—53cm H↓	949	696	1645
— do — 106 cm H↓	947	707	1654
PT 1 + 1 m d/2 + E*	—	—	1472
S/4 d/2 50% + E**	1526	—	1526
		LSD (5%)	294
		(1%)	399

H = Higher cut; ↓ Tapped downwards

E* = 5% Ethrel applied every 4-6 weeks on trees puncture tapped with two one metre bands on opposite panels.

E** = 5% Ethrel applied on a band of scraped bark 4 cm broad below the cut.

Separating the two cuts wider apart than usual (53 cm) gave no benefit. The two upper cuts yielded less than the lower cuts. Puncture tapping and s/4 cut tapping with Ethrel stimulation so far have outyielded S/2 d/2 and d/3 tappings. (U. P. de S. Waidyanatha & M. C. Perera).

Tapping Experiment, RRIC 100, 1969 Replantation, Eladuwa (T 78/2/F)

The treatments given in Table 10 were applied on 4-tree plots each replicated five times in a randomised block experiment.

Table 10. *Yield (kg/ha/yr) for 1979*

	Lower cut	*Upper cut*	*Total*
S/2 d/3 67%	1499	—	1499
S/2 d/2 100%	1850	—	1850
S/2 d/2 (2x2d/4) 100%—53cm H↓	1062	764	1826
— do — 106 cm H↑	1124	660	1780
			NS

Tapped upwards↑ Tapped downwards↓

H = Upper cut; 53 cm, 106 cm = distance between the two cuts.

Table 11. *Yield (kg/ha/yr) and girth increments (cm) in parenthesis for 1979*

Tapping System	*RRIC 10*	*RRIC 100*	*RRIC 13*	*RRIC 45*	*PR 252*	*AV 1734*	*IRCI 2*	*WR 101*	*MEAN*
s/2, d/3, 67%	1187 (2.4)	1114 (3.5)	643 (5.3)	701 (4.8)	570 (2.3)	507 (3.1)	651 (2.7)	481 (2.9)	732 (3.5)
s/2, d/2, 100%	1765 (2.6)	1605 (3.9)	686 (5.1)	902 (5.4)	736 (2.7)	611 (2.1)	896 (3.0)	681 (2.9)	992 (3.5)
s/4, d/2, 50+E*	1112 (3.6)	787 (5.2)	437 (5.3)	559 (5.6)	420 (3.3)	465 (2.4)	603 (4.0)	548 (3.6)	679 (4.1)
PT 1m d/3+E*	338 (5.8)	459 (6.3)	190 (6.7)	298 (5.8)	415 (4.4)	420 (2.8)	437 (5.0)	254 (5.4)	352 (5.3)
PT 1.5m d/3+E*	709 (5.7)	680 (6.2)	383 (7.4)	430 (6.5)	618 (4.0)	658 (3.6)	761 (4.8)	365 (5.4)	574 (5.5)
MEAN	1022 (4.1)	929 (5.0)	468 (6.0)	578 (5.6)	552 (3.3)	532 (2.8)	670 (3.9)	466 (4.0)	

* E=5% Ethrel applied every 4 - 5 weeks on puncture bands (1g/metre) and every 2 months on s/4 cuts (1g/cut).

The total yields for the various treatments were not significantly different. In this clone too the lower panels have given significantly higher yields than the upper. (U. P. de S. Waidyanatha & M. C. Perera).

Tapping Experiment, 1970 Replantation, Nivitigalakele (T 77/2/F)

The tapping systems given in Table 11 are being tested in virgin bark on 8 clones. The design of the experiment is split-plot with clones in the main plots and tapping systems in the sub-plots. Each clone and tapping system are replicated 5 times. Each sub-plot accommodates 6 trees. Tapping commenced in November 1977.

S/2 d/2 tapping has outyielded S/2 d/3 tapping, in all clones. The mean yields of S/2 d/3 and S/4 d/2 + E are comparable. However RRIC 13, RRIC 45, PR 252 have given appreciably lower yields for S/4 tapping with Ethrel stimulation than for S/2 d/3 tapping, whereas WR 101 has shown the opposite trend. Puncture tapping yields are generally poor except for clones PR 252, AV 1734 and IRCI 2 which have given yields comparable to or greater than for the S/2 d/3 system when a 1.5 m band is puncture tapped.

In terms of clonal yields, RRIC 101 and RRIC 100 have greatly outyielded the other. (U. P. de S. Waidyanatha & S. Wilbert).

Tapping Experiment, 1970 Replantation, Nivitigalakele (T 77/1/F)

The five tapping systems given in Table 12 were applied in July 1977 to single - tree plots. Each treatment was replicated 6 times within each of the 5 clones.

Puncture tapping on two 1 metre bands and 2S/8 tapping both with stimulation have outyielded conventional S/2 tapping. It is noteworthy that the stimulated 2S/8 cuts have given higher yields than the stimulated S/4 cuts. In this experiment unlike in the previous one, puncture tapping a 1 m band has given yields comparable with S/2 tapping. AV 1734 as in the previous experiment has again given strikingly higher yields for puncture tapping than for the other methods of tapping.

Table 12. *Yield (kg/ha/yr) and girth increment (cm) per tree in parenthesis for 1979*

Tapping system	*RRIC 45*	*AV 1734*	*RRIC 101*	*WR 101*	*RRIC 100*	*Mean*
2S/8d/3 + E	618 (1.9)	441 (0.7)	867 (2.4)	562 (0.6)	1195 (0.2)	735 (1.3)
S/4 d/3 + E	478 (0.7)	364 (0.3)	651 (2.3)	632 (0.6)	989 (0.5)	623 (0.9)
PT 1m d/3 + E	599 (2.4)	713 (2.0)	658 (2.2)	562 (1.0)	709 (0.6)	648 (1.7)
PT 1 + 1 m d/3 + E	831 (1.4)	684 (1.1)	869 (1.0)	532 (0.9)	970 (0.5)	766 (1.1)
S/2 d/3 67%	595 (1.6)	415 (0.4)	723 (2.0)	518 (0.9)	1018 (0.9)	652 (1.2)
Mean	624 (1.6)	523 (0.9)	750 (2.0)	561 (0.8)	976 (0.9)	

E = 1 gm 5% Ethrel per application applied monthly per 1m of puncture band and bimonthly per S/4 cut or two S/8 cuts. (U. P. de S. Waidyanatha & S. Wilbert).

Clone/Tapping Experiment, 1979 Replantation, St. George Estate (CT/77/3/F)

The 15 clones given in Table 13 were planted in May 1977 in a randomised block experiment with each clone replicated 5 times. Each plot accommodated 40 trees.

At maturity 5 tapping systems will be introduced into each plot on a split-plot design.

The girth data show that many of the RRIC 100 series clones have out-grown PB 86 and RRIM 600 significantly. (U.P. de S. Waidyanatha & L. S. S. Pathiratne).

Table 13. *Girth (cm) as at December 1979*

RRIC 100	17.1	RRIC 108	17.0	RRIC 105	17.1
RRIC 101	19.1	RRIC 109	17.4	RRIC 113	17.9
RRIC 102	20.4	RRIC 110	19.5	RRIC 112	20.0
RRIC 103	19.9	HP 2427	19.1	RRIM 600	17.5
RRIC 104	23.1	RRIC 117	18.2	PB 86	17.4
		LSD 5%	2.6		

TAPPING IMMATURE TREES

Three experiments comparing tapping of immature trees of girth 30-40 cm by conventional, puncture and short-cut tappings were continued.

Tapping immature trees with punctures and short-cuts; PB 86, 1973 Replantation, Dartonfield (T 79/3/F)

The treatments given in Table 14 were replicated 15 times in a randomised block experiment with single-tree plots. Treatments commenced in August 1977.

Table 14. *Yield for second year in tapping (Aug. 78 to July 1979), girth increment (Aug. 77 to July 1979), Sucrose content and % drc in latex*

Tapping system	*Yield (kg/ha/yr)*	*Girth Increment (cm)*	*Sucrose (mg/ml latex serum)*	*% drc*
S/2 d/3	470.8	12.6	1.42	36.9
S/2 d/6	300.2	14.6	2.05	35.3
S/8 d/3 + E*	494.5	14.7	1.68	38.1
S/8 d/6 + E*	232.1	13.1	1.65	37.7
PT 0.5 m d/3 + E*	328.2	13.5	6.41	38.3
PT 0.5 m d/6 + E*	164.6	14.4	6.77	37.3
PT 1 m d/3 + E*	433.2	13.4	4.78	36.7
PT 1 m d/6 + E*	200.2	13.8	5.33	38.0
Untapped	—	15.4	—	—
LSD 5%	56.3	NS	1.56	NS
LSD 1%	74.9		2.10	

E = 1 gm of 5% Ethrel applied monthly on puncture tapped bands and bimonthly on cuts. PT = Puncture tapped 0.5 m. 1m = 0.5 or 1 metre band. Mean girth of trees in Aug. 1977 — 28.9 cm; July 79 — 42.8 cm.

At the d/3 tapping frequency yields of 1 metre puncture tapped bands and S/8 cuts, both stimulated, were not significantly different from yields of conventional S/2 cuts, but were at the d/6 frequency. Puncture tapping 0.5 metre bands gave poor yields. Although not statistically significant, there was some indication that on the d/3 tapping frequency S/8 cuts and puncture-bands allowed better girthing than S/2 cuts. Puncture tapped trees had very significantly higher sucrose contents in the latex than in trees tapped by the other two methods. The percentage drc was comparable for all tapping treatments. (U. P. de S. Waidyanatha & D. K. Angammana).

Levels of Ethrel, Number of punctures and frequency of tapping:

PB 86 1973 Replantation, Dartonfield (T 78/4/F)

This experiment investigating the effect of three levels of Ethrel, 3 puncture numbers per band of 1 metre length and two frequencies of tapping was set down in March 1978. The design is factorial with single tree plots replicated 8 times. Two conventional tapping treatments S/2 d/4 and S/2 d/2 served as controls.

The data (Table 15) show that increasing both the quantity of Ethrel and number of punctures increased yields. Conventional half spiral tapping in this experiment gave far less yields than puncture tapping. Yields per tapping had not improved significantly at the lower (d/4) tapping frequency when compared to the higher (d/2) with either tapping method. Clearly, therefore, the yields per hectare per year were strikingly higher for the higher tapping frequency. There was no difference in girthing between the two methods of tapping. Therefore the yield recovered per unit of girth increment should be higher for puncture tapping. (U. P. de S. Waidyanatha & D. K. Angammana).

Table 15. *Yield and girth increment data for 1979*

Treatments	*Yield g/tree/tapping*	*kg/ha/yr*	*Girth Increment (cm)*
Puncture tapping			
0.5 g, 5% Ethrel	14.5		11.1
1.0 ,, ,,	16.7		11.5
2.0 ,, ,,	19.4		10.2
5 punctures/1 m band	15.2		11.1
10 ,, ,, ,,	17.2		10.9
15 ,, ,, ,,	18.6		10.8
LSD (5%)	1.2		N.S
LSD (1%)	1.6		
Puncture tapping d/2	15.8	873.7	
— do — d/4	16.3	451.5	
	N.S		
Conventional tapping			
S/2 d/2 100%	8.3	459.0	11.2
S/2 d/4 50%	7.5	207.7	12.1
	NS		NS
S/2 tapping (mean)	7.9		
Puncture tapping (mean)	17.1		
LSD (0.1%)	2.6		

Effect of puncture size on yield; PB 86, 1973 Replantation, Dartonfield (T 79/1/F)

Three sizes of punctures (needles) were compared on puncture tapping bands 1 m long receiving 10 punctures per tapping and 1.0 g of 5 % Ethrel per application. S/2 d/3 tapping was the control.

The results (Table 16) show that increasing the size of the incision from 1 to 2.0 mm did not affect the yield. In this experiment too puncture tapping outyielded conventional tapping.

Table 16. *Yield (g/tree/tapping) for 1979*

S/2 d/3	8.77
PT, 1 mm incision, d/3	19.03
PT, 1.5 mm incision, d/3	18.19
PT, 2.0 mm incision, d/3	18.65
LSD (5%)	1.84
LSD (1%)	2.46

It may therefore be concluded in general that puncture and short-cut tapping with Ethrel stimulation is potentially attractive particularly for exploiting immature *Hevea.* (U. P. de S. Waidyanatha & D. K. Angammana).

CLONE EVALUATION

Most of the older large scale clone trials involving local and foreign clones were discontinued during 1979. Among the clones under test in these trials, the clone RRIM 600 have given outstanding yields in all planting districts, followed by clone RRIC 36 in the drier planting districts. Two other clones whose yields have reached over 2000 kg/ha are RRIC 13 and 48. These four clones, namely RRIC 13, 48, 36 and RRIM 600 are now considered suitable for planting in estates in Sri Lanka.

Among clone trials that are in progress, Table 17 summarises the yields recorded to date of some of the more promising clones.

Table 17. *Average yield of dry rubber in kg/ha recorded over a period of 3 to 4 years from the first year of tapping (tapped S/2, d/2, 100%)*

Field Experiment	*CLONE* *RRIC 100*	*RRIC 101*	*AVROS 1734*	*RRIC 45*	*PB 86*	*Period tapped (yrs)*
YT/69/1(F)	1592	1733	1501	1396	—	4
YT/69/2(F)	1398	1731	—	—	1297	3
YT/70/1(F)	1150	1480	1202	1057	—	3

Of the above clones the clone RRIC 101 has remained the best yielder. (L. B. Chandresekera, N. L. D. Ruban, S. Kodikara).

Stock Experiment, 1969 Replantation, Nivitigalakele (St.Sc/69/3/F)

Clone RRIC 45 has been grafted on to six seedling families. Data to date indicate RRIC 45 to grow better on all rootstocks other than Tjir 1 and RRIC 89. The girth and yield data are summarised in Table 18. (A. C. I. Samaranayake & W. S. Weerakoon).

Table 18. *Mean girth and yields of clone RRIC 45 on different rootstock families*

Rootstock	*Mean girth cm*	*Mean yield g/tree/tapping*
RRIC 52	61.9	28.34
RRIC 41	61.8	24.92
RRIC 5	60.5	25.05
RRIM 623	60.4	25.09
Tjir 1	56.9	22.45
RRIC 89	56.2	22.70

The treatments joined by a vertical line do not show significant differences, according to the multiple range test.

Stock Experiment, 1975 Replantation, St. George State Plantation, Matugama (St.Sc/75/4/F)

Scion clones RRIC 45, RRIC 103, PB 86 and Wagga 6278 have been budded onto seedling rootstocks of RRIC 45, RRIC 103, PB 86 and Wagga 6278. Girth of scion at 4½ years of age are summarised in Table 19.

Table 19. *Mean girths of scions for various combinations of rootstocks and scions (cms)*

Rootstock	*SCION*				*Rootstock mean*
	PB 86	*RRIC 45*	*Wagga 6278*	*RRIC 103*	
PB 86	40.5	44.1	40.4	47.9	43.2
RRIC 45	38.8	44.0	40.1	47.3	42.6
Wagga 6278	38.8	42.7	40.1	45.7	41.8
RRIC 103	39.3	42.5	40.3	45.2	41.8
Scion mean	39.4	43.3	40.2	46.5	

L.S.D. (5%) = 1.08

As a rootstock, PB 86 has been better than RRIC 103 and Wagga 6278. It does not differ significantly from RRIC 45. Scion clone RRIC 103 shows the most vigorous growth followed by RRIC 45. (A. C. I. Samaranayake, R. B. Gunaratne & L. S. Kariyawasam).

Stock Experiment, 1978 Replantation, Eladuwa State Plantation, Paiyagala (St.Sc/78/5/F)

Clones PB 86, RRIC 13, 48, 52, 94 and RRIC 100 have been budgrafted on to seedling rootstocks of PB 86, RRIC 52, 94 and RRIC 100. Analysis of girth data taken one and a half years after planting does not show any significant rootstock effects. (A. C. I. Samaranayake, R. B. Gunaratne & G. Bandara).

INTERCROPPING

FOOD CROPS

The intercropping trials sited at Yatawatta State Plantation, Matale, Hatbawe Estate, Rambukkana and Elston Estate, Puwakpitiya and as reported in the Annual Review for 1978 were discontinued with effect from September 1979. Based on the results of these trials, banana, passion fruit, pineapple and coffee were recommended as suitable crops for intercropping during the immature phase of rubber. The question as to whether coffee would continue to thrive under mature rubber and give economic returns has still to be resolved. Arrangements were made for setting down further trials in smallholdings as well as on Estates in the various planting districts in order to popularise intercropping and to evaluate the economics of intercropping rubber with the recommended crops. Investigations are also under way on the possible intercropping of cocao with rubber planted in wide avenues in both the dry and the wet planting districts of Sri Lanka.

Based on the results of experiments that have been carried out so far the following recommendations are made for intercropping rubber (planted at spacings of 2.4 m x 9 m) during the immature phase.

Banana — A single row of bananas planted between each pair of rubber rows spaced 3.7 metres along the row. This would give an approximate stand of 296 banana plants per hectare. (A double row of banana planted between each pair of rubber rows in an estate in the Kegalla District was observed to result in too severe competition for rubber).

Passion fruit — A single row of passion fruit plants planted centrally between each pair of rubber rows spaced 7.5 metres along the row. The number of passion fruit plants would be approximately 143 ha.

Pineapple — Suitable for flat land. Two double rows of pineapple could be planted centrally between each pair of rubber rows with a central path 1½ metres wide between each pair of pineapple rows. Pineapple is spaced 45.7 cm along the row and 0.6 metres between rows. At this spacing, approximately 9485 pineapple plants could be planted per hectare.

Coffee — A single row of coffee planted centrally between each pair of rubber rows spaced 2.4 metres along the row to give an approximate stand of 445 coffee plants per hectare. Temporary shade in the first year of growth of coffee would be beneficial.

In order to popularise intercropping, three smallholder demonstration plots were set down at Kegalla, Pitigala and Welipenna. In all three instances, the smallholders preference was for bananas.

In pineapple cultivation in the Wet Zone, weeding has been one of the costliest items. A small scale trial was therefore set down at Dartonfield to test the effectiveness of pre-emergent weedicides and mulches on the frequency of weeding required in pineapple plantings. The pineapple in the two plots treated with pre-emergent weedicides Lasso and Diuron initially showed retarded growth indicating a certain degree of phytotoxicity to pineapple. However, the plants, especially in plots treated with Diuron recovered subsequently. Diuron therefore appear to be a suitable weedicide for pineapple cultivation. Arrangements have been made to test this on a wider scale.

In pepper, rooting of single leaf pepper cuttings under highly humid conditions were found to be successful. This method is now being adopted for large scale propagation of pepper for field trials in 1980. Methods of pruning and training of pepper vines on to *Gliricidia* stems were also under study.

H OF DIFFERENT ISOLATES OF *GLOEOSPORIUM*

	pH⁷					pH⁸					pH⁹				
	days after inoculation														
7	3	4	5	6	7	3	4	5	6	7	3	4	5	6	7
85·0	49·0	63·1	78·8	85·0	85·0	47·5	62·1	74·6	85·0	85·0	45·5	61·5	73·3	84·3	85·0
85·0	47·1	61·0	76·5	85·0	85·0	45·6	64·3	74·5	85·0	85·0	43·0	60·1	70·5	82·3	85·0
82·8	37·3	47·5	58·0	70·1	79·0	37·3	50·0	60·3	72·0	79·6	35·5	48·3	58·1	66·0	78·1
85·0	47·1	61·0	76·3	85·0	85·0	46·0	63·3	76·6	84·5	85·0	43·8	60·3	71·5	80·6	85·0
85·0	44·8	54·0	82·1	85·0	85·0	46·5	64·6	77·6	85·0	85·0	44·6	60·6	75·3	85·0	85·0
81·5	36·5	44·3	57·1	67·0	78·5	36·1	47·5	59·5	71·3	77·8	35·5	47·3	57·5	65·5	77·5
60·8	30·1	37·5	46·1	52·1	60·6	25·6	33·6	40·0	45·5	50·6	27·5	37·5	43·1	47·3	53·3
82·8	33·5	44·3	58·3	69·5	81·1	36·1	56·3	64·1	81·8	85·0	35·6	52·6	65·1	75·0	85·0
84·0	44·1	56·1	69·5	81·1	84·6	40·1	52·6	69·0	82·1	85·0	41·1	56·6	69·5	79·3	85·0
85·0	43·8	55·6	71·0	82·0	85·0	41·0	57·1	69·3	82·0	85·0	39·5	55·5	68·1	76·8	85·0
85·0	46·3	60·6	77·5	85·0	85·0	43·5	62·0	73·6	84·5	85·0	41·3	59·1	73·3	84·3	83·0
61·1	28·6	36·1	44·0	52·8	60·8	27·8	37·1	42·8	52·3	58·1	25·1	34·1	40·6	45·8	55·5

With coffee, provision of temporary shade for coffee during the first year of planting results in better growth than when planted exposed to sun. The new introductions of *C. robusta* from Matale have shown vigorous growth with hardly any yellowing during the first year when grown without any shade. Of the two leguminous ground covers *Desmodium ovalifolium* and *Pueraria phasioloides*, the latter has more effectivley suppressed weeds when planted with coffee. The use of one year old polybag coffee seedlings for interplanting among rubber so as to bring them into bearing in the first year of field planting is being investigated. (L. B. Chandresekera, U. K. D. Lewis & N. L. D. Ruban).

FORAGE GRASSES AND LEGUMES

Productivity of 3 grasses grown singly or in combination with two legumes and their effects on Hevea (FP1/75/F)

The productivity of three forage grasses, *Panicum maximum*, *Brachiaria brizantha*, *B. miliformis*, each alone or in combination with *Pueraria* or *Centrosema* is being investigated. The grasses are grown at two levels of nitrogen, 100 and 200 kg/ha/yr. The legume-grass plots receive no nitrogen but phosphorus at 30 or 60 kg/ha/yr as concentrated superphosphate. All plots receive potassium and dolomite as a basal dressing. Unfertilized plots of *Pueraria* cover and natural cover were accommodated in each block. The design of the experiment is a randomised block with three replicates. Each plot accommodates 20 trees planted 4.3 x 4.9 metres. The forage plots were zero grazed every 6 to 8 weeks.

Panicum (Table 20) produced more dry matter than the two *Brachiaria* species, both when growing alone (with nitrogen) or in combinaton with a legume. The grass only plots had comparable dry matter yields to the grass + legume plots for each grass species. The total productivity of the plots for each species was comparable. There was no significant response to increasing amounts of nitrogen or phosphorus. There was a higher legume component in the total dry matter when *Pueraria* was the legume than when it was *Centrosema*, except when *Brachiaria miliformis* was the accompanying grass. On the whole the dry matter yields have decreased with time. This is partly a result of increased shading by the expanding *Hevea* canopy.

Table 20. *Dry matter yields of forage and girths of Hevea trees in 1979*

	Forage yield (kg/ha/yr)		*Tree girths (cm)*	
	100 kg/N/ha/yr	*200 kg/N/ha/yr*	*100 kg/N/ha/yr*	*200 kg/N/ha/yr*
P. maximum (Pm)	6090	7225	27.9	26.4
B. brizantha (Bb)	3190	4311	23.2	24.0
B. miliformis (Bm)	2914	3497	31.8	34.6
	30 kg/P/ha/yr	*60 kg/P/ha/yr*	*30 kg/P/ha/yr*	*60 kg/P/ha/yr*
Pm + Centrosema	6418 (12.7)	7216 (11.9)	27.5	26.8
Pm + Pueraria	5873 (15.0)	7651 (16.3)	28.9	30.8
Bb + Centrosema	3318 (6.5)	4162 (8.4)	24.3	22.9
Bb + Pueraria	3780 (17.9)	4177 (13.2)	25.7	25.2
Bm + Centrosema	2032 (25.4)	2331 (24.0)	33.1	33.9
Bm + Pueraria	2682 (22.8)	2622 (22.2)	33.5	33.5
	LSD (5%) 1808			
	LSD (1%) 2428			
Pueraria cover	—	—	36.1	
Natural cover	—	—	35.5	
			LSD (5%) 4.0	
			LSD (1%) 5.3	

Figures in parenthesis are the percentages of legume in the forage.

B. brizantha and *P. maximum* both depressed growth of *Hevea* significantly both when growing singly or in combination with a legume when compared to *Pueraria* cover or natural cover. There has been some indication that the competitive effect is mitigated when the two grasses were growing with *Pueraria*. This is particularly so for *P. maximum*. *B. miliformis* which was the least productive was also the least competitive and did not significantly affect the growth of the rubber trees except when it was growing alone at 100 kg/N/ha/yr. (U. P. de S. Waidyanatha & D. S. Wijesinghe).

Varietal testing of forage grasses; Replantation, Eladuwa (FP2/75/F)

The species given in Table 21 are being tested in a randomised block experiment, each treatment replicated thrice. Each plot accommodates 4 *Hevea* trees planted 16 x 14 ft. The grass cover in each plot receives a basal dressing of 100 kg N (urea), 200 kg rock phosphate and 100 kg muriate of potash/ha/yr.

Guinea A and Guinea B are the most productive of the varieties tested. *B. dictyoneura* (Koronovia grass) although not a popular species in Sri Lanka has shown promise. It forms a weed-free cover very quickly. NB 21 although initially (first year) very productive has rapidly declined. Despite increasing shade with expansion of the *Hevea* canopy, the dry matter yields have remained at the same level as last year. This is probably partly due to the greater rainfall this year than last year.

Table 21. *Dry matter yields of forage and girth of Hevea trees in 1979*

	Forage yield (kg/ha/yr)	*Tree girths (cm)*
Brachiria miliformis	2532	37.7
B. ruziziensis	4035	30.4
B. dictyoneura	6142	28.3
B. mutica	1501	37.6
Setaria anceps	5732	31.9
Paspalum plicatulum	6949	32.5
Pennisetum purpureum **(NB 21)**	3452	31.9
Panicum maximum (Guinea B)	9638	27.9
P. maximum (Guinea A)	15309	33.5
P. maximum (green Panic)	3228	32.0
Naturals	—	36.5
LSD (5%)	2623	4.6
LSD (1%)	3609	6.3

Guinea A and *B. dictyoneura* appear to tolerate shade comparatively more than the other species.

Many species, notably *B. ruziziensis*, *B. dictyoneura* and Guinea B have depressed growth of the *Hevea* trees. It is difficult to explain why Guinea A the most productive species has been less detrimental to the rubber trees than many other less productive species. (U. P. de S. Waidyanatha & D. S. Wijesinghe).

Productivity and effects on Hevea of P. maximum growing singly or with Pueraria (FP3/77/F)

This is a single-tree plot experiment on a fully randomised design with 12 replicates. The grass and *Pueraria* are cultivated around each rubber plant leaving a vacant space of 1.0 or 1.5 m radius at the bole of the tree. The grass-only plots received 100 kgN/ha/yr plus 30 kgP/ha/yr.

The grass-legume plots received 60 kgP/ha/yr. All plots received K at 60 kg/ha/yr and sulphur at 20 kg/ha/yr as basal fertilizers.

Table 22. *Dry matter (DM) yields of forage (effective area basis) and tree girths in 1979*

	DM Yield (kg/ha/yr)		*Tree girths* ***
	grass only	*grass+Pueraria*	
Pm + 100 kgN, 1.0 m space*	15005	15005	18.9 a
,, ,, 1.5 m ,,	13946	13946	21.6 ab
Pm + *Pueraria*, 1.0 m ,,	18782	24945 (24.7)	19.7 a
,, ,, 1.5 m ,,	16948	22745 (25.4)	21.4 ab
Uncut *Pueraria* cover	2510	2868	23.3 b
LSD (5%)	3370	3860	
LSD (1%)			

* Radius of circular free (uncultivated) space between tree bole and pasture.

** % legume in dry matter.

*** Figures against the same letter not significantly different.

The total dry matter yields of the grass-legume plots are very significantly greater than that of the grass-only plots. Even the dry matter component of grass of the grass-legume plots significantly exceeded the total dry matter content of the grass-only plots, at either vacant (uncultivated) space around the tree bole. The total increase in dry matter in grass-legume plots over the grass-only plots is of the order of60% of which well over half is accounted for by the legume. The results clearly depict the benefit of a mixed pasture and suggest also that beside other probable benefits, the legume provided more nitrogen than was available to the grass-only plots which received 100 kgN/ha/yr.

It was evident that growing the pasture 1.0 m away from the tree bole depressed girthing significantly more than having it 1.5 m away. This was so whether or not the grass was alone or with legume. However, considering that the grass-legume plots yielded significantly more herbage than grass-only plots, at the same level of herbage production, a grass-legume pasture is likely to be less competitive. (U. P. de S. Waidyanatha & D. S. Wijesinghe).

TISSUE AND ORGAN CULTURE

Experiments with *Hevea* callus established from source material like seedling and clonal stem explants, anthers and endosperm tissue were continued. The experiments were mainly aimed at establishing the optimum conditions required for growth of callus, inducing differentiation and organ formation and plantlet development in callus.

Seedling stem callus

For seedling stem explants modified MS medium proved to be best for callus growth, for callus initiation as well as for sub-culture.

Stem callus from clonal source

Although callus initiation was observed on modified MS medium, the callus failed to maintain good growth on sub-culture in this medium.

Effect of alkaloids caffeine, nicotine and colchicine on growth of callus

When the modified MS medium used for culturing seedling stem callus was supplemented with very low concentrations of alkaloids like caffeine, nicotine and colchicine, a marked increase in callus growth through continuous sub-culture was observed in callus cultures from clonal stem explants. In the absence of alkaloids the callus established from clonal stem explants proved to be recalcitrant. Caffeine was found to be better than nicotine or colchicine for promoting callus growth. The callus cultures grown on modified MS medium supplemented with caffeine remained fresh and white in colour without showing signs of deterioration and discolouration for more than six months, which is usually not the case with callus cultures grown on other media.

Effect of different sugars on growth of callus

Sucrose, glucose, fructose and maltose were individually tested in the growth medium for their effect on growth of callus. They were incorporated in the medium at 2, 2.5, 3, 3.5, 4, 4.5 and 5%. Sucrose at 3% and 4% w/v was found to be best for callus growth.

Effect of coconut milk on growth of callus

Coconut milk obtained from mature and green coconuts was tested at 10% and 15% V/V with modified MS medium for growth of callus. At both concentrations tested coconut milk suppressed the growth of callus.

Effect of light on growth and differentiation of callus

Callus cultures were grown on modified MS medium under (*a*) continuous light, (*b*) 12 hours light and 12 hours darkness and (*c*) continuous darkness in a temperature controlled incubator. Callus growth was best under continuous darkness. Callus grown under light turned green.

Experiments to induce differentiation and organ formation

(i) Two different media (MS and Y_3) were used with different levels of auxins and kinins. Root formation was observed when callus grown on high auxin medium was transferred and grown on low auxin medium, with kinetin. Root differentiation was not observed when zeatin was substituted for kinetin.

(ii) Low levels of cinnamic acid (0.25 to 1.0 mg/l) in the presence of kinetin (0.2 mg/l) also induced root formation. Shoot differentiation was not observed.

(iii) Callus grown on media containing caffeine failed to differentiate roots. Although caffeine promoted good callus growth it appears to suppress root formation in *Hevea* callus.

Anther culture for the development of haploid plants

(i) Experiments were carried out with anthers to induce haploid plant development from pollen grains, using different growth media. Two of the media tried contained plant extracts from potato and carrot.

The extract was prepared by boiling 200 g of potato or carrot in 1 litre distilled water and squeezing through cheese cloth. To the extract various growth substances were added. The medium containing potato extract with 2.4-D (0.02 - 0.4 mg/1) and kinetin (0.1 - 0.5 mg/1) was found to be superior to other media tried for the culture of anther callus.

(ii) **Experiments to induce differentiation in anther callus**

Anther callus grown for 4 weeks on medium containing high auxin was transferred to medium containing low auxin, and grown under diffused light. Profuse root differentiation was observed within 3 weeks. Callus grown in continuous darkness also produced roots. Shoot differentiation or plantlet formation was not observed.

(iii) Experiments described by Chen Cheng-Hua in Scientica Sinica 22(1) 81-90 for the production of haploid plants from *Hevea* anthers were repeated. But embryogenesis as reported could not be achieved.

Organ culture

Green axillary buds from clones PB 86 and RRIC 52 were inoculated on Y_3 and potato medium containing different concentrations of 2, 4-D, NAA and kinetin, zeatin and GA_3 and cultured in the dark. The axillary buds developed small rudimentary leaves in both Y_3 and potato medium containing 2, 4-D (0.02 mg/1) kinetin (0.02 - 0.2 mg/1) and GA_3 (0.5 mg/1). Further development of the buds did not take place. Experiments are being continued to induce further growth of the axillary buds. (R. Satchuthananthavale, M. H. Mendis and I. R. M. Amarakoon).

Embryo culture and colchicine treatment of embryos for the induction of polyploids

Experiments on the culturing of decotylised embryos were continued during the pod set season from April onwards. Embryos from immature green pods as well as from mature pods were used. The cotyledons were removed and the embryos were used for culture under aseptic conditions. They were cultured in culture tubes containing 10 ml of liquid medium with filter paper bridges on which the embryos were kept.

Two different liquid media were tried. These included the inorganic salts and organic constituents of Murashige & Skoog medium (MS) and Yuwens medium (Y_3) (Yuwens 1973), with different levels of sucrose and kinetin and auxin 2, 4-D, at different concentrations.

The best medium for embryo development was found to be Y_3 medium with 8% sucrose and kinetin (0.4 mg/1). In this medium the decotylised embryos developed into seedlings with well developed leaves and roots. In the presence of 2, 4-D above 0.01 mg/1 embryo development was affected resulting in short stunted seedlings with short stems and leaves and small thick roots. The presence of kinetin alone or kinetin with very low level of 2, 4-D (0.001 mg/1) in the medium favoured the development of embryos into seedlings.

The seedlings were later transferred to sterile sand in pots supplied with half strength Y_3 inorganic salt solution. The seedlings remained alive for more than two months but later died due to fungal infection. It should be possible, with proper green-house conditions, to transfer these seedlings successfully to the soil.

Colchicine treatment of decotylised embryos

Experiments with colchicine treatment of decotylised embryos were carried out to examine the possibilities of developing polyploid plants.

Immature, decotylised embryos were treated with colchicine (10 mg/l) under aseptic conditions, for 60 hours. They were then transferred to liquid nutrient medium (Y_3) containing 3% sucrose and kinetin (0.04 mg/l) in culture tubes with filter paper supports. The treated embryos developed into seedlings. Treatment of decotylised embryos with colchicine (10 mg/l) for 60 hours appeared to be optimum for seedling development. Treatment with colchicine at higher concentrations or for longer periods (more than 60 hours) with colchicine (10 mg/l) produced deformed plantlets. At higher levels of treatment the embryos failed to develop at all.

This work is being continued. Once the treated seedlings are successfully established in soil a chromosome count from leaf tips and root tips will be carried out. (R. Satchuthananthavale & I.M.R.Amarakoon).

BROWN BAST STUDIES

The studies reported are primarily aimed at ascertaining how best to exploit trees affected by this disorder.

Tapping Brown Bast Trees; RRIC 101, 1969 Replantation E'aduwa (BB78/1/F)

Following a spell of excessive yield, about 40 trees in this replantation were affected by this disorder in May-August 1977. The following treatments (Table 23) were applied in October 1977.

Good yields were obtained until end of 1978 for treatments 3 to 5 where high panels were tapped (see Annual Review for 1978).

Table 23. *Yield (g/tree/tapping/ for 1973)*

1.	Resting of affected trees .	—
2.	Removal of affected bark, application of Kankerdood and resting	—
3.	Same as (2) but tapping on S/2 d/3 downwards starting at 100" on the opposite panel	10.2
4.	Isolation of affected bark with grooves and tapping as in (3)	9.1
5.	Tapping downwards starting at 100" without any treatment for affected bark	12.5
6.	Continuation of tapping of affected bark	13.1

The yields have declined drastically in 1979 and some cuts are now partially dry in all three treatments. This year, unlike last year, continued tapping of affected bark has given yields comparable with that for high-panel tapping. The rested trees (Treatment 1) were retapped on the affected panels but negligible yields were obtained. Therefore continued tapping of affected bark or tapping on high panels are more suitable; resting does not cure the disorder. (U. P. de S. Waidyanatha & M. C. Perera).

Tapping of Brown Bast Trees; Clone RRIC 89, PB 28/59, 1961 Replantation, Dartonfield (BB 78/2/F)

Table 24. *Yield (g/tree/tapping) for 1979*

	RRIC 89	*PB 28/59*
1. Tapping upwards on V cuts (d/2) above affected bark	29.2	36.6
2. Tapping opposite panel on S/2 d/2 downwards	17.8	9.1
3. Affected bark removed, Kankerdood applied and tapped as in (1)	27.8	41.1
4. Continued tapping of affected panel on S/2 d/2	4.4	22.8
5. Unaffected (normal) trees tapped S/2 d/2	18.7	28.0

The above treatments were applied to Brown Bast affected trees in July 1978; there being 5 to 8 trees per treatment.

The results for 1979 are consistent with that for 1978 in that tapping upwards on V cuts has given better yields than continued tapping of the affected panel or tapping the opposite panel. Several cuts of the treatment 4 are partially dry. (U. P. de S. Waidyanatha & D. K. Angammana).

NITROGEN FIXATION

Rhizobium isolations

Nodules were collected for *Rhizobium* isolations from six locations covering much of the rubber growing regions of Sri Lanka. The locations were, Hedigalla Estate, Lowmont Estate (Kalutara), Muwankande Estate (Kurunegala), Nalanda Estate (Matale), Nakiadeniya Group (Galle) and Parambe Estate (Kegalle).

The isolates are now being maintained on agar slopes and work is in progress to identify them on the basis of their resistance to antibiotics. (U. P. de S. Waidyanatha & L. S. S. Pathiratne).

Nitrogen fixation by ground covers and their effects on Hevea, PB 86, 1979 Replantation, Padukka Estate (NF 75/1/F)

The treatments given in Table 25 are being tested in a randomised block experiment with 5 replicates. There are 20 rubber plants spaced 4.27 x 4.88 metres per plot. The experiment commenced in June/July 1975 with the planting of the rubber and legume covers.

Calopogonium has been almost completely displaced from the plots by *Desmodium ovalifolium* and other weeds despite selective weeding. The same is true of *Pueraria* plots to some extent but *Pueraria* still remains the dominant species in them. This succession is due to shading by the *Hevea* canopy which is now near closing. Shading encourages the displacement of other cover legumes by *Desmodium* which eventually usually becomes the dominant species at canopy closure.

Table 25. *Girths of Hevea trees in December 1979*

Treatment	*Tree girths (cm)*
Pueraria inoculated with *Rhizobium*	37.4
Pueraria not inoculated	38.0
Pueraria not inculated + 100 kgN/ha/yr	40.8
Calopogonium inoculated with *Rhizobium*	37.4
Calopogonium not inoculated	37.4
Calopogonium not inoculated + 100 kgN/ha/yr	38.6
Naturally established legumes	39.3
Naturals (without *Mikania*)	38.3

The girth data show that *Hevea* trees have not benefited from grown legumes or naturally established legumes than from the naturals. Until mid 1979, when selective weeding was terminated, the natural plots contained mostly grasses and dicotyledonous weeds and less than 15% legumes as compared to near complete cover of legumes in both grown and naturally established legume plots. (U. P. de S. Waidyanatha, L. S. S. Pathiratne, W. A. Ariyaratne).

MYCORRHIZA

Survey of spore types in rubber growing soils

Soil samples were collected during March-April 1979, from six locations namely, Hedigalla Estate, Lowmont Estate (Kalutara), Nalanda Estate (Matale), Parambe Estate (Kegalle), Muwankanda Estate (Kurunegala) and Nakiadeniya Group (Galle).

Collections were made from five sites at each location to include various stages of the rubber replanting cycle, *viz.*

Site A 1—3 year old replantation

,, B 7—8 year old replantation

,, C 15—20 year old replantation

,, D Very old replantation due for uprooting

,, E Cleared land under preparation for replanting.

The soils from four locations have been examined and the spore counts obtained are shown in Table 26.

Table 26. *Number of mycorrhizal spores per 50 g soil*

Location/site	*A*	*B*	*C*	*D*	*E*	*MEAN*
Hedigalla	1694	3097	2120	942	1248	1820
Lowmont	1692	874	1109	1342	2605	1524
Nalanda	1535	190	211	1563	—	874
Parambe	314	400	879	446	—	510
MEAN	1309	1140	1080	1048		

Nalanda (Matale) and Parambe (Kegalle) soils have shown lower spore numbers than soils of Hedigalla and Lowmont (Kalutara). This difference is not correlated to soil moisture. The site to site variation in spore numbers appears to be rather large and is most noticeable in Nalanda soils. There is however no definite pattern in this variation.

Glomus was the most predominant of the spores of mycorrhizal fungi. The other types observed were *Acaulospora*, *Gigaspora* and *Sclerocystis* of which the first type was more prevalent particularly in the Hedigalla soils.

A study of the infectivity of four mycorrhizal fungi *viz: Glomus fasciculatus*, *Glomus mosseae*, E_3 (Glomus species) and *Gigaspora marguerita* on *Hevea* and their effect on growth and uptake of phosphorus by the host plant was commenced. The results are yet not available. (U. P. de S. Waidyanatha and A. H. Ranjan, Research student).

BIOLOGICAL SUPERPHOSPHATE

The principle of biological superphosphate as described in the 1978 Annual Review is being further investigated. The results to date of one field experiment and two pot experiments are given below.

Field experiment on immature Hevea (PB 86); 1978 Replantation, Lowmont (BS4/78/F)

The treatments given in Table 27 are being tested in a fully randomised experiment with single-tree plots replicated 18 times. The phosphate fertilizers were applied in two doses amounting in all to 18 g P/plant for 1979. Appropriate amounts of N, K and Mg were given as basal dressings in four applications. Fertilizers were placed in crow bar holes made around the base of the plant. Each plant received 15 g (S) or 30 g(2S) of sulphur either mixed with the phosphate or pelletized with it using a latex formulation as the adhesive. The pellets also contained a soil inoculum of sulphur bacteria. Neither girth measurements taken in December 1979 nor phosphate concentration in leaves revealed any significant effects due to treatment. (U. P. de S. Waidyanatha & W. A. Ariyaratne).

Pot experiment with Panicum maximum (Guinea β) (BS2/78/P)

The treatments indicated in Table 27 were tested commencing in May 1978 in pots containing 14 kg soil each. Amounts of phosphates to contain 30 mg P/kg soil (approx. 250 mg apatite/kg soil; 50 kg P/ha) were supplied alone, mixed or pelletized with sulphur as described

before. Sulphur was used at 25 mg (S) or 50 mg (2S) per kg of soil. In all, 8 harvests of the grass were taken after which the experiment was terminated on 16th June, 1979. The cumulative DM yields are given in Table 27.

All three sources of phosphate, local apatite (A) imported rock phosphate (RP) and concentrated superphosphate (CSP) improved dry matter yields when compared with the controls, and RP was the best phosphate. Addition of sulphur in any form to A or RP did not improve the DM yields but there was some indication that CSP + S was better than CSP alone. The response in this experiment to the latex formulation used as the pelletizing agent is unexpected and inexplicable: such an effect has not been observed in other experiments. (U. P. de S. Waidyanatha & W. A. Ariyaratne).

Pot experiment with Pueraria (BS 7/79/P)

The treatments, each replicated 6 times, given in Table 27 were applied commencing on 29th March, 1979. As in the previous experiment, the appropriate amounts of phosphate each containing 30 mg P per kg of soil, 25 mg sulphur/kg soil and 156 kg gypsum (25 mg S)/kg soil were used. Three harvests of tops were taken up to early December 1979.

All three phosphates very significantly increased plant growth over the controls but apatite was distinctly inferior to RP and CSP. Addition of sulphur did not increase the response to any of the phosphates. There has been some indication that apatite when pelletised with sulphur was inferior than when applied by itself. This perhaps is because pelletising increases particle size and thereby decreases phosphate solubility, and any improvement in phosphate availability through pelletising could not compensate for it. There was no response to gypsum or sulphur.

The data on the whole suggest that phosphate solubility has not been increased by the addition of sulphur. However apatite clearly provided phosphorus to plants although it was inferior to RP and CSP as a phosphatic fertilizer. It should be possible to bring the response to apatite in par with the other two sources by increasing the quantity of apatite appropriately. Apatite should still be cost competitive because it is available locally. (U. P. de S. Waidyanatha & W. A. Ariyaratne).

Table 27. *Dry matter yields (DM) and girth of trees (GI) for various treatments in three experiments*

Treatment	*Panicum Experiment Panicum DM (g)*	*Pueraria Experiment Pueraria DM (g)*	*Hevea Experiment Tree Girth measurement (cm)*
A + S	138.4	23.4	12.1
A + 2S	140.3	—	12.5
A + S pellets	152.7	17.6	11.9
A + 2S pellets	137.7	—	12.1
RP + S	153.5	30.8	12.5
RP + S pellets	140.4	28.3	12.5
CSP + S	175.8	27.6	13.0
CSP + S pellets	169.1	—	—
A + gypsum	—	24.1	—
RP + gypsum	—	29.2	—
CSP + gypsum	—	30.8	—
A	146.3	21.2	11.9
RP	196.1	34.2	11.9
CSP	152.7	30.0	12.1
S	89.2	9.5	11.9
2S	102.4	—	11.4
Gypsum	—	10.2	—
Nil + Latex*	104.8	9.2	11.5
NIL	75.1	9.6	11.5
LSD (5%)	25.6	5.3	NS
LSD (1%)	33.9	7.0	—

A = local apatite RP = Imported rock phosphate CSP = concentrated superphosphate

*Formulation of latex used as pelletizing agent.

Crown budding

Crown budding experiment, St. George Group, Matugama, 1975 (CB/75/1/F)

In this experiment, clones RRIC 45, 48, 101 and RRIM 600 are grafted on to seedling rootstocks of clone Tjir 1 and planted in the field in 1975. They were crown budded with clones RRIC 45, 48, 101, 102, 117, RRIM 600 and PB 86 in 1977.

Girth data recorded at the end of 1979 are summarised in Table 28. They indicate that the growth of the trunk is markedly affected by the nature of the crown. Growth of RRIC 101 and RRIC 45 trunks were significantly reduced by PB 86 and RRIC 117 crowns. On the other hand the growth of RRIC 45 and RRIM 600 trunks was significantly increased by RRIC 102 crowns. (A. C. I. Samaranayake & R. B. Gunaratne).

Table 28. *Mean girths (in cms) of trunks in Crown budded trees*

Trunk Clone	*Crowns*	*Girth (cms)*
RRIC 101	RRIC 101	35.1
	PB 86	30.8***
	RRIC 117	29.0*
	RRIC 102	35.5
RRIC 45	RRIC 45	28.9
	PB 86	29.8
	RRIC 117	27.6
	RRIC 102	33.8***
RRIC 48	RRIC 48	31.1
	PB 86	27.4**
	RRIC 117	25.4***
	RRIC 102	31.7
RRIM 600	RRIM 600	27.7
	PB 86	27.7
	RRIC 117	26.3
	RRIC 102	34.7***

L.S.D. = 2.5
(P = 0.05)
L.S.D. = 3.3
(P = 0.01)
L.S.D. = 4.3
(P = 0.001)

*P = .05
**P = .01
***P = .001

Preparation and establishment of three part trees (CB/79/2/F)

Budgrafts of clone PB 86 growing in a nursery were crown budded with green buds of clone RRIC 102. When the crown shoot had developed brown bark up to two leaf whorls, they were prepared as stumped buddings and field planted at Dartonfield in December 1979 to serve as an observation plot. (A. C. I. Samaranayake, R. B. Gunaratne & W. T. Silva)

1976, Comparison of Green and Brown buddings, Eladuwa Estate, Paiyagala (PT/76/1/F)

Girth data given in Table 29 show no significant growth differences between green and brown buddings at 3½ years from planting. (A. C. I. Samaranayake, R. B. Gunaratne & L. S. Kariyawasam).

Table 29. *Mean girths of green and brown buddings at 3½ years age*

Treatment	*Mean girth of Scion (cms)*
Green buddings	31.7
Brown buddings	30.3

Reduction of the immature period by the use of polybag plants

1978 experiment, Belmont Estate, Padukka (RI/78/1/F)

In this trial, established in November 1978, the growth rates of plants raised in polybags are compared with bare root budded stumps after transplanting in the field. Table 30 summarises the average girths of such plants taken at the end of one year.

Table 30. *Mean girths (in cms) of polybag plants and bare root budded stumps used as planting material*

Treatment	*Mean girth of Scion (cms)*
Polybag plants	10.2
Budded stumps	6.1

t = 8.1582***

The differences between the two treatments are highly significant (A. C. I. Samaranayake, R. B. Gunaratne & L. S. Kariyawasam).

Reduction of the immature period by the use of stumped buddings, 1978 Experiment, Eladuwa State Plantation, Paiyagala (RI/78/2/F)

This experiment, field planted in June 1978, compares the growth rates of standard bare root budded stumps with stumped buddings when used as initial planting material. The girth data recorded at 1½ years from planting are given in Table 31.

Table 31. *Mean girth of stumped buddings and budded stumps after 1½ years from planting*

Treatment	*Mean girth of Scion (cms)*
Stumped buddings	18.3
Budded stumps	11.3

T = 13.7080***

There is difference in girth between the two treatments. (A. C. I. Samaranayake, R. B. Gunaratne & G. Bandara).

Effects of root inducing hormones and other chemical substances on establishment and growth of budded stumps (NP/78/1/F)

Budded stumps were treated separately with three concentrations of NAA and two concentrations of Furadan, an insecticide. (Details Annual Review—1978). None of the treatments promoted early emergence of buds. 100 ppm IBA, at 100 and 500 ppm IBA and Furadan delayed bud emergence.

There were no significant differences in subsequent growth of buddings due to treatments. (A. C. I. Samaranayake & R. B. Gunaratne).

Effects of IBA on root-induction of budded stumps planted in poly bags (NP/78/2/F)

A powder formulation of 2000 ppm IBA in Kaolin was prepared and tested on budded stumps with the following treatments:

Treatment 1 — lateral roots pruned completely.

,, 2 — lateral roots pruned to 4 inches.

,, 3 — lateral roots pruned completely and a powder formulation of IBA made into a slurry, painted on the tap root and allowed to dry.

There was no significant differences in the time of bud emergence and in subsequent growth of the buddings due to the various treatments. (A. C. I. Samaranayake & L. S. Kariyawasam).

Relationship between the weight of seeds and time of germination and growth of seedlings (NP/78/3/F)

Pods of clone RRIC 103 were picked from trees, weight of each seed recorded and planted in polybags during the 1978 seed season. The germinated seeds were transplanted in a seedling nursery. The time taken for each seed to germinate and its subsequent growth was recorded.

There was a significant effect of the weight of seed on the time taken for germination. The heavier seeds germinated early and early germination had a growth advantage over the late germinators in early growth measured at 4 months. This advantage disappeared at 9 months from planting. Hence seed weight would not be an index to growth vigour in seedlings. (A. C. I. Samaranayake, R. B. Gunaratne & G. Bandara).

Galewatta, Peenkande and Pallegama Estates (GB/79/1/F1:F2:F3)

Green buddings have been found to be suitable for large scale planting in the Kalutara District. Arrangements were therefore made for trial plantings in other districts as well. The following treatments will be tested in a randomised block experiment with 40—60 tree plots replicated 8 times.

1. Green buddings planted bare root.
2. Brown buddings planted bare root.
3. Green budded stumps grown in polybags up to two leaf whorl stage and transplanted in the field.

4. Seedlings raised and green budded in polybags, grown up to two leaf whorl stage and transplanted in the field.

5. Seedlings budded at stake in the field.

Fertilizer and density trial — Stock seedling nurseries

Under climatic conditions prevailing in Sri Lanka, the stock seedlings have to reach buddable size in 5—6 months for effective green budding. Hence an experiment was set down in collaboration with the Soils and Plant Nutrition Department to see if the growth of plants could be improved by changing the planting density, and levels and frequency of fertilizer application. (A. C. I. Samaranayake & G. Bandara).

CLONE CHARACTERS

Eladuwa Estate, Paiyagala (CC/77/1/F)

The purpose of this study is to investigate a number of clones in order to identify criteria, if any, that could be used in the early selection of clones.

Ten clones of varying yield potentials were selected and 50 budded stumps of each clone were planted in the field as completely randomised single tree plots, at a spacing of 2.4 m x 9.1 m. In between two rows an additional row was planted with the same clones so that plants could be removed for destructive sampling at various stages of growth, leaving a normal stand of plants for long term observations.

A growth analysis of ten plants from each clone at 15 months age was made and samples from different tissue were preserved for anatomical studies. On analysing the data recorded during the growth analysis, some distinct clonal characters in early growth emerged.

RRIM 600, PB 86, RRIC 45, 52 & GT 1 plants have a significantly taller growth habit than clones RRIC 100, 101, 88, LCB 870 and IRCI 2. Clones RRIC 45, and PB 86 produce higher extension growth as branches as well as going tall. Clones LCB 870, RRIC 88 and RRIC 101, while being shorter in their growth habit produce significantly more extension growth as branches than IRCI 2 and RRIC 100. Clones RRIC 45, 88 and RRIM 600 produce trees having a significantly lower girth than the rest. These three clones produce trees having a lower total fresh weight of plant too.

Fresh weight of whole plants do not differ significantly in clones RRIC 100, 101, GT 1, RRIC 52 and PB 86. But there seems to be a difference in the partitioning of assimilates within the plant, RRIC 52 partitioning less towards roots and PB 86 less towards leaf.

Clones RRIC 45, RRIM 600 and RRIC 88 have lower leaf areas than the others.

A second growth analysis was made at the age of 30 months and the results are being processed.

On microtapping these plants at 17 months the accepted high yielding clones gave high yields (Ann. Review. 1978). They were microtapped again at 30 months. Yield trend was the same except for clone RRIC 100. To stimulation of a 10 cm band per tree with 0.1 g of 2.5% Ethrel the different clones responded differently. RRIC 88 which gave a low yield on microtapping, gave the highest response to Ethrel stimulation (Table 32). (A. C. I. Samaranayake, U. P. de S. Waidyanatha, A. Ekanayake & L.S. Kariyawasam).

Table 32. *Yield on Microtapping*

Without Ethrel		*With Ethrel*	
Clone	*Yield g/t/tap*	*Clone*	*Yield g/t/tap*
PB 86	0.388	RRIC 88	3.259
RRIC 101	0.359	RRIC 101	2.915
RRIM 600	0.328	RRIC 100	2.883
GT 1	0.254	PB 86	2.615
RRIC 52	0.245	GT 1	2.000
RRIC 100	0.225	RRIC 52	1.901
IRCI 2	0.215	RRIC 45	1.659
RRIC 88	0.180	RRIM 600	1.609
RRIC 45	0.175	IRCI 2	1.585
LCB 870	0.062	LCB 870	0.542

Treatments joined by a vertical line do not show significant differences, according to the multiple range test.

Growth substances

Work on this project was undertaken only during the first quarter of the year. An attempt was made to assess quantitatively the amount of germination inhibitor detected in young shoots of *Hevea* at different stages of growth in developing shoots after "wintering".

With agar diffusion technique, no inhibition could be detected probably due to insufficient time of diffusion of the tissue. Methanolic extracts of the tissues gave very inconsistent results. (A. C. I. Samaranayake, R. Satchuthananthavale & L. S. Kariyawasam).

RAINGUARDS

Rainguard trial, GT 1, RRIM 623, RRIC 45 & 75, 1963 Replantation, Eladuwa Estate, (RG/77/1/F)

This large scale trial started in 1977 was in progress during the year. There are five tapping tasks with rainguards and five controls.

The rainguarded blocks recorded 18 tappings more than the control blocks, giving a total of 270 kg dry rubber. The average crop/tapper/day for rainguard blocks and control blocks were 3.55 kg and 3.69 kg, respectively.

Rainguard trial, PB 86, 1951 Replantation, Eladuwa Estate (RG/73/1/F)

In this trial six tapping tasks are with rainguards. Any additional tappings in these tasks are counted against the rest of the estate.

These tapping tasks recorded 24 tappings more than the estate tasks without rainguards. The total crop harvested for these additional days was 317 kg. dry rubber with an average intake of 4.37 kg. dry rubber per tapper per day for the additional tapping days.

Rainguard trial, RRIC 100, 1972 Replantation, Elston Estate (RG/79/1/F)

In this large scale trial started in 1979 and tapped S/2 d/3 67%, there are 11 tasks with rainguard and 6 tasks without rainguards.

The rainguarded blocks recorded 8 additional tappings compared to the controls. The total crop gained was 142.42 kg. dry rubber for the extra tappings. The mean intake per tapper per day for rainguard blocks and control blocks being 4.09 kg. and 4.1 kg. respectively.

Rainguard trial, RRIC 45, RRIC 623 and Waga 6278, 1966 Replantation, Frocester Estate, (RG/78/1/F)

In this large scale trial there are 18 tapping tasks with rainguards and 16 tapping tasks without rainguards.

In this trial only 4 additional tappings were recorded for the year, giving a total of 148.14 kg. dry rubber as additional crop. The mean intake per tapper per day for control and rainguard blocks were 4.49 kg and 3.9 kg respectively.

One important fact observed in all the rainguard trials is that the co-operation of the Field Supervisory staff is required to make these trials a success. Without their co-operation the tappers are reluctant to tap the trees even if the field is ready for tapping after the rain has ceased.

Smallholding rainguard trial, Kajugahawatta, Bentota (RG/78/2/F)

In this trial no additional tappings were recorded for the year, although the rainguards were serviced and kept in proper order. This was attributed to heavy rainfall and the tappers who are non-resident not turning up for work during rainy days.

This trial will be discontinued. (R. Satchuthananthavale, I.R.M. Amarakoon & R. P. Karunasena).

REVIEW OF THE GENETICS AND PLANT BREEDING DEPARTMENT

By

D. M. FERNANDO

SUMMARY

The main discovery for the year was the South American Leaf Blight (SALB) resistance of 3 clones viz., RRIC 121, RRIC 130 and 72-133. The yields of both RRIC 121 and RRIC 130 are satisfactory and the growth of RRIC 121 is above average. RRIC 103 and RRIC 118 showed satisfactory yields in the Matale District. RRIC 104 also showed suitability for larger scale planting in the Kalutara and Moneragala Districts. Budwood multiplied in 1978 was distributed in quantity in 1979 and requests towards the end of 1979 could not be met.

DETAILED REVIEW

Staff

Mr. D. M. Fernando, Head of the Department, and Dr. N. E. M. Jayasekera, Geneticist, were on duty throughout the year.

Mr. P. Samaranayake, Senior Technical Assistant; Mr. B. M. S. G. Peiris, Senior Field Assistant; and Messrs. K. B. A. Karunasekera, K. W. Rupatunga and W. D. Gunadasa, Technical Assistants were on duty throughout the year. Field Assistants Messrs. D. S. Gamage, A. K. M. S. Senaratne and Field Attendants Messrs. W. D. Armon and D. S. Dedduwakumara were also on duty throughout the year.

Publications

1. D. M. Fernando, Review of the Genetics and Plant Breeding Department for 1978.
2. D. M. Fernando and A. de S. Liyanage, 1978. SALB Resistance Studies in Sri Lanka, SALB Workshop. Kuala Lumpur, Malaysia, September 1978.

Visits

Estates in the Kurunegala District were visited in connection with the planting of rubber in uneconomic tea estates. The Moneragala District was visited in connection with the new planting of rubber and the feasibility of polybag plants. SPC and JEDB seminars were attended in connection with planting advice.

Research Students

Mr. L. C. Wijetilleke commenced work on a National Science Council Grant on SALB resistance.

General

The most important finding for the year was the location of South American Leaf Blight resistance in RRIC 121 and RRIC 130; tests were conducted in the RRIM Unit at Trinidad under the supervision of Dr. Chee and preliminary findings indicated very high resistance in RRIC 130 and appreciable resistance in RRIC 121. Of the two clones, RRIC 121 is more suited to general planting on the basis of immature and mature vigour and yields which are equivalent to RRIC 103. RRIC 130 exhibits less vigour and very high yields. These high yields of RRIC 130 may indicate a predisposition to Brown Bast. 200 yards of RRIC 121 were distributed to the SPC and JEDB for multiplication. A complete diallel crossing was made by the Geneticist and the progeny planted out on a fully randomized layout. Precise information relevant to the population studied should emerge soon from this experiment.

Clone Evaluation

With attractive rubber prices in 1979 control of tapping has presented difficulties in some experiments. Tapping of wet trees and double tapping has increased Brown Bast and lowered per tree yields leading to irregularity in yields in some clones even in the same District. Intake figures from estates which have planted RRIC 100, RRIC 101 and RRIC 103 were however rather constant. Susceptibility to *Corynospora cassicola* has been reported for RRIC 103 in Malaysia. This type of attack has not been reported in Sri Lanka. No attack has been reported in the case of RRIC 100, 101, 102 and 110 which are in the same nursery in Malaysia. The planting of a number of clones, now that we have them tapped for a number of years, is therefore essential in order to insure against infection by pathogens. It is expected that RRIC 121 will vie with RRIC 103 for popularity in estates and could be distributed in small quantities to the smallholders as well. The planting of RRIC 117, RRIC 121 and RRIC 130 is definitely advisable as insurance against SALB.

Statistical Sensitivity

Small scale trials planted in Kuruwita in 1967, 1968, 1969 with three 10-tree replicates and up to sixty clones showed more sensitivity than earlier trials with replicated 150 to 300-tree plots. Thus RRIC 102, 110, 112, 130, 121, 128 and 129 were found significantly better in yields than the control clones in these experiments. However, large plots show up wind damage susceptibility and leaf disease incidence more clearly than the small scale trials.

Tapping Policy in the New Clones

As there is an appreciable extent with RRIC 100 and 101 in tapping and estates are planting RRIC 103, RRIC 105 and RRIC 110, and multiplication of budwood of RRIC 121, RRIC 118 is well under way, it is useful to view extraction of rubber in a perspective geared to greatly enhanced value of rubber today and its increasing value with time. It has been found that increased prices invariably lead to increased tapping intensities and increase of dry trees. As a long term policy it would therefore be best to reduce tapping intensity or maintain at the same levels with frequent inspection.

CLONE TRIALS

Matale District

Experiment No. 10 - 1965. Kaikawala: A number of trees were damaged by the cyclone in this area. As shown in Table 1 RRIC 118 and RRIC 103 yielded best. The yields of RRIC 118 was very slightly below significance at the 5% level over the control clone 1108. (D. M. Fernando and D. S. Gamage).

Table 1. *Experiment No. 10 - 1965 Clone Trial, Matale*

Tapped: S/2, d/2, 100%

Clone	*Trees Tapped*	*Mean Girth cm 1979*	*Yield g/t/t. Mean 1974 to 1978*	*1979*
RRIC 103	12	66.8	33.1	29.1
RRIC 118	68	54.3	31.9	23.0
RRIC 116	58	63.7	22.7	20.2
1108	29	59.8	21.9	16.2
IAN 710	52	58.1	21.6	17.7

Experiment No. 25-1968. Wariapola, Matale: Prior to handing back to the owners the tapping intensity was increased to 200%. Under highly unfavourable conditions of exposure to *Oidium* leaf disease, early neglected and current increased tapping intensities, RRIC 101 maintained satisfactory yields though at the expenses of girth. Under very favourable prices the SALB resistant clone IAN 710 was found to show a satisfactory combination of girth and yields (Table 2).
(D. M. Fernando and B. M. S. G. Peiris).

Table 2: *Girth and yield of different clones at Matale*

Tapped: S/2, d/1, 200% (1979)

Clone	*Girth cm 1978*	*1979*	*Yield g/t/t. Mean 1977 to 1978*	*1979*
RRIC 101	41.0	47.4	39.7	28.6
RRIC 102	42.7	46.2	28.7	23.0
IAN 710	53.7	53.8	28.6	40.8
RRIC 103	47.6	47.5	22.0	23.0
1004	48.8	49.9	19.3	16.2
RRIC 100	42.9	47.2	22.8	26.0
RRIC 45	46.7	50.2	17.9	24.8

Moneragala and Bibile Districts

Experiment No. 9 - 1965. Kumarawatta: Survival of the plants in the replicates of this experiment were not sufficient to permit statistical analysis. Flowering was extended and profuse and facilitated diallel crossing. IAN 710 pollen was also used for combination with clones in the Kalutara District. RRIC 104 which showed statistically significant superiority in girth and yield at Kuruwita showed satisfactory growth and yield at Moneragala (Table 3). It is evident that clones which show above average growth and yields in the wet zone could be expected to succeed under drier conditions. Therefore RRIC 117, 121 could supplement RRIC 102, RRIC 103 and RRIC 104 for these areas. Establishment, which is a major constraint could be best overcome using the poly-bag system which was successfully used to supply this 1965 planting in 1967.
(D. M. Fernando and D. S. Gamage).

Table 3. *Girth and yield of different clones planted at Moneragala in 1965*

Tapped: S/2, d/2, 100%

Clones	*Trees Tapped*	*Girth 1979*	*Mean Yield g/t/t. 1974 to 1978*	*1979*
RRIC 102	16	60.0	25.8	28.3
RRIC 103	18	63.6	24.6	28.4
RRIC 104	18	64.9	24.5	25.9
RRIC 45	24	60.1	21.2	24.6
IAN 710	27	56.9	20.7	26.9
RRIM 623	29	60.7	17.4	15.4
RRIC 101	23	57.2	24.4	20.9
RRIC 112	21	59.8	21.4	23.3

Experiment No. 13 - 1966. Kumarawatta: RRIC 103 was test tapped with RRIM 623 as control. Significantly better yields were obtained from RRIC 103 over the control clone at the 5% level (Table 4). There was no significant difference in growth between the two clones. (D. M. Fernando and D. S. Gamage).

Table 4. *Girth and yield of clones planted in 1966, Moneragala*

Tapped: S/2, d/2, 100%

Clone	*Trees Tapped*	*Mean Girth cm*		*Mean Yield g/t/t.*	
		1978	*1979*	*1976 to 1978*	*1979*
RRIC 103	204	67.4	70.5	27.1	39.3
RRIM 623	198	58.7	61.1	21.9	20.6

Experiment No. 20 - 1967. Bibile: Reversion to 67% increased yields per tree. This increase of yield was noticeable from 1977 and has persisted up to 1979 (Table 5). (D. M. Fernando and B.M.S.G. Peiris).

Table 5. *Yield of clones planted at Bibile*

Tapped: S/2, d/3, 67%

Clones	*Yield kg/ hect*		*Yield g/t/t. mean*	
	1976	*1978*	*1976 to 1978*	*1979*
RRIC 101	1581	1583	42.1	55.6
RRIC 100	626	1704	31.2	48.8
RRIC 103	891	1553	28.4	43.9
RRIC 112	1338	1426	29.2	48.0
RRIC 45	663	1213	21.2	39.0
IAN 710	686	1483	22.6	53.4

Kalutara District

Experiment No. 8 - 1965. Small Scale Clone Trial. Dartonfield: RRIC 120 and RRIC 121 were despatched to Trinidad for an appraisal of South American Leaf Blight resistance. RRIC 121 was found resistant and RRIC 120 highly susceptible. RRIC 121 was multiplied earlier for routine distribution and 200 metres of budwood was distributed to the SPC and JEDB for multiplication and dispersal through the different planting districts. The 1978 yields of RRIC 117 and RRIC 121 were significantly greater than the controls RRIC 45 and RRIM 623 at 1% level (Table 6).
(D. M. Fernando and D.S. Gamage).

Table 6. *Girth and yield of clones planted at Dartonfield*

Clone	*Trees Tapped*	*Mean Girth cm*		*Mean Yield g/t/t.*		*Dry Trees*
		1978	*1979*	*1974 to 1978*	*1979*	
RRIC 117	13	71.9	74.3	45.1	41.1	
RRIC 114	14	62.0	65.2	45.1	42.1	
RRIC 120	8	74.0	74.0	43.0	46.2	3
RRIC 121	13	80.0	83.1	37.3	40.7	1
RRIM 623	12	69.4	71.4	28.9	26.8	1
IAN 710	13	68.6	71.0	26.5	34.7	
RRIC 45	13	71.0	68.0	26.1	34.1	4
RRIC 102	8	65.6	67.6	43.6	49.1	

Experiment No. 12 - 1966. Nivitigalakele: The yields of RRIC 103 were well above the control clone RRIC 45 (Table 7).
(D. M. Fernando and K. W. Rupatunga).

Table 7. *Girth and yield of clones planted at Nivitigalakele in 1966*

Tapped: S/2, d/2, 100%

Clone	*Trees Tapped*	*Mean Girth cm*		*Yield g/t/t.*	
		1978	*1979*	*1974 to 1978*	*1979*
RRIC 103	181	71.0	76.3	65.4	69.6
RRIC 45	133	62.1	66.0	33.3	30.8

Experiment No. 50. Nivitigalakele: This area was weeded during the year and extra fertilizer as recommended by the Visiting Agent, was applied.

Experiment No. 16. Neboda: The average yields over a 5 year period show similar yields for RRIC 103 and RRIC 102. Poor control of tapping led to much irregularity in the different clones and lowered the yields of RRIC 102 in 1979. Brown Bast incidence was approximately 8% of the original stand in each of the clones RRIC 102, 103 and RRIM 623 (Table 8).
(D. M. Fernando and S. S. Senaratne).

Table 8. *Data from clone trial planted at Neboda*

Tapped: S/2, d/2, 100%

Clone	*Trees Tapped*	*Mean Girth cm*		*Yield g/t/t mean*		*Dry Trees*
		1978	*1979*	*1974 to 1978*	*1979*	
RRIC 103	376	76.1	78.7	48.9	53.2	43
RRIC 102	228	68.5	71.4	43.2	27.3	31
1004	310	73.3	76.7	39.1	44.1	18
RRIM 623	247	67.1	70.6	39.8	38.0	37

Experiment No. 14 - 1967. Nivitigalakele: The first five years average is shown in **Table 9.** The yields of RRIC 102 improved to reach levels similar to RRIC 101.
(D. M. Fernando and W. D. Gunadasa).

Table 9. *Data from clone trial planted at Nivitigalakele in 1967*

Tapped: S/2 d/2, 100%

Clone	*Trees Tapped*	*Yield g/t/t. mean*	
		1974 to 1978	*1979*
RRIC 102	303	42.6	43.1
RRIC 101	306	43.7	34.6
RRIC 111	394	26.9	23.0
RRIM 623	152	22.6	28.3

Experiment No. 19 and 23. Hedigalla: In these experiments RRIC 103 showed significantly better girth as 5% level than RRIC 45. The yields of RRIC 103 though better in both experiments were not significantly so over RRIC 45 (Table 10).
(D. M. Fernando and W. D. Armon).

Table 10. *Data from Experimental Nos. 19 and 22 planted at Hedigalla in 1967 and 1968*

Tapped: S/2, d/2, 100%

Clone	*Trees Tapped*	*EXP. No. 19 Yield g/t/t 1975 to 1978*	*EXP.No. 23 Yield g/t/t 1975 to 1978*	*Dry Trees*
RRIC 101	331	33.4	38.2	14
RRIC 103	523	28.4	30.2	8
RRIC 45	471	21.6	22.7	22

Experiment No. 26 — 1969. Sirikandura: This experimental area was transferred in the first year of tapping to Co-operative Management and after 2 years to the SPC and may now be vested again with the original owners. Under these conditions RRIC 102 showed better yields than RRIC 103 (Table 11).
(D. M. Fernando and W. D. Gunadasa).

Table 11. *Yield of RRIC clones planted at Sirikandura*

Tapped: S/2, d/2, 100%

Clone	*Trees Tapped*	*Yield g/t/t Mean*	
		1975 to 1978	*1979*
RRIC 101	175	27.5	21.3
RRIC 102	193	27.3	30.6
RRIC 103	182	24.0	30.2
RRIC 45	190	22.6	25.1

Experiment No. 29 — 1969. Eladuwa: In this fully randomised trial RRIC 112, 101, 103 and 100 showed significantly better yields than the control RRIC 45 in 1978. Measurements for 1979 are shown in Table 12.

Table 12. *Data from clone trial planted at Eladuwa Estate*

Tapped: S/2, d/3, 67%

Clone	*Trees Tapped*	*Mean Girth cm*	*Yield g/t/t Mean*	*Dry Trees*	*Wind Damage*
		1979	*1976 to 1978*	*1979*	*1979*
RRIC 101	24	59.9	39.4	2	
RRIC 112	27	63.7	31.5	1	
RRIC 100	27	54.7	27.9	1	
RRIC 103	28	66.4	27.7	1	
82	27	62.7	27.6	1	
RRIC 45	144	56.1	24.4	12	2
1458	28	55.2	22.0	4	

Experiment No. 30 — 1969. Hedigalla: In this experiment on the same design as the 1969 trial at Eladuwa RRIC 102 showed approximately similar yields to RRIC 103. The measurements are being analysed for significance. The incidence of dry trees in adjacent large plots of the same clone was appreciably higher (Table 13.)

Table 13. *Girth and yield data from 1969 planting at Hedigalla*

Tapped: S/2, d/2, 100%

Clone	*Trees Tapped*	*Mean Girth cm*	*Yield g/t/t*		*Dry Trees*
		1979	*1978 to*	*1979*	*1979*
RRIC 100	27	56.9	29.3	27.8	
RRIC 101	24	59.7	32.5	30.6	
RRIC 102	28	58.7	27.8	29.8	
RRIC 103	27	62.2	31.5	31.9	1
1173	24	53.0	19.0	16.5	
1458	25	60.2	23.0	23.0	
RRIC 45	125	54.7	21.3	19.3	4

Commercial Yields

Kalutara (*a*): RRIC 100 and RRIC 101 averaged 44.3 and 38.5 *g* of dry rubber per tree per tapping at 67% intensity in 1979 from a 1970 planting. RRIM 600 from a 1969 planting on the same estate tapped at 100% intensity averaged 44.7 *g* per tree per tapping (D. M. Fernando).

Kalutara (*b*): Sampling of a 1971 clearing of another estate at Kalutara tapped at 67% intensity gave 56.0, 61.3, 60.8, and 60.1 *g* of dry rubber per tree per tapping for RRIC 101, PB 86, RRIM 623 and RRIC 100. The main yield effect was on the number of trees tapped in each 5 acre block.
(N. E. M. Jayasekera and P. Samaranayake).

Sabaragamuwa District:

Experiment No. 17 — 1967 Trial-Peenkande: RRIC 111 showed the best yields and girth (Table 14). In other experiments *eg.* Nivitigalakele, RRIC 111 showed a barely economic yield for the first four years. Due to rapid girthing even after tapping, high yields are possible later on. It would be interesting to investigate the reaction of this clone to stimulation and puncture tapping as an average girth of 45 cm can be achieved in 30 months.

Table 14. *Girth and yield data from clone trial at Peenkande*

Tapped: S/2, d/2, 100%

Clone	*Trees Tapped*	*Girth cm 1979*	*Yield g/t/t 1974 to 1978*	*1979*	*Dry Trees*	*Wind Damage*
RRIC 111	386	89.8	57.2	56.7	30	
RRIC 100	403	76.5	60.3	54.7	68	4
RRIC 101	411	67.3	61.4	46.7	66	3
1004	290	79.2	50.7	45.8	57	
RRIM 623	390	71.6	47.8	41.3	42	6
RRIC 45	306	64.2	37.8	32.7	43	1

Experiment No. 6 — 1963. Kuruwita: In this small-scale trial, RRIC 109 showed the best yields (Table 15) and girth. RRIC 105 and RRIC 118 were also appreciably better than the control clone PB 86. Recording was discontinued from 1979.

Table 15. *Girth and yield data from clone trial at Kuruwita planted in 1963*

Tapped: S/2, d/2, 100%

Clone	*Trees Tapped*	*Mean Girth cm 1978*	*Yield g/t/t 1974 to 1978*
RRIC 109	6	87.3	68.4
RRIC 105	5	85.0	61.0
RRIC 118	7	78.4	57.6
PB 86	55	76.1	43.1
RRIC 108	7	68.7	43.9

Experiment No. 7 — 1964. Kuruwita: In this experiment RRIC 102 was initially matched against PB 86 but RRIC 110 showed yields better than both clones (Table 16). This superiority in yields was demonstrated statistically over RRIC 45 in the 1968 trial at Kuruwita.

Table 16. *Data from clone trial at Kuruwita planted in 1964*

Tapped: S/2, d/2, 100%

Clone	*Trees Tapped*	*Mean Girth cm 1978 to 1979*	*Yield g/t/t*
RRIC 110	12	80.0	68.3
266	18	85.9	48.1
RRIC 102	72	71.9	57.8
1152	13	78.4	43.3
PB 86	27	61.6	31.4

Experiment No. 15 — 1967. Kuruwita: RRIC 121 which was found resistant to SALB showed very favourable growth, number of trees brought into tapping and high yields (Table 17). Nucleus quantities of budwood were distributed to SPC and JEDB estates.
(D. M. Fernando and B.M.S.G.Peiris).

Table 17. *Girth and yields from 1967 clone trial at Kuruwita*

Tapped: S/2, d/3, 67%

Clone	*Trees Tapped*	*Mean Girth cm 1978*	*Yield g/t/t Mean 1976 to 1978*
10570	14	75.1	66.0
RRIC 122	4	65.3	52.0
RRIC 121	19	79.4	56.4
7281	16	68.6	43.9
10727	16	71.1	39.3
5682	21	49.3	39.3
RRIM 623	36	75.8	33.1
8798	8	71.1	31.1

Experiment No. 21 — 1968. Kuruwita: RRIC 130 found resistant to SALB showed very high yields; however vigour, which is important and complementary to yield, was not as satisfactory as RRIC 121 (which shows similar resistance) in this experiment. Carefully supervised planting of RRIC 130 is advised on the grounds of its high degree of resistance to SALB. On the 1978 yield measurements RRIC 130, 112, 131, 123, 102, 110 and 121 show statistically significant yields above the control RRIC 45 (Table 18). (D. M. Fernando and B. M. S. G. Peiris).

Table 18. *Girth and yields from 1968 clone trial at Kuruwita*

Tapped: S/2, d/3, 67%

Clone	*Trees Tapped*	*Mean Girth cm 1979*	*Yield g/t/t Mean 1976 to 1978*	*1979*	*Dry Trees*
RRIC 130	19	64.3	84.7	86.4	
RRIC 112	18	72.1	60.7	62.5	
RRIC 131	22	66.1	62.3	77.8	1
RRIC 123	17	73.0	62.0	61.8	1
RRIC 102	23	70.2	67.3	82.3	1
RRIC 110	25	70.8	68.9	74.0	
RRIC 104	26	81.7	57.6	68.0	
RRIC 121	19	81.5	58.4	78.8	
7263	23	70.3		49.6	1
RRIC 120	21	65.1	50.9	47.0	3
RRIC 45	27	58.3	44.8	49.7	
590	16	89.8	47.9	70.3	
RRIC 113	20	72.7	45.0	55.9	1
6 — 541	18	71.3	36.9	41.8	

Experiment No. 28 — 1969. Kuruwita: RRIC 128, RRIC 129, RRIC 127 and clone 7-1189 showed yields in 1978 significantly better than the control RRIC 45. RRIC 129 (Ch 26. x RRIC 100) and RRIC 128 (RRIC 102 x Ch 26) showed satisfactory girth as well (Table 19).
(D. M. Fernando and B.M.S.G. Peiris).

Table 19. *Girth and yields from 1969 clone trial at Kuruwita*

Tapped: S/2, d/2, 67%

Clone	*Trees Tapped*	*Mean Girth cm*		*Yield g/t/t*		*Dry*
		1978	*1979*	*1976 to 1978*	*1979*	*Trees*
7—1189	24	61.0	62.0	60.4	47.9	
RRIC 128	25	68.3	71.9	58.9	65.5	
RRIC 124	19	60.2	61.0	52.5	44.2	
7—1415	26	60.4	62.4	51.8	45.0	1
RRIC 129	24	74.4	77.4	53.3	53.5	
7—1413	19	64.4	67.4	51.0	55.2	1
RRIC 127	19	59.7	62.4	57.6	54.2	3
RRIC 125	18	55.6	59.0	48.2	46.3	1
7—1176	24	68.3	70.4	41.7	48.3	
RRIC 45	10	64.5	65.0	41.4	39.8	
RRIC 126	24	65.3	67.0	41.1	46.2	1
7—1218	25	67.0	69.0	38.2	27.8	1
7—1077	22	68.7	77.0	37.9	38.5	1

1971 Experimental Planting — Tatuwalakanda:

A replicated planting was attempted in this area, but it was possible to monitor only one set of clones for yields. The yields and girth of RRIC 121 which is resistant to SALB are interesting in comparison with RRIC 100 and RRIC 103 (Table 20) RRIC 121 is clearly indicated as a substitute for RRIC 103.
(D. M. Fernando and B.M.S.G. Peiris).

Table 20. *Data from 1971 clone trial at Tatuwalakanda*

Tapped: S/2, d/2, 100%

Clone	*Trees Tapped*	*Girth cm 1979*	*Yield g/t/t 1979*
RRIC 100	57	57.0	40.7
RRIC 103	72	56.9	32.7
RRIC 121	33	59.6	57.4

NEW PLANTINGS

1979 South West — International Clone Trial

4 x 60 tree randomised plots were planted at Belmont Estate, Padukka with clones from the 1974 Multilateral Exchange Programme. The clones planted included BPM 3, BPM 22, BPM 24, RRIM 712, RRIM 717, RRIC 100, RRIC 101, RRIC 110 with RRIM 600 as control. Additional promising local clones included in this trial were RRIC 107, RRIC 113, RRIC 117, RRIC 118 and RRIC 121.

1979 — North East Matara District

Clones S1, S2, S3, S4, S5 accessed from an outside estate and representing Tjikadoe seedling selections were planted on a randomised 25 single tree design with RRIM 600 as control at Menikwatte Estate, Weligama.

Experiment No. HPS/74-75/1(F): Screening of 1974 and 1975 hand pollinated seedling populations for high yielding genotypes.

Selected genotypes from 1974 and 1975 hand pollinated progenies were multiplied in budwood multiplication nurseries. Budwood was available, in sufficient quantities, from some of the selections from 1974 population. Arrangements have been made to test these selections in four small scale clone trials.

The selections from 1975 are still in multiplication nurseries and there was insufficient budwood to use them in small scale trials.
(N. E. M. Jayasekera, D. S. Gamage & K. W. Rupatunge).

Project No. HPS/76/2(F): Seedlings derived from 1976 hand pollination programme are still being tested for their yield potential and growth rate.
(N. E. M. Jayasekera, D. S. Gamage & K. W. Rupatunge).

Project No. GE/75/1(F): Genotype — Environment interaction studies.

Routine visits were made to all the sites of this experiment. At the Bentota site (Bentota State Plantation, Elpitiya) a number of *Fomes* affected trees were observed and treated with collar protectant. During November and December of 1979, the annual girth measurement was recorded and the mean girth for each clone in each experimental site is given in Table 22. It is evident that RRIC 52, RRIC 101 and RRIC 103 have reached the highest girth when averaged over all the sites. When averaged over all clones, growth in Bibile and Golinda was poor in comparison with other sites.
(N. E. M. Jayasekera, P. Samaranayake and K. B. Karunasekera).

Table 22. *Mean girth (cm) for the ten clones in the genotype-environment interaction experiment*

Clones	*Densworth*	*Pimbura*	*Hunuwela*	*Golinda*	*Bentota*	*Monrovia*	*Bibile*	*Clone mean*
RRIC 36	29.0	31.2	28.7	27.3	38.0	34.5	27.4	30.8
RRIC 52	36.2	39.2	38.1	30.5	48.5	40.3	32.6	37.9
RRIC 100	31.7	35.8	32.0	29.7	39.5	34.0	27.5	32.8
RRIC 101	39.2	37.2	38.3	32.1	41.1	37.8	32.5	36.8
RRIC 102	37.8	36.2	39.1	26.6	38.2	32.7	26.0	33.8
RRIC 103	34.2	39.0	39.7	32.4	41.7	36.0	31.7	36.3
RRIM 600	33.2	33.9	32.8	29.7	37.8	30.9	25.8	32.0
RRIM 623	34.9	36.5	34.3	28.2	38.9	36.4	26.6	33.6
PB 86	29.6	32.9	32.6	39.1	34.7	33.0	24.6	30.9
IAN 45/71	31.4	34.4	32.7	32.0	34.4	31.2	25.4	31.6
SITE MEAN	33.7	35.6	34.8	29.7	39.2	34.6	28.0	33.6

Experiment No. SC/76/1(F): Rootstock-scions trial using diallel design

Data recorded on rootstock seedlings at the nursery stage were subjected to an analysis of variance. Some seedlings were lost at budgrafting and when establishing the experiment in the field. Therefore, only the data from the surviving seedlings were analysed. Results of the two characters scored (diameter and height) are given in Table 23. Results indicates that there is no significant difference between the four seedling populations of RRIC 52, RRIC 100, RRIC 111 and 1004 (unregistered). The reason for this could be that RRIC 52, included in the experiments, is one of the two parents of the other three clones used in the experiments. Therefore one could expect less genetic differences between these seedling progenies. Parentage of the three clones is given below.
(N. E. M. Jayasekera, P. Samaranayake & K. B. Karunasekera)..

Clone	*Parentage*
1. RRIC 100	RRIC 52 x PB 86
2. RRIC 111	RRIC 52 x PB 5/B 9
3. 1004	T 170 x RRIC 52

Table 23. *Results of the analysis of variance*

Source of variance	*Mean square*	
	Height	*Diameter*
1. Between rootstocks	35.301 N.S.	0.0499 N.S.
2. Between plots within rootstocks	107.101 **	0.2366 **
3. Between plants within plots	50.442	

N.S. Not significant ** 1.0 — 0.1%

Experiment No. GEN/78/1(F): Diallel crossing programme

The sixteen families derived from the dialles cross were planted in the field at the RRI (Substation), Nivitigalakele. Seedlings were fully randomized (single tree plots) and spaced at 8 ft between rows and 6 ft within rows.
(N. E. M. Jayasekera, P. Samaranayake & K. B. Karunasekera)

Experiment No. VAR/78/2F: Variability studies in mono-clonal stands of *Hevea.*

Yields of individual trees have been recorded on unrandomized mono-clonal plantings of RRIC 100, RRIC 101, RRIC 102 and RRIC 103. Each clone has at least an area of one tapping task. Girth, length of tapping cut, height at the lower level of tapping cut and bark thickness have been recorded for each tree. During 1979 eleven test tappings were done and after the 12th test tapping the data will be analysed to study the (a) cause of variability in mono-clonal *Hevea* stands and (b) to determine the optimum number of test tapping to be done per year, in the evaluation of *Hevea* clones.
(N. E. M. Jayasekera, K. W. Rupatunge & W. D. Armon).

Experiment No. CET/79/1(F): Testing of RRIC 100 series clones

The main objectives of this experiment are to study the yield variation in promising RRIC 100 series clones with respect to (a) environmental variation and (b) different tapping systems. In addition to these main objectives, yields of RRIC 100 series clones included in this experiment will be compared with that of the three control clones RRIM 600, PB 86 and GT 1.

The experiment was planted in 1979 during south west planting season, in four sites. In each planting site, fifty five combinations of eleven clones (eight RRIC 100 series clones and three control clones) and five tapping systems have been replicated four times to give 220 fully randomized plots with ten trees per plot. Relevant details are given in Table 24.

Table 24. *Project No. CET/79/1(F). 1979 S. W. Planting*

Site	*Planting Districts*	*Dates of Planting*
1. Elston Estate	Kelani Valley	22nd and 23rd May 79
2. Peenkande State Plantation	Ratnapura	29th May 79
3. Eladuwa State Plantation	Kalutara	1st June 79
4. Hathbawe Estate	Kegalle	14th June 79

The eight RRIC 100 series clones used in this experiment are 100, 101, 102, 103, 104, 105, 107 and 118. (N. E. M. Jayasekera in collaboration with U.P. de S. Waidyanatha, assisted by P. Samaranayake and K. B. Karunasekera).

Experiment No. HP/79/2(F): Hand pollination programme for 1979

In 1979 hand pollinations was done on Eladuwa State Plantation. The main objective was to cross RRIC 100, RRIC 101, RRIC 102 and RRIC 103 with two RRIM clones, 600 and 623 and GT 1. Only a limited number of pollinations were possible as flowering of mother clones did not coincide with that of pollen parents. Therefore it was decided to intercross RRIC clones to make use of male and female flowers of RRIC clones. Details of the crossing programmes are given in Table 25. A success of 2.2% was achieved in 1979 hand pollination programme. Pods were collected on maturity and seedlings were established in polybags. These seedlings will be planted at Eladuwa State Plantation in 1980 S.W. for future selection.

Table 25. *Project No. HP/79/2(F) Details of hand pollination programme of 1979*

Cross	*No. of Pollinations*	*No. of Pods*
1. RRIC 100 x RRIM 600	1901	19
2. RRIC 100 x RRIM 623	240	Nil
3. RRIC 101 x RRIM 600	3593	163
4. RRIC 101 x RRIM 623	450	03
5. RRIC 102 x RRIM 600	1142	16
6. RRIC 102 x RRIM 623	466	02
7. RRIC 102 x GT 1	100	Nil
8. RRIC 103 x RRIM 600	1907	11
9. RRIC 103 x RRIM 623	600	26
10. RRIC 103 x RRIC 101	150	21
11. RRIC 100 x RRIC 101	1163	05
12. RRIC 101 x RRI 101	604	Nil
TOTAL	12116	266

REVIEW OF THE PLANT PATHOLOGY DEPARTMENT

By

O. S. PERIES

SUMMARY

The incidence of leaf diseases was mild in 1979. White and Black Root diseases are now the important diseases in the wet and dry districts, respectively.

F, FX and IAN, foreign clones, were more resistant to *Oidium* leaf disease than local ones, of which the RRIC 100 series clones, particularly RRIC 103, were the best. Up to 25% artificial defoliation does not affect yields but over 50% does.

The maximum amount of phenolic compounds were released 6 h after inoculation of pods with *Phytophthora* zoospores. The pathogenicity of *Phytophthora* isolates varies with both clone and location. Panels tapped on the d/1 and d/2 systems are more susceptible than those tapped on the d/3, and those on d/4 are not affected. Susceptibility to Bark Rot decreases with age of trees.

Germinating *Gloeosporium* spores produce more appressoria on leaves of resistant clones than on susceptible ones, which encourage mycelial growth. One anti-fungal substance was isolated from PB 86 and RRIC 100 in chromatographic studies.

The release and viability of *R. lignosus* basidiospores are correlated with high humidity. Detached sporocarps stop release of spores 96 h after storage at all humidities.

The size of the foodbase is important in the initiation and spread of White Root disease. Only a few plants were infected when even large food bases were buried near plants; but even small pieces of inoculum caused infection when placed in contact with roots. Therefore, soil conditions and environment are closely linked with the spread of the disease. Infected material remains viable for more than 30 months in the soil.

Roots grow out of planting holes after about 6 months. Tap roots grow deep; infection too spreads deep and has been recorded at 186 cm depth. Infection of laterals was mostly confined to the top 30 cm of soil.

The soil pH, lowered by the addition of sulphur, remains so for over 18 months. Several fungi antagonistic to *Rigidoporus* have been isolated. *Mikenia cordata* contains a compound which inhibits *Rigidoporus*. The rate of decay of rubber stumps is increased by treatment with 2,4,5-T. *Xylaria* (Black Root) infection can be controlled by the same methods of treatment as White Root disease.

DETAILED REPORT

Staff

Dr. A. de S. Liyanage, Head of the Department, was on duty throughout the year. He attended the workshop on South American Leaf Blight (SALB) organised by the Association of Natural Rubber Producing Countries, and held in Kuala Lumpur, Malaysia, from 9—12 October, 1979. He proceeded to Trinidad on 17th November, 1979 to carry out studies on SALB

and its control. The Director will be in charge of the work of the Department during the absence of the Head of Department.

Dr. O. S. Peries, Director, continued to work in the Department, with the assistance of Departmental staff. His main areas of interest were Phytophthoras and soil fungi.

Mr. C. K. Jayasinghe, M. Sc., Plant Pathology, assumed duties as Assistant Plant Pathologist on 1 June, 1979.

The Experimental Officer, Mrs. N. I. S. Liyanage, was on duty throughout the year. Messrs. Z. E. Irugalbandara and D. M. Dantanarayana, Senior Technical Officers left for the U. K. for training on 19 April and 31 May, respectively. Technical Officers, Messrs. W. Amaratunga, S. Wettasinghe, A. Dharmaratne, B. Fernando, S. S. Warnapura, E. A. T. Senadheera, who assumed duties on 1 March 1979, and Miss J. L. P. Chandrika were on duty throughout the year.

Mr. P. K. Samaradeewa, National Science Council Scholar, continued his studies on: "Mechanisms of resistance to *Gloeosporium* leaf disease", leading to the M. Sc. degree.

Mr. V. Perera joined the Institute on 1 November 1979, on a National Science Council scholarship, to study certain aspects of root disease control, leading to the M. Sc. degree.

Visits

The following visits were paid during the year by the staff of the Department:

Experimental	...	286
Advisory	...	15
Miscellaneous	...	32
Total		333

Meetings

A. de S. Liyanage attended the following meetings:

Board of study in Biology at the Post Graduate Institute of Agriculture, Peradeniya	...	1
Country Committee on SALB	...	2
IRPTC meeting	...	1

Seminars

A. de S. Liyanage conducted a course of lectures (15 h) on epidemiology for M.Sc. students in Plant Pathology at the University of Colombo.

Committees

A. de S. Liyanage continued to serve on the Academic Syndicate of Agricultural Biology at the Post Graduate Institute of Agriculture, Peradeniya University. He also assisted the Department of Minor Export Crops in the supervision of post-graduate students, working on pathological subjects.

Research Students

Mr. K. Karannagoda, a M.Sc. student in the Colombo Campus, completed a research project entitled "Inhibitory compounds in *Mikania cordata*."

Publications

The following papers were prepared for publication by the staff of the Department during the year:

A. de S. Liyanage—

Annual Review of the Plant Pathology Department for 1978.

D. M. Fernando and A. de S. Liyanage—

Clones bred in Sri Lanka for resistance to South American Leaf Blight. (Paper presented at the ANRPC workshop on SALB, held in Kuala Lumpur, Malaysia 12 — 14 October 1979).

O. S. Peries—

Research assessment and financial control in research institutes. (Sri Lanka lead paper for Workshop on Research Administration and Management, held in Kuala Lumpur, 2 — 14 December 1979).

General

The incidence of *Oidium* leaf disease (*Oidium heveae*) was negligible in all rubber growing districts, the weather conditions during the refoliation period being unfavourable for the propagation of the causal fungus.

There was little *Phytophthora* leaf fall and Bark Rot during the year, except on one estate in the Kalutara District, where considerable leaf fall occurred on clone RRIC 36, which had been heavily infected with Bark Rot in previous years. Clone RRIC 36 is known to be very susceptible to Bark Rot.

Gloeosporium leaf disease was recorded on a few estates, especially in immature clearings, but did not present any problems.

White Root disease, caused by *Rigidoporus lignosus*, is the major disease problem on *Hevea* in Sri Lanka at present. This fungal disease causes extensive damage to mature areas, especially in the wetter rubber growing districts like Kalutara, Avissawella and Ratnapura.

Black Root disease, caused by a species of *Xylaria*, is a problem comparable with White Root disease in wet areas, in the Kegalla District. This disease is now being identified more frequently in immature clearings and is a definite hazard; as it is more difficult to detect in the early stages than *Rigidoporus* infection, and consequently control measures may be delayed.

The new root disease, caused by *Fusarium solani*, and reported in the 1978 Review from an estate in Akuressa, has now been identified in another clearing on the same estate. In this 4-year old area, 138 trees of clone RRIC 101 have been infected. Fungicides have been applied for the control of the disease and preliminary observations indicate that the response has been good.

LABORATORY INVESTIGATIONS

Diseased specimens

The following diseases were identified on specimens received by the Institute from various sources:

	Identity of the disease	*Number of specimens*
(*a*) Fungi		
	Ustulina zonata	2
	Oidium heveae	1
	Unidentified	1
(*b*) Other causes		
	Cockchafer grubs	1
	Malformation of tissue	1
	Sulphur damage to stumps	1

Biology

Rigidoporus lignosus

Size of inoculum and rhizomorph production: Inoculum discs of different sizes, grown on Malt Agar, were placed on soil plaques in Petri dishes. The smaller inoculum discs did not produce any rhizomorphs at all; the discs 6.5 mm in diameter produced indistinct silky mycelial threads, which underwent lysis after 2 weeks. However, discs 11 and 23 mm in diameter produced distinct rhizomorphs as well as silky mycelial threads, the larger inoculum discs produced a greater number of rhizomorphs (Table 1). Lysis of rhizomorphs was observed only after 5 weeks in the case of the larger inocula compared to 2 weeks in the smaller ones. (O. S. Peries and N. I. S. Liyanage).

Table 1. *Number and length of rhizomorphs produced by inoculum discs of different sizes*

Diam. of inoculum discs (mm)	*No. of rhizomorphs*	*Total length (mm)*	*No. of silky threads*	*Total length (mm)*
3.5	0	0	0	0
5	0	0	0	0
6.5	0	0	6	156
11	3	115	7	95
23	16	510	13	242

Comparison of isolates from different hosts: *In vitro* studies showed that the optimum temperature for growth of all isolates was 30°C. However, there were significant differences in the growth habits of different isolates: those obtained from *Manihot* and *Monstera* were slow growers compared to those from *Hevea*, particularly the virulant 'H' isolate (see *Ann. Rev.* 1978). None of the isolates grew at 15°C or at 40°C, except the 'H' isolate, which made some growth at 15°C, but not at 40°C. The optimum pH for growth for all isolates was 8. Continuous darkness or intermittent light and dark conditions favoured the growth of all isolates; but continuous light retarded all of them. (O. S. Peries, N. I. S. Liyanage and J. L. P. Chandrika).

Miscellaneous

Screening of fungicides: Thirty four fungicides were screened against *R. lignosus*, *Phytophthora* sp, *Colletotrichum gloeosporioides* and *Fusarium solani* using the contact sterile filter paper technique. (A. de S. Liyanage, O. S. Peries, N. I. S. Liyanage, D. M. Dantanarayana, J. L. P. Chandrika and E. A. T. Senadheera).

Host-parasite Relationships

Oidium heveae

Histological basis of resistance: Disease-free copper brown and apple green leaves of several clones: RRIC 52, 100, 103 and PB 86, were dusted, on their adaxial surfaces, with 24 h old conidia and inoculated under optimum environmental conditions. Samples were removed after 2, 4, 6, 12, 24, 48, 72, 96 and 120 h to study the pre- and post-penetration behaviour and a part of the material was fixed in formalin - acetic - alcohol for sectioning. The percentage germination of conidia on leaves of different clones is shown in Table 2. (A. de S. Liyanage, A. Dharmaratne and B. Fernando).

Table 2. *Mean percentage and av. germ tube length (μ) of Oidium conidia on leaves of different clones* (*Germ tube lengths are in parenthesis*)

Clone	*TIME* 2h	4h	6h	12h	24h	48h	72h
RRIC 52	38.25 (21.81)	37.29 (22.76)	45.11 (33.48)	45.15 (39.58)	54.09 (80.21)	67.26 (81.29)	41.88 (92.97)
RRIC 103	34.43 (21.23)	26.97 (24.10)	45.29 (33.05)	52.13 (34.61)	59.78 (56.91)	57.96 (77.66)	54.54 (110.88)
RRIC 100	24.45 (19.30)	25.49 (23.57)	31.30 (28.68)	37.15 (35.07)	53.22 (45.39)	54.42 (62.00)	— (—)
PB 86	34.06 (21.09)	27.70 (25.16)	44.79 (34.45)	49.52 (34.14)	47.71 (49.97)	58.44 (54.62)	— (—)

— Too long therefore not recorded.

Phytophthora sp.

Biochemistry of host penetration: The maximum amount of phenolic compounds were released 6h after immersing the pods in a zoospore suspension. Later, several pod cavities were inoculated with a zoospore suspension and kept for 6 h to collect the diffusates, to be used for identification by chromotographic and spectroscopic methods. This material is now ready to be despatched for identification. (A. de S. Liyanage, O. S. Peries and N. I. S. Liyanage, in collaboration with P. A. J. Yapa).

Colletotrichum gloeosporioides

Biochemistry and histology of host penetration: Pre-penetration studies were carried out on clones RRIC 100, 103, 105, 117, PB 86, IAN 873 and FX 4098. Significant differences in percentage germination were not observed, between the different clones tested. However, more appressoria were formed on resistant clones than on susceptible ones. Mycelial growth was more extensive on susceptible than on resistant clones. The appressoria were mostly

found at the junctions of epidermal cell walls. Epidermal cells showed a discolouration 8 h after inoculation. This occurred almost always at the sites where appressoria formed. It was observed that comparatively more cells were discoloured in resistant varieties.

Studies were carried out to determine the antifungal substances present in the leaves of clones RRIC 100 and PB 86. Five spots were located on the chromotograms and elutes of one of these spots showed a high degree of inhibition on spore germination, when the bioassays were done.

Cuticle development was studied under field conditions. In this preliminary investigation, it was observed that in the clone RRIC 105 the cuticle was formed in 7 days, while in RRIC 100, 104, 117 it took 9 days. However, its formation was delayed in PB 86 and Tjir 1 where it took 11 and 10 days, respectively. In RRIC 52 the cuticle was formed in 8 days. Further studies on the pre-penetration behaviour of *C. gloeosporioides* on different varieties will be continued. (P. K. Samaradeewa and A. de S. Liyanage in collaboration with P. A. J. Yapa).

Epidemiology

Rigidoporus lignosus

Release and viability of spores: Studies on sporocarps maintained at different humidities showed that no spores were released at 0% RH, the maximum number of spores was released during the first 24 h period at all other humidities. The numbers decrease rapidly after 48 h and no spores were released after 96 h storage, at all humidities tested (Table 3). Germination of spores and germ-tube length were highest at high humidities. (O. S. Peries & N. I. S. Liyanage).

Table 3. *Release of basidiospores from detached sporocarps maintained for various periods under different conditions of humidity*

RH	*Period of exposure(h)*	*Mean no. of spores released**	*% germination under optimum conditions*	*Germ tube length (μ)*
0	24	0	0	0
52		14.6	32.3	6.3
80		65.2	65.7	45.9
100		67.8	68.3	49.8
0	48	0	0	0
52		7.0	18.2	3.2
80		51.8	49.7	35.6
100		57.5	53.5	42.7
0	72	0	0	0
52		2.4	0	0
80		9.8	25.1	18.2
100		9.9	25.8	23.6
0	96	0	0	0
52		0	0	0
80		0	0	0
100		0	0	0

* per microscope field.

Biological Control: A survey of soil bacteria and actinomycetes antagonistic to *R. lignosus* was made using soils collected from Agalawatta, Homagama and Boralu series soils. Potentially antagonistic organisms were detected using Herr's triple-agar-layer technique. It was found that Czapeck's Dox Agar medium was unsuitable for the third layer. Further, introduction of macerated mycelium to the third layer resulted in very poor growth of *R. lignosus* and quick sporing soil fungi tended to smother growth. The recommended dilution of 10^{-3} resulted in the development of numerous colonies which overlapped each other. Therefore, Herr's triple-agar-layer was modified by using Malt Agar (MA) for the third layer. Agar blocks from 3-day old cultures of *R. lignosus* were used instead of macerated mycelium on the third layer and the best dilution ranged from 10^{-4} to 10^{-7}. (C. K. Jayasinghe).

FIELD INVESTIGATIONS

Host-Parasite Relationships

Oidium heveae

Clonal susceptibility: Twenty plants each of 124 clones, grown in a nursery at Dartonfield, were assessed to determine susceptibility to *Oidium* leaf disease, by recording the percentage leaf area affected by the disease, under natural conditions in the field.

These studies indicated that the F, FX and IAN clones, of South American origin, were more resistant to *Oidium* than local clones. However, some of the RRIC 100 series selections, particularly RRIC 103 appear to be more resistant than the other local clones (Table 4). (A. de S. Liyanage, S. Wettasinghe and A. Dharmaratne in collaboration with D. M. Fernando).

Table 4. *Percentage leaf area infected by Oidium*

Clone	*Mean % of leaf area infected*	*Clone*	*Mean % of leaf area infected*
IAN 45/717	0.57	2473	5.44
2427	0.93	RRIC 94	5.50
RRIC 107	1.43	RRIC 95	5.64
6306 (RRIC 120)	1.65	RRIC 76	5.87
F 351	1.66	RRIC 50	5.90
IAN 45/710	2.01	NAB 12	5.97
FX 714	2.02	RRIC 105	6.01
F 4542	2.15	RRIM 605	6.02
AV 1349	2.37	CH 32	6.30
2418 (RRIC 115)	2.49	Wagga 6278	6.39
RRIC 60	2.51	RRIM 707	6.56
F 409	2.75	IRCI 10	6.64
RRIC 108	2.90	RRIM 623	6.70
RRIC 103	3.00	RRIC 42	6.81
RRIC 91	3.20	RRIC 109	6.82
IAN 45/873	3.28	RRIC 63	6.86
RRIC 52	4.08	RRIC 87	6.98

Clone	*Mean % of leaf area infected*	*Clone*	*Mean % of leaf area infected*
3221 (RRIC 113)	4.76	M.K. 3/2	7.00
NAB 15	4.79	RRIC 5	7.02
RRIC 32	5.28	RRIC 49	7.18
RRIC 86	5.37	PB 86	7.22
IRCI 2	5.41	RRIC 45	7.24
Tjir 1	5.42	RRIC 57	7.31
RRIC 106	5.43	RRIC 68	7.33
RRIC 117	5.44	RRIC 54	7.34
RRIC 88	7.47	IRCI 1	7.44
RRIC 55	7.79	AY 1735	12.86
LCB 1320	7.80	IRCI 7	13.13
RRIC 47	8.04	GT 1	13.14
RRIC 33	8.10	RRIM 628	13.32
RRIC 48	8.27	RRIC 75	13.59
PR 252	8.35	RRIC 59	14.14
RRIC 104	8.80	RRIC 82	14.30
NAB 17	8.92	RRIC 3	14.40
AV 1734	8.98	RRIC 62	14.40
RRIC 66	9.25	RRIC 36	14.88
RRIC 31	9.43	1305 (RRIC 112)	14.96
RRIM 604	9.59	GLEN 1	15.27
PB 5/51	9.65	AV 385	15.32
RRIC 70	9.76	RRIC 85	15.51
RRIC 41	9.77	RRIC 99	15.56
RRIM 701	9.87	RRIC 7	15.92
IRCI 6	9.88	RRIM 607	16.79
RRIM 621	10.15	RRIM 526	17.27
IRCI 9	10.24	PB 28/59	17.57
RRIC 65	10.81	RRIC 17	18.61
RRIC 64	10.82	RR 255	18.85
PR 107	10.92	RRIC 38	18.87
RRIC 22	11.08	RRIC 37	19.03
RRIM 608	11.11	RRIC 4	19.07
RRIC 13	11.15	RRIM 603	20.55
RRIC 40	11.27	RRIC 39	21.44
RRIM 600	11.41	PR 251	21.76
RRIC 92	11.43	RRIC 110	22.29
RRIC 9	11.57	RRIM 602	22.56
RRIM 609	11.86	RRIC 69	23.42
RRIC 102	12.20	RRIC 89	24.31
RRIC 46	12.21	RRIC 101	24.33
RRIC 6	12.34	PR 253	27.86
RRIC 100	12.52	2417 (RRIC 114)	28.48
RRIM 620	12.58	WR 101	29.74
		AV 1328	36.36
		RRIC 67	51.97

Oidium heveae

Pattern of wintering and incidence of Oidium: This experiment, started in 1978 (see *Ann. Rev.* 1978 p 80) was repeated. The results shown in Table 5 show that wintering started about mid-December and was completed around mid-March. Leaf fall caused by *O. heveae* lasted over the period 10 February to 30 April.

Table 5. *Pattern of wintering and incidence of Oidium leaf fall*

Clone	Wintering		Oidium leaf fall		Highest no.	
	Started	Completed	Started	Completed	1st Peak	2nd Peak
RRIC 7	12 Dec.	24 Feb.	24 Feb.	15 March	25 Feb.	11 March
RRIC 45	12 Dec.	12 March	3 March	30 April	10 March	21 March
RRIC 52	12 Dec.	11 March	23 Feb.	25 March	25 Feb.	9 March
PB 86	12 Dec.	11 March	10 Feb.	30 April	17 Feb.	3 April

Phytophthora spp.

Establishment of infection and sporulation on rubber pods: This experiment, where the development of the disease on inoculated pods was studied, was repeated (see *Ann. Rev.* 1978 p 81.) The disease did not develop on pods inoculated on 14 June, 11 July and 17 July. This was probably due to the unfavourable weather conditions after inoculation. The pods inoculated on 20 June, 26 June and 2 July produced sporangia within a few days, and those inoculated on 20 and 26 June continued to produce sporangia for a few weeks. The data here are difficult to interpret at present; therefore this experiment will be continued over several years in order to correlate weather conditions with infection patterns. (A. de S. Liyanage, O.S. Peries and A. Dharmaratne).

Influence of environment and genotype on infection: Twenty plants of the clones RRIC 36, 45, 52, 100, 102, 103, 104, 105, 107, RRIM 513, 600, 623, PB 86, Glen 1 and Wagga 6278 were inoculated at eight locations using 2 cm diameter cotton wool plugs, and a standardized inoculum to give 100,000 spores per ml, the isolate used being No. 362 in each case. The lesions produced were measured one month after inoculation and are shown in Table 6. Girth measurements and yield (by microtapping) were also recorded; but no significant differences were observed between clones in respect to these two parameters. (A. de S. Liyanage, A. Dharmaratne and S. Wettasinghe).

Table 6. *Area (sq. cm) of infection by the same isolate of Phytophthora sp. on different clones at different locations*

Clone	Stokes-land	Uru-mutta	Paduk-ka	Kiriba-thgala	Amba-deniya	Pitia-kande	Udabage	Mora-lioya
RRIC 36	16.91	17.48	13.95	—	17.18	—	14.44	17.55
RRIC 45	17.13	22.79	23.57	12.55	28.00	20.75	16.82	19.41
RRIC 52	12.10	18.43	11.25	—	11.27	7.52	12.54	12.97
RRIC 100	13.02	15.17	11.72	9.01	13.46	12.05	11.66	13.13
RRIC 101	21.58	29.22	24.22	13.46	15.44	16.31	13.89	18.61
RRIC 102	13.90	18.59	9.64	6.52	12.20	11.60	9.07	16.56
RRIC 103	12.75	17.31	11.35	11.02	14.84	12.54	9.04	14.59
RRIC 104	13.39	13.99	14.48	12.62	14.00	10.07	14.17	—
RRIC 105	13.30	16.06	15.87	12.23	15.06	11.42	12.43	14.90
RRIC 107	9.71	22.34	13.70	7.53	12.00	12.40	14.14	11.89
RRIM 513	18.93	30.39	20.46	17.10	16.16	14.43	16.55	26.27
RRIM 602	18.75	35.24	24.03	12.16	17.48	19.67	17.81	25.76
RRIM 623	13.90	16.92	13.46	8.74	11.27	12.11	11.58	19.58
PB 86	17.35	—	15.12	9.37	13.46	9.89	20.34	16.47

Effect of different factors on the incidence of Bark Rot: The experiment on the effect of different factors such as age of trees, height and depth of tapping and zoospore concentration on the incidence of Bark Rot, started in 1978, was continued. (see p 77 *Ann. Rev.* 1978).

The panels tapped daily and every alternate day were significantly more susceptible than those tapped on every third day. Those tapped on the S_2 d_4 system did not show any infection. These results confirmed the findings of the previous year.

Although a spore suspension of 10 zoospore/ml caused an infection in the previous year, this year the infection started with a higher concentration of 100 zoospore/ml. The lesion area increased significantly with the increase in spore concentration.

The variation in lesion area, between the different ages of trees was significant. Although it was difficult to interpret the results obtained in the previous year, due to its variability, the results this year indicate that the younger clearings tend to be more susceptible to *Phytophthora* infection.

The height of tapping did not influence the spread of the fungus and a reducton of lesion size was observed with the use of the Michie Golledge knife.

The data on the depth of tapping were variable this year and were not analysed. (A. de S. Liyanage and B. Fernando).

Rigidoporus lignosus

Spread from buried inoculum: Large stumps and big lateral roots were buried at various distances from freshly planted budded stumps. None of these plants showed foliar symptoms of *Rigidoporus* infection 8 months after introduction of the inoculum, although some large sources of inoculum were buried only 60 cm from them. After 18 months only two plants had died of infection, and another showed leaf symptoms. At this stage (18 months) all plants on either side of the buried inoculum pieces were collar inspected, when two more infected plants were identified but neither of them had shown foliar symptoms. Therefore, after 18 months only 5 out of 480 plants had been infected, and in each case the infection had spread either from a stump buried between two planting points, *i.e.* 180 cm away or from a large lateral buried 60 cm or 180 cm away from the plant.

The degree of decay of the inoculum and its viability were also assessed. After 18 months, 35% of the inoculum had decayed fully and lost viability, while 45% had decayed partially and 20% slightly. The latter two categories were viable at this stage. No new infections were recorded at the end of 30 months. Most of the laterals had completely decayed by this time, and 25% of stumps were partially decayed; all remaining inoculum was viable. (O. S. Peries, N. I. S. Liyanage and W. Amaratunga).

Inoculation: Lateral roots of 6-year old plants were inoculated with inoculum of different sizes. When these roots were examined after 3 months only external growth of fungal mycelium was noted; after 6 months the number of roots showing external symptoms remained the same, but on splitting open the roots, it was noted that the fungus had penetrated the roots at this stage. Even small inoculum pieces, 1 cm in diameter, had led to penetration and internal spread of the disease in 6 months (Table 7). (O. S. Peries, N. I. S. Liyanage, A. de S. Liyanage and S. S. Warnapura).

Table 7. *Development of disease on inoculated roots, mean spread on laterals (cm)*

Inoculum diameter (cm)	*3 months after inoculation*		*6 months after inoculation*		
	Towards collar	*Away from collar*	*Towards collar*		*Away from collar*
	External infection	*External infection*	*External infection*	*Internal infection*	*External infection*
0.6	21.7	51.0	0	0	0
	0	0	0	0	0
	0	0	40.5	23.0	0
	0	0	20.0	0	0
	0	0	22.0	0	decayed
2.54	0	0	0	0	0
	0	0	0	0	0
	79.5	30.0	0	0	0
	79.0	96.0	53.3	0	45.0
	64.3	53.5	70.0	0	30.0
5.08	59.0	68.0	0	0	0
	0	0	128.0	18.0	61.0
	0	0	178.0	540	decayed
	61.0	74.0	66.5	28.5	decayed
7.62	0	0	88.5	0	0
	76.7	52.0	0	0	0

There was no internal infection at all after 3 months, and after 6 months all internal infections were seen to move towards the collar and not away from it.

Natural spread: The natural spread of White Root disease was studied on a number of estates. The percentage infection was high at Padukka, Gallewatta, Dartonfield and Stokesland Estates. The mortality rate was highest at Doloswela Group, with Padukka and Gallewatta Estates being the next two in that order (Table 8).

Table 8. *The rate of spread of White Root disease on several estates*

Estate	*% Cumulative infection up to 1977*	*% Increase 1978*	*% Increase 1979*
Muwankande	57.8	4.3	3.1
Peenkande	3.0	0.9	0.7
Doloswela	21.9	5.4	3.0
Moralioya	28.5	5.2	1.1
Mahaoya	14.0	9.9	2.9
Urumutta	10.0	2.2	0.9
Ambadeniya	25.1	2.2	1.0
Golinda	18.7	6.1	1.7
Gallewatta	13.2	8.0	4.1
Dartonfield	18.1	7.2	3.8
Kiriwanaketiya	27.7	5.5	3.5
Padukka	17.4	9.7	4.6
Stokesland	19.3	10.4	3.8

Viability of food base: The viability and stage of decay of the food base were assessed in several diseased patches at Mapalagama, Parambe, Peenkande, Gallewatta, Kiriwanaketiya, Elston, Urumutta, Ambadeniya and Nakiadeniya Estates.

The data available to date are very variable, and this experiment must be followed up for a longer period, before any conclusions can be drawn fro m it.

Vertical and horizontal spreads: In certain instances, when soil conditions were favourable, *Hevea* tap roots were traced to depths up to 262 cm. When the tap root is infected, the vertical spread of the fungus is quite rapid and was recorded at depths of 186 and 163 cm. In almost all trees examined, a majority of the laterals had decayed due to infection and in two cases all the laterals had decayed, with only the infected tap root remaining. However, in some trees, although collar infection was quite apparent, some laterals were free of infection while in others the infection had spread throughout their whole length. An important observation was that, in a majority of cases, the infection had spread from the collar outwards to the tip of the laterals, rather than the other way around. Therefore, apparently, the collar gets infected from an external food base either direct or through another lateral, which rapidly decays. The infection then spreads from the diseased collar region to the remaining laterals, spreading outwards from the centre (Table 9).

Table 9. *Vertical and horizontal spread (cm) of R. lignosus in mature Hevea trees showing foliar symptoms*

Estate	*Year of Planting*	*Mean length tap root*	*Mean vertical spread on tap root*	*Mean horizontal spread on laterals from collar*
Ambadeniya	1959	131	134	all laterals fully decayed
Elston	1953	108	108	161
Gallewatta	1953	147	104	107
Kiriwanaketiya	1954	178	103	155
Nakiadeniya	1954	148	135	all laterals fully decayed
Padukka	1953	115	91	153
Panawatta	1949	205	142	71
Parambe	1955	262	186	193
Peenkande	1956	177	163	105
Urumutta	1959	107	91	158

The clone was PB 86 on all estates except at Panawatta where it was a polyclone area.

In some cases infected laterals were seen just below the soil surface, but deeper laterals too were infected, and some were noted at depths up to 79 cm with the deepest being recorded at 249 cm. However, the majority of infected laterals were noted at depths of 0—30 cm (Table 10).

Table 10. *Distribution of infected laterals at different depths shown as a percentage of the total number of infected laterals recorded*

Estate	*Depth*		
	0—30cm	*31—60cm*	*61—90 cm*
Elston	81.8	18.2	0
Gallewatta	58.0	42.0	0
Kiriwanaketiya	60.0	20.0	20.0
Padukka	83.4	16.6	0
Panawatta	44.0	28.0	28.0
Parambe	66.6	33.4	0
Peenkande	58.4	25.0	16.6
Urumutta	75.0	12.5	12.5
Mean	65.9	24.4	9.7

Table 10 shows that the highest percentage of infected roots were observed at depths of 0—30 cm on all sites inspected, with a marked reduction in infection at greater depths. This is probably connected with aeration and hence with soil conditions, and will therefore be studied in detail now. (O. S. Peries, A. de S. Liyanage, N. I. S. Liyanage & S. S. Warnapura).

CONTROL

Oidium heveae

Effect of nitrogen on incidence: *Oidium* infected leaves were counted in treated areas of Kiribathgala, Hunuwella, Ambadeniya and Parambe Estates at weekly intervals during the first quarter of the year and are presented in Table 11. Yield records were also made at monthly intervals, but a continuous record could not be made due to heavy rains at certain times of the year.

The various levels of nitrogen (Table 11) were applied to the experimental areas in the second quarter of the year in preparation for the 1980 season. (A. de S. Liyanage in collaboration with N. Yogaratnam).

Table 11. *The average number of Oidium affected leaves falling in leaf count beds in areas given different levels of N fertilizer*

Kiribathgala	*28.2.79*	*9.3.79*	*19.3.79*	*26.3.79*
No	602.43	324.00	90.43	60.29
N 1	560.57	334.00	73.86	60.29
N 2	496.51	373.14	69.43	60.71
Hunuwella	*1.3.79*	*10.3.79*	*20.3.79*	*26.3.79*
No	624.43	800.00	208.71	77.14
N 1	572.00	544.71	127.71	72.43
N 2	705.86	661.71	217.29	75.71
Ambadeniya	*2.3.79*	*11.3.79*	*22.3.79*	*29.3.79*
No	737.57	245.00	111.00	98.71
N 1	851.00	330.00	122.29	111.29
N 2	884.00	203.86	104.57	82.43
Parambe	*1.3.79*	*12.3.79*	*21.3.79*	*28.3.79*
No	110.29	72.43	143.00	114.14
N 1	81.43	63.29	158.57	117.29
N 2	112.57	75.71	158.71	134.29

No, N_1, N_2 — indicate no N, a single and a double dose of N, at the recommended level for that estate.

Efficacy of fungicides: The comparison of Bayleton, a new fungicide for *Oidium* leaf disease control, with Sulphur dust, started in 1978 was repeated. This is a randomized block experiment, with three treatments: Sulphur, Bayleton and Control, replicated 7 times. Dusting was done at weekly intervals from 9 February and 7 leaf counts were taken at weekly intervals from 9 February to 25 March 1979. The results are summarised in Table 12.

Table 12. *Effect of two fungicides on incidence of Oidium leaf disease*

Leaf Count No.	*Mean leaf fall*		
	Bayleton	*Sulphur*	*Control*
1	40	45	118
2	248	150	349
3	536	452	532
4	873	512	1076
5	910	831	995
6	705	877	995
7	224	311	422
8	169	142	179
9	85	76	100
10	38	47	54
11	84	77	110
12	39	33	47
13	41	46	49
14	56	68	66
Total	4048	3667	5092
Mean	289.14	261.93	363.71

Dusting with Sulphur and Bayleton have both reduced *Oidium* leaf fall; but not significantly and there was no significant difference between the two fungicides. This experiment will be repeated in 1980. (A. de S. Liyanage, S. S. Warnapura, A. Dharmaratne and B. Fernando).

Defoliation and the yield of latex: Yield records were taken prior to and after controlled defoliation to various pre-determined levels. In another trial area, reduction of canopy due to naturally occurring *Oidium* leaf disease was noted visually. Yield records were made regularly. The results of this experiment are presented in Table 13.

Table 13. *Effect of artificial control of canopy on yield of dry rubber*

Level of defoliation	*Av. yield (g)*
100	8.14
75	15.07
50	18.72
25	20.61
Control	22.54

These results indicate that there is no marked reduction in yield following the artificial reduction of 25% of the canopy. However, at levels over 50% reduction there is an obvious reduction in yield. This experiment is being continued. (A. de S. Liyanage and Z. E. Irugalbandara).

Phytophthora sp.

Rainguards and Bark Rot: This is a continuation of the 1978 experiment. The experimental area was dusted with sulphur at weekly intervals throughout the *Oidium* leaf disease season in an effort to control *Oidium* infection of flowers and encourage pod set. Data on yield and tapping days were recorded. The rainguards were refitted on renewed panels during the second quarter.

The incidence of *Phytophthora* leaf fall was negligible and no useful observations can be made. (O. S. Peries, D. M. Dantanarayana & N. I. S. Liyanage).

Bark Rot: This experiment was carried out to determine the most economical method of controlling Bark Rot and the factors that influence bark renewal after infection. The tapping panels of 60 trees of clone PB 86 were inoculated with a standard inoculum of *Phytophthora* sp. to test the methods of control given in Table 14.

Table 14. *Size of lesion (cm^2) following various treatments for Bark Rot*

Treatment	*Lesion area (mean of 10 trees)*
Nail treatment (removal of initial black stripes with a nail)	10.43
Nail treatment and application of fungicides	23.77
Removal of infected bark and application of fungicides	4.49
Removal of infected bark only	4.35
Application of fungicide without removal of bark	1.01
Control — no treatment	2.11

These preliminary results indicate that it is not advisable to merely injure the bark without removing all infected material at the early stages of infection. If the bark is injured, even the application of a fungicide does not appear to assist in the control of the disease. (O. S. Peries, N.I.S. Liyanage, B. Fernando and A. de S. Liyanage).

Rigidoporus lignosus

Effect of sulphur: Soil samples were collected from two levels (1—10 cm and 30—40 cm depth), from planting holes, 12 and 18 months after treatment with sulphur. It was noted at all locations, that the pH of the soil had not reverted to the original level after 18 months, except at Dartonfield where it was very close to the original level (Table 15). The difference in pH on the addition of 114 g and 228 g was very slight, the higher dosage giving a lower pH. (O. S. Peries, A. de S. Liyanage, N. I. S. Liyanage and S. S. Warnapura).

Table 15. *The effect of sulphur on the pH of soils at various locations*

Estate & District	*Soil type*	*pH before application of sulphur*	*pH after 12 months*				*pH after 18 months*			
			228g sulphur		*114g sulphur*		*228g sulphur*		*114g sulphur*	
			U	*L*	*U*	*L*	*U*	*L*	*U*	*L*
Dartonfield (Kalutara)	Agalawatta	4.2	3.3	3.6	3.4	3.7	4.2	4.2	4.2	4.2
Doloswela (Ratnapura)	Ratnapura	4.9	3.3	3.4	3.4	3.7	3.4	3.8	3.8	3.9
	Boralu	4.7	3.2	3.4	3.4	3.6	3.8	3.8	3.8	3.9
Golinda (Kegalle)	Parambe	4.4	3.3	3.5	3.3	3.7	3.6	3.6	3.9	3.8
Moralioya (KV)	Agalawatta	4.4	3.6	3.9	3.9	3.9	3.7	3.8	4.0	4.0
Muwankande (Kurunegala)	Parambe	4.4	3.3	3.6	3.6	3.7	3.7	3.7	3.7	3.7
Padukka (Colombo)	Agalawatta	4.5	3.4	3.5	3.5	3.6	3.8	3.8	3.8	3.9
	Boralu	4.5	3.4	3.5	3.6	3.7	3.8	3.8	3.9	3.9
Peenkande (Ratnapura)	Agalawatta	4.7	3.4	3.7	3.5	3.7	3.9	3.9	4.0	4.0
Stokesland (Galle)	Agalawatta	4.3	3.5	3.8	3.7	3.8	3.8	3.9	4.0	4.0

U = upper layer L = lower layer

The pH of untreated soil (control) was recorded in each estate on every sampling date, and was more or less constant.

Control in the field: Several patches on Padukka, Nakiadeniya, Peenkanda, Panawatta and Gallawatta Estates, which were affected by ***Rigidoporus*** were marked, and these areas were treated as follows before replanting:

(*a*) Roots grubbed out and soil treated with sulphur,
(*b*) Roots grubbed out, but no sulphur was added,
(*c*) Roots not grubbed out, but soil treated with sulphur,
(*d*) Two rows at edge of patch grubbed out and sulphur added,
(*e*) As above (*d*) but without sulphur,
(*f*) Control — no grubbing, no sulphur.

The incidence of *Rigidoporus* infection in these areas will be recorded. (A. de S. Liyanage, S. S. Warnapura & E. A. T. Senadheera).

Fungicides: A new formulation named M_3 was found to be effective in controlling *Rigidoporus* infection, under laboratory conditions. But when applied to the roots of 1-year old plants, it was noted that it was highly phytotoxic. An improved formulation of M_3 was tested on 6-year old infected trees. These were examined after 4 months and the trees that were slightly infected at the time of treatment with Fomac 2 or M_3 showed regeneration of roots. However, the fungus did not grow on the roots treated with Fomac 2 whereas fungal rhizomorphs were seen on four trees treated with M_3.

Collar infected trees died irrespective of whether they were treated with Fomac 2 or M_3.

Methods of clearing on the incidence of Rigidoporus: The trials laid down at Woodend (2 experiments), Yogama, Moralioya, Hathbewa, Muwankanda and Gallawatta Estates are being continued (see 1978 *Ann. Rev.*). It was observed that 2,4,5-T is more effective than Urea or Borax in increasing the rate of decay of rubber stumps, see Table 16.

Table 16. *The percentage decay of rubber stumps treated with different materials (Results from Woodend Estate)*

Treatment	*Amount of decay* (%)
227g Borax per stump	48.14
227g Urea per stump	45.01
Application 2,4,5-T 10% on cut surface	63.48
Control	44.88

The incidence of *Rigidoporus* infection was highest at Woodend Estate during 1979, but generally it was low at all other experimental sites except at Mahaoya Estate, where a few trees were found to be infected (Table 17). (A. de S. Liyanage and W. Amaratunga).

Table 17. *Incidence of Rigidoporus at different sites, where stumps were treated*

Treatment	*No. of trees infected*				
	Woodend	*Hathbewa*	*Dartonfield*	*Mahaoya*	*Muwankanda*
Uproot and burn	2	1	0	2	0
Borax	5	1	0	2	1
Urea	10	0	1	0	0
2,4,5-T	3	0	0	2	0
Control	2	0	2	2	0

Rate of decay of inoculum: Pieces of wood infected by *R. lignosus* were placed under different cover crops *viz.* *Centrosema* sp., *Calopagonium* sp., *Stylosanthus* sp. *Pueraria* sp. and *Desmodium* sp. to assess the rate of decay. There was no obvious difference between the rate of decay under the various covers, 6 months after the experiment was started. However, it was noted that small pieces of inoculum (100 cm^3) decayed faster than larger pieces (200 and 400 cm^3). The larger pieces of inoculum also remained viable for longer periods. Under *Mimosa* sp., although decay was slow, fungal viability was lost rapidly (see Tables 18 and 19).

Table 18. *Percentage viability of inoculum pieces of various sizes placed under different covers for 6 months*

Cover crop	*Inoculum size cm³*	*Lowmont Estate*	*Moralioya Estate*	*Parambe Estate*	*Eduragalla Estate*	*Mean viability*
Centrosema	100	—	50	25	25	33.3
	200	—	25	25	25	25.0
	400	—	25	50	50	41.67
Calapogonium	100	25	25	25	50	31.25
	200	25	25	0	25	18.75
	400	25	75	0	0	25.00
Mimosa	100	0	0	25	25	12.50
	200	0	0	25	6	6.25
	400	25	25	0	50	25.00
Stylosanthus	100	25	0	0	50	18.75
	200	50	50	0	50	37.50
	400	50	25	50	50	43.75
Pueraria	100	50	0	0	25	18.75
	200	25	0	25	50	25.00
	400	50	50	25	50	43.75
Desmodium	100	25	50	25	0	25.00
	200	50	0	50	50	37.50
	400	50	75	50	75	62.50
Naturals	100	25	0	25	0	12.50
	200	25	50	0	50	31.25
	400	25	25	25	50	31.25

— = Not recorded.

Table 19. *The amount of decay (%) of inoculum pieces of different sizes under different covers after 6 months*

Cover crop	*Inoculum size cm³*	*Lowmont Estate*	*Moralioya Estate*	*Parambe Estate*	*Eduragalla Estate*	*Mean decay %*
Centrosema	100	—	50	50	75	58.3
	200	—	25	0	75	33.3
	400	—	25	25	50	33.3
Calapogonium	100	75	25	—	50	50.00
	200	50	25	—	50	41.67
	400	25	75	—	25	41.67
Mimosa	100	25	0	50	25	25.0
	200	25	0	0	50	18.75
	400	25	25	25	50	31.25
Stylosanthus	100	75	0	75	50	50.0
	200	50	50	75	25	50.0
	400	50	25	25	25	31.25
Pueraria	100	25	0	100	50	43.75
	200	75	0	50	0	31.25
	400	50	50	75	25	50.00
Desmodium	100	75	50	50	100	68.75
	200	50	0	50	25	31.25
	400	50	75	25	0	37.50
Naturals	100	25	0	50	100	43.75
	200	25	50	25	25	31.25
	400	25	25	25	25	25.00

— = Not recorded.

It was generally observed that, in the process of decay, wood rots away faster than bark, the latter remaining firm for a few months longer. Fresh growth of the fungus was observed on such persisting bark, even after the wood had completely rotted away. (O. S. Peries and N. I. S. Liyanage).

Xylaria spp.

Methods of Control: The treatment methods carried out in 1975, on 400 infected trees, was assessed this year, by examining the root systems of treated trees. The results observed are summarized in Table 20. The treatments were as follows:

(*a*) Removal of infected tissue and application of Fomac,
(*b*) Removal of infected tissue, application of Fomac and sulphur,
(*c*) Removal of infected tissue and application of sulphur,
(*d*) Removal of infected tissue only,
(*e*) Control.

Table 20. *Effect of different treatments for the control of Xylaria infection*

Treatment	*% No. roots infected*	*% No. roots decayed*	*Mean No. roots regenerated*
a	10.3	4.0	247.1
b	11.3	3.5	265.9
c	10.7	4.3	271.0
d	15.2	5.9	203.6
e	14.5	16.0	149.5

Considering all factors the treatments with Fomac and Sulphur alone or in combination appear to be good. It is also to be noted that the regeneration of roots appears to be poor in the control. (A. de S. Liyanage, S. Wettasinghe and A. Dharmaratne).

Rate of decay of inoculum: The rate of decay of roots of different sizes infected with *Xylaria* spp., was assessed by burying them at various depths (30, 60, 90 and 120 cm from the surface) in the soil and re-examining them 18 and 24 months afterwards.

Infected roots buried at 30 and 60 cm decayed faster than those at greater depths, irrespective of size of inoculum. Smaller roots decayed faster and the weight loss of such roots was greater than in larger roots. (A. de S. Liyanage, S. Wettasinghe and A. Dharmaratne).

SURVEYS

R. lignosus

Incidence of White Root disease in different districts: As only a few estates in the Kurunegala District were surveyed in the previous large-scale survey, three more estates in this district were brought into this survey in 1979. The percentage area infected in Kurunegala was found to be less in the previous survey; the current survey confirmed this as shown below:

District	*No. of Estates*	*Area Surveyed (ha)*	*Area infected (ha)*	*% Area infected*	*Av. infected in Wet Districts*
Kurunegala	3	559.24	2.14	0.38	7.7

Some estates were re-surveyed to assess the increase in spread of the disease. Two estates in which the survey was carried out earlier were selected from each district. The results obtained up to end 1979 are recorded in Table 21. (A. de S. Liyanage, W. Amaratunga and J. L. P. Chandrika).

Table 21. *The amount of infection in 1979 compared to 1978 in selected estates*

Estate & District	*Area Surveyed (ha)*		*Area infected (ha)*		*% area infected*	
	1978	*1979*	*1978*	*1979*	*1978*	*1979*
Kiriwanaketiya (Kalutara)	523	506	41.1	41.4	7.9	8.2
Mahaoya (Avissawella)	942	707	150.6	116.7	16.0	16.5
Pussella (Ratnapura)	531	479	51.9	51.6	9.8	10.8

MISCELLANEOUS

Root Development:

The development of the root system of newly planted budded stumps was carefully studied. The following were the observations:

After 3 months — all roots were confined to the planting hole and were 6 — 10 cm long.

After 6 months — the laterals were beginning to grow out of the planting holes.

After 9 months — there was an average of 30 small roots per plant, not much more than at 6 months. The number of medium sized roots increased rapidly, there being 3—26 per plant, with an average of 10. There were a few larger roots 5—8 mm in diameter too.

After 12 months — the majority of laterals had grown out of the planting hole.

Generally, at all stages of growth, RRIC 45 and RRIC 52 produced more laterals than other clones. It was also noted that the soils at Parambe Estate allowed better root development than the soils on the other estates studied. (N. I. S. Liyanage and B. Fernando).

Effect of Plant Vigour on White Root disease: 350 seeds of clones LCB 870, PB 86, RRIC 45 and RRIC 52 were individually weighed and sown in germination beds to assess germination daily. The seedlings have been planted in the field using a fully randomized design, and growth measurements are being recorded at regular intervals. These plants will be inoculated with *R. lignosus* in due course to assess the effect of vigour of seedlings on incidence of White Root disease. (C. K. Jayasinghe, A. de S. Liyanage in collaboration with N. E. M. Jayasekera).

Resistance to South American Leaf Blight: Several clones, RRIC 114, 115, 117, 119, 121, 130 and 6005 and 8798 were studied. Biochemical assays showed that there were several compounds in RRIC 130 which inhibit spore germination in *Colletotrichum gloeosporioides* when compared to a susceptible clone like 6005. However, there was one compound in susceptible clones which showed 100% inhibition of spore germination in *C. gloeosporioides*. This fungus is used for studies in Sri Lanka, as it has been found that clones resistant to infection by it are also generally resistant to SALB.

There was no difference in germination of spores on the leaf surfaces of susceptible and resistant clones.

Preliminary studies on the peroxidase activity have been completed. (L. C. Wijetillake, D. M. Fernando, A. de S. Liyanage and P. A. J. Yapa).

Effect of Mikania cordata or R. lignosus: Extracts from buds, leaves, stems and roots of *M. cordata* were incorporated separately into Malt Agar and assayed on the growth of *R. lignosus* mycelium and germination of its basidiospores. There was evidence to show that there are some inhibitary compounds present especially in leaves and stems of *M. cordata* and less so in buds. Chromatographic separation of the extracts is in progress. (N. Karannagoda, M.Sc. student, A. de S. Liyanage, M. K. S. A. Samaraweera and P. A. J. Yapa).

Services to outside organisations

Minor Exports Crops Department: *C. gloeosporioides* was isolated from seeds of pepper sent by the Department of Minor Exports Crops to the RRI.

The systemic fungicide, Derosol, either alone or in combination with Candarson, was found to be the most effective fungicide tested for the control of *Fusarium* spp. on Mulberry. (A. de S. Liyanage and D. M. Dantanarayana).

STUDIES OVERSEAS

Three officers of the Department are overseas carrying out various studies as follows:

South American Leaf Blight:

Dr. A. de S. Liyanage, Head of Department, left Sri Lanka on 17th November to join Dr. K. H. Chee of the Unit of the Rubber Research Institute of Malaysia at the University of the West Indies in Trinidad, to undertake collaborative research on South American Leaf Blight (SALB), on a fellowship awarded by the FAO, for 12 months.

The following investigations have been initiated:

Identification of pathogenic races of Microcyclus ulei: Leaf discs from ten clones with or without the F 4542 parentage have been inoculated in the laboratory, using a 'wild' strain and an isolate obtained from the clone IAN 2664, which had succumbed to SALB recently. These isolates have also been cultured on potato-sucrose-agar to study their morphology.

Assessment of clones bred in Sri Lanka: A detailed evaluation of the C and SL clones was initiated. The observations and records included the total number of leaves, total leaves infected, total number leaves shed, severity of the damage, total leaf area damaged, sporulation, presence or absence of perithecia and morphology of the stroma (Table 22).

Leaf discs obtained from them were inoculated using the two strains (mentioned above) to assess the rate of growth and lesion size, under laboratory conditions. (A. de S. Liyanage).

Table 22. *Detailed evaluation of SALB resistance of SL clones*

Clone No.	*Field Disease rating*	*Perithecia*
SL25	4	Present
26	1	Absent
27	4	Present
28	1	Absent
29	3	Present
30	2	Absent
31	4	Present
32	5	Present
33	3	Present
34	1	Absent
36	5	Present
39	4	Present

Clones SL 35, 37 & 38 are not available.

Phytophthora spp.

Mr. D. M. Dantanarayana, Senior Technical Officer, left Sri Lanka on 31 May for a short course of study at the Commonwealth Mycological Institute, U.K.

Studies on the morpho logy of *Phytophthora* isolates from Rubber, Cacao and Coconut in Sri Lanka were continued.

The course on the identification of micro-fungi, conducted by the Commonwealth Mycological Institute was followed.

An attempt was made to obtain a single spore isolate of *Xylaria* spp. from the ascostroma received from Sri Lanka.

A *Synchytrium* spp. was found to be associated with the diseased specimen of Cardamum from Sri Lanka. Six new isolates of *Phytophthora* from Sri Lanka Rubber were included in the study.

Perithecial sections were also prepared from the ascostroma of *Xylaria* spp. from Sri Lanka. (D. M. Dantanarayana).

Electron — Microscope

Mr. Z. E. Irugalbandara, Senior Technical Officer, left Sri Lanka on 19 April, to study host-parasite relationships of leaf pathogens, using the electron microscope, at East Malling Research Station, U. K.

REVIEW OF THE SOILS AND PLANT NUTRITION DEPARTMENT

By

N. YOGARATNAM

SUMMARY

The main concern of the Department is the study of the response of the rubber tree to the supply of nutrients. It appears that the amount of some nutrients in particular potassium, required by the rubber trees (PB 86) in replantings is higher than what is recommended currently to *Boralu* soils. Moreover, the potassium requirements of the RRIC 100 series clones appear to be still higher than that of the PB 86. There are also indications in general of higher yields with applications of N, P and K. Yield increases ranging from 5 to 32% over no fertilizer plots, have been recorded.

Yield data obtained from an experiment that has been in progress for the last 7 years indicated that urea is as effective as sulphate of ammonia as a source of nitrogen for mature rubber growing in Boralu soils. Other experiments also showed similar tendencies. With regard to sources of phosphate, imported rock phosphate appeared to be more efficient than Eppawela apatite as a source of phosphate for immature rubber. Increasing the concentration of P with Eppawela apatite as the source is not likely to increase its efficiency. Among the three sources of magnesium *viz*: commercial epsom salt, kieserite and dolomite, it seems that even a sparingly soluble form of Mg such as dolomite could be used in replantings. Based on these findings, fertilizer recommendations to rubber are being revised in order to accommodate dolomite, the cheapest source of Mg available in the country, in the fertilizer schedule.

It has been observed that from an economic as well as agronomic point of view, all fertilizers to mature rubber should be applied within one month after refoliation if only a single application is envisaged, within one and three months after refoliation if two applications are given and when three applications are made within one, two and three months after refoliation. This would however depend on weather conditions at the time.

Some cover management practices such as establishment of legumes and fertilizing them with phosphate continued to show their long term beneficial effects on growth and yield of mature rubber. But, with regard to potassium fertilizers, its application direct to the rubber tree appears to be a more efficient method at least during the early stages of a replanting, than its application to the ground covers, especially in K deficient soils.

Investigations on soil conservation practices showed that until the establishment of a good leguminous cover in a new or replanting, use of mulch is a good agronomic practice. Attempts should also be made to establish good legume covers without resorting to clean weeding. Spraying with latex alone or compounded latex is not likely to be beneficial under our conditions.

DETAILED REVIEW

GENERAL

Name of the Department

The Rubber Research Board accepted a suggestion from all Research Staff to change the name of the Department to that of: "Soils and Plant Nutrition Department".

Staff

Dr. N. Yogaratnam was in charge of the Department from June 1979. The Soils Chemist, Mr. C. G. Silva, was released to work for the National Fertilizer Secretariat for a period of one year from June 1979. Dr. M. K. S. A. Samaraweera, Assistant Soils Chemist, returned to Sri Lanka in June 1979, after being awarded the Ph.D. degree of the University of Bristol for his thesis entitled "A study of the growth regulator in Dimethyl amino succinamic acid".

Mr. J. G. de Mel was transferred from the Botany Department to this Department. Miss C. Mahipala, Mr. Nandasiri Silva, and Miss U. G. Dingiriamma were appointed as Technical Officers and assumed duties on 16th January 1979, 6th March 1979 and 3rd September 1979, respectively. Mr. K. S. K. Wijeratne resigned from the services of the Institute in September 1979. All other staff were on duty throughout the year.

Visits

N.Yogaratnam, paid 84 experimental visits, 8 advisory visits and 18 other visits. M. K. S. A. Samaraweera paid 17 experimental and 8 other visits. Routine visits to the experimental areas were made by the Experimental Officers, Technical Assistants and Field Assistants.

Working Groups and Committees

N. Yogaratnam served on the following :—

Co-ordinating committee on "fertilizer supplies" of the Ministry of Plan Implementation.

Technical Committee of the Tender Board of the Ceylon Fertilizer Corporation.

Agriculture Group of the Atomic Energy Authority (AEA) of Sri Lanka.

Working Group on "Studies related to the use of Neutron Moisture Probe for assessing availability and conservation of soil water in plantation crops in Sri Lanka" sponsored by the AEA of Sri Lanka.

Working group on "Phosphate Fertilizer Efficiency Studies" sponsored by the AEA of Sri Lanka.

Sub-Committee to draw up an internal co-ordinated programme on the use of ^{15}N in Soil/Plant studies, sponsored by the AEA of Sri Lanka.

Executive Committee of the Soil Science Society of Sri Lanka.

Seminar and Conferences

N. Yogaratnam presented a paper entitled "Developments in fertilizer use for rubber in Sri Lanka" at the seminar on Soil Science and National Development organised by the Soil Science Society of Sri Lanka and held in December.

N. Yogaratnam addressed the Estate Superintendents of the Sri Lanka State Plantations Corporation in the Galle and Deniyaya regions on fertilizer usage in rubber plantations.

Research Students

The following research students were supervised by N. Yogaratnam and worked in the Soils and Plant Nutrition Department on the projects given below.

M. A. Thilakasiri, Advanced Course in Soil Science. Final year B.Sc. (Agriculture), "Some factors influencing the molybdenum concentration in *Agalawatte* Soils (Rubber) of Sri Lanka".

W. M. Karunatilleke Bandara, Advanced Course in Soil Science. Final year B.Sc. (Agriculture), "Inter-relationship between Soil and Plant Nutrient Status in Rubber Plantations."

RESEARCH

RESPONSE TO FERTILIZERS

Growth of immature rubber

Four experiments studying the effects of fertilizers on nutrient uptake and growth of immature rubber were in progress.

In an experiment, *F/76/1*, started on Pembroke Estate, effects of 5 levels of N, P, K and Mg on clone PB 86 growing in *Boralu* series, was studied in a central composite second order design. This experiment was designed to study the response surface of the nutrients N, P, K and Mg by fitting the function Y (girth response) = $b_0 \pm b_1N \pm b_2P \pm b_3K \pm b_4N^2 \pm b_5P^2 \pm b_6K^2 \pm b_7NP \pm b_8NK \pm$ bgPK. Analysis of the girth measurements made at the end of 1979 indicates a significant linear response to application of potassium and curvilinear response to applications of nitrogen and phosphorus. It therefore appears that the amount of potassium required by the tree in replantings is higher than that recommended currently to *Boralu* soils. (N. Yogaratnam and W. C. Dayaratne).

Two other experiments, *F/76/3* and *F/76/4* were laid down on *Agalawatte* and *Homagama* soils to study the effects of different levels of nitrogen, phosphorus and potassium on growth of immature RRIC 100 series clones in comparison with that of clone PB 86. The rate of growth of all RRIC clones was greater than that of PB 86 and there were significant responses to application of nitrogen (Table 1).

Table 1. *Effect of three levels of nitrogen on growth of PB 86, RRIC 101 & 102 on Boralu Soils*

Clone	*Girth (cm)*	*Levels of Nitrogen*	*Girth (cm)*
PB 86	20.75	n_0	20.38
RRIC 101	22.53	n_1	21.65
RRIC 102	23.63*	n_2	23.86*

Another experiment, *F/76/5*, laid down on *Boralu* soils compared the effects of three levels of potassium on clones PB 86, RRIC 101 and RRIC 102. Provision was also made in the experimental design to compare the effects of three tapping systems during the mature phase. Analysis of girth measurements made at the end of 42 months from planting (Table 2) showed a significant interaction ($P > 1.0$) between clones and levels of potassium indicating that the potassium requirement of the RRIC 100 series clones is higher than that of the PB 86. (N. Yogaratnam & J. G. de Mel).

Table 2. *Effect of three levels of potassium on growth of PB 86, RRIC 100 and 102 on Boralu series*

Levels/Clones of K/	*PB 86*	*RRIC 100*	*RRIC 101*
k_0	20.23	24.08	23.27
k_1	22.82	26.71	29.17
k_2	24.05	26.63	29.20

Growth and yield of mature rubber

Eight experiments studying the effects of fertilizers on growth and yield of mature rubber were in progress covering *Boralu*, *Agalawatte*, *Ratnapura* and *Parambe* series soils. Experiment *F/61/1* in progress at the Kuruwita Sub-station, compared the effects of two levels of N, P and K on the performance of clone PB 86 in *Boralu* soils. Yield data obtained in 1979 (Table 3) showed that applications of fertilizers at the currently recommended rates are likely to give yield increases in the order of 7%, 8% and 21% with regard to N, P and K, respectively.

Table 3. *Effect of two levels of nitrogen, phosphorus and potassium on yield of PB 86 in Boralu series soils*

Treatments	*Yields (kg/ha)*	*Relative Yields (%)*
n_0	1855	100
n_1	1991	107
p_0	1846	100
p_1	2000	108
k_0	1738	100
k_1	2108	121

Yield data obtained from another experiment *F/61/2*, in the same site comparing the effects of three levels of N and P also showed (Table 4) similar yield increases. Results of this experiment also indicated that increasing the levels of N and P beyond the currently recommended rates is not likely to be beneficial.

Table 4. *Effect of three levels of N and P on yield of PB 86 in Boralu series soils*

Treatment	*Yields (kg/ha)*	*Relative Yields (%)*
n_0	1474	100
n_1	1677	117
n_2	1689	118
p_0	1510	100
p_1	1700	114
p_2	1688	114

In general, there were indications of the possibility of obtaining greater yields with applications of N, P and K from experiments started in 1976, covering the *Boralu, Agalawatte, Ratnapura,* and *Parambe* soil series. Yield increases ranging from 5 to 15% have been recorded. (N. Yogaratnam and L. Wickramasingha).

Bark renewal

A study of the effects of three levels of N, P and K on bark regeneration in clone RRIM 623 did not indicate any significant effect of treatments on bark regeneration. (N. Yogaratnam and J. G. de Mel).

Stimulation

Three experiments (*F/60/1, F/78/1 and F/78/2*) studying the effects of different levels of N, P and K in relation to stimulation with Ethrel were in progress. There were no significant effects of fertilizer treatments on yield in relation to stimulation, in the first year of these experiments. (N. Yogaratnam, M. Abeysinghe and M. A. Mendis).

Intercrops

Two experiments were started in Parambe Estate, Undugoda, to study the fertilizer requirements of rubber in relation to intercrops and also of that of the intercrops. In one experiment, (*FI/79/1*) the effect of three levels of N and P to rubber intercropped with passion fruit on growth of both rubber and passion fruit is being studied on *Parambe* Soils. A comparison is also being made between two sources of nitrogen *viz*: sulphate of ammonia and Urea.

A second experiment, (*FI/79/2*) was started to evaluate (1) the feasibility (2) the economics of growing coffee under rubber with provision for studying the effect of the intercrop on the yield of rubber. The treatments that are being tested in a split plot design are three levels of nitrogen and phosphate and two spacings for coffee (30′×8′ and 15′×8′). This experiment was also started on Parambe soils using clone PB 86. (N. Yogaratnam and M. A. Mendis).

Rubber after tea

An experiment, *F/71/2*, was started in 1971 at Neuchatel Estate, Neboda, to study the effects of three levels of the fertilizer mixture 8:5:4:1 on the performance of rubber (clone PB 214) planted in areas previously under Tea. Girth and yield measurements recorded in 1979 confirm the findings in the previous years that applications of fertilizers improved growth and

yield over that of the trees that did not receive any fertilizers, but there is no significant difference between the two doses of the fertilizer mixture. It seems possible that for rubber planted in areas previously under tea, fertilizers, at least some nutrients. at rates lower than the current recommendation may be sufficient for normal growth. (N. Yogaratnam and M. A. Mendis).

EFFICIENCY OF FERTILIZER UTILIZATION

Full benefits from fertilizers can only be achieved if they are efficiently applied. Experiments were in progress to study the effects of sources of nutrients, method and time of their application.

Sources and placement of nutrients

Nitrogen: An experiment, *F/76/2*, compared the effects of three forms of N, *viz:* sulphate of ammonia, urea and ammonium chloride, three forms of P, *viz:* imported rock phosphate, Eppawela apatite and concentrated super phosphate and three forms of Mg, *viz:* commercial epsom salt, dolomite and kieserite on growth of PB 86 in Boralu Soils. Girth measurements made at the end of 42 months after planting (Table 5) did not indicate any significant differences in growth due to the different forms of nitrogen.

Table 5. *Effect of three forms of nitrogen on growth of immature PB 86 on Boralu Soils*

Treatment	*Girth (cm)*	*Relative Girth %*
Nil nitrogen	18.23	100
Sulphate of ammonia	21.74	119
Urea	22.52	123
Ammonium chloride	21.77	119

Experiment, *F/72/2*, started in 1972 compared the effects of sulphate of ammonia, forked-in and urea, broadcast and forked-in, as sources of N and methods of placement for mature PB 86 in *Boralu* series soil. Yield data obtained from this experiment which has been in progress for the last seven years showed (Table 6) that urea is as effective as sulphate of ammonia with regard to its effect on yield of rubber in *Boralu* soils. Other experiments also indicated similar effects.

Table 6. *Effect of nitrogenous fertilizers on yield of PB 86 in Boralu soils*

Treatment	*Yield (kg/ha)*	*Relative Yields (%)*
Nil nitrogen	1292	100
Sulphate of ammonia	1717*	132
Urea, broadcast	1619**	125
Urea, forked-in	1703***	131

Phosphorus: Four experiments (*F/73/1, F/76/2, F/76/12* and *F/76/17*) compared the effects of different forms of phosphate on the performance of rubber in different soils. Experiment *F/73/1*, in progress at Dartonfield, compared the effects of imported rock phosphate and Eppawela apatite on growth of immature RRIC 101. A count of the number of trees that were brought into tapping at the end of 6 years from planting appears to indicate (Table 7) that the trees in the plots that received imported rock phosphate were growing more vigorously than the trees that received Eppawala apatite.

Table 7. *Effect of two sources of phosphate on the performance of RRIC 101 in Agalawatte soils*

Treatment	*Girth (cm)*	*Trees in Tapping (%)*
Nil phosphate	41.1	27
Eppawela Rock phosphate	42.6	29
Imported Rock phosphate	45.0	45

The effects of these two sources of phosphate were compared at three levels of P in experiment *F/76/17*, on the performance of PB 86 in Boralu soils. Girth measurements recorded at the end of 42 months after the commencement of this experiment indicate (Table 8) that at higher levels of P, imported rock phosphate is superior to Eppawela apatite on its effect on growth of immature rubber in *Boralu* soils. Increasing the concentration of P, with Eppawela apatite as the source, did not have any beneficial effect on growth, suggesting that P availability may not be increased with increase in the levels of Eppawela apatite.

Table 8. *Effects of imported rock phosphate and Eppawela apatite on growth of immature rubber*

Treatments		*Mean Girth (cm)*	*Relative girth (%)*
Nil phosphate		42.76	100
Eppawela apatite:	Level 1	45.66	106
	Level 2	45.91	107
Imported rock phosphate:	Level 1	45.53	106
	Level 2	48.30	112
LSD		1.84	

Magnesium: The effects of three sources of magnesium *viz:* commercial epsom salt, dolomite and kieserite on the performance of rubber were studied in two experiments (*F/76/2* and *F/76/12*). Assessments made at the end of 42 months after the commencement of the experiments did not reveal any significant differences on growth and yield due to different sources of magnesium. It seems that even a sparingly soluble form of Mg such as dolomite could be used in replantings. (N. Yogaratnam, M. A. Mendis and J. G. de Mel).

Time of fertilizer application

Two experiments, *F/76/13* and *16* studying the effects of N, P and K applied at defoliation, at refoliation or after hardening of leaves, on nutrient uptake in mature rubber, confirmed the previous year's findings that for efficient uptake of nutrients, fertilizers in particular N and K should be applied either at defoliation or within three to four months after refoliation. Based on this and economic considerations, it is now recommended that all fertilizers to mature rubber should be applied within one month after refoliation if only a single application is envisaged, within one and three months after refoliation if two applications are given and when three applications are made within one, two and three months after refoliation. (N. Yogaratnam and B. Arsakularatne).

Foliar nutrition

Experiments on the effects of foliar nutrient sprays containing different concentrations of Zn, B, Fe, Mn and Mo on nutrient uptake and growth of immature PB 86 did not show any significant effect of treatments on growth. It appears that none of the trace elements tested are likely to be limiting growth of young rubber in Boralu soils. (N. Yogaratnam and W. C. Dayaratne).

TRACER - AIDED STUDIES

Root activity pattern of Hevea

Studies on the root activity pattern of *Hevea* using ^{32}P as the tracer were continued. An experiment (*P-32/79/2*) was laid down at Clyde State Plantation to test ten combinations of fertilizer placement *viz:* two vertical depths, 0-15 cm and 15-30 cm and five lateral distances, 0.75 m, 1.5 m, 3.0 m and 3.75 m. Routine fertilizers other than phosphate were applied to all the experimental plants. ^{32}P labelled super phosphate will be applied according to the experimental design in early 1980. (C. G. Silva, N. Yogaratnam and B. Arsekularatne).

Evaluation of the efficiency of Eppawela apatite using ^{32}P

An experiment (*P 32/79/1*) to study the effectiveness of Eppawela apatite as a source of phosphate for rubber was started at the RRI Sub-station in Nivitigalakelle. In this experiment 5 treatments *viz:* (1) Nil phosphate (2) Eppawela apatite, level 1 (3) Eppawela apatite, level 2, (4) imported rock phosphate, level 1, (5) imported rock phosphate, level 2, are being compared in a randomised block design, treatments replicated six times. ^{32}P labelled super phosphate will be applied in early 1980. (C. G. Silva, N. Yogaratnam and B. Arsekularatne).

Use of ^{45}Ca in plant nutrition studies

A supplementary vote was approved by the RRI Board to commence studies in plant nutrition using ^{45}Ca as the tracer. Analytical methods were tested. (M. K. S. A. Samaraweera and P. S. R. S. Samarakoon).

NURSERY INVESTIGATIONS

Effects of different sources and levels of N, P and K on growth of plants grown in "poly bags"

Three experiments (*FP/79/1 to 3*), studying the effects of two sources of nitrogen *viz:* urea and sulphate of ammonia, three sources of phosphate *viz:* imported rock phosphate, Eppawela apatite and super phosphate at three levels of N, P and K on growth of nursery plants grown in "poly bags" were started in Dartonfield. Plants (Clone RRIC 100) were established in polythene bags and fertilizers were applied according to the experimental treatments. (N. Yogaratnam, C. Samaranayake and L. J. Wickremasinghe).

COVERS AND COVER MANAGEMENT

Ten experiments were in progress studying the effects of ground covers and cover management practices on growth of immature *Hevea.*

Types of Covers

In experiment, *C/72/2*, an attempt was made to determine whether legumes are superior to naturals in promoting growth of immature rubber. If so, whether application of extra nitrogen to non-legume covers could improve growth during immaturity and yield during early maturity. Girth measurements made in November 1979 (Table 9) indicate that plants that were in legumes are still superior to the ones that were in naturals. But the girth increments over the last 12 months were greater in trees that were in naturals than those in legumes.

Table 9. *Effect of covers on growth of immature rubber*

Treatments	*Mean girth (cm)*	*Girth increment (1978 to 1979)*
Naturals (control)	47.37	7.5
Legumes	54.08***	0.5
Elimination of non-legumes	51.34	1.3
Naturals with extra nitrogen	49.51	2.4
Naturals with extra nitrogen based on leaf analysis	51.83	8.5
LSD	2.25	—

Studies on the effect of various leguminous covers *viz: Pueraria phaseoloides, Calapogonium muconoides, Desmodium ovalifolium, Mimosa invisa, Centrosema pubescens* and *Stylosanthus guyanensis* (*gracilis*) on growth and production of *Hevea*, were in progress in several sites. The control plots in these experiments are in naturals. Girth measurements made 30 months after planting (Table 10) indicated that in general, trees in legumes were superior to the trees in naturals with regard to their growth. (N. Yogaratnam and F. P. W. Silva).

Table 10. *Effect of leguminous covers on growth of immature rubber*

Treatments	*Mean Girth (cm)*			
	C/77/2	*C/77/3*	*C/77/4*	*C/77/5*
Naturals	15.19	17.63	16.2	11.2
Pueraria	18.98	19.01	19.0	14.8
Calapogonium	18.30	19.42	19.1	14.8
Desmodium	21.01	20.08	19.9	15.5
Mimosa	18.14	17.48	15.7	15.3
Stylosanthus	17.02	18.94	16.3	13.1
Centrosema	18.51	—	17.8	15.8

Phosphate: The influence of phosphate application to covers was studied in an experiment (*C/70/2*) at Pussella Estate, Parakaduwa. The ground cover treatments ceased to exist from 1974 and the phosphate treatments were also discontinued from 1974. Rubber trees that received phosphate still continued to show superiority in growth (Table 11) over the trees that did not receive any phosphate during the immature phase. This effect was shown irrespective of the type of cover grown. Moreover, application of P to covers continued to show their long term residual effect, beneficial to the growth of rubber, in comparison with P application direct to the rubber tree. (N. Yogaratnam and M. Abeyasingha).

Table 11. *Effect of phosphate application on growth of rubber*

Treatments	*Mean girth (cm)*
Nil phosphate	55.05
P to rubber	57.22
P to cover	59.75
P to rubber and cover	60.16
LSD	1.69

Potassium: The influence of potassium application to the ground covers was investigated in an experiment (*C/77/8*) on *Boralu* series soils. Results obtained at the end of 30 months after planting (Table 12) indicate that unlike phosphate application, potassium application direct to the rubber tree appears to be a more efficient method than its application to the ground covers, especially on potassium deficient soils such as *Boralu* series. (N. Yogaratnam and B. Arsekularatne).

Table 12. *Effect of potassium on growth of immature rubber in Boralu series*

Treatments	*Mean girth (cm)*
Nil potassium	13.59
Potassium to rubber	17.63
Potassium to cover—Level 1	15.64
Potassium to cover—Level 2	16.83
Potassium to rubber+cover—Level 1	19.10
Potassium to rubber+cover—Level 2	19.45
LSD	1.73

SOIL CONSERVATION

Investigations undertaken to study the influence of ground covers, mulch and consolidation with natural rubber formulations on run-off and soil losses were continued. Results obtained in 1979 confirmed the previous years findings that mulching with Guatamala grass loppings can reduce run-off and soil erosion losses markedly, as compared to clean weeded and bare land. On the other hand plots in legumes also showed effective control of run-off and soil erosion losses, unlike the observations made in the previous year. This is possibly due to the fact that there was a delay in the establishment of leguminous cover crops in the first year of planting. But, once the legumes are established and a good ground cover is formed, run-off and soil erosion losses could be reduced considerably. Of the natural rubber treatments, latex-oil emulsion gave effective protection against erosion. From the soil conservation point of view it therefore appears that until the establishment of legume covers in a new or replanting, use of mulch is a good agronomic practice. Attempt should also be made to establish good legume covers without resorting to clean weeding. (N. Yogaratnam and W. C. Dayaratne).

Table 13. *Effect of ground covers on soil erosion*

Treatments	*Soil loss (kg)*	
	per plot	*per hectare*
Control (bare)	125.6	25,113
Naturals	0.3	64
Legumes	2.8	550
Mulch	8.3	1664
Latex only	260.4	52,071
Latex+oil	47.3	9460
Compounded latex	190.0	30,004

SOIL MOISTURE

A Neutron Moisture Gauge (Model 1255) and a Plant Water Status Console (Model 3005) were received from the IAEA through the AEA of Sri Lanka, in the latter part of 1979. Work on the calibration of the Neutron Moisture Gauge was started. A technique suitable for the assessment of leaf water potential of rubber leaves was also tested and finalised using the Plant Water Status Console. (N. Yogaratnam and L. J. Wickramasinghe).

SOIL SURVEY AND CLASSIFICATION

Soil Survey of the smallholder areas

This project is an extension of the soil surveying programme, to the smallholder sector of the rubber industry. Detailed soil survey of a few selected smallholdings in the Dodangoda and Agalawatte D.O. Divisions were started. Analysis of the aerial photographs of 1:25,000 scale lead to the recognition of a physiographic map on which the land form and types were demarcated. The soil survey work was carried out according to the physiographic map. A short description of the recognized soil series found in different land forms is given below.

Soils of Hill and Valley terrain

(*a*) High and dissected hills; Agalawatte - Boralu association, Agalawatte on the crests and Boralu on the slopes.

(*b*) High and Eroded hills; Agalawatte - Boralu association, Agalawatte on the crests and Boralu on the slopes, rock out crops are seen on some of the crests.

(*c*) Medium hills; Lowmont - Boralu complex.

(*d*) Low hills; Boralu - Cabook - Lowmont complex.

Soils of Rolling to Undulating terrain

(*a*) Broad and long crests; Ambegedara - Boralu complex with cabook inclusions.

(*b*) Narrow and short crests; Boralu - Cabook complex with Ambegedara inclusions.

This work is being continued. (C. G. Silva, F. P. W. Silva and S. Wasanthadeva.)

SOIL CHEMISTRY AND FERTILITY

Micronutrients

Studies on the micronutrient status of the rubber growing soils and their effect on nutrient concentrations in leaf were continued.

Study of some factors that influence the molybdenum concentrations in *Hevea* leaves indicated a significant positive correlation between acid extractable molybdenum concentration in *Agalawatte* and *Parambe* soils and leaf molybdenum concentration of Clone PB 86. Leaf molybdenum concentration is higher in shaded mature leaves than in exposed young leaves suggesting that shaded mature leaves may be a convenient sample for similar studies. (N. Yogaratnam and M. Perera).

ANALYTICAL CHEMISTRY

Routine Analyses

Routine chemical analyses of survey, experimental and advisory, soil and leaf samples of the Department were done. Requests from other Departments, Research Institutions, the University and other organisations such as the Janatha Estates Development Board and the Ceylon Fertilizer Corporation were also considered. A break down of the number of samples analysed in 1979 is given in Table 14. (N. Yogaratnam, M. K. S. A. Samaraweera, M. Perera, I. Denewaka, P. Samarakoon, C. Mahipala, Nandasiri Silva and U. Dingiriamma).

Analytical Methods:

Methods suitable for quantitative analysis of the nutrient content in latex were tested. (M. K. S. A. Samaraweera and P.S.R.S. Samarakoon).

Weed Control:

No work was done in this field. But, observations were made from experiments started under covers and cover management on weed competition and succession. Use of herbicides does not appear to be an economic proposition at today's prices. (N. Yogaratnam).

Table 14. *Chemical analyses done in 1979 (Number of samples)*

Department		*N, P, K, Ca, Mg & Mn*	*Trace elements (Mo, Cu,Zn, Fe and B)*	*Mechanical analysis, CEC & Organic carbon*
Soils and Plant Nutrition	Leaf:	6080	966	—
	Soil:	261	280	316
Botany	Leaf:	2124	125	—
	Soil:	8	8	—
Biochemistry	Latex:	72	—	—
Tea Research Institute	Leaf:	—	20	—
Coconut Research Institute	Leaf:	338	36	—
	Soil:	338	—	—
University of Colombo	Soil:	3	—	—
Ceylon Fertilizer Corporation	Fertilizers:	15	2	8
Janatha Estates Development Board	Soil:	33	—	99
Nakiadeniya Oil Palm State Plantation				
	Oil Palm Leaves:	65	—	—

EXTENSION

Foliar Survey for Discriminatory Fertilizer Recommendations

The foliar survey programme for 1979 commenced in the first week of June. Seventy three estates covering an approximate acreage of 29,720 were surveyed this year. Of this, 9,417 acres were new surveys and 20,303 acres were resurveys. In addition to this, sixty four small holdings covering an approximate acreage of 281 were also surveyed this year. Fertilizer recommendations to all these estates were sent in December. (N. Yogaratnam, F. P. W. Silva, S. Wasanthadeva and B. Arsakularatne).

Fertilizers to Oil Palm

Fertilizer recommendations to oil palm grown in Nakiadeniya State Plantation had been our responsibility. A foliar survey programme covering an extent of 1180 hectares, was implemented and fertilizer recommendations have also been sent to the estate on the basis of this survey. The leaf analytical data of the mature areas that are in production indicated a decrease in the concentrations of N and K in comparison with the values observed in the previous years. (N. Yogaratnam and F. P. W. Silva)

INDEX TO FIELD EXPERIMENTS

F/61/1 — Fertilizers on yield, RRISL Sub-station, Kuruwita.
F/61/2 — Fertilizers on yield, RRISL Sub-station, Kuruwita.
F/71/1 — Fertilizers on bark renewal, Lowmont Division, St. George Estate, Kalutara.
F/71/2 — Fertilizers on growth, Neuchatel Estate, Neboda.
F/72/1 — Sources of nitrogen on yield, Pahan, Sorana, Lowmont, Clyde, Neuchatel and Nellunuyana Estates, Kalutara District.
F/73/1 — Sources of phosphorus on growth, Dartonfield Group, Agalawatte.
F/76/1 — Fertilizers on growth, Pembroke Estate, Kalutara.
F/76/2 — Sources of nutrients on growth, Pembroke Estate, Kalutara.
F/76/3 — Fertilizers on growth, Elpitiya Estate, Elpitiya.
F/76/4 — Fertilizers on growth, Sorana Estate, Horana.
F/76/5 — Fertilizers on growth, Eladuwa Estate, Paiyagala.
F/76/6 — Fertilizers on yield, Annasigalla Division, St. George Estate, Matugama.
F/76/7 — Sources and methods of placement of nitrogen on yield, Annasigalla Division, St.George Estate, Matugama.
F/76/8 — Fertilizers on yield, Rayigam Estate, Ingiriya.
F/76/9 — Fertilizers on yield, Kiribathgala Estate, Ratnapura.
F/76/10 — Fertilizers on yield, Hathbawe Estate, Rambukkana.
F/76/11 — Fertilizers on yield, Muwankande Estate, Mawathagama.
F/76/12 — Sources of nutrients on yield, Glassel Division, Maha Oya Estate, Dehiowita.
F/76/13 — Time of fertilizer application on nutrient uptake and yield, Vincit Estate, Waharaka.
F/76/14 — Discriminatory application of fertilizers on yield, Pembroke Estate, Kalutara.
F/76/15 — Fertilizers (economics) Pembroke Estate, Kalutara.
F/76/16 — Time of fertilizer application on nutrient uptake and yield, Padukka Estate, Padukka.
F/76/17 — Sources of phosphorus on growth, Eladuwa Estate, Paiyagala.
C/70/1 — Covers and cover management practices, on growth and yield, Pussella Estate, Parakaduwa.
C/72/1 — Covers and cover management practices on growth, Sorana Estate, Horana.
C/77/1 — Types of covers on growth, Mirishena Estate, Mahagama.
C/77/2 — Types of covers on growth, Eduragalla Estate, Ingiriya.
C/77/3 — Types of covers on growth, Lowmont Division, St. George Estate, Kalutara.
C/77/4 — Types of covers on growth, Moralioya Estate, Ruwanwella.
C/77/5 — Types of covers on growth, Parambe Estate, Undugoda.
C/77/6 — Types of covers on growth, Muwankande Estate, Mawathagama.
C/77/7 — Types of covers on growth, Artherfield Estate, Avissawella.
C/77/8 — Potassium nutrition of covers on nitrogen fixation and growth, Lowmont, Division, St. George Estate, Kalutara.
P-32/79/1 — Tracer-Aided phosphate on phosphate uptake, RRISL Substation, Nivitigalakele.
P-32/79/2 — Root activity pattern, Pembroke Estate, Kalutara.
SC/77/1 — Soil erosion and surface run-off, Eladuwa Estate, Paiyagala.
FN/77/1-5 — Foliar nutrient sprays on growth, Pembroke Estate, Kalutara.
FS/60/1 — Fertilizers in relation to stimulation, Eladuwa Estate, Paiyagala.
FS/78/1 — Fertilizers in relation to stimulation, Pembroke Estate, Kalutara.
FS/78/2 — Fertilizers in relation to stimulation, Parambe Estate, Kegalle.
FI/79/1 — Fertilizers in relation to Intercrops (Passion fruit), Parambe Estate, Kegalle.
FI/79/2 — Fertilizers in relation to Intercrops (Coffee), Parambe Estate, Kegalle.
FP/79/1-3 — Fertilizers to 'Poly bag' plants, Dartonfield, Agalawatte.

REVIEW OF THE RUBBER CHEMISTRY DEPARTMENT

By

S. W. KARUNARATNE

SUMMARY

The Rubber Chemistry Department deals with:

Rubber Chemistry

Rubber Technology

Specifications and Analysis

Crepe Rubber Development

Biochemistry

Non-rubber resources

An alternative bleaching agent to xylyl mercaptan (RPA3), namely tolyl mercaptan (brand named RR17), was found suitable for use in the manufacture of high quality crepe rubber. At least 10 different types of mercaptans had to be screened in order to select tolyl mercaptan which was found to be even superior to RPA3. The Crepe Rubber Development Unit (CRDU) has concentrated on the manufacture of light coloured high quality NR to consumer requirements. The development of colour (discolouration) during storage of crepe rubber, the colour coding system for crepe rubber, which is based on the production method and the classification of crepe rubber on the basis of its solution viscosity was studied.

It was found that storage hardening of liquid rubber could be reduced by incorporating a radical quencher like ZDC. Several attempts inter-related or otherwise, have been made in order to introduce thermoplastic properties into NR. Both blending and grafting techniques are described. Attempts have been made to synthesise amine-based antioxidants and dual purpose accelerators. The work on the development of network bound antioxidants in NR by the thiol addition reaction has come to a standstill due to the non-availability of the chemical required in commercial quantities.

Several applications for low temperature curing systems are highlighted here. An interesting and useful application is in the rubberising of bullock cart wheels. However without changing the design of the cart, maximum benefit from the above development would not be feasible. Low temperature curing systems based on NR could be used to safeguard the tea bush against desiccation and borer attacks by effective sealing of pruning cuts. Promising ebonite formulations for compression moulding of engineering components are described. About 5 tons of cyclised rubber per month are manufactured presently in four estate factories. Deproteinised NR prepared by papain/acid coagulation is satisfactory for cyclisation in the open mill using p-toluene sulphonic acid. Incorporation of 5% CaO helps in the neutralisation of excess acid.

Metal salts of higher fatty acids such as calcium stearate and the calcium salt of rubber seed oil fatty acid (CARSOF) have been shown to be very effective activators of sulphur vulcanization. Carboxy methyl cellulose (0.5%) was used as a wetting agent in the manufacture of

Rubber/Carbon black masterbatch in the latex stage. It has been found that the sheet form is the most suitable way to prepare the masterbatch for drying. Compounds prepared from the masterbatch have been tested out and found to be satisfactory. The properties of local clay were continually monitored. Some variation in acidity leading to retardation of vulcanisation has been spotlighted.

One of the main functions of the Technology Section is to give an adequate technical service to the rubber products industry and several multifaceted activities in this direction are highlighted in the report. In the processing of latex, the work reported includes preservation, concentration and dialysis of NR latex.

In the field of raw rubber processing, RRIC 103 was found to be the most suitable of the RRIC 100 series clones for crepe rubber manufacture, whereas RRIC 102 was found to be unsuitable due to discolouration. An attempt to make CV block rubber by direct pressing of CV lace crepe is reported.

Solar energy for drying crepe rubber is appropriate in the context of the energy crisis. Arrangements are being made at Padukka Estate rubber factory to install a solar collector unit for a new drying tower under construction.

Technical specification of NR continued to be one of major functions of the Department. Six block rubber factories are registered with the Specifications Unit and the average number of samples tested daily is about 100.

The clone RRIC 39 has been found to be the best clone for enzyme deproteinisation, using papain. Effect of Ethrel stimulation on some of the non-rubber constituents were investigated. No significant change in thiols were observed in the A-serum during the first 24 h after stimulation. An electrophoretic technique for the separation of serum proteins on polyacrylamide has been established.

A useful non-rubber resource is rubber seed oil (RSO). Of the triglycerides available in Sri Lanka, RSO is the only one which has useful drying properties. Light coloured alkyd resins were prepared in a purified form and this work is reported. The free import of linseed oil may jeopardise this nascent industry.

Students from both the Sri Lanka Jayawardenapura University and the Moratuwa University have carried out practical classes in our laboratories, and our Officers have devoted not less than 170 hours during the year to lecture to students in Polymer Chemistry, Technology and Biochemistry at all the Universities in the country and students preparing for examinations conducted by the Plastics and Rubber Institute (PRI).

DETAILED REVIEW

Staff and staff movements

Mr. M. Nadarajah, Head of the Department, was on duty till 1979.11.26 when he retired from the services of the Institute. Mr. S. W. Karunaratne, the Chief Rubber Technologist, was appointed Acting Head of the Department with effect from 1979.12.01. The Biochemist Dr. P. A. J. Yapa, Chemical Engineer, Mr. R. Tharmalingam, Specifications Officer, Dr. L. M. K. Tillekeratne, Rubber Chemists, Drs. M. R. N. Fernando, A. M. A. Amarapathy and W. S. E. Fernando and Research Assistant, Mr. M. C. S. Perera were on duty throughout the year. Assistant Development Officers, Mr. M. D. R. J. Goonatilake and P. A. D. T. Vimalasiri joined the Institute on 1979.06.01. Mr. Vimalasiri was later appointed Assistant Specifications Officer with effect from 1979.09.20. Dr. A. Coomarasamy, Rubber Chemist, proceeded to U. K. on

1979.07.01 to work at the Malaysian Rubber Producers' Research Association (MRPRA) on a joint project on the development of thermoplastic natural rubber. This project is sponsored by UNIDO on behalf of the Association of Natural Rubber Producing Countries (ANRPC). Mr. L. B. Keerthie Silva, Experimental Officer, who joined the Bristol Polytechnic in U. K. in September 1978 to follow a course in the care and maintenance of electronic equipment, returned to the Department on 1979.09.16.

Mr. Sunil Amarawansa, Mr. K. C. Croose, Mr. P. W. Sedirishamy, Miss P. Opanayake and Miss P. Kariyawasam joined the Department as Experimental Officers on 1979.09.30. Miss P. Kariyawasam and Miss P. Opanayake left the services of the Institute within the year.

Mr. A. S. Dekumpitiya, Mr. D. D. Medagama and Mr. S. Kasinathan served as Senior Technical Officers of the Department throughout the year. Senior Technical Officers Mr. P. P. Jayasinghe and Mr. S. Kasinathan underwent a course of training at the Rubber Research Institute of Malaysia for a period of six months each during the period May to October 1979. This was under the sponsorship of the UNDP. Mr. D. G. Samaneris, Mr. K. M. U. Mithranande, Miss W. C. M. Perera and Miss R. L. Perera joined the Department as Technical Officers during the first quarter of the year. Mr. R. Fernando was transferred to the post of Stores Assistant with effect from 1979.02.12. Mr. R. Munamalpe, Experimental Officer, left the services of the Department on 1979.02.15. In addition to the above staff 16 Technical Officers and 9 Specifications Officers served the Department throughout the year.

Participation in activities of other organisations

Mr. M. Nadarajah served as a Director of State Rubber Manufacturing Corporation (SRMC) and as Director of Ceylon Co-operative Industries Union throughout the year. He has held the post of Chairman of Plastics and Rubber Institute (PRI) since March 1979.

Mr. S. W. Karunaratne was Chairman of the PRI till March 1979, but continued to be the managing editor of the PRI. During this period Mr. Karunaratne edited and published the first number of the PRI Journal. Dr. M. R. N. Fernando held the post of committee member of the PRI throughout the year. Dr. P. A. J. Yapa played an active role in the committee for the Popularisation of Science (CPS) of the SLAAS. He also headed the editorial sub-committee of the CPS.

The Department took an active part in the formulation of standards on rubber and rubber products and worked in close liaison with the Bureau of Ceylon Standards. The NR drafting committee was represented by three Officers and was chaired by Mr. S. W. Karunaratne. Dr. M. R. N. Fernando was the Chairman of the drafting committee on rice huller rollers. Mr. Karunaratne also chaired the committee which was appointed by the National Apprenticeship Board to draw up a scheme for inplant training of NDT students in rubber technology. Mr. S. W. Karunaratne and Dr. L. M. K. Tillekeratne assisted the Curriculum Centre of the Education Department to organise a workshop to assist senior teachers in drawing up a scheme to include 'rubber' as a resource material in the G.C.E. 'A' Level Syllabus.

Awards

Mr. M. Nadarajah was awarded the Institute of Chemistry medal for 1979 for the most outstanding contribution in the Development and Innovation in Industry using a local raw material.

Planters Conferences

Departmental staff addressed four planters conferences held at Avissawella and Galle during the year. Lectures were given on broad aspects of raw rubber manufacture to trainee planters on three separate occasions at Agalawatta.

Publications

The following papers were submitted for publication:—

1. Suitability of RRIC 100 series clones for crepe manufacture by M. C. S. Perera, R. Tharmalingam and W. S. E. Fernando. (Accepted for publication in the Journal of RRISL).

2. Use of papain treatment in the preparation of superior quality rubber by P. A. J. Yapa, M. Nadarajah and K. S. Loganathan. (This paper has been accepted for publication in the Plastics and Rubber International).

3. Enzyme deproteinisation of *Hevea* latex II. Use of papain treatment in RSS manufacture by P. A. J. Yapa and W. A. Lionel. (Accepted for publication in the Journal of the RRISL).

4. Enzyme deproteinisation of *Hevea* latex III. Clonal suitability of papain treatment by P. A. J. Yapa and W. A. Lionel. (Accepted for publication in the Journal of the RRISL).

5. Elimination of the use of RPA3 in crepe rubber manufacture by L. M. K. Tillekeratne. (Accepted for publication in the Bulletin of the RRISL).

6. Deproteinised natural rubber (in Sinhala) for 'Rubber Puwath', by W.A. Lionel.

7. Creaming of natural rubber latex (in Sinhala) for 'Rubber Puwath', by A.M.A. Amarapathy.

8. Rubber Industry in Sri Lanka (in Sinhala) for 'Rubber Puwath', by A.M.A. Amarapathy.

9. Manufacture of crepe rubber and its uses (in Sinhala) for 'Rubber Puwath', by M.C.S. Perera.

SLAAS Annual Sessions

The following papers were read at the 35th annual sessions of the SLAAS, held in December 1979:—

1. Use of NR in engineering applications in Sri Lanka, by M. Nadarajah. (Review paper for Section C).

2. Possibilities of concentration of latex by electrodecantation by S. W. Karunaratne and B.A.P.R. Mendis.

3. Cross link degradation of NR sulphur vulcanisates in the presence of ferric complexes by W. S. E. Fernando and M. C. S. Perera.

4. Analysis of synergistic accelerator combinations by M. R. N. Fernando and K. A. R. M. Perera.

5. Feasibility of creaming NR latex in Sri Lanka by A. M. A. Amarapathy.

6. Alternative bleaching agents instead of xylyl mercaptan (RPA3) for latex crepe manufacture by W. S. E. Fernando, L. M. K. Tillekeratne, M. R. N. Fernando and M. C. S. Perera.

International Conferences and Meetings

Mr. R. Tharmalingam read a paper on 'Presentation of Sri Lanka latex crepe rubber to suit end use requirements' at the International Rubber Conference held in Venice, Italy, in October 1979. Dr. L. M. K. Tillekeratne participated in the 27th ISO/TC 45 meeting held in Ottawa, Canada in October 1979.

Research Students

Five students on National Science Council grants started the following research projects supervised by Departmental staff.

1. Miss K. G. K. Jayatilake's project on 'Some aspects of modification of NR' was supervised by Dr. A. Coomarasamy.

2. Miss H. D. W. M. Perera's project on 'Liquid NR and chemical modification thereof' was supervised by Dr. L. M. K. Tillekeratne.

3. Miss A. M. I. Jayawardena's project on 'Synthesis of new types of antioxidants for NR' was supervised by Dr. A. M. A. Amarapathy.

4. Miss M. Angammana's project on 'The effect of metal salts of higher fatty acids on sulphur vulcanisation of NR and its blends' was supervised by Dr. W. S. E. Fernando.

5. Mr. S. P. Prematilaka's project on 'Serum proteins' was supervised by Dr. P. A. J. Yapa.

Lectures in Polymer Chemistry and Technology

Details of lectures given by our staff to LPRI and TPRI students, Undergraduate students following the Applied Science course at Moratuwa University, Undergraduate Chemistry Students of the Colombo University and the M.Sc. students of Sri Jayawardenapura University are M. Nadarajah (30 lectures, mainly to LPRI students) R. Tharmalingam (10 lectures, to the Applied Science students) M. R. N. Fernando (26 lectures, to M.Sc. and TPRI students) A. M. A. Amarapathy (26 lectures, to M.Sc. and B.Sc. students) S.W. Karunaratne (6 lectures to TPRI students) and L. M. K. Tillekeratne (54 lectures to M.Sc., Applied Science, TPRI and NDT students), W.S.E. Fernando (16 lectures, M.Sc. and Applied Science students).

Specialist lectures were delivered by S. W. Karunaratne and L. M. K. Tillekeratne on 'Rubber to metal bonding' and 'Physical testing of rubber', respectively, to a group of engineers; R. Tharmalingam, on the 'Role of chemical technology in the development of the rubber industry' to the SLAAS and by W. S. E. Fernando on 'The mechanism of vulcanisation of NR' to a group of chemists at the Peradeniya University.

RUBBER CHEMISTRY

Effect of Fe^{2+}/Fe^{3+} ions on the stability and colour of NR

It has been suggested that the development of colour during storage of crepe rubber is due to an interaction between Fe^{2+}/Fe^{3+} ions and naturally occurring phenolic compounds. This project was initiated to investigate the mechanism of:

(*a*) the development of colour in the presence of these ions,

(*b*) if the colour is produced, how this problem can be overcome,

(*c*) to assess the stability of raw and vulcanised rubber in the presence of Fe^{2+}/Fe^{3+} ions in the form of their rubber soluble complexes.

The UV Spectrophotometer was used to obtain the Fe^{3+} content. It was observed that crepe made from PB 86 latex is less discoloured and has a lower Fe^{3+} content than RRIC 7, the crepe of which discolours badly. (W. S. E. Fernando and M. C. S. Perera).

Effect of ferric complexes in the degradation of NR/Sulphur vulcanisates

To study the effect of ferric complexes on the NR Sulphur vulcanisates, three complexes, namely: ferric stearate, ferric 8 hydroxy quinolene, ferric diethyl-dithiocarbamate [Fe (DEDC)] were used.

To introduce them to the vulcanisates, a swelling method was tried, but unfortunately ferric 8-hydroxy quinolene is found to be insoluble in common organic solvents. The other two chemicals, when freshly prepared were soluble in turpentine.

In both ACS-1 vulcanisates and standard rubber vulcanisates, the swelled (24 h in 1% solution) and de-swelled samples showed a higher breakdown with Fe (stearate)/turpentine. In Fe (DEDC)/turpentine swollen samples, the breakdown was less.

When compounded into rubber, all the complexes tend to enhance oxidation. This effect could be reduced by the incorporation of glucose, cresol or hydroquinone.

Sunlight degradation of raw rubber is found to be enhanced by ferric stearate and ferric 8-hydroxy quinolene, but reduced in the presence of Fe (DEDC). This was observed by studying the variations in raw Mooney Viscosity. (W. S. E. Fernando and M. C. S. Perera).

Substitutes for RPA 3

The search for a suitable substitute for RPA 3 (xylyl mercaptan) for bleaching carotenoids in NR latex was continued from last year. Since September 1978, when this project was initiated dodecyl mercaptan, tertiary dodecyl mercaptan, thioglycollic acid, 2-mercapto ethanol, penta chlorothiophenol, zinc salt of pentachlorothiophenol, tolyl mercaptan, thio-beta-naphthol, mercaptobenz thiazole, sodium mercapto benz thiazole, have been tested.

The most promising of these were tolyl mercaptan and thio-beta-naphthol. Tolyl mercaptan was initially synthesised in the laboratory for small scale trials. The synthetic route, starting from toluene is via the sulphonyl chloride which is finally reduced to the mercaptan by reacting with zinc and HCl. By the end of the year, tolyl mercaptan, which was given the brand name RR17, was widely accepted as a very suitable alternative to RPA3.

Commercial suppliers of thio-beta-naphthol could not be located but tolyl mercaptan is readily available. (M. R. N. Fernando, W. S. E. Fernando and L. M. K. Tillekeratne).

The path-way for the bleaching

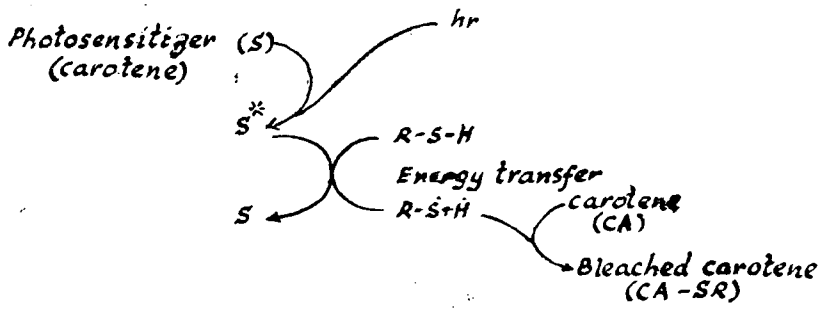
Based on the observations, that

(*a*) electron withdrawing groups directly attached to the ring of aromatic thiols hinder their activity;

(*b*) thioglycollic acid and tertiary dodecyl mercaptan are very poor bleaching agents;

(*c*) this effect of thioglycollic acid is brought about not by its low reactivity but due to its solubility in the aqueous phase.

The following mechanism is proposed for the bleaching action of thiols in natural rubber:



According to this mechanism mercaptans where the S-H bond strength is low can take part effectively in the bleaching process. If this is so thiols where the SH is directly attached to the benzene ring can act as an effective bleaching agent unless electron withdrawing groups such as—NO_2 are found in the ring. (W. S. E. Fernando and D. Nirmala).

Liquid Rubber

The cause for the storage hardening of liquid rubber was studied. Depolymerisation of NR in the presence of nitrobenzene is a radical process and hence there is a possibility for these free radicals to recombine with time causing branching of the rubber molecule by increasing the molecular weight. Therefore, a radical quencher such as ZDC was incorporated into this freshly prepared liquid NR and the rate of hardening of the product was compared with the control. It was found that the rate of storage hardening is less in the case where ZDC is present indicating that the reaction is at least partly due to a radical process.

Experiments were also in progress to see the contribution of the carbonyl groups to the product using carbonyl blocking agents such as 2,4 dinitro phenyl hydrazine. The rate of storage hardening of liquid NR in the solution phase was also studied and it was observed that it is much slower than in the solid phase. Studies of the variation of molecular weight of liquid rubber during this process will also be studied. (L. M. K. Tillekeratne and Miss H. D. W. M. Perera, research student).

Epoxidised liquid rubber

Oxirane oxygen content of the epoxidised liquid NR was determined by a titrimetric method. This is apparently the only method available for the estimation of the amount of epoxy groups in the epoxidised polymer. This estimation was carried out at various stages of storage of the epoxidised polymer to study how the epoxy group breaks down and also to find a way of stabilising the epoxy group in order to make the polymer more stable. (L. M. K. Tillekeratne and Miss H. D. W. M. Perera, research student).

Treatment of NR with peracetic acid in latex stage: A thermoplastic polymer was obtained by treating suitably stabilised centrifuged latex with H_2O_2 and CH_3COOH (glacial) in the presence of small amounts of conc. H_2SO_4 at about 40—50° C for 4 to 20 hours. The rubbery nature was reduced with the increase in reaction time. Detailed structural analysis is being carried out. (A. Coomarasamy, R. Surendrakumar and D. Nirmala).

Preparation of thermoplastic NR

Modification of NR by graft polymerisation: Copolymers of NR containing 80% styrene/acrylonitrile were prepared in the following manner:

(i) Graft copolymers containing 66% styrene and acrylonitrile were prepared and blended with the copolymer of styrene and acrylonitrile prepared by emulsion polymerisation using CHP/TEP initiator system at room temperature. The graft copolymers were prepared at 50 - 55° C. Ammonium oleate prepared *in situ* was used as the emulsifier. These blends of copolymers were coagulated with H_2SO_4 after treating with sodium bisulphite and after incorporating 1% of a phenolic antioxidant. (A. Coomarasamy, D. Nirmala and R. Surendrakumar).

(ii) Graft copolymers of polystyrene with cis polyisoprene were prepared by mixing azotipped polystyrene of controlled mol. wt. with Cariflex IR 305 (or NR grades) in the Hampden - Shawbury torque Rheometer by a dry mixing procedure. The torque pattern in the Rheometer is an indication of the grafting efficiency, a high peak torque indicating a high grafting efficiency. Mixes containing 20%, 30%, 40% and 50% by weight of polystyrene were prepared in the torque Rheometer. The mixing time of all the mixes was 15 minutes. In the case of Cariflex IR 305 the grafting efficiency recorded was over 70% for all mixes varying from 20% to 50% polystyrene. With papain coagulated NR the grafting efficiency was about 47% but with pale crepe (both bleached and unbleached) the grafting efficiency dropped to 14%. The reduction in grafting efficiency in NR compounds could probably be due to the interference of the non-rubber substances in the reaction of azo functionality with rubber.

This work was carried out at the MRPRA in London under a UNIDO grant for the development of thermoplastic natural rubber. (A. Coomarasamy.)

(*c*) **Blending with Poly Vinyl Chloride (PVC):** 20 - 50% Methyl methacrylate grafted rubber was prepared and this was blended with PVC at 130° C for 4 minutes in a Banbury mixer with and without a plasticizer. It was found that the compatibility of the blend was not very satisfactory. Work on this project is in progress. (A. M. A. Amarapathy, W. S. E. Fernando, N. R. Munamalpe and D. G. Samaneris).

(*d*) **Epoxidation of MG grafted latex:** Methyl methacrylate grafted natural rubber was epoxidised using hydrogen peroxide and glacial acetic acid. For this work MG 30 and 40 were used. It was found that the plastic properties of MG rubber were improved slightly by epoxidation. (A. M. A. Amarapathy and D. G. Samaneris).

Synthesis of new types of amine based antioxidants

The synthesis is mainly based on the Mannich reaction.

In order to obtain the required Mannich base, 2.6 ditertiary butyl phenol was reacted with aldehydes and primary and secondary amines. The amines used were: aniline, piperidine, cyclohexyl amine, dimethyl amine, benzyl amine, napthyl amine and 4-amine diphenyl amine.

The aldehydes used were formaldehyde and acetaldehyde.

Infrared spectroscopy, melting point and Lassaigne's sodium fusion test were employed in characterising and identifying the prepared compounds. They were incorporated into natural rubber and the physical properties :

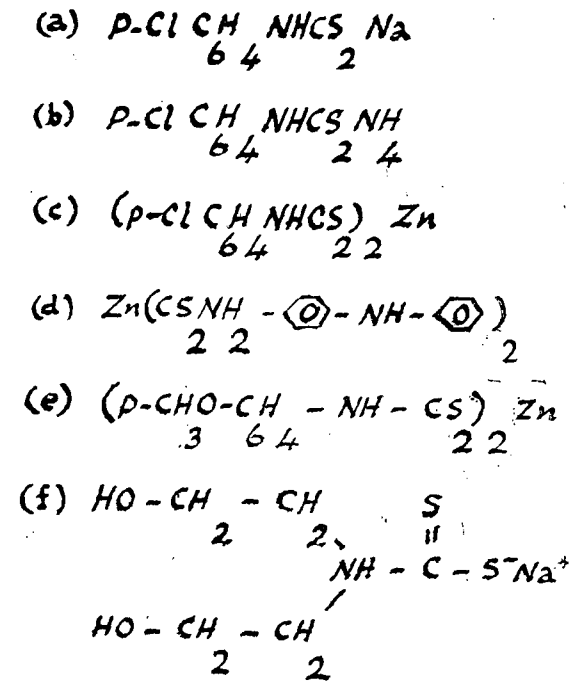
(*a*) Curing characteristics (using Monsanto Rheometer); (*b*) Retention of tensile strength; (*c*) Elongation at break; and (*d*) Stress relaxation were evaluated.

The antioxidant properties of two of the prepared compounds were very satisfactory. (Equivalent to PBN). Further work is in progress. (A. M. A. Amarapathy and Miss I. Jayawardena, research student).

Synthesis of dual purpose accelerators

This experiment was started with a view to synthesise new accelerators with an antioxidant effect on them. Such bifunctional chemicals would assist in the compound preparation as well. Since during vulcanisation, accelerator segments get attached to the polymer, the antioxidant part would also be bound to the polymer because the accelerator moeity, functions as an antioxidant.

Compounds shown below were prepared and studied:



None of them gave favourable results. (W. S. E. Fernando, M. C. S. Perera and K. R. U. Mithrananda).

A different approach has been to react aldehydes of a number of hindered phenols with aromatic primary amines. It is expected that these compounds will show antioxidant activity due to the presence of a phenol group and the accelerator effect due to a—NH group being present in the molecule. Work is in progress. (A. M. A. Amarapathy, P. W. Sedirishamy and D. G. Samaneris).

Network-bound antioxidants in NR using the thiol addition reaction

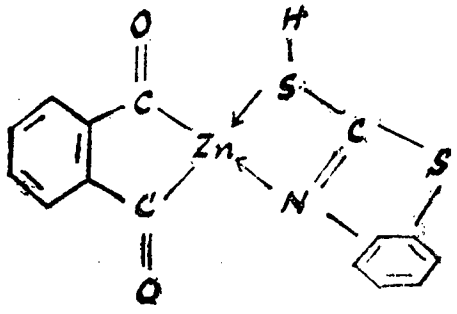
A process for the preparation of network-bound antioxidants using a thiol addition reaction was developed by RRISL as far back as 1974. Although work has been done in various parts of the world to obtain antioxidant attached rubbers, no process has yet been successful at commercial level and such rubbers have not yet appeared in the market. The method developed by RRISL has been found to be very successful at laboratory level and the process has been repeatedly checked by other workers abroad.

It is unfortunate that the developed process cannot be extended to commercial levels; the only obstacle to the success of this process is the non-availability of the chemical required, in commercial quantities. It has not been possible to obtain supplies of this chemical (3,5 ditertiary-butyl-4-hydroxy benzyl mercaptan) from any of the known chemical manufacturers or dealers abroad. The local manufacture of this chemical is also not possible on a commercial scale.

Professor Gerald Scott of the University of Aston in Birmingham, U.K., who is a Consultant to the RRISL and who has been involved in the development of this process has made arrangements with Diamond Shamrock a manufacturer of chemicals to produce this chemical for us and use this process to make antioxidant containing rubbers in collaboration with RRISL. Unless, such a joint venture is initiated, it is very unlikely that this development will ever be put into any use. This is in the negotiation stage yet and we have referred the matter to the Ministry of Plantation Industries for Government approval to go ahead with this venture. (M. R. N. Fernando).

Retardation of vulcanisation

It is reported that the retarding effect of phthalic anhydride is due to the formation of the following compound:



Work was carried out to study the mechanism of retardation with phthalic anhydride. In the system studied, phthalic anhydride and salicyclic acid are found to have a greater retarding effect than phthalic acid. Benzoic acid, terephthalic acid, and anthranilic acid have little or no retarding effect. An increase in the scorch time, by about 2½ minutes at 120°C, was observed when gum vulcanisates were matured for 3 days. It was also found that the scorching tendency is influenced by the nature of the antioxidant in the following order: Flectol H > PAN > DPPD > IPPD (W. S. E. Fernando, M. C. S. Perera and K. R. U. Mithrananda).

Polymers containing carboxyl groups

The styrene/maleic anhydride copolymer (1:1) was prepared by solution polymerisation in benzene with benzoyl peroxide as the initiator. The use of this polymer for the preparation of a granular form of NR was investigated. The actual encapsulating/partitioning agent in this case is the aluminium salt of the copolymer. The sodium (or ammonium) salt of the copolymer was incorporated into the latex and both were precipitated or coagulated together by adding an alum solution. The coagulum obtained was filtered, washed and dried. Technological properties were satisfactory for formulations containing 15% copolymer and 25% carbon black. Polymeric antioxidants with phenolic and amine groups were synthesised. These antioxidants were found to be incompatible with NR but were found to be compatible with NBR (nitrile rubber). The performance of these antioxidants in nitrile rubber was satisfactory. (A. Coomarasamy, D. Nirmala and R. Surendrakumar).

Low temperature curing systems

Rubberising bullock cart wheels: Some further work was done on rubberising the wheels of bullock carts using a room temperature vulcanising system. Our attempts to rubberise wheels with absolutely no modification in design and without using any rubber to metal bonding system has not produced very satisfactory results. It has not been possible to carry out sufficient trials too on this approach due to the non-availability of cart wheels for experimental work. The response shown by actual cart owners to collaborate in such types of experiments has been very poor.

However, very satisfactory results have been obtained in a joint venture with the National Engineering Research and Development (NERD) centre where a sunlight curing system has been successfully used to rubberize the wheels of a cart with an entirely new design. At present these carts are being subjected to intensive road tests. (M. R. N. Fernando and K. A. R. M. Perera).

Carpet backing: Formaldehyde stabilised centrifuged latex containing a room temperature curing system has been successfully used in the manufacture of candlewick mats. During the year more than 100 gallons of this mixture has been used in this application. The layer of rubber thus produced can withstand about 50 machine washings. (M. R. N. Fernando and K. A. R. M. Perera).

Roof sealing mixtures: A 1:1 mixtures of Shelkote-type 3 bitumen emulsion and formaldehyde stabilized field latex containing a sunlight curing system was used to seal cracks in concrete roofs. A large number of trials have been carried out and successful results have been obtained. In one trial at the Ratmalana Airport more than 60 gallons of this mixture were used. It has also been found that the incorporation of an antioxidant and mineral oil considerably improves the ageing properties of this mixture. The performance of such mixtures and latex-cement coatings in minimising seepage in irrigation channels has been investigated and promising results obtained. (M. R. N. Fernando, M. Nadarajah, K. A. R. M. Perera and R. Surendrakumar).

Sealing of pruning cuts: Experiments were carried out to investigate the possibility of using sunlight curing latex-bitumen emulsion mixtures to seal pruning cuts in tea plantations. The presently used bituminous preparations are expensive and are not completely effective. Both field latex and centrifuged latex stabilised with formaldehyde and containing a room temperature vulcanisating system have been used in the trials. The effect of the presence of TMTD which is an accelerator as well as a fungicide has also been tested. At an annual pruning rate of 25 - 35,000 hectares and at an average applications level of 30 litres/hectare, Sri Lanka needs about 450-670,000 litres of the product for application over pruning cuts, if efficient control of die-back and borer attack are to be achieved. The performance of the latex-bitumen mixtures is being studied. This work has been done in collaboration with the Tea Research Institute. (M. R. N. Fernando and M. Nadarajah).

Cashew nut shell liquid (CNSL)

Extensive work was done to evaluate the suitability of modified CNSL as an antioxidant in natural rubber vulcanisates. Assessment of decay in properties like tensile strength, modulus at 100% elongation, modulus at 300% elongation and elongation at break with oven ageing at 70° C and 100° C, did not show any reproducibility in results to state conclusively whether CNSL is effective or not as an antioxidant. However, continuous stress relaxation measurements and oxygen absorption studies of vulcanisates showed that CNSL is much less effective than common amine-type antioxidants like PBN and IPPD. Further ageing tests and physical property measurements are being done to obtain reproducible results. (M. R. N. Fernando, K. A. R. M. Perera and W. C. M. Perera).

Ebonite formulations in engineering

Work was done to develop ebonite formulations, which can be used to manufacture machine components. To obtain components of sufficient hardness, good surface finish and dimensional stability within reasonable curing periods, ternary combinations of accelerators were used. A formulation consisting of 100 parts of rubber, 40 parts of clay, 40 parts of sulphur, 2 parts of MBT, 2 parts of ZDC and 1 part of DPG was found to be suitable for a component having a thickness of more than 1 cm. This formulation cures in 35 minutes at 140°C and the surface finish obtained is good. A small industrialist is using this process and the formulation to supply components to the Textile Corporation. It has been proved that ebonite formulations can be used as a good substitute for plastic material in certain engineering components, if the curing system and curing temperature are carefully selected and controlled. (M. R. N. Fernando and K. A. R. M. Perera).

Cyclised Rubber

Cyclised rubber masterbatches were made at D. Samson Industries, Galle and at Premjay Industries, Homagama on two roll mills. The raw rubber for masterbatching was masticated and 5% CaO on the weight of cyclised rubber used, was incorporated into it. The cyclised rubber was then banded on the warm mill and the masticated rubber containing CaO was mixed. It was observed that vulcanisates of acceptable quality could be obtained when MBTS/TMTD or MBTS/ZDC systems were used.

Deproteinised RSS prepared by papain coagulation was satisfactorily cyclised at Yahalakele Estate, Horana using para-toluene sulphonic acid. It was observed that RSS prepared from latex coagulated with a 50-50 mixture of acid and papain for commercial trials, as they dry faster than RSS from latex coagulated with papain alone. A small quantity of this rubber has been made for further trials. Four estates viz: Yahalakele and Sorana at Horana, Delkeith at Lathpandura and Frocester at Bulathsinhala now manufacture about 5 tons of cyclised rubber per month. (W. S. E. Fernando, M. Nadarajah, A. Coomarasamy and R. Surendrakumar).

Metal salts of higher fatty acids as activators

Calcium stearate: Joint laboratory investigations on the use of calcium stearate in tread type formulations were concluded by the RRI and the Sri Lanka Tyre Corporation during the year. The economic and technological advantages of using this activator in tread formulations were assessed at the Tyre Corporation Central Laboratory; and found to be:

a. A saving of 14 cts, per kg of compounded NR;
b. improved ageing properties;
c. better flex cracking resistance; and
d. increased resistance to crack growth.

A full report on the performance of this activator is being prepared.

Use of calcium salt of rubber seed oil fatty acid (CARSOF):

This material was so successful in factory trials that one retreading firm purchased 150 kg of it after the trials. (W. S. E. Fernando and M. Angammana, research student).

Carbon Black Masterbatch

A wetting agent, carboxy methyl cellulose (CMC) helped in the preparation of the masterbatch. A processing oil was added to reduce the hardness (Table 1.) Trials have been carried out to find out the most suitable form in which the masterbatch should be prepared. The sheet form was best both cost-wise and ease in handling. Two batches of 20 kg each of the masterbatch were handed-over to the Industrial Development Board (IDB) to be used by the small scale industrialists. The industrialists have used the blends successfully in the manufacture

of fish plates and engine mounts. Detailed technological studies have been carried out on the compounds with varying amounts of wetting agent and processing oil to estimate the exact amount of these two ingredients required for proper masterbatch preparation. The initial problem of drying the masterbatch has been overcome to a great extent by reducing the oil used in the masterbatch.

Samples will be sent to the Dunlop Research Centre, Birmingham, U.K. to evaluate the dynamic and rheological properties. Table 3 gives the basic properties of vulcanised rubber prepared according to the formulation given in Table 2. (R. Tharmalingam, W. S. E. Fernando and R. Goonetilake).

Table 1. *Masterbatch Preparation*

	Parts by weight
Rubber (latex)	100
Carbon Black	45
C.M.C	0.5
Oil in Emulsion form	5.0

Table 2. *Compound formulation*

	Parts by weights
NR	100*
Carbon Black	45
Oil	5
ZnO	5
Stearic acid	2
CBS	0.5
PBN	1
S	2.5

***Control**—Rubber from the same bulk as the latex used for masterbatch preparation.

Table 3. *Summary of Test Results*

	% Resilience	*Shore Hardness*	*Abraison Index*	*Mod 100% MN/m²*	*Mod 300% MN/m²*	*Elongation*	*T.S. MN/m²*
Control mixing	58.5	55	0.67	2.9	14.7	450	19.6
Masterbatch mixing	55.5	60	0.69	2.4	12.7	450	22.8

Network-bound antioxidants

A 10 kg sample of latex crepe with bound antioxidant (Topanol A) was sent to Messrs. Easthampton Rubber Thread, U.S.A. for the evaluation of its properties. They have informed us that these samples do not stain textile fibres and it is adequate and acceptable in oxygen ageing values. They have asked for a 1 ton sample of latex crepe with bound antioxidant. We are making arrangements to comply with their request. (A. M. A. Amarapathy).

Powdered NR (spray drying of NR latex)

Trials were carried out using grafted and modified NR latex as partitioning agents. MG 50 and prevulcanized latices were used for this purpose. The product obtained by spray drying a mixture of MG latex and field latex was tested as an adhesive for PVC. Trials carried out so far have indicated that the desired improvement in adhesion is not obtained. (R. Tharmalingam, W. S. E. Fernando and K. P. N. de Silva).

Technological properties of NR latex

The aim of this project is to study the optimum conditions for maturing and prevulcanisation for the manufacture of latex based products. Identifying the ideal conditions can cut down the vulcanising time.

Vulcanisation ingredients were incorporated into centrifuged latex and matured at room temperature and prevulcanised at 60° C for known lengths of time. The latex films were cast and tensile strength and elongation at break were studied. Intensity of cross linking was studied by the determination of swelling index. Work on this project is in progress. (A. M. A. Amarapathy and D. G. Samaneris).

Custom compounding

An attempt was made to obtain low and constant viscosity rubber by the addition of hydroxylamine and peptising agents to latex.

Renacit 7 was incorporated as a dispersion at 0.03%, 0.04%, 0.05% and 0.07% on the dry rubber. PRI values came down but was in the region of 60 for the sample with the highest dosage of peptiser and there was a drop of 21.5 units in the raw Mooney viscosity. There was no significant reduction in resilience and hardness of vulcanisates prepared from this rubber. But some of the samples gave low tensile strength and poor stress relaxation values.

Investigations with latices of three clones: RRIC 45, PB 86 and RRIM 600 showed that PB 86 gave the highest breakdown. Raw Mooney Viscosity dropped to below 20 units. PRI values were higher than 60 units but the vulcanisates gave low tensile strength and poor stress relaxation values.

An alternative method for the drying of wet coagulum will be looked into in order to improve the quality of the rubber. (A. M. A. Amarapathy, M. C. S. Perera and D. G. Samaneris).

Local raw material for the rubber industry

Samples of clay from the clay refineries situated at Boralesgamuwa and Dediyawela were monitored on a regular basis to study their effects on the rate of vulcanisation in typical rubber compounds. Two improved grades of clay supplied by the Ceramics Corporation were also tested. The inherent acidity in the clay samples tested was responsible for the delayed cure time. In certain instances with thiazole accelerators cure rate was completely retarded. In such instances a booster accelerator was necessary to step up the cure rate and the incorporation of accelerator by a masterbatch technique gave more reliable results. (S. W. Karunaratne, D. D. Medegama, P. P. Jayasinghe, B. H. R. Mendis and L. Perera).

Technical services

a. Lecture demonstrations were held during the year on the use of latex and raw rubber in rubber products manufacture. The demonstrations were mainly in the manufacture of latex-based rubber goods, such as dipped products, castings, rubberised coir, latex thread and latex foam. (S. W. Karunaratne, A. M. A. Amarapathy and W. D. Dharmasena).

b. The Department also organised several exhibitions on rubber products and their manufacture throughout the country. (S. W. Karunaratne and W. D. Dharmasena).

c. The workers of the Seeduwa Rubber Industries were trained in the manufacture of foam rubber and necessary advice was given to install machinery to manufacture rubberised coir products. (A. M. A. Amarapathy).

d. Technical advice was given to Metrofoam Industries to install machinery to manufacture foam rubber and dipped products in their factory at Ekala. (A. M. A. Amarapathy).

e. Technical advice was given to "Polymero" Ltd., Polgasowita, to set up a latex-based industry, including factory layout and design of a vulcanising chamber. (S. W. Karunaratne).

f. We assisted the National Institute of Management to organise a field training scheme in rubber products manufacture. (S. W. Karunaratne).

g. Elasto Ltd. was given assistance in preparing concentrated latex to International Specifications. (S. W. Karunaratne).

h. A project report on the manufacture of rubberised coir mattresses with a capital cost of approximately Rs. 500,000/- was submitted to J. E. D. B.'s Regional Office at Avissawella. A survey was carried out to identify a suitable site and an abandoned factory in Ruanwella Estate was finally selected to site the factory. (S. W. Karunaratne).

i. A scheme for the evaluation of rubber-based products on the basis of the technological content, man-power utilisation and the percentage of rubber used in the finished product was submitted to the Ministry of Plantation Industries and the Investment Promotion Zone (IPZ). (S. W. Karunaratne).

j. Work on the development of a tennis ball core was undertaken in collaboration with Richard Pieris & Co., Ltd. The problem was to develop sufficient pressure in the core of the ball without reducing the bond strength between the two hemispheres. A two part adhesive system was used to bond the two halves and the necessary bounce was obtained by suitable adjustment of the chemicals used in the core, to generate the gas during the fixing of the two hemispheres, in a special mould under heat and pressure. (S. W. Karunaratne and P. P. Jayasinghe).

k. Trials were carried out to assist Elasto Ltd., Bentota, to manufacture a suitably soft foam pad to be used as a corn protector. Foam from both dry rubber and latex was prepared to different hardnesses by adjusting the filler loading and blowing/foaming efficiency. In the case of latex foam, stiffness was obtained by incorporating PVA as a stiffening agent upto a maximum of 10 phr. (S. W. Karunaratne., W. D. Dharmasena, B. H. R. Mendis and L. Perera).

l. A fishing float was developed from rubber by a casting process, using a plaster of paris mould. Attempts to use coir dust were not successful due to the prohibitive weight of the coir dust. There is no apparent cost benefit in the manufacture of fishing floats from rubber compared to plastics such as polystyrene. (S. W. Karunaratne and W. D. Dharmasena).

Processing of latex

(*a*) Electrodecantation of NR latex

Electrodecantation is the process by which the latex could be concentrated by the passage of an electric current in a vessel which contains several membrane partitions. The results obtained indicate that the reduction in field strength alone is not sufficieut

for avoiding the deposition of rubber particles on the surface of the membranes. Due to membrane deposition in certain instances there was a reduction in the concentration of latex in the top layer. Highly ammoniated latex was found to be the most suitable starting material, out of a number of systems tried out. It gives the least amount of membrane deposition. There was pronounced membrane deposition when formaldehyde stabilised latex was used. Addition of anionic stabilisers helped to reduce the membrane deposition. Time of maturation of latex after addition of anionic stabilisers, especially with sodium oleyl para-anisidine sulphate, had a marked effect on the efficiency of concentration especially when added to latex at a concentration of less than 15% dry rubber content. Peak efficiency was observed after 76 hours of maturation.

The current was switched on only for short periods during trials. The longest was less than 3 h as a precaution against heat generation due to dissipation of electrical energy. During this time the maximum concentration achieved in the top layer was only 45%. This was not limited by the initial concentration of the latex. Starting with diluted field latex (15%DRC) it was possible to achieve a concentration of 45%.

The current was reversed at short intervals to prevent membrane deposition and clogging of the membranes. The best results were obtained when the current reversal time was adjusted to 2 min and the duration of current reversal was 10 sec. Field strength was maintained at 0.75 volts/cm to minimise any agglomeration of latex particles at the membrane surface and also to help redispersion when the current was reversed.

A severe shortcoming in the laboratory experiment was the heating up and accompanying loss of ammonia. With a low voltage gradient it was not possible to increase the efficiency of concentration (using field latex at 30% DRC), beyond 25% increase in concentration within a period of 3 hrs. If a means of cooling by water circulation could be incorporated into the electrolytic cell, its efficiency could be further increased.

The chief advantage of the electrodecantation process would be the much reduced initial investment compared with centrifuging.

No attempt has so far been made to study the economics of the process as it is considered essential first to collect actual experimental data from a continuous process. (S. W. Karunaratne and B. H. R. Mendis).

(*b*) **Dialysis of NR latex**

This project was done in collaboration with the Department of Chemistry, University of Peradeniya. Thirty samples were analysed and N_2 levels as low as 0.04% have been obtained. The most promising experiments were repeated and their results are awaited. Factory trials will be conducted during the first half of 1980 to evaluate the suitability of this technique in large-scale operation. (W. S. E. Fernando and D. Nirmala).

Preservation of formaldehyde stabilised field latex

Secondary preservation of formaldehyde (HCHO) stabilised field latex with ZnO/TMTD and ZnO/NaDDC could prolong its storage life upto 3 months. The following formulations latex were succcessful:

(1) HCHO—1 %, ZnO/TMTD—0.05 %, NH_4 salt of coconut oil fatty acid—0.05% on latex and NaOH at a pH of 8.5.

(2) HCHO 1%, ZnO—0.0325%, NaDDC—0.0325% NH_4 salt of coconut oil fatty acid 0.05% on latex and NaOH at a pH of 9. (M. Nadarajah and D. Nirmala).

Preparation of heat sensitive latex

The effectiveness of both poly vinyl methyl ether (PVME) and poly propylene glycol (PPG) as heat sensitive agents in latex were studied under different conditions of stabilisation. An ethylene oxide/fatty alcohol condensate (Vulcastab LW) was found to be an effective stabiliser at a concentration of 0.2% on DRC. Stabiliser effect was improved and the subsequent heat sensitivity increased when the latex was matured for over 24 h after the addition of the stabiliser. (S. W. Karunaratne, S, Amarawansa & L. Perera).

Centrifuged latex

The Centrifuge Unit of the Department continued to function at Dartonfield during the year. The following types of latex were prepared and supplied for research and other purposes in 1979:

Table 2. *Types of latex prepared*

Type of latex	*Volume/Litre*
High ammonia centrifuged latex	545
High ammonia field latex	475
Low ammonia field latex	45
NaOH/HCHO/TMTD/ZnO stabilized centrifuged latex	310
NaOH/HCHO/TMTD/ZnO stabilized field latex	550
Compounded latex	50

The Unit advised the Centrifuge Factory at Undugoda in rectifying their problems of low dry rubber content and recovery of skim latex. Several industrialists who were interested in putting up new centrifuge factories, visited the Unit at Dartonfield for first-hand information. (P. A. J. Yapa).

Processing of raw rubber

(*a*) **Crepe from RRIC 100 series clones**

Fourteen clones including RRIC 100, 101, 102, 103, 112, PB 86 and RRIM 600 were studied. The physical and technological properties of the crepe rubber made out of these latices were studied. Latex from all the RRIC 100 series clones and RRIM 600 were from Eladuwa Estate; others were from Dartonfield.

The conclusions were that:

a. RRIC 103 is similar to PB 86 with respect to discolouration on storage. RRIC 102 is badly discoloured.

b. The PRI of the crepe prepared from the latex of all RRIC 100 series studied, except RRIC 102, is better than or at least similar to that of PB 86.

c. There is no relationship between stress relaxation of vulcanisates and the PRI of raw rubber.

These studies are being continued to find out the effect of seasonal variations in weather conditions on RRIC 100 series clones. Six trials were done in September, October, November and December 1978 and March, July and September 1979. (M. C. S. Perera, R. Tharmalingam, W. S. E. Fernando and P. A. D. T. Vimalasiri).

(*b*) **Constant viscosity (CV) block rubber manufacture from CV lace crepe**

Due to a high demand for CV block rubber in the market today an attempt was made here to make CV lace crepe in a normal crepe rubber factory prior to pressing the laces into bales by the usual blocking process. Viscosity stabilisation of the crepe laces was done in two stages:

1. Incorporating hydroxylamine hydrochloride and semicarbazide sulphate into latex.

2. Soaking the fresh laces in 2% solution of hydroxylamine hydrochloride and semicarbazide solution separately for different durations.

Further small scale trials are planned before large scale production is envisaged. (L. M. K. Tillekeratne and M. C. S. Perera).

Solution Viscosity of Crepe Rubber

One of the primary end uses for good quality crepe rubber is in the field of adhesives. Crepe rubber could be in great demand if the solution viscosity can be controlled within limits. We have received complaints from manufacturers that there is a wide variation in the solution viscosity of crepe rubber and the present investigation is to find out whether crepe rubber can be broadly separated into two or three groups depending on the solution viscosity. It is anticipated that such a grading system would have a bearing on the method of manufacture mainly of monoclonal latex and it is hoped that a classification using the viscosity as a parameter would not interfere with the colour coding system, suggested to improve the presentation of crepe rubber. At present a data bank is being compiled on the solution viscosity of crepe rubber from different estates. (R. Tharmalingam and R. Goonetilleka).

CREPE RUBBER DEVELOPMENT UNIT (CRDU)

RRI-7 as a bleaching agent in the manufacture of good quality crepe rubber

RRI7 is supplied in the form of a solid or as a solution (30 to 50%) in turpentine, kerosene or low aromatic white spirit (LAWS). The final emulsion is made using a 30% solution. A suitable emulsifying agent is Dupanol OS. Suppliers of this chemical should clearly label the product as RRI7 to avoid any confusion in the minds of the actual users of this chemical, in raw rubber manufacture.

On the basis of factory trials carried out by the CRDU an instruction circular has been issued to estates on the correct procedure of mixing RRI7 with latex. Briefly, a 5% emulsion is prepared from the 30% stock solution by mixing 10 parts of the stock solution with 189 parts of water and 1 part of Dupanol OS or any similar emulsifier; 1000 to 1750 cc of the 5% emulsion is sufficient to bleach the carotenoids in latex equivalent to 50 kg of dry rubber.

Factory trials were carried out by the CRDU to determine the suitability and dosage requirements of other proprietary chemicals. Of the chemicals tested Rupepa 29 (a mixture of aromatic mercaptans) was also found to be satisfactory as a bleaching agent. (R. Tharmalingam and R. Goonetilleka).

Colour Coding Scheme

Objective: Crepe rubber manufactured in Sri Lanka can be classified into three groups. This classification is based on two important unit operations, which are unique to the latex crepe processing industry, namely fractionation and bleaching. Bleaching is an operation carried out in every factory, but fractionation is not. The three groups of classification are:

Fractionated and Bleached (FB)

Unfractionated and Bleached (UFB)

Yellow Fraction (YF)

These three classes of crepe rubber differ in some technical and technological properties. Visual grading does not take these properties into account. The objective of the scheme is to indicate to the consumer the method of manufacture using a colour code.

Technical Properties: The technical properties of the three classes of crepe rubber, *viz.* FB, UFB and YF were evaluated. The average test results of a number of samples from different estates processed in different factories is given in Table 5.

From Table 5, it is evident that the three classes of rubber can be classified technically on the method of manufacture.

The Scheme: The colour coding scheme suggested here is as follows:

The three classes of rubber will carry a different coloured, polythene band $1\frac{1}{2}''$ width, wrapped around each 50 kg bale prior to packing *viz.* a yellow band for Fractionated Bleached crepe rubber, an orange band for Unfractionated Bleached crepe rubber and a brown band for the Yellow Fraction rubber. Table 5 gives some physical properties of crepe rubber classified as above. (R. Tharmalingam and M. C. S. Perera).

Table 5. *Average Test Results*

	FB	*UFB*	*YF*
Dirt (% wt.)	0.03	0.03	0.03
Volatile Matter (% wt.)	0.60	0.60	0.60
Initial Wallace Plasticity (Po)	40	40	40
Plasticity Retention Index (PRI)	70	75	80
Nitrogen Content (% wt.)	0.35	0.40	0.60
Acetone Extract (% wt.)	3.0	3.5	7.0
Relaxed Modulus (MR 100)	6.0	6.5	8.0

Crepe Rubber Drying

Use of electrical heaters in preference to radiators for the drying of crepe rubber laces is becoming popular. These units have been installed already at Dartonfield, Badureliya, Glenross, Kallamallay, Rubber Convertors (2 units) and Pokunuwita factories and they are found to be working very satisfactorily.

In Mahaoya factory (under the JEDB) a unit is being installed. So far all the installation work has been carried out by M/s. Walker Sons & Co. Ltd. Now M/s. Brown & Co., Ltd., has also started installing these units. (R. Tharmalingam and K. P. N. de Silva).

Use of Solar Energy

Arrangements are being made with Padduka crepe rubber factory to install a solar collector unit for the new drying tower which is under construction. Necessary layout and modification necessary in the structure of the building have been provided by the RRISL.

A solar collector will be fabricated in due course in the Colombo Laboratories to evaluate the geometry of the solar collector required for the drying tower at Padukka which has a capacity of 5450 kg. (R. Tharmalingam and R. Goonetilleka).

Raw Rubber Specifications and Rubber/Latex Analysis

Due to the increased activity in the manufacture of Technically Specified Rubber (TSR), more samples were tested during 1979 than any other year since the establishment of the Specifications Unit. The Staff of the Unit had to work overtime to achieve tight targets in issuing certificates. Rubber samples are received on a regular basis from block rubber factories and other similar establishments. Code names of factories, the intensity of testing, and the grades of block rubber produced are given in Table 6.

Table 6. *Identity and main grades of Block Rubber produced in Sri Lanka*

	Factory/Establishment	*Code Number*	*Main grades of SLR produced*	*No. of samples tested during the year (1979)*
1.	Mawanella Block Rubber Factory	AA	5L, 5	6,397
2.	Cenat Factory, Paiyagala	AB	5, 10, 20, 50	3,507
3.	C.W. Mackie & Co.	AC	5L, 5 (RSS)	10,301
4.	Statcon	AD	5, 10, 20, 50	7,603
5.	Sherman & Sons	AE	5L, 5 (RSS)	7,946
6.	Ceymac, Horana	AF	5L, 5 (RSS)	453

The second revision of the Sri Lanka Standard Specification for technically specified raw natural rubber was approved by the Council of the Bureau of Ceylon Standards as a Sri Lanka Standard at the last Council meeting held in December 1979. One of the improvements in the new specification is that, from a particular grade, the source of its raw material could be clearly identified. This specification also outlines a scheme of technically specifying latex crepe, which hitherto has been sold entirely to visual specification. This grade of SLR is unique to Sri Lanka, which has the reputation of producing the best latex crepe in the World. In the latest specification producer limits for volatile matter (VM) are of two different levels for different grades of rubber. If the raw base material used to prepare a particular grade of rubber has been dried initially, a higher value for VM is specified, otherwise a low value is specified which would ensure that proper drying is done in the process of manufacture of this grade of TSR.

During this year as the limit of volatile matter (VM) for dry rubber based block rubber was increased to 0.7% from 0.5% the percentage rejects due to high VM was extremely small. Trials were carried out at both Mawanella Block Rubber Factory and at the Cenat Factory at Paiyagala to see how fraction rubber, precoagulated rubber and cuplump material could be processed and upgraded to meet SLR requirements; so that the cost of production is low and hence the process is economically viable. Meetings were held with the block rubber manufacturers and with the Commissioner of Commodity Purchase, regarding various aspects of block rubber production.

Six inspection visits were made by the Specifications Officer to all the block rubber factories in Sri Lanka to detect and rectify shortcomings in block rubber manufacturers. Approval was given to one block rubber factory, namely Standard Lanka Rubber Producers to send in their samples for TSR testing after checking the facilities available with them for producing technically specified rubbers.

In addition to normal TSR testing this Unit also handled the issue of test reports on 168 miscellaneous samples of acid, latex, water and chemicals. (L. K. M. Tillekaratne, P. A. D. T. Vimalasiri and A. S. Dekumpitiya).

BIOCHEMISTRY

Enzyme deproteinisation

Studies on enzyme deproteinisation of *Hevea* latex were continued in collaboration with Dunlops India Ltd. Two further sets of DPNR prepared with papain were sent to Dunlops for testing for dynamic properties. An eight-ton batch of papain treated rubber was prepared at the Mawanella Block Rubber Factory, to be sent to Dunlops India, to carry out road tests. However, the despatch of this eight-ton batch has been delayed due to non-availability of vessels sailing to either Madras or Calcutta ports during the last six months.

Another one-ton batch of papain-treated rubber was prepared at Mawanella Block Rubber Factory at the request of Weber & Schaer Co., West Germany, for the purpose of exploring the market potential for this rubber in Europe.

The studies on the use of papain in RSS manufacture were completed and a paper on this work was prepared for publication. It was found that the drying problem of enzyme-treated sheet rubber can be alleviated by using papain as a part coagulant with acid. Milling into a thinner sheet also improved drying time (Table 7). The possibility of using acid/papain treated sheet rubber on a large scale in cyclised rubber manufacture was investigated. Several batches of acid/papain treated sheet rubber were prepared at Miriswatta GPC and the cyclisation patterns are now being studied.

Table 7. *Effect of sheet thickness and coagulant on drying time*

	Treatment/thickness		*Drying time (Hours)*
1.	Acid/thick	(2.20 mm) —	63
2.	Acid/thin	(1.70 mm) —	39
3.	Acid/papain/thick	(2.02 mm) —	111
4.	Acid/papain/thin	(1.60 mm) —	99
5.	Papain/thick	(2.60 mm) —	171
6.	Papain/thin	(1.52 mm) —	135

The work on the project on suitability of the latex of various *Hevea* clones for papain treatment was completed during the year. Of the 24 clones tested, RRIC 39 was found to be the best all round clone for enzyme deproteinisation with papain. Three other clones RRIC 52, RRIC 101 and PB 86 were also found to be saitsfactory.

The possibility of using bromelain for enzyme deproteinisation of NR was investigated towards the end of the year. Preliminary results have been satisfactory and further work will be carried out next year.

Samples of DPNR (papain-treated) and LNL (low nitrogen latex) were supplied to CISIR, Colombo for various experimental applications during the year. It was observed that the consumer interest for DPNR is increasing, judging by the number of inquiries received during the year. (P. A. J. Yapa, M. Nadarajah, W. S. E. Fernando, W. A. Lionel, M. D. C. Seneviratne in collaboration with K. S. Loganathan of Dunlops India Ltd.).

Non-Rubber constituents

Amino acids: The investigation on non-rubber constituents in *Hevea* latex was continued, and their effect on Storage Hardening was investigated. Several amino acids were found to have a marked effect on Initial Plasticity and Storage Hardening. Tryptophan, lysine, serine and glutamic acid increased the degree of Storage Hardening whilst cysteine and tyrosine reduced it. Further work is in progress. (P. A. J. Yapa, M. D. C. Seneviratne, and A. M. K. Hemalatha).

Thiols: Studies on thiols were continued. No significant change in thiol content in A-serum was observed during the first 24 h after Ethrel stimulation. This study is to be repeated with F-serum of latex obtained from stimulated trees. Analysis of A-serum for nutrients (N, P, K, Ca & Mg) showed a marked increase in the two clones investigated. (P. A. J. Yapa, S. Kasinathan, M. D. C. Seneviratne and S. P. Prematillake, research student).

Quebrachitol: Preparation of quebrachitol on a commercial scale was looked into in response to a request made by an Overseas Firm. A 500 g sample of crude quebrachitol was sent for evaluation and it has been reported to contain about 25% quebrachitol. (P. A. J. Yapa).

Brown Bast

A chemical analysis of the tissues obtained from Brown Bast affected trees was attempted. However, the work had to be temporarily abandoned due to the resignation of the Officer who was assigned to do this work. Arrangements were made to make an electron microscopical examination of the affected tissue. Tissue samples were sent to U.K. during the latter part of the year. An Interdepartmental Research Group was also formed in order to make a full investigation in all aspects of this physiological disorder. (P. A. J. Yapa and P. Opanayake in collaboration with Dr. A. de S. Liyanage of Plant Pathology Department).

Heretability of rubber properties

The results of this study are being re-analysed by the Statistical Unit and it is hoped to publish the results early next year. (P. A. J. Yapa, D. M. Fernando, B. M. S. G. Peiris and M. D. C. Seneviratne).

Enzymology

Peroxidase and polyphenoloxidase activities of the A-serum were determined. (S. P. Prematillake).

Utilisation of rubber seed oil

Further work was carried out during the year to gather more information on rubber seed oil, with the ultimate aim of obtaining light coloured alkyd resins with good drying properties. Work was carried out with freshly collected seeds, and it was possible to obtain an oil content of about 50% on the weight of kernel by solvent extraction. The iodine value of the oil was approximately 138. Oil content and unsaturation level did not show any change when dried at 40°C in an air circulated oven for periods upto 1 week. But there was a considerable increase in the acid value, and the colour deteriorated due to oven drying. The solvent extracted oil has been further purified and bleached by treatment with methanol and Fullers Earth, and the resulting oil does not darken when heated to 260°C in contrast to untreated oils. Alkyd resins produced from these purified oils are lighter in colour.

Rubber seed oil is a semi-drying oil, which has been used in this country in the paint industry over a long period. Although the quality of the paints did not compare with those based on linseed oil alkyds, the products have been accepted by the local market at least in the non-white varieties. This has been a positive step forward because rubber seed oil is the only oil which has any useful drying properties when compared with all the other triglyceride oils available in Sri Lanka in sufficiently large quantities. The recent import of linseed oil alkyds to the country has become a serious blow to further development of this industry. By utilising the oil of rubber seeds, a new industry had been started and a local raw material which otherwise would have been a waste product, had been utilized. But free import of better alkyds to the country will hinder the development of this local industry. One cannot expect the high quality of linseed oil alkyds from rubber seed oil alkyds, but at the same time to displace a product which has been accepted by the market cannot be regarded as the best way to promote local industries in a developing country. (M. R. N. Fernando and K. C. Croose).

Rubber Seed Oil Fatty Acid (CARSOF) as a water proofing agent (*Extracts from the report of Mr. C Atukorala, Engineering Student Peradeniya, University*)

CARSOF was mixed with cement and its effect as a water proofing agent was tested. The main conclusions are:

Setting time—The variation of setting time was within the specified bounds of ordinary Portland cement with CARSOF percentage varying up to 10% by weight of cement.

Strength—The addition of the chemical tends to have a significant effect on strength.

Absorption—After a period of 5 days the mortar blocks containing CARSOF tends to gain more water than pure mortar blocks.

Permeability—No significant change of permeability was noted with the increase in chemical percentage.

It is concluded that CARSOF is not a very effective water proofing agent for cement. (W. S. E. Fernando).

REVIEW OF THE STATISTICAL SECTION

By

W. N. WICKREMASINGHE

SUMMARY

There was considerable expansion in the analytical work during this year, compared to previous years. To meet with the increasing number of analyses a programmable calculator with a special applied statistics module was received. Staff, too, was increased by one Technical Officer. A dissertation, written on the error reduction in field experiments on *Hevea*, was presented to the University of Colombo, in partial fulfilment of the requirements for the Post Graduate Diploma in Applied Statistics, which the Assistant Statistician followed.

A data bank was opened to keep the files containing details of all the projects of other research departments. Routine Meteorological data were also recorded.

DETAILED REVIEW

General

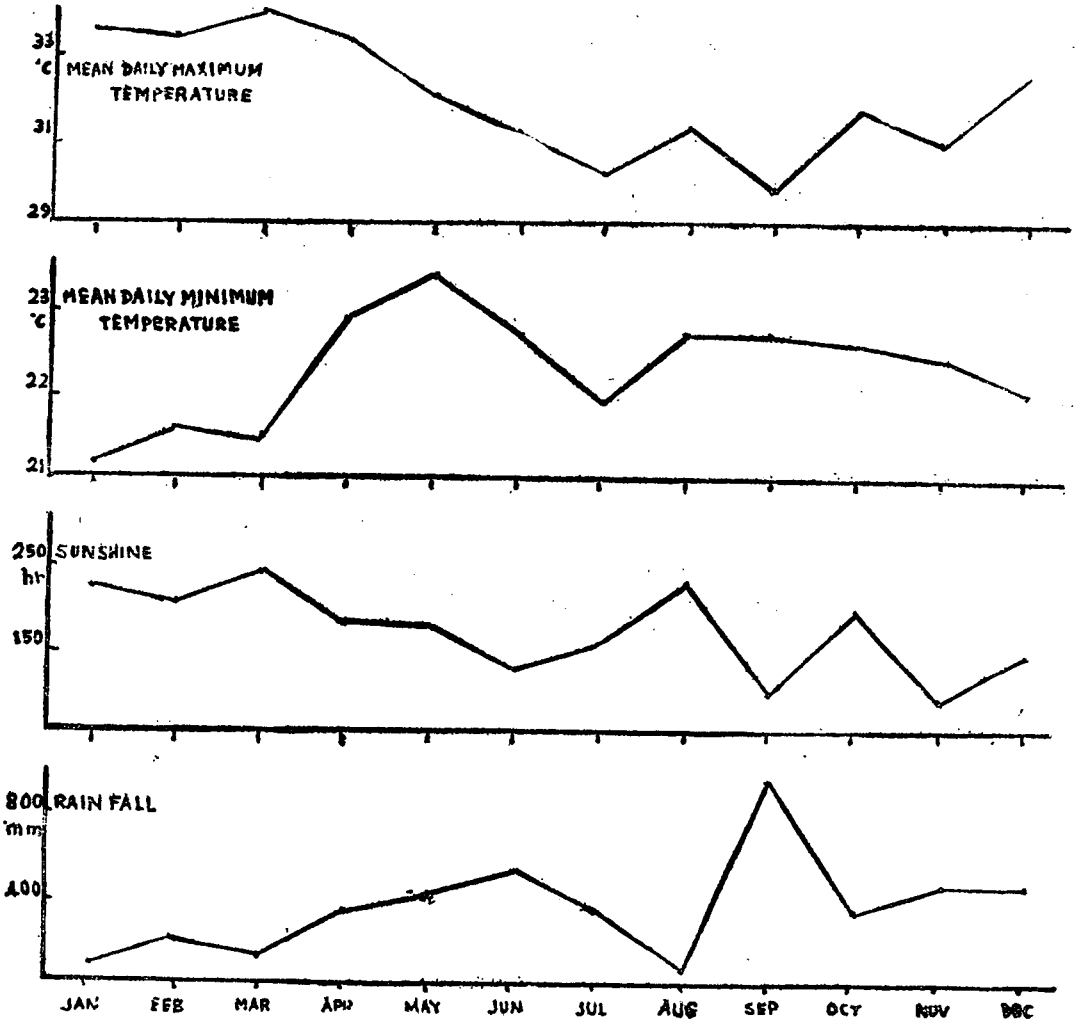
The Statistics Section assists other research departments in designing and analysing their field, green house and laboratory experiments and also interpreting the data which have been analysed. Such assistance is extended to non research departments, too.

The year under review also commenced with the necessity for attending to this statistical analytical work. During this year, there was a significant increase in the statistical analyses undertaken, compared to the previous years. Among these there were complicated and lengthy analyses, too. So it was necessary to complete and interpret analyses within the shortest possible period enabling the Research Officers to write reports in time.

To assist in this analytical work, a TI-Programmable-59 calculator with a special applied statistics module with pre-written programmes, was made available to the section. The bulk of these programmes being analysis of variance, regression analyses, model fitting, significance tests and correlation analyses which are the most frequently used statistical methods in the section. In addition to this, scientific calculators are also available. The programmable calculator not only reduced the computer-time hence saving money spent on computerisation of lengthy analyses, but gave accurate and speedy results just as a standard computer. Assistance of the State Engineering Corporation's computer service was sought only in exceptional cases where, our mini-computer proved to be insufficient in storage capacity. Routine Meteorological work was also attended to on time.

The Assistant Statistician was away from the Institute from January to March, undergoing training on Statistical Methods at the Coconut Research Institute. On returning to station, he gave talks on "Basic concepts of Statistics" to three batches of trainee Assistant Superintendents during their training programmes at the Rubber Research Institute.

It was decided that a record of all the experiments carried out by each research department be kept by the Statistics Section. This was done by keeping the files, opened for each project, in the data bank.



Rainfall, duration of sunshine and temperature at Dartonfield

Fig 1.

Studies

The Assistant Statistician followed the Post Graduate Diploma Course in Applied Statistics conducted by the University of Colombo. A project titled "Error reduction in field experiments on *Hevea* using convariance techniques and effective blocking" was carried out under the supervision of Mr. V. Abeywardena, as a partial requirement of the course. A dissertation on this project was submitted and it was accepted also to write a short communication on this to be published in the Rubber Research Institute's Journal.

Visits

Statistical advisory visits were paid to some estates where experiments have been located. State Engineering Corporation was also visited several times for computerisation purposes.

One visit was paid to each of the estates: Atale, Kuruwita, Nakiyadeniya and Elpitiya, where meteorological instruments have been installed by the Statistics Section. Several visits were also made to the Meteorology Department.

Meteorology

Weather data of the Dartonfield Meteorology Station were recorded daily and summaries of these were sent regularly to the Meteorology Department and also to the Land and Water Use Division, Peradeniya. Arrangements were made to calibrate several instruments and repair some clock machines. The Meteorology Department gave their kind assistance in this connection. The Assistant Statistician underwent a two weeks' training on meteorology, at the Meteorology Department.

The graphs of rainfall, sunshine duration and temperature at Dartonfield are shown in Fig 1.

Staff

Mr. W. N. Wickremasinghe, Assistant Statistician, was on duty throughout the year.

The Technical Officers, Mr. L. T. Pieris, Mr. R. A. P. Abayapala and Miss J D. Nandani, who assumed duties on 2nd April, were also on duty throughout the year. Mr. V. Abeywardena continued to pay his regular visits as the consultant Biometrician.

REVIEW OF THE ESTATE DEPARTMENT

By

R. G. SIRIWARDENE

SUMMARY

The Institute's Group of Estates known as Dartonfield Group, comprises of Dartonfield and Gallawatta Divisions at Agalawatta and Nivitigalakele Division at Matugama. The estate now has an extent of 344.60 ha (851 acres) which includes .71 ha of jungle land. The planted area is 299.54 ha of which 216.36 ha were in tapping during the year. The 1974 Replantings of Nivitigalakele and 1973 Replantings of Dartonfield were brought into tapping during the year under review.

Felling and clearing of 1952 field at Dartonfield — 10.88 ha and 1952 field at Gallawatta 8.00 ha commenced during the year, and trees were sold at Rs. 42/50; and Rs. 56/25 each from the two Divisions.

The weather pattern experienced during the year was not favourable for harvesting of crop. The severe drought experienced from mid January to April and the unusual distribution of rainfall especially during September to November, when normally the intakes were high, contributed to the drop in crop harvested.

The crop harvested was 181,059 kilos representing an average yield of 838 kilos per ha. The crop secured fell short of the season's estimate by 28,941 kilos, and 5,016 kilos when compared with the same date in the previous season (1978).

No symptoms of *Oidium* leaf disease were noticeable, since wintering was early this year.

Budwood of clones of the RRIC series and PB 86 continued to be much in demand and issues were made accordingly.

All Agricultural operations were carried out in both mature and immature areas of the Group.

DETAILED REVIEW

The writer assumed duties as Estate Superintendent, Dartonfield Group, with effect from 1st, January, 1979. Mr. B. H. Rodrigo who was earlier transferred to the Rubber Research Board (Plantations Division) was transferred back to Dartonfield Group, as Chief Clerk with effect from 1st May, 1979. Mr. K. D. Sumanasena, was appointed as Junior Assistant Clerk with effect from 1st December, 1979, thus completing the Office Staff Cadre.

The Dartonfield cadre is made up as follows:—

Senior Staff	—	1
Assistant Staff	—	13
Minor Staff	—	3
		17

HECTARAGE SUMMARY:

	DF	*GW*	*NK*	*TOTAL*
Mature Areas	36.37	133.75	46.24	216.36
Immature Areas	10.38	59.00	6.95	76.33
Nurseries	2.22	.50	4.13	6.85
Total	48.97	193.25	57.32	299.54
Abandoned	3.95	—	5.58	9.53
Buildings etc.	16.23	—	6.09	22.32
Roads	2.67	6.50	.32	9.49
Swamps	—	—	.21	.21
Streams/Reservations	.03	—	—	.03
Jungle etc.	—	—	.71	.71
Paddy fields	—	.25	—	.25
Food Production	—	.50	—	.50
Land taken over by L.R.C.	—	2.02	—	2.02
Grand Total Hectares	71.85	200.50	72.25	344.60
Acreage	177	496	178	851

7.20 hectares from the 1977 clearing and 3.40 hectares from the 1975 clearing at Gallawatta Division were acquired by the Government for a housing scheme.

AGRICULTURAL ADVISER: The Agricultural Adviser, Mr. R. C. Peries of Elston Estate, Puwakpitiya, visited the property on the 24th January, 16th July, and 12th December, 1979; (3 visits) and his reports on Dartonfield Group, were submitted to the Board for their perusal and information.

WEATHER (Estate Gauge): Comparative Rainfall figures (mm) for 1979 and 1978 were as follows:

	DF		*GW*		*NK*	
	1979	*1978*	*1979*	*1978*	*1979*	*1978*
January	87.4	146.4	96.0	161.5	90.4	149.8
February	205.5	153.9	204.9	92.2	431.5	70.1
March	133.3	382.1	106.7	533.4	280.9	223.3
April	348.2	161.2	334.8	176.3	499.2	198.4
May	434.3	735.4	389.6	722.2	585.2	663.7
June	530.2	275.4	639.6	245.6	697.4	233.9
July	342.3	182.9	133.0	140.7	478.5	153.4
August	99.9	176.3	31.5	183.6	99.5	181.4
September	983.2	293.9	364.4	300.5	368.2	229.6
October	338.1	351.9	134.7	288.3	537.0	338.3
November	456.6	499.7	185.2	508.5	916.4	488.4
December	446.6	312.6	191.4	366.8	166.3	123.4
Total	4367.6	3671.7	2812.8	3722.6	4644.5	2833.8
Average five (5) year period	4167.2		3121.5		4166.5	
Total number of wet days	242		211		239	

The season had begun with a dry January, but February was wetter than usual. Weather from April to June was unusual. September to November proved to be the wettest months. The average rainfall for the Group for the year stands at 3818.4 mm.

CROP: This year's harvest is estimated at 210,000 kg: from 216.36 na. The intake per tapper averaged were DF: 5.63 kg; NK: 5.63 kg; and GW: 5.91 kg:

The unfavourable weather which prevailed also resulted in a heavy shortfall in Crop.

	1978	*1978*
Estimated	210.000	191,950
Harvested	181,059	186,075
Deficit	28,941	5,875

TAPPING: Tapping continued throughout the year, including the wintering period. Recovery tapping was done at Dartonfield Division on 38 days; Nivitigalakele 27 days; and Gallawatta Division 42 days.

All tapping panels in experimental areas were treated with Anti mucin on the recommendation of the Scientific Departments. Tapping cuts were marked with appropriate guide lines for bark consumption.

MANUFACTURE: A summary of the manufacture records during the year 1979 is as follows:

Latex Grade		*Total Kilos*	*Percentage*
Latex Crepe No.	1	140,313	92%
	2	1,800	1%
	3	10,950	7%
		153,063	100%
Scrap Crepe			
Scrap Crepe No.	1	7,350	55%
	2	3,850	30%
	3	1,950	15%
		13,150	100%

83 M. tons of Thin Crepe was contracted and supplied during the year.

Dartonfield Group, commenced outside manufacture during the year under review and manufactured 42,657 kilos.

An Invoice of 1X crepe rubber fetched a record breaking price of Rs. 22/31 per kilo at the auctions on 25th May, 1979. The Rubber Research Board decided to gear the factory to manufacture Sole Crepe when the markets are favourable.

WEEDING: Normal weeding rounds were carried out satisfactorily.

PESTS & DISEASES: There was no significant attack of *Oidium*, on any of the divisions. A few rounds of sulphur dusting was carried out as a precautionary measure.

MANURING: Manure application was done in accordance with the programme.

NURSERIES: Routine weeding, manuring and other agricultural operations were carried out on all nurseries.

FIELD AND TECHNOLOGICAL EXPERIMENTS: Necessary assistance by way of labour and various other requirements were rendered to the Research Departments to carry out their field and technological experiments. In addition, labour requirements to the Works Section and to the Statistical Section were provided.

REVIEW OF THE LIBRARY AND PUBLICATIONS SECTION

By

V. S. PERERA

Staff

Miss L. I. T. Ramenaden, Library Assistant and Assistant Publication Officer, attached to the Colombo Office Library, Mr. D. C. Thambawita, Library Clerk and Mrs. D. T. Danthanarayana, Clerk/Typist at Head Office Library were on duty throughout the year. Miss V. S. Perera assumed duties as the Library Assistant and Assistant Publication Officer, Head Office Library with effect from 1979.05.02.

Acquisitions

During the year 1979, 82 books were added to the existing library collection of 3,593 books both in Colombo and the Head Office. Of these, 36 books were gifted by the British Council, 12 were purchased locally and abroad and 34 were received as gifts and donations.

About 204 titles of current periodicals are being received at both the Headquarters and Colombo Office Library of the Institute including abstracting and indexing periodicals.

	Local	*Overseas*
On subscription	—	116
On exchange/gratis	35	89

A sum of about Rs. 200,000/- was spent, mainly on periodicals. Thirty two journals were leather bound and added to the library collection of bound volumes.

Inter library loans

We loaned 13 periodicals and 2 books to outside libraries on the inter library loan scheme and obtained 15 periodicals from various research libraries on requests made by our Research Staff during the year 1979.

Information Service/Publications

The RRISL library attends to publication, communication and dissemination of information etc., on behalf of the Institute.

The library also performs the vital role of continuously keeping the research staff informed of the latest advances in the various branches of research done throughout the world, through its information service.

It has five regular publications and bears the responsibility on advisory and information services to extend the benefits of research and development done by the RRISL Research Officers, to all sectors of the industry.

Liaison with other libraries

The RRISL library participates with the other Research Libraries in the Union Catalogue of Scientific and Technical Publications (UNICAST) project managed by the National Science Council of Sri Lanka and 46 more catalogue cards were sent as our contribution.

REVIEW OF THE ADVISORY SERVICES DEPARTMENT AND THE ECONOMIC RESEARCH UNIT

By

A. B. DISSANAYAKE

GENERAL

The Annual Review describes the work carried out by the Department in providing an Advisory Service to Smallholders and to Estates and in Economic Research.

STAFF

The Head Advisory Services Department and Economic Research Unit, Mr. A. B. Dissanayake, the Deputy, and three Regional Advisory Officers were on duty throughout the year. Five Rubber trainee Extension Officers selected during the third quarter are undergoing training under Senior Rubber Extension Officers. Mr. K. P. Siriwardena, Divisional Rubber Extension Officer, Dodangoda and Mr. D. J. Ratnayake, Rubber Extension Officer, Talangama, retired from service after serving the Rubber Research Institute for 32 and 26 years respectively. Mr. L. R. Attygalla and Mr. U. J. Hirimuthugoda, Rubber Extension Officers, resigned from service during the third quarter. The death of Mr. U. S. Somapala, Rubber Extension Officer, Elpitiya occurred in August 1979. He served the Rubber Research Institute for 21 years. Mr. H. R. Dias, Rubber Extension Officer, Palawela, was appointed Divisional Rubber Extension Officer in December 1979.

Mr. H. D. B. H. Gunasekera, Assistant Agricultural Economist, continued his post graduate studies at the Australian National University, Canberra. Two Assistant Agricultural Economists: Mr. N. K. Atapattu and Miss K. Samarasinghe joined the Economic Research Unit in March but Miss K. Samarasinghe resigned a few months later.

ADMINISTRATIVE MATTTERS

Correspondence

Inward — 9970
Outward — 9517

With Rubber Controller:

Inward—3820 (applications for new planting, unregistered rubber lands and new planting permits)

Outward—4038 (preliminary reports, final inspection reports and special reports)

From the Rubber Extension Officers to smallholders—4127

ADVISORY SERVICES TO SMALLHOLDERS

New Planting

Visits: The following visits were carried out:

First visits	...	1841
Subsequent visits	...	2488
Preliminary Reports	...	4897
Final inspection and special reports	...	3249

Lining

This year's permit areas:		*No of. permits*	*Acreage*
Soil conservation	...	871	1219
Planting Holes	...	795	1099
Last year's permit areas:			
Soil conservation	...	319	559
Planting Holes	...	256	337

Replanting:

Visits		*No. of permits*	*Acreage*
Permits issued	...	3695	5059
Visits to this year's permit areas	...	4360	
Visits to previous permit areas	...	7137	
Special Reports	...	2020	

Lining

This year's permit areas:		*No. of permits*	*Acreage*
Soil conservation	...	1704	2180
Planting Holes	...	1863	2421
Last year's permit areas:			
Soil conservation	...	568	852
Planting Holes	...	567	856
Marking of trees for tapping	...	134	2174 trees

Special inspection for Rubber Control Department

Visits for preliminary reports	...	4897
Visits for final inspection reports and special reports (new planting)	...	3249
Visits for special inspection reports (replanting)	...	2020
Visits to planting material checks at the Commodity Purchase Depots	...	23
Plants inspected	...	4427
Plants nursery reports	...	116
Visits for recommendations of Subsidy payments	...	5850
Visits to Commodity Purchase Depots	...	136

Smallholders' Rubber Conferences

Fifty smallholder conferences was held in the form of group discussions, at range level.

Meetings and Conferences

All Staff Officers attended the Staff Meetings presided by the Director.

The Head of the Department attended the ANRPC/ESCAP preliminary meeting held in December, at Kuala Lumpur, Malaysia, on the "Determination of the Maximum Production capacity of NR in member countries of the ANRPC." He also did a short study tour of some

departments of the RRIM and some aspects of the work of RISDA. He also attended a number of meetings convened to organise the ANRPC Seminar on the Development of Smallholdings due to be held in Sri Lanka in July 1980, and the "Steering Committee" meetings in connection with the World Bank project in replanting and the preparation of the "Master Plan" for the Rubber Industry.

All Regional Advisory Officers and Divisional Rubber Extension Officers attended a conference regarding maintenance of accounts in GPCs. The Chief Accountant explained to the Staff the details of procedure.

The DREOs and REOs attended a meeting at Kegalle, Dodangoda, Ratnapura, Homagama and Galle to discuss the procedure regarding conducting a survey by Mr. Cobban, Agricultural Economist of the Rubber Master Plan Mission.

The Head of the Department took part in discussions on the use of Urea in rubber fertilizer at the National Fertilizer Secretariat, Ministry of Plan Implementation. A proposal to popularise the use of Urea among rubber smallholders was submitted and is being put into effect. He also attended, with the Regional Advisory Officer, Ratnapura, the International Seminar on "Prevention of Environmental Pollution" at the Sri Lanka Foundation Institute.

The Regional Advisory Officer, Ratnapura, and the Assistant Agricultural Economist attended a Seminar on "Sources of Scientific Information" at the CISIR Auditorium. The Regional Advisory Officer, Ratnapura, attended SLAAS Sessions, 1979.

Improvement of Smallholders' Sheet Rubber

Programme on the construction of Group Processing Centres is as follows:

Group Processing Centres in operation	...	99
Group Processing Centres (work completed)	...	02
Group Processing Centres (under construction)	...	02
TOTAL	....	103

As a result of the one-day seminars for GPC Officials, organised in 1978, a set of account books necessary for the proper maintenance of accounts in GPCs were prepared. Each set consisting of 8 books were sold to GPCs.

Eleven one-day Seminars for GPC Officials were held in all 11 Divisions. Three officials from each GPC were invited for the Seminar. Other Departments who took part and addressed the participants were the Rubber Control Department, Commodity Purchase Department and the All Ceylon Rubber Co-operative Societies Union. The subjects discussed at these Seminars were: maintaining accounts, calculation of the cost of processing, general management, problem solving procedure, marketing of RSS and replanting. A total of 232 officials attended these Seminars.

Recoveries on GPC loans amounted to Rs. 46,898.08 while Rs. 3,360.86 were recovered on sales of coagulating pans. The Societies paid Rs. 570.00 towards the cost of the set of accounts books. The Institute released Rs. 13,000.00 as loans for buildings.

Other Visits

A total of 3,178 visits to GPC and 559 visits to ordinary and demonstration smoke houses were made during the year under review.

Training Classes

A total of 28 training classes for 787 smallholders were held of which 460 smallholders successfully completed the course.

Two Final Year undergraduates of the Faculty of Agriculture, University of Peradeniya, completed the following projects under the guidance of the officers of the Department.

i. Comparative analysis of marketing of rubber by smallholders through private licence dealers, Commodity Purchase Depots and Group Processing Centres.

ii. Dissemination of information with respect to planting material and fertilizer in a selected rubber growing area.

Demonstrations

The following demonstrations were held by the field staff:

Sheet making	...	214
Tapping	...	230
Disease Control	...	219
Miscellaneous	...	380

Sale at Subsidised Price

A total of 94½ square feet of monel metal mesh were sold at subsidised rates.

Exhibitions

The Department participated in 3 District Level Exhibitions at Kirindiwela, Elpitiya and Pelawatte during the year. The Department also helped by providing posters and exhibits in organising the Trade Fair being held at Niyagama in Hiniduma Electorate early January 1980.

Intercropping

It was decided to start demonstration plots on intercropping for the benefit of smallholders. Such demonstration plots were selected in each D. R. E. O. Division for planting banana and pineapples.

Rubber Master Plan Team

The entire field staff of the Department co-operated with the Mission's Team of Experts from Mid-January to March, 1979 in identifying selected areas, carrying out surveys and filling questionnaires.

World Bank Team

The World Bank Team visited, on two occasions during the year, different divisions of Kegalle, Ratnapura and Kalutara Districts to study the replanting programme.

Dr. D. Etherington of the Australian National University, Canberra, visited the Department and had discussions with the officers of the Economic Research Section.

Dr. M. J. Harteley of the World Bank Research Division visited the Department and had discussions regarding a combined research project on rubber.

Mr. Shuib Putech, Economist of the Malaysian Rubber Research and Development Board visited the Department and had discussions with the officers of the Economic Researeh Section on the ANRPC Project study on improvement of NR statistics.

ADVICE TO ESTATES

A total of fifty-eight visits were made to medium and small estates during the quarter.

The visits included advice on soil conservation, tapping and disease control. In addition a further 42 visits were made to GPCs and estates in connection with the manufacture of rubber, smokehouse construction, improving efficiency of manufacture and latex coagulation.

ECONOMIC RESEARCH

Survey of the Economics of Production of Rubber

The survey is expected to cover 1400 holdings composed of 560 smallholdings below 4 acres, 490 smallholdings of 4-10 acres and 350 small estates of 10-50 acres. The completed questionnaires are coming in and are being checked. Some have been returned for collection of more data. Analysis of data will be started during the 1st quarter of 1980.

Long Term record keeping survey

Three villages in the Kalutara District and 2 villages in the Ratnapura District have been selected. Of these villages 10 smallholders per village have been selected and briefed in filling the questionnaires. Temporary Supervisors have been appointed to supervise the filling of the forms. The records are being kept from 1.1.1980.

Group Processing Centres

The progress of Group Processing Centres for the year is being studied and a separate report on them will be sent to the Director, R.R.I., Ministry of Plantation Industries and the Ministry of Plan Implementation.

A study of the monthly reports sent by GPCs has revealed that the average daily intake of GPCs is low on account of the fact that on a fair number of days only a few smallholders tap their holdings and bring a small amount of rubber to the centre. This tends to drag down the daily average intake. An adjustment for this is being worked out and it is hoped to incorporate it in the new monthly report forms.

The study of the economics of production of GPCs is being continued but is delayed due to the resignation of the Assistant Agricultural Economist in charge of the study.

As a result of the studies so far undertaken on GPCs it was observed that the weakest links in the G.P.C. Scheme are:

the General Management level of smallholders, &

the measurement of dry rubber in latex by means of the metrolac.

To improve the general management level of G.P.CC. and the level of maintenance of accounts a series of eleven one-day seminars for G.P.C.Officials were held in the 11 Advisory Divisions.

The Economics of Processing different types of rubbers

This study is progressing. The very wide fluctuations in the prices of the different types of rubbers complicates the study. To nullify the effects of wide fluctuations it is hoped to use prices over a sufficiently long period of time.

Intercropping

Arrangements are being finalised to start 11 demonstration plots of intercrops in rubber smallholdings. To start with bananas and pineapples will be tried out. A questionnaire has been perfected for the smallholder to maintain accounts in respect of intercrops so that the economics of intercropping could be worked out at the end of the cropping season.

Training Classes for smallholders

A study of the reasons for the poor attendance of smallholders in our training classes is being carried out with the idea of finding ways and means of improving the attendance.

Talks

The following talks were given to the final year B.Sc. Agriculture students of the University of Peradeniya:

"Extension Services for the NR industry of Sri Lanka" by A.B. Dissanayake.

"New Accounting system for use in Rubber Plantations" by A. B. Dissanayake.

"The Economics of manufacturing different types of rubber" by N. K. Atapattu.

"The Organisation, functioning and problems of the G.P.C. Scheme" by R. P. M. de Zoysa.

"The Economics of Group Processing Centres" by Miss K. Samarasinghe.

INSTITUTE PUBLICATIONS

Thesis

SAMARAWEERA, M. K. S. A. — A study of the growth regulator N-dimethylaminosuccinamic acid. *Thesis submitted for the Degree of Doctor of Philosophy of the University of Bristol, U. K.* **1979.**

Papers

CHANDRASEKERA, L. B. — Potential for intercropping rubber lands in Sri Lanka.

FERNANDO, D. M. AND LIYANAGE, A. DE S. — Clones bred in Sri Lanka for resistance to South American Leaf Blight. *Paper read at the ANRPC Technical Committee on SALB.*

LIONEL, W. A. — Deproteinized natural rubber (in Sinhala). *Rubber Puwath.* Accepted for publication — 1979.

PERERA, M. C. S., THARMALINGAM, R. AND FERNANDO, W. S. E. — Suitability of RRIC 100 series clones for crepe manufacture. *Jl. Rubb. Res. Inst. Sri Lanka* **56, 1979.**

PERIES, O. S. — Research assessment and financial control in research institutes. *Sri Lanka lead paper for Workshop on Research Administration and Management, held in Kuala Lampur* **2-14** *Dec.* **1979.**

SAMARANAYAKE, C., ABEYWARDENA, V., GUNARATNE, R. B. AND BANDARA, K. A. G. — Effect of the rootstock and scion on bud emergence of *Hevea* budgrafts. *Jl. Rubb. Res. Inst. Sri Lanka (in press).*

TILLEKERATNE, L. M. K. — Elimination of the use of RPA - 3 in crepe rubber manufacture. *RRISL Bulletin* **14, 1979.**

WAIDYANATHA, U. P. DE S. AND ANGAMMANA, D. K. — Early exploitation of *Hevea* rubber trees by puncture and short-cut tappings. *Submitted for publication to Experimental Agriculture.*

YAPA, P. A. J. AND LIONEL, W. A. — Enzyme deproteinization of *Hevea* latex II. Use of papain treatment in RSS manufacture. *Jl. Rubb. Res. Inst. Sri Lanka* **56, 1979.**

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YAPA, P. A. J., NADARAJAH, M. AND LOGANATHAN, K. S. — Use of papain treatment to produce superior quality rubber. *Jl. Plastics and Rubber Institute — Rubber Processing* **1979.**

YOGARATNAM, N. — Developments in fertilizer use for rubber in Sri Lanka. *Paper presented at the Seminar on Soil Science Society of Sri Lanka, Colombo, December* **1979.**