The Rubber Research Institute of Sri Lanka

Annual Review 1984

THE RUBBER RESEARCH INSTITUTE OF SRI LANKA

ANNUAL REVIEW 1984

CONTENTS

RUBBER RESEARCH INSTITUTE OF SRI LANKA

BOARD OF MANAGEMENT

(As at 31st December, 1984)

Ex-Officio Members

The Director of Agriculture — Dr G. W. E. Fernando

Representative of the Treasury — Mrs M. N. Mendis

The Rubber Controller — Mr T. P. G. N. Leelaratne

The Director, Rubber Research Institute of Sri Lanka — Dr O. S. Peries,
BAgrSc. (Melb), PhD (Bristol), MI Biol (*Vice Chairman*)

Nominated Members

Member of National State Assembly under the Rubber Research Ordinance
Mr Merryl Kariyawasam

Member nominated by the Planters' Association of Ceylon
Mr H. G. R. de Mel (*Chairman*)

Members nominated by the Low-Country Products Association of Ceylon
Mr D. Jayasiri Perera
Mr Gunasoma Hettiarachchi

Secretary, Planters' Association of Ceylon
Mr C. S. Ilangakoon

STANDING COMMITTEES

Estate Committee :

Mr H. G. R. de Mel (*Chairman*)
Dr O. S. Peries
Mr D. Jayasiri Perera
Mr R. Salgado
Mr R. G. Siriwardene

Scientific Committee :

Mr H. G. R. de Mel (*Chairman*)
Dr O. S. Peries
Mr D. Jayasiri Perera
Mr R. C. Peries
Mr R. Madane
Mr A. B. Weerasekera
Mr D. H. Giragama
Mr P. Eardley Perera
Mr V. C. de Silva
Mr Stanley de Silva
Mr M. M. A. Naina Marikkar
Heads of Departments
Mr B. S. Ratnayake (*Secretary*)

Provident Fund Committee :

Mr G. Hettiarachchi (*Chairman of P.F. Committee*)
Dr O. S. Peries
Mr A. L. Ratnayake
Mr M. C. Samarasekera

Secretary to the Board
Mr B. S. Ratnayake

Lawyers
M/s. F. J. & G. de Saram,
Attorneys-at-Law,
P.O. Box 212,
Colombo.

M/s. De Silva & Gurusinghe,
Attorneys-at-Law,
157, Mihindu Mawatha,
Colombo.

Mr Manilal Fernando,
Attorney-at-Law,
14, De Silva Road,
Kalutara.

Auditors

Messrs H. T. Peiris & Co.,
Chartered Accountants,
P.O. Box 499,
Colombo 6.

Bankers

Bank of Ceylon,
York Street, Colombo 1.
Bank of Ceylon, Matugama.
Bank of Ceylon, Agalawatta.

Registered Office, Laboratories

Dartonfield, Agalawatta.

Colombo Office

Consisting of :
Advisory Services Department,
Economic Research Unit,
Rubber Chemistry Department and
Specifications Laboratory
Telawala Road, Ratmalana,
Mt. Lavinia.

THE RUBBER RESEARCH INSTITUTE OF SRI LANKA

STAFF

(As at 31st December 1984)

Director — O. S. Peries, BAgrSc. (Melb.), PhD (Bristol),
M.I.Biol.

Deputy Director (Research) — A. de S. Liyanage, BAgrSc. (Cey.), PhD (Lond.)

RESEARCH DEPARTMENTS

Plant Science

Head of Department — Mrs A. C. I. Samaranayake. BSc (Cey.), PhD (Lond.)

Assistant Botanists — R. C. W. M. R. A. Nugawela, BSc (Cey.)
MSc (Lond.)
Miss G. P. W. P. Pushpika, BSc (Cey.)

Experimental Officers — A. H. R. Jayaratne, BSc (Cey.), MSc (Cey.)
L. S. S. Pathiratne, M.I. Biol.

Technical Officers — Miss C. W. Ranasinghe, BA (Cey.)
Miss G. A. S. Wijesekara
Miss A. R. Kusum
L. S. Kariyawasam
K. A. G. B. Amaratunga
R. P. Karunasena
U. S. Weerakoon

Senior Experimental Assistants — M. C. Perera
R. B. Gunaratne

Experimental Assistant — S. Wilbert

Clerk/Typist — Mrs V. Jayasundera

Intercropping

Head of Department — L. B. Chandrasekera, BSc (Cey.) Dip AgrSc (Cantab.)

Experimental Assistants — U. K. D. Lewis
W. A. T. Silva

Genetics & Plant Breeding

Head of Department — N. E. M. Jayasekara, BAgrSc (Cey.) PhD (Birm.)

Assistant Geneticist & Plant Breeders — Mrs S. C. Dharmaratne, BSc (Cey.)
D. P. S. T. G. Attanayake, BAgrSc (Cey.)

Experimental Officer — K. B. A. Karunasekera

Senior Experimental Assistants — B. M. S. G. Peiris

Technical Officers — K. W. Rupatunga
R. A. S. K. Ranatunga
I. D. M. J. Sarath Kumara

Experimental Assistants — D. S. Gamage
A. K. M. S. Senaratne

Plant Pathology

Head of Department — A, de S. Liyanage, BAgrSc. (Cey.) PhD (Lond.)

Assistant Plant Pathologists — C. K. Jayasinghe, BSc (Cey.) MSc (Cey.)
Mrs N. I. S. Liyanage, BAgrSc (Cey.) MSc (Cey.)

Senior Technical Officers — Z. E. Irugalbandara
*L. W. Amaratunga
A. Dharmaratne

Technical Officers — Mrs P. C. Wettasinghe
W. A. D. D. S. Wettasinghe
E. B. Fernando
S. S. Warnapura
E. A. T. Senadeera

Clerk/Typist — Mrs W. S. P. Amarasekera

Soils & Plant Nutrition

Head of Department — N. Yogaratnam, BAgrSc. (Alhabad) PhD (Lond.)

Agricultural Chemists — M. K. S. A. Samaraweera, BSc (Cey.)
MSc (Bristol) PhD (Bristol)

Assistant Soils Chemist — Mrs M. L. A. Samarappuli, BAgrSc, (Cey.)

Experimental Officers — W. C. Dayaratane
A. M. A. Perera
F. P. W. Silva

Senior Technical Officer — J. G. de Mel

Technical Officers — Miss D. I. R. Denawake
Miss S. D. C. K. Maheepala
Miss U. G. Dingiriamma
Miss H. V. Kumudinie
Miss P. A. L. Jayaweera
S. N. Silva
P. Karunadasa
A. H. U. Mitrasena

Experimental Assistant — K. A. T. Wijenayake

Specification Assistant — T. M. Ahamadeen

Rubber Chemistry, Biochemistry, Polymer Chemistry, Specifications and Analysis & Rubber Technology & Dvelopment

Head of Department — S. W. Karunaratne, BSc (Cey.) MSc(Aston,). ARIC, ANCRT, FPRI, FIC

Head of Biochemistry Section — *P. A. J. Yapa, BSc (Cey.), PhD (Lond.)

Head of Polymer Chemistry Section — A. Coomarasamy, BSc (Cey.) PhD (Aston)

Head of Rubber Technology & Development Section — W. S. E. Fernando, BSc (Cey.) MSc (Aston) PhD (Aston)

Head of Specifications & Analysis Section — L. M. K. Tillekerante, BSc (Cey.), MSc (Aston,). PhD (Aston)

Assistant Rubber Chemists
*N. M. V. Kalyani, BSc (Cey.)
*M. C. S. Perera, BSc (Cey.), MSc (Cey.)
*M. D. R. J. Gunatilleke, BSc (Cey.)
*E. D. I. H. Perera, BSc (Cey.)
W. M. G. Seneviratne, BSc (Cey.)
U. L. M. Perera, BSc (Cey.)

Research Assistant — L. B. K. Silva, BSc (Cey.), LPRI

Assistant Rubber Chemist/ Specifications Officer — *P. A. D. T. Vimalasiri, BSc (Cey.)

Assistant Development Officer — Miss S. A. P. P. Sirimanne, BSc (Cey.)
T. L. G. Fernando, BSc (Cey.) ICMA

Assistant Biochemist — Mrs S. I. Wickremasinghe, BSc (Cey.)

Experimental Officers — H. K. Chandralal, BSc (Cey.)
P. P. Jayasinghe, LPRI
K. A. R. M. Perera, BSc (Cey.)
S. Kasinathan, M. I. Biol., A. I. Chem.
W. W. D. Y. Jayasinghe , BSc (Cey.)

Senior Technical Officers — A. S. Dekumpitiya
D. D. Medagama
I. S. H. L. Weerasinghe

Technical Officers — Mrs N. A. Baduge, BA (Cey.)
Mrs H. S. Weeraman
Mrs M. G. M. M. Nilaweera
Mrs L. Wanigatunga
Mrs W. C. M. Kuruppu
Mrs M. K. Wickremapala
Miss N. M. M. de Costa
**Mrs S. I. Yapa
W. D. Dharmasena
K. M. U. Mitranande
P. H. Sarath Kumara
M. D. C. Seneviratne

Instrument Technicians — Miss K. C. S. Dissanayake
G. R. S. S. Gamlath
L. G. Piyasena

Specifications Assistant — W. A. S. Wijesekara
(Special Grade)

Specifications Assistants — G. Wanigatunga
T. A. S. Siriwardene
P. D. J. Rodrigo
K. K. Austin
B. Gunasiri
W. W. Nandasena
**M. A. Mendis

Clerk/Stores Assistant — Mrs L .Rukmanie

Clerk/Typists — Mrs D. T. Dantanarayana
Mrs S. A. Paranawithana
Miss M. D. I. Premawathie
Miss K. A. J. Malkanthie

Biometry Section

Biometrician — W. N. Wickremasinghe, BSc (Cey),
Dip. Stat. (Cey.), MSc (Iowa State)

Senior Technical Officer — L. T. Peiris

Technical Officers — Miss J. D. Nandanie
R. A. P. Abayapala

ADMINISTRATION DEPARTMENT

Chief Administrative Officer

Secretaty to the Board — B. S. Ratnayake, BA (Cey.)

Office Assistant — T. H. Wijesena

Medical Assistant — K. N. W. Fernando

Experimental Officer — Mrs I. Samaraweera, BSc (*Cey.*), MSc (*Cey.*)

(Technical Assistant to the Director)

Chief Clerk — J. D. Gunaratne

Clerk (Special Grade) — Mrs D. F. Thambawita

Translator/Clerk — D. U. Kannangara

Clerk/Typists — R. G. D. Sakaraja
Mrs R. S. Amarasekera
Mrs W. Paul
Miss M. D. P. Gunasekera

Internal Audit Unit

Internal Audit Assistant — N. C Silva

Library

Librarian & Publications Officer .. Mrs V. S. Jayaratne, BA (*Cey.*)
DLS (Univ. Kelaniya)

Library Assistant & Asst. Publications Officers —**Miss L. I. T. Ramanaden, ALA (Cey.)
D. C. Thambawita

Clerk/Typist — Miss R. M. Mahakumara

Works Section

Works Engineer — A. M. S. Kulasekera

Chief Clerk (Works Section) — D. D. D. Adikaram

Transport Assistant — B. D. Ponnamperuma

Mechanical Foreman — W. D. Dharmawardena

Building Foreman — K. K. A. S. Kannangara

Electrical Foreman — W. D. Ratnasinghe

Clerk/Typists — Miss M. Gunawathie Silva
Mrs K. P. R. Gunasekera

Accounts Department

Accountant — D. P. Ashley Perera

Accounting Assistant — K. G. A. K. Dharmawardena

Book-Keeper — A. L. Ratnayake

Clerk (Special Grade) — D. A. Rajapaksa

Graduate Assistants — Mrs G. K. Somasiri, BA (Cey.)
Mrs K. K. Jagoda, BA (Cey.)

Clerks — G. A. Kannangara
G. S. Doolewla

Clerk/Typists — W. Kularatne
Mrs C. C. Silva
Miss S. Irene
Mrs M. Gunawardena
Miss M. Mullevidana
Mrs K. Kapuge

Assistant Store-keepers	— P. D. Somadasa P. L. R. A. W. Cooray D. C. P. Pothmitiyage
Cashier	— D. C. A. D. B. de Silva

ESTATE DEPARTMENT

Chief Clerk	— A. A. Ariyaratne
Actg. Senior Assistant Clerk	— K. K. P. Gunawardene
Junior Assistant Clerk	— K. D. Sumanasena C. N. Wickramasinghe
Rubber Factory Officer	— D. C. C. Jayasekera
Assistant Factory Officer	— D. S. K. Ranaweera
Field Officers	— N. L. D. Piyadasa A. K. D. Hemapala S. K. S. de Silva H. M. Jayantha Premalal
Assistant Field Officers	— J. A. Wimalasena A. K. D. M. Wickramasinghe
Field Supervisors	— T. Somaratne S. R. Vadivel W. D. D. Senanayake

Kuruwita Sub-station

Visiting Superintendent	— R. C. Peries
Asst. Estate Superintendent	— S. A. R. Samarasekera

* On study leave overseas

** On no pay leave overseas.

THE RUBBER RESEARCH INSTITUTE OF SRI LANKA
DIRECTOR'S ANNUAL REVIEW

By

O. S. PERIES

The most important event of the year was the International Rubber Conference, which was held at the Bandaranaike Memorial International Conference Hall (BMICH) from 17 – 19 September 1984, to celebrate 75 years of rubber research in Sri Lanka. This was one of the best organized and well attended Conferences of any kind ever held in Sri Lanka. Participants from 28 natural rubber (NR) producing and consuming countries took part, with about 100 foreign delegates participating and contributing papers. Altogether, 86 papers were presented in the 3 – day Conference, where parallel sessions in biology and chemistry were held to accommodate the large number of papers offered, particularly from foreign NR producing countries. We were happy to see China taking part in an NR Conference for the first time in Sri Lanka, along with all the International Rubber Research and Development Board member countries. All papers were read to packed audiences, and we are happy to record here the very close and unstinted support given to us by the two State Corporations managing all the Government owned rubber estates in Sri Lanka. The full complement of Superintendents and their Assistants attended the Conference, which was spoken of as the best International Conference on rubber ever held anywhere in the world. All members of the staff of the Institute, from every grade, contributed their best freely, to make the occasion a succcess and they have my sincere thanks for their magnificent effort.

The success of an Institute like ours, which supports a single commodity, requires the backing of a wide-ranging body of scientific knowledge on practical problems that arise in the field, together with the latest information on certain basic areas of scientific investigation, so that a well balanced solution can be provided to the industry on every issue. Therefore, the Institute has always endeavoured to carry out an appropriate blend of mission oriented or applied research with an adequate amount of fundamental studies. These two sectors must be closely linked for any research facility to function productively. Sometimes, although rarely, there are "lucky breaks" in research too ; however, the worker concerned must be both knowledgeable and astute to see the essential importance of an observation. The discovery of penicillin by Sir Alexander Fleming is the classic example of serendipity in science. These instances are most likely to occur and to be exploited in an environment made receptive by the awareness of field problems and considerations. Our Institute has always taken pride in carrying out such a blend of research covering the widest range of inter-related subjects, as staff and facilities permit, so that the Institute has always been in the best position to contribute to the industry it serves. This is not just our opinion but the consensus of opinion, expressed by the experts on the subject, who attended the International Rubber Conference and visited the Institute. One of our major problems now is to re-orient the reseacrh to suit the present problems facing the industry, and the significant tilt towards smallholder ownership of rubber growing land. Smallholders now own approximately 70 percent of the total area under rubber. The most important features of the new work is the emphasis on tissue culture, plant breeding, plant density, tapping systems involving yield stimulants, intercropping, marketing and smallholder oriented research. The new research programme will have to operate under conditions of severe financial restrictions, as a result of decreasing production due to accelerated replanting and falling rupee values. In spite of these problems, we are happy to report solid progress during the year on many areas, which reflect the principles stated above and clearly show the benefits of the correct blend of fundamental studies bearing on practical field problems.

ORGANISATIONAL DEVELOPMENTS

The most important organisation change that was effected during the year was the division of the Rubber Chemistry Department into four sections ; Polymer Chemistry, Rubber Technology & Development, Biochemistry and Specifications & Analytical Chemistry – the fifth section Raw Rubber Development will be operational as soon as staff, now under training abroad, return to the Institute. This new allocation of functions enables each Sectional Head to specialize in certain areas of rubber chemistry, so that the organization of multidisciplinary projects will be more meaningful ; as each Section can now contribute something special to the project, and the project coordinator can specify the type of contribution necessary from each discipling, and this can be evaluated. The Sections have functioned well during the year, as can be seen by the Sectional Reports. The Heads of the different Sections have gained a great deal in administrative skills, and they have been given the opportunity to exercise a certain amount of autonomy, in the development of their sectional work programmes and staff training. The progress has been so satisfactory that the scheme can be extended to other Departments too. This will be effected, when the staff strength is built up and the numbers are sufficient for division on a disciplinary basis.

The other useful development has been our attempt to increase the multidisciplinary and interdepartmental research projects. We have started appointing "task force" type research teams, drawn from different Departments, to study important problems, which require urgent solution. One such problem we are looking into is the economics of fertilizer use of rubber. This is being studied in depth so as to enable us to advise growers on all aspects of fertilizer application. We are especially interested in finding out whether the rubber tree can give economic yields, without fertilizer, at least for short periods of 2 – 5 years in early or late maturity. This type of information will be most useful in the long term economy of the crop.

The Plant Pathology Department is carrying out an interesting interdepartmental project, with expert assistance from abroad. This is the study of the effect of weather on disease incidence and severity. Our staff is collaborating with the staff of the Universities of Colombo, Sri Lanka, and Reading, UK, on this project. It is known that pests and diseases occur sporadically, depending on weather conditions. If the conditions that are likely to lead to epidemics and mild attacks can be predicted, well ahead of the normal disease seasons, the expenditure on control methods can be regulated to the benefit of the grower. Our studies have already given very useful results.

AREAS OF SPECIAL INTEREST

Genetic base

The International Rubber Research and Development Board (IRRDB) took the initiative to broaden the available genetic base of *Hevea* by making collections of different germ plasm material from the home of the rubber plant, Brazil. About 13,000 seedlings from the collections made since 1981 have been planted in Malaysia, and we have selected 100 of these varieties, which were introduced to Sri Lanka, during the year, after the normal plant quarantine procedures. This new material will give us a broader choice of parent genes, remembering that all our breeding stock at present comes from a few dozen seedlings that survived from the Wickham introduction, made almost 110 years ago.

Tissue culture

High priority has been given to studies on tissue culture, and our laboratories have been fitted out with special equipment to carry out these studies. However, it is felt that real headway can be made in this area only when a specialized laboratory is built to carry them out. Any makeshift laboratory will have its own limitations. Staff has been recruited for this work and we have screened all culture media used up to date for their ability to support callus formation and organ differentiation. Biochemical studies to isolate, identify and specify the function of enzymes and plant growth substances naturally present in the rubber tree, have been started. This will provide the basic data required to make a systematic study of the process, starting from the fundamentals.

Rubber wood

The replanting cycle for rubber has come in for special interest ; because, on replanting, the old trees provide a very important source of light, hard timber. Rubber wood has for long years been regarded as a waste product, and generally found to be an ideal source of firewood. All that was changed by the studies carried out and popularised by this Institute. Now rubber timber, properly treated with an insecticide, soon after felling, has been found to be a most useful hardwood for the manufacture of furniture, flooring, panelling, pallets, and every conceivable use, that wood is put to, except for use outdoors, where the insecticide in the wood can be leached out. The RRISL assisted all users of rubber wood in process development, during the year.

IRRDB scholarships

The IRRDB sponsored a scheme of scholarships whereby any member institute can request any other institute to train its staff members in specialised areas of research. The RRI of Sri Lanka was named a centre of excellence for plant pathology and certain areas of rubber technology. China was selected for tissue culture studies, Malaysia for plant breeding, rubber technology, specifications and product development, Thailand for smallholder training and India for plant physiology. We have already had three students from China, Indonesia and Thailand for studies in our specialised fields and two of our officers were trained in China and Malaysia in tissue culture and rubber technology, respectively.

SELECTED RESEARCH PROJECTS

The Institute has continued to provide the necessary support to the industry to solve problems that come up and we have also made certain innovations in various fields. Some of these will be highlighted here ; but the Departmental reports carry their own summaries ; therefore, no attempt will be made here to review the work of each Department.

Plant Breeding

The South American leaf blight resistant clone RRIC 121 continued to show a rapid growth rate and high yields. If these trends continue this will be one of our best clones for planting in the wetter areas of the country.

The analyses of girth in the 6th year and yield in the 2nd year of tapping, collected from 10 clones planted in genotype-environment trials, have shown that both these characters have a significant interaction with the genotype and environment. This is the first time that this has been clearly demonstrated in *Hevea.*

Laboratory investigations have shown that the percentage of pollen germination is highest at the time of opening of flowers, which occurs in the early afternoon. This indicates that hand pollinations will be more successful, if carried out at about this time. These results and those of other studies on pollen and pollen germination, we hope, will help improve the percentage of pod set in hand pollinations.

Three promising new selections, made from the 1975 hand pollination programme, have been taken on for large-scale testing.

Plant Science

The girth of clone PB 86 is not significantly affected up to 12 years from planting, when the stand per acre is increased well above that recommended for planting at present. However, the RRIC 100 series clones, particularly RRIC 101 and 103, showed significant reduction in girth, when planted in dense stands. This shows that the RRIC 100 series clones, presently recommended, would not be suitable for the type of high stand per acre, often advocated by various persons. We do not entirely agree with this thesis in any case, as it is based on the wrong premise that the opportunity cost of the smallholder's labour is nil. This is not so now with plenty of opportunity for alternate employment or for leisure. However, serious studies are under way to breed clones, with the smallholder in mind.

Several experiments started during the year to study the best method of exploitation of old trees, just prior to uprooting for replanting, have shown that the half spiral cut is far better than the V cut tapped upwards for high panel tapping. These studies are being made to support the ongoing work on replanting cycles.

Plant Pathology

A special study, carried out at the University of London, by one of our officers, on *Phytophthora* species affecting *Hevea* in various parts of the world, has shown that more than one species of *Phytophthora* can infect the rubber tree in any country. However, one species will be dominant. In Sri Lanka, compatibility type A1 of *P. meadii* is the predominant species, but *P. palmivora* has also been isolated from *Hevea* in this country. *P. palmivora* and *P. botryosa* are present on rubber in Malaysia, and the latter is the dominant pathogen. In Brazil and Ivory Coast *P. palmivora* MF4 and MF1, respectively, are the dominant species and types. Both types of *P. meadii* occur with about the same regularity in India.

We have also found that *P. meadii* is more pathogenic to *Hevea* in Sri Lanka than *P. palmivora ;* but that the infection picture on cocoa is exactly the reverse of this, *P. palmivora* being more pathogenic. Our studies have also shown that many species of *Phytophthora* can cause infection on different plants, when inoculated under controlled conditions of temperature, humidity, light and other environmental factors, as happens in laboratory, and greenhouse studies. Therefore, it is important to carry out inoculation trials on field material too, to back up greenhouse studies.

Nitrogen fixation studies showed that *Rhizobium* cowpea complex is absent in virgin soils. Nodulation of *P. phaseoloides* when introduced to seedling agar, was inhibited at a concentration above 128 ppm of NH_4 NO_3 in sterile test tubes and addition of 200 ppm NH_4 NO_3 inhibited nodule formation in Homagama soils. It was also observed that only a few nodules were formed by introduced strains.

Soils and Plant Nutrition

Fertilization of immature rubber at the currently recommended rates is considered adequate even for the more vigorously growing clones such as the RRIC 100 series. Fertilizer application at these rates can reduce the unproductive period of RRIC 100 series clones by about 18 to 24 months in comparison with PB 86. Yield increases in mature rubber can be obtained from existing plantations with increased applications of nitrogen in the form of urea. Some yield increases may also be obtained with applications of K but applications of P and Mg may not be always beneficial. It aslo seems possible to apply fertilizers at least to mature areas during the dry periods, of January to April, if there had been approximately 1000 mm of rain during the north east monsoon in the previous year.

Rubber Chemistry

The Rubber Chemistry Department has assisted the rubber products manufacturing industry in overcoming technical problems associated with the manufacturing processes, both for the local and export markets. Research on new applications for NR and new methods of presentation and novel vulcanization processes were continued. The Department also assisted in the production of speciality grades of NR such as deproteinised natural rubber (DPNR) which has now established a special market in West Germany. The use of solar energy for drying crepe rubber was one of the key problems studied during the year.

The Department carried out a planned programme of advisory visits in consultation with the State sector plantations, and this programme was strengthened by holding periodic lecture programmes for the benefit of all personnel in the estates.

Research on the improvement of the quality of crepe rubber has been progressing steadily and the use of novel bleaching agents for manufacture of good quality crepe rubber was tested continuously.

Intercropping

During a 4 – year period, intercropping *Hevea* replantings with banana, passion fruit, pineapples and pepper has not shown statistically significant effects on growth of budgrafts in their immature phase. Betel, trained on vertical wooden posts, appears to be another promising intercrop in the wet zone.

STAFF

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

Mr S. W. Karunaratne, Head of Rubber Chemistry Department, attended the Second Training Programme, on Radiation Vulcanization of Natural Rubber Latex, held in Indonesia from 12 – 24 April. He has also attended the SMR Revision Workshop held in the United Kingdom from 29 – 31 October.

Dr N. Yogaratnam, Head of Soils and Plant Nutrition Department, attended the International Conference on Soils and Nutrition of Perennial Crops in Malaysia from 13 – 15 August.

Dr (Mrs) A. C. I. Samaranayake, Head of Plant Science Department, visited the RRIM to ascertain the progress made there in tissue culture of *Hevea* and to study any new techniques, from 11 – 16 June.

Dr P. A. J. Yapa, Head of Biochemistry Section, attended the 3-day course on Management and Treatment of Wastes held at the RRIM from 26 – 28 March. He also has been granted a 6 – months Research Fellowship, at the Okayama University, Japan, where he has been on sabbatical leave commencing 1 October.

Dr N. E. M. Jayasekera, Head of Genetics and Plant Breeding Department, attended the IRRDB meeting on *Hevea* physiology, exploitation and breeding, held in Montpellier, France, from 9 – 12 July.

Dr L. M. K. Tillekeratne, Head of Specification & Analysis Section, attended the ISO/TC 45 Conference at Bangkok from 1 – 9 November.

Mrs N. I. S. Liyanage, Assistant Plant Pathologist, followed a course of training in Plant Pathology at the Imperial College of Science and Technology, United Kingdom, for 1 year and returned to the Institute on 15 October.

Mr M. D. R. J. Goonatilleka, Assistant Rubber Chemist is on 2½ years post graduate studies, commencing 1 October at the University of Aston in the United Kingdom leading to the PhD.

Mr R. C. W. M. R. A. Nugawela, Assistant Botanist, followed a 1 - month course of training in Tissue Culture at the Headquarters of the South China Academy of Tropical Crops, Baodac Kincun, China, commencing 1 August.

Mr M. C. S. Perera, Assistant Rubber Chemist is following a course of training in Chemistry and Technology of Polymer Processing at the Australian National University at Canberra.

Mr P. A. D. T. Vimalasiri, Assistant Rubber Chemist is undergoing a course of training, at the University of New South Wales, Australia, in Chemistry and Technology of Polymer Processing.

Mr E. D. I. H. Perera, Assistant Rubber Chemist is undergoing a course of training, in Chemical Engineering, at the University of Reading in the United Kingdom.

Miss N. M. V. Kalyani, Assistant Rubber Chemist is following a course of training in Latex Technology at the London School of Polymer Science, United Kingdom.

Mr L. W. Amaratunge, Technical Officer of the Plant Pathology Department is following a course of training in the United Kingdom in Photography and Audio Visual Aids at the City of Bath Technical College, United Kingdom

Mr H. N. K. K. Chandralal, Experimental Officer of the Rubber Chemistry Department, followed a course of training in Demonstration on Radiation Vulcanization of Natural Rubber Latex in Indonesia for 6 months commencing October 1983.

Mr S. L. Weerasinghe, Senior Technical Officer of the Rubber Chemistry Department followed a course of training leading to the Diploma in Natural Rubber Processing at the RRIM for 10 months commencing 7 March 1983.

Mr G. A. Kannanagara, a Clerk of the Accounts Department was on one year's no pay leave up to March having accepted a contracted assignment in Saudi Arabia as Property Control Clerk.

Mr B. D. Ponnamperuma, Transport Assistant, resumed duties on 10 September having completed a contracted assignment in Saudi Arabia for 2 years as Collection Route Supervisor.

Mr K. D. J. Siriwardena, Driver resumed duties on 10 September having completed a contracted assignment in Saudi Arabia for 2 years as a Driver.

Miss L. I. T. Ramanaden, Library Assistant and Assistant Publications Officer was on no pay leave for 1 year commencing 1 January having accepted a contracted assignment in Pakistan as a Secretary.

Mrs S. P. S. I. Yapa, Technical Officer of the Biochemistry Section is on 6 months no pay leave in Japan commencing 1 October.

Mr M. A. Mendis, Specification Assistant of the Rubber Chemistry Department, is on 2 years no pay leave commencing June, having accepted a contracted assignment in Saudi Arabia as a Labour Foreman.

The salaried staff of the Institute at the end of the year (1984) was as follows :

Officers in Grade I — VI	..	37
Officers in Grade VII — XV	..	129
Officers in Grade XVI — XIX	..	108
Total	..	274

Director's Publications

The following publications were prepared by the Director with the assistance of the staff members named, for publication during the year :

Peries, O. S. (1984). The role of pure and applied science in development. *Inaugural Presidential Address, Inst. Biology Sri Lanka. Bull. Rubb. Res. Inst. Sri Lanka.* (in press)

Peries, O. S. (1984). Toxic hazards of the chemical industry with special reference to agriculture. *Jl. Nat. Inst. Plant. Mgmt.* (in press)

Peries, O. S. (1984). The tasks and challenges ahead of University faculties of applied science. *Lecture prepared for the Silver Jubilie celebration of Vidyodaya University Sri Lanka. Bull. Rubb. Res. Inst. Sri Lanka.* (in press)

Peries, O. S. (1984). The importance of the Agricultural sector productivity in National Development. *Paper read* at *ICMA Seminar Sri Lanka.* (in press.)

Peries, O. S. (1984). Development to increase income from the rubber industry. *The Bulletin, Jl. Cey. Pl. Soc.* 38 (2), 2 - 4.

Peries, O. S. (1984). Seventy five years of rubber research in Sri Lanka. *Planter Malaysia* (in press)

Peries, O. S. and Liyanage, A. de S. (1984). The degree and importance of pollution caused by the raw rubber manufacturing industry and effective control measures. *Jl. Nat. Inst. Plant. Mgmt.* (in press)

Peries, O. S. and Liyanage, N. I. S. (1983). The use of sulphur for the control of white root desease caused by *Rigidoporus lignosus*. *Jl. Rubb. Res. Inst. Sri Lanka*, **61**, 35 – 40.

Peries, O. S. and Liyanage, A. de. S. (1984). Chemicals used in the raw rubber manufacturing industry. *Jl. Nat. Inst. Plant. Mgmt.* (in press)

Peries, O. S. and Yogaratnam, N. (1983). Fertilizer use among perennial crops. *Jl. Rubb. Res. Inst. Sri Lanka*, **60**, 1 – 15.

Peries, O. S. and Liyanage, A. de S. (1984). The use of chemicals in the rubber growing industry. *Jl. Nat. Inst. Plant. Mgmt.* 4 (1), 9 – 21.

Peries, O. S. and Liyanage, A. de S. (1984). Systemic fungicides and their potential for use in Torpical countries. *Jl. Nat. Inst. Plant. Mgmt.*, 4 (1) ,67 – 75.

Peries, O. S. and Liyanage, A. de S. (1984). Chemicals used in the rubber growing industry as fertilizers and herbicides. *Jl. Nat. Inst. Plant. Mgmt.* (in press)

Liyanage, A. de S., Peries, O. S., Dharmaratne, A. and Dantanarayana, D. M. (1983). Effect of weather factors on disease establishment and sporulation of *Phytophthora meadii* on rubber pods. *Jl. Rubb. Res. Inst. Sri Lanka*, **61**, 41 – 48.

Liyanage, A. de S. and Peries, O. S. (1984). *A Practical Guide to Rubber Planting and Processing.* Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka : RRI.

Liyanage, A. de S. and Peries, O. S. (1984). *Souvenir International Rubber Conference and Exhibition : 75th Anniversary of Rubber Research in Sri Lanka.* Eds. A. de S. Liyanage, and O. S. Peries, Sri Lanka : RRI.

පීරිස්, ඕ. එස්. (1983). ශ්‍රී ලංකාවේ හැත්තෑපස් වසරක රබර් පර්යේෂණ, රබර් පුවත් **11.** (මුද්‍රණය සඳහා ඉදිරිපත් කොට ඇත.)

Reports

Peries, O. S. (1984). Director's Annual Review for 1983.

Director's duties

Apart from his day to day reserch and administrative duties, O. S. Peries served on the following bodies during the year :

Member of the Rubber Research Board.
Member of the Natural Resources, Energy and Science Authority of Sri Lanka
Member of the Board of Governors, Ceylon Institute of Scientific and Industrial Research.
Member of the Coconut Research Board.
Member of the Board of Management of the Post Graduate Institute of Agriculture.
Member of the Board of the National Institute of Plantation Management.
Member of the Rubber Replanting Advisory Board.

Member of Committe appointed by the Cabinet to propose means of improving the Public Service.

Member of the Steering Committee of the smallholder Rubber Replanting Project.

Editor, Journal of the Rubber Research Institute of Sri Lanka.

Editor, Journal of the National Institute of Plantation Management.

Editor, National Academy of Sciences, Sri Lanka.

VISITORS

Visitors to the Institute included.

Dr J. W. Blencowe, 24, Dale Close, Oxford OXI ITU, England.
Mr Paul Speed, Uxbridge, Middx, England.
Mr Matthew Dagg, ISNAR, The Hague, Netherlands.
Mr Robert L. Cushing, HSPA, Honolulu, Hawaii.
Dr M. Wessel, Agri. University, Wageniyan, Netherlands.
Mr Jomar Da Paes Pereira, Manus, Amazonas, Brazil.
Mr B. M. Oifa, No. 4 – 5, 5 – Chome Himonya, Tokyo, Japan.
Mr U. Geiser, Dept, of Geography, Zurich University, 8057, Zur ich, Switzerland.
Mr F. Samsudin, RRIM, Malaysia.
Mr S. K. Leong, RRIM, Malaysia.
Mr Raja Badrul Shahkobat, RRIM Salan Ampang, Kuala Lumpur,.
Mr M. R. Sethuraj, RRI, India.
Mr Dang van Vinh, RRIV, Vietnam.
Mr Thai van Soin, RRIV, Vietnam.
Mr Abdul Aziz S. A. Kadir, RRIM, Malaysia.
Mr Jiang Chi-liang, Commission of Integrated Survey of Natural Resources, Chinese Acadamy of Science Beijing, China.
Miss Corola Hund, University of Mainz, West Germany.
Mr E. C. Paardekooper, C/o, FAO Investment Centre, Rome.
Mr H. Von Sahcr, Chairman Rubber Foundation, Amsterdam, Holland.
Mr Jack Smith, Raychem Ltd Swindon, England.

REVIEW OF THE PLANT SCIENCE DEPARTMENT

By

CHANDRA SAMARANAYAKE

SUMMARY

Studies on plantlet regeneration through tissue culture techniques were given high priority in the Research Programme of the Department.

Studies on raw rubber properties of latex collected from the trunks of crown budded trees, indicates a significant influence of the crown on these properties.

The girthing of clone PB 86 is not significantly affected up to 7 years from planting when planted in denser stands than the recommended density of planting. However, clones RRIC 101 and 103 showed a significant retardation in girthing with denser stands.

A series of experiments started during the year, to study suitable methods of exploitation, prior to uprooting, indicated the superiority of the half spiral cut over the V cut tapped upwards on high panels.

DETAILED REVIEW

Staff

Dr (Mrs) A. C. I. Samaranayake, Head of Department, and Mr A. Nugawela, Assistant Botanist were on duty throughout the year. Mr A. G. A. de Soyza, Assistant Botanist, resigned his post in August. Miss G. P. W. P. Pushpika was appointed Assistant Botanist, in October.

Messrs A. H. R. Jayaratne and L. S. S. Pathiratne, Experimental officers, Messrs M. C. Perera and R. B. Gunaratne, Senior Experimental Assistants, Mr S. Wilbert, Experimental Assistant, Messrs L. S. Kariyawasam, K. A. G. B. Ameratunge, R. P. Karunasena, U. S. Weerakoon, Miss C. W. Ranasinghe and Miss G. A. S. Wijesekera, Technical Officers, were on duty throughout the year.

Miss Renuka Aluthhewage was appointed as Technical Officer in January.

Mr K. A. Piyasena, Office Labourer passed away on 18 December.

Visits

Chandra Samaranayake visited the Rubber Research Institute of Malaysia in June for a week to study the work on tissue culture done at the Rubber Research Institute of Malaysia.

A. Nugawela, Assistant Botanist, underwent a months training in tissue culture techniques in *Hevea,* in the Peoples Republic of China, under the auspices of the International Rubber Research and Development Board (IRRDB) Technical Training Programme.

The Department staff made advisory visits to plantations and made regular visits to experimental areas.

Mr R. B. Gunaratne and Mr U. S. Weerakoon of the Nursery Inspection Unit inspected stock seedling nurseries in estates managed by the Janatha Estate Development Board (JEDB), Sri Lanka State Plantation Corporation (SLSPC) and Private nurseries that supply plants to the Smallholder Rubber Rehabilitation Project (SRRP). They inspected stock seedling nurseries and budwood multiplication nurseries owned by private nurserymen for the Rubber Control Department. They also inspected and identified clones in budwood multiplication nurseries in State Plantations in the Kalutara District.

Meetings

The Head of Department addressed the Visiting Agents' Conference of the SLSPC Board V held at Sapugaskande State Plantation on "The Institute's recommendations on nursery practices, planting and exploitation of *Hevea.*" She also attended the SLSPC Visiting Agents' Seminar at the Agricultural Research and Training Institute.

Training

Training courses were conducted by the Department staff for the Divisional Rubber Extension Officers, Rubber Extension Officers and Rubber Extension Assistants of the Advisory Services Department.

A training programme was also conducted on "Nursery and planting practices and exploitation of *Hevea*" for Planters who followed a course leading to the Diploma in Plantation Management.

Publications

De Soyza, A. G. A., Samaranayake, Chandra, Abeywardene, V., Jayratne, A. H. R., and Wilbert, S. (1983). A survey on the incidence and pattern of distribution of the brown bast disease of *Hevea* in Sri Lanka. *Jl. Rubb. Res. Inst. Sri Lanka,* **61**, 1 – 6.

De Soyza, A. G. A. and Samaranayake, Chandra. (1983). Effect of puncture vs conventional tapping on the yield and girth of *Hevea. Jl. Rubb. Res. Inst. Sri Lanka,* **61**, 7 – 16.

De Soyza, A. G. A. and Samaranayake, Chandra. (1984). Puncture tapping of *Hevea brasiliensis* in Sri Lanka. *Paper presented at the IRRDB Exploitation Group meeting at Montpellier, France.*

De Soyza, A. G. A. (1984). Revised International notation for exploitation system. *A Practical Guide to Rubber Planting and Processing,* p. 89 – 91, Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka : RRI.

De Soyza, A. G. A. (1984). Tapping. *A Practical Guide to Rubber Planting and Processing,* p. 82 – 88, Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka : RRI.

Nugawela, A. and Aluthhewage, Renuka. (1984). Net photosynthetic activity and its relationships with potential productivity of some selected *Hevea* clones. *Proc. Int. Rubb. Conf. Colombo,* 1984. (in press)

Samaranayake, Chandra and de Soyza, A. G. A. (1984). Studies on exploitation of newer clones. *Proc. Int. Rubb. Conf. Colombo,* 1984. (in press)

Samaranayake, Chandra, Gunaratne, R. B. and Kariyawasam, L. S. (1984). Effect of crown in topworked trees. *Proc. Int. Rubb. Conf. Colombo,* 1984. (in press)

Samaranayake, Chandra. (1984). Rootstock seedling nurseries, *A Practical Guide to Rubber Planting and Processing,* p. 1 – 3, Eds. A. de. S. Liyanage and O. S. Peries, Sri Lanka : RRI.

Samaranayake, Chandra. (1984). Budwood nurseries. *A Practical Guide to Rubber Planting and Processing,* p. 3 – 8. Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka : RRI.

Samaranayake, Chandra. (1984). Field establishment. *A Practical Guide to Rubber Planting and Processing,* p. 40 – 50, Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka : RRI.

Samaranayake, Chandra. (1984). Branch induction. *A Practical Guide to Rubber Planting and Processing.* P. 54 – 57, Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka : RRI.

Samaranayake, Chandra. (1984). Rainguards. *A Practical Guide to Rubber Planting and Processing.* p. 92 – 95. Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka : RRI.

Samaranayake, Chandra. (1984). Improvements in propagation and exploitation. *International Rubber Conference and Exhibition Souvenir,* Eds. A. de S. Liyanage and O. S. Peries, Sri Lanka : RRI.

Waidyanatha, U. P. de S., Samaranayake, Chandra, de Soyza, A. G. A. and Perera, M. C. (1983). Virgin bark tapping of RRIC 100, 101 and RRIC 103. *Jl. Rubb. Res. Inst. Sri Lanka,* 61, 17 – 24.

Reports

Samaranayake, Chandra. (1984). Annual Review of the Plant Science Department.

Laboratory Investigations

Tissue culture

Experiments on tissue culture were distrupted due to frequent power failures experienced during the year. The cultures were finally entirely destroyed due to the prolonged power failures experienced in May and June following extensive land slides. Tissue culture studies were temporarily suspended and later the facilities for these studies were improved.

Stem cultures

Young stem explants were successfully cultured on the medium used by Chen and others in China to induce callus formation from anthers. The callus from young stem explants could be subcultured on the same medium. When 2-months old calli were transferred to a differentiating medium, no differentiation into embryoids was observed.

Embryo culture

Plantlets were obtained from embryos cultured on a differentiating medium. These plants were transferred into pots containing a mixture of soil and sand. The majority of the plants survived on transfer, but the growth seemed to be very slow.

Anther culture

Successful callus formation, although at a low success rate was observed when anthers removed from flowers of clone PB 86 were cultured. (A. Nugawela, Priyani Pushpika and Suneetha Wijesekera)

Studies on photosynthesis of *Hevea*

Gas exchange studies

Net photosynthetic activity of *Hevea* clones, RRIC 100, 103 and 45, PB 86 and IAN 710 were determined in the laboratory, with the help of an ADC Model 225/2B/SS Infra Red Gas Analyser. Leaf sections taken from leaves detached under water were used in this study.

The preliminary studies indicated that net photosynthetic rates of the five clones were very significantly different although they did not necessarily correlate with yield. Studies are being continued to determine other important gas exchange parameters such as dark respiration and photorespiration.

Preliminary studies were carried out to study respiration rate and leaf diffusive resistance using a Li Cor Model 1600 Steady State Porometer, in the field. (A. Nugawela and Renuka Aluthhewage)

Studies on mycorrhiza in *Hevea*

Establishment of non-mycorrhizal Hevea *buddings*

Preliminary studies were carried out to investigate the possibility of establishing non-mycorrhizal budded *Hevea* plants. Budded stumps washed and surface sterilized were planted in sterilized soil, sterilized sand and unsterilized soil. Non-mycorrhizal budded plants can be established using this procedure and establishement seems to be much better in soil than in sand. (A. H. R. Jayaratne)

Field Experiments

Tapping

PB 86, 1963 replantation, Nivitigalakele (T/75/3)

The aim of this experiment is to investigate the tappability of PB 86 at higher frequencies of tapping than d/2, using half spiral cuts, and the merits of controlled vs uncontrolled systems of recovery tapping. Yield and brown bast data for 1984 are summarised in Table 1.

Table 1. *Yield (kg/ha/yr) and brown bast (%) for 1983 in response to different tapping systems (T/75/3)*

Tapping system	Yield (kg/ha/yr)	Brown bast (%)
½ S d/2	1355	15.0
½ S d/1	1814	32.5
½ S 2d/3	1587	17.5
½ S d/2 + Recovery tapping*	2292	15.0
½ S d/2 + Recovery tapping**	1842	12.5
LSD (0.5%) – 380.8	380.8	

* Recovery of lost tapping days by daily tapping.

** Recovery tapping spaced, so that not more than six recovery tappings per month or two per week. (controlled recovery tapping)

In treatment D and E, 60 and 59 recovery tappings, respectively, were carried out during the year in addition to normal tapping. Treatments with recovery tappings have given significantly higher yields than ½ S d/2 tapping. The ½ S d/1 system has given relatively higher yields than the ½ S d/2. However, brown bast incidence has been much higher in the former. It should be noted that brown bast has not been taken into account when calculating yields in Table 1. (A. G. A. de Soyza and S. Wilbert)

RRIC 100, 1969 replantation, Eladuwa (T/78/2)

This experiment was carried out to investigate the effect of tapping at high relative intensities, with or without change over of tapping panels at each tapping. The incidence of brown bast in this experiment has been far above the accepted limits. (A. G. A. de Soyza and M. C. Perera)

RRIC 103, 1969 replantation, Eladuwa (T/78/3)

Conventional tapping systems, puncture tapping, and short cut tapping with Ethrel stimulation were tested in this experiment. In conventional tapping treatments ½ S cuts were tapped at higher frequencies and were compared with the standard ½ S d/2 system. In these treatments the incidence of brown bast has been much higher than the accepted limits. (A. G. A. de Soyza and M. C. Perera)

PB 86, 1974 replantation, Eladuwa (T/81/1)

This experiment was started in 1981 to investigate the use of puncture tapping on a large scale in comparison with the conventional tapping method. After completion of 2 years, puncture tapping was discontinued and conventional tapping was started on all the puncture tapped trees and tapped on ½ S d/2 system. Puncture tapped trees, on conventional tapping have given significantly higher yields than trees that have been tapped on conventional system throughout. (A. G. A. de Soyza, Chandra Samaranayake, M. C. Perera and S. Wilbert)

PB 86, 1973 replantation, Dartonfield (T/78/4)

This experiment was carried out to investigate the effect of three levels of Ethrel stimulation and three numbers of punctures per 1 metre band ; compared to ½ S d/2 and ½ S d/4 with Ethrel stimulation serving as controls. Yield data for 1984 did not show significant differences in yield between the puncture tapping treatments, they were significantly lower than the two conventional tapping controls, as in the previous year. (A. G. A.de Soyza and A. H. R. Jayaratne)

PB 86, 1978 replantation, Urumeewela (T/84/3)

This experiment was set down to investigate whether economic yields could be obtained by starting tapping at heights above the recommended 105 cm level and tapping higher panels upwards before tapping the normal base panels.

The treatments included are

1. ½ S d/3
    - a. beginning at 105 cm height
    - b. beginning at 120 cm height
    - c. beginning at 135 cm height
2. ½ S d/3 beginning at 105 cm

This experiment has been in progress for only 6 months and the results so far do not indicate a significant difference between treatments. (A. G. A. de Soyza, Chandra Samaranayake and M. C. Perera)

RRIC 103, 1978 replantation, Pallegama (T/84/1)

This experiment was set down to compare several initial girths for commencement of tapping, for their effect on yield and subsequent girth increase. The following girth classes were used. :

40 .0 — 44 .9 cm girth
45 .0 — 49 .9 cm girth
50 .0 — 54 .9 cm girth
Greater than 55 .0 cm girth

The system of tapping was ½ S d/3.

This experiment has been in progress for 6 months. Results available so far indicate significantly higher yields with trees of greater girths. (A. G. A. de Soyza, Chandra Samaranayake and R. P. Karunasena)

PB 86, 1977 replantation, Dalkeith (T/84/2)

This experiment was set down to compare several initial girths for commencement of tapping on conventional and puncture tapping systems, for their effect on yield and subsequent girth increase. The following treatments were included :

Tapping systems :

½ S d/2
6 Pg/100 (0.5) d/2 + stimulated with Ethrel

Girth classes :

40 .0 — 44 .9 cm girth
45 .0 — 49 .9 cm girth
50 .0 — 54 .9 cm girth
Greater than 55 cm girth

Experiment has been in progress only for 3 months. (A. G. A. de Soyza, Chandra Samaranayake and S. Wilbert)

High intensity tapping during the last few years of a plantation, Frocester (IS/84/1) (IS/84/2)

The aim of these experiments is to investigate suitable systems of high intensity tapping during the last few years of a plantation. Four treatments are compared in each of these experiments on a fully randomized design. Data for the first year of tapping are summarised in Tables 2 and 3.

Table 2. *Monthly mean yield (kg/tapper/task) from different tapping systems (IS/84/1)*

Treatments	July	Aug.	Sept.	Oct.	Nov.
1. ½ S + ¼S*(↙ ↗) d/3	5.0	8.5	8.5	8.8	11.0
2. ½ S + V (↙ ↗) d/3	4.2	7.5	8.7	9.0	10.3
3, ½ S + ½ S (↙ ↗) d/3	5.7	10.1	11.4	10.8	11.9
4. ½ S + ¼ S (↙ ↗) d/3	4.8	7.3	7.3	7.3	8.7
LSD	0.83	1.75	1.90	1.94	2.07

* 5% ET, Ba 0.8 (2.5) 4/y

Two ½ S cuts one tapped upward and the other downwards have given significantly higher yields when compared to ½ S cut tapped downwards and a V cut tapped upwards. Treatment where a ¼ S cut is stimulated with Ethrel has not given significantly higher yields when compared with a S cut unstimulated.

Table 3. *Monthly mean yields (kg/tapper/task) (IS/84/2)*

Treatment	July	Aug.	Sept.	Oct.	Nov.
1. V* d/2 (↗)	5.7	8.2	6.7	6.5	6.5
2. S/2* d/2 (↗)	5.0	7.3	6.6	6.3	6.3
3. S/2 + S/4 (↙ ↗) d/2	4.8	6.8	6.6	6.1	6.0
4. S/2 + PT* (↙ ↗) d/2	5.7	7.3	6.7	7.2	6.6
LSD	0.69	0.87	0.89	0.91	0.61

* 5% ET Ba 0.8 (2.5) 4/y

** 5% ET Ba 1.0 2w

On the higher panels V cuts and ½ S cuts stimulated and tapped upwards have given yields comparable with ½ S + S/4 cuts and ½ S + PT.

These two experiments are repeated in two other Districts, Kegalle and Galle. (A. Nugawela, A. H. R. Jayaratne and S. Wilbert)

Interaction of clones and tapping systems St. George (CT/77/3)

The purpose of this experiment is to ascertain the most effective tapping system for different clones. The four tapping systems tested, on 15 clones, are as follows :

1. ½ S d/3
2. ½ S d/2
3. ½ S d/2 with provision for change over of panels for introducing higher frequencies of tapping.
4. 2 S d/2 for 8 months and Pg/100 (0.5) d/2 + E for 4 months.

The yield data for 1984 indicate no significant clone and tapping interaction. Puncture tapping treatments have given significantly lower yields during the year. (Chandra Samaranayake, L. S. S. Pathiratne, C. W. Ranasinghe and N. D. Yawanis)

Brown bast

RRIC 101, 1976 replantation, Eladuwa (BB/77/1)

This area was planted in 1977 with clone RRIC 101 ; the buds for grafting were derived from mother plants which were (a) high yielding (b) low yielding (c) brown bast affected trees growing in the 1969 replantation of the same estate. The successful budgrafts were planted randomly in the field, The area was brought into tapping towards the latter part of 1983, yield records on individual trees and brown bast incidence were recorded. (A. G. A. de Soyza and R. P. Karunasena)

Brown bast survey

The second part of the survey was started in 1984 to study the pattern of spread of this disorder in five *Hevea* clones, viz. RRIC 100, 101, 102, 103 and PB 86. Areas 5 acres in extent were mapped where brown bast has just appeared and the spread of this disorder in each area will be monitored to see whether there is a regular pattern of spread. (A. H. R. Jayaratne, S. Wilbert and Chandra Samaranayake)

Yield stimulation

Yield stimulants on renewed bark, Gallewatta (ETH/81/1)

Two concentrations of Ethrel viz. 2.5%, 5%, two frequencies and two methods of application were tested in this experiment started in 1981. Yield data recorded in 1983 indicated no significant response to treatment. Application of stimulants was suspended in 1984 and will be resumed in 1985 to see whether the response to Ethrel will improve with a period of rest. (A. H. R. Jayaratne, and S Wilbert)

Tree spacing and density

Tree spacing and density, Millewa (CD/77/1)

Clones RRIC 101, 103 and PB 86 were established at six spacings and densities on a factorial experiment with three replicates. Tapping commenced in January, yield data recorded for 1984 indicated a significant spacing and density effect on yield.

Table 4. *Mean yield (g/t/t), spacing and density experiment (CD/77/1)*

	Spacing (m)	Denisty trees/ha	Yield g/t/t
S_1	2.5 X 10.0	400	21.90
S_2	2.5 X 7.5	533	17.70
S_3	2.5 X 6.0	666	16.38
S_4	2.5 X 5.0	800	14.21
S_5	3.87 triangular	771	15.91
S_6	3.54 triangular	920	14.98
	LSD 0.5		3.63

Girth of trees indicated a significant interaction between clones and spacings.

Table 5. *Mean girth (cm) spacing and density experiment (CD/77/1)*

	Spacing					
Clone	S_1	S_2	S_3	S_4	S_5	S_6
PB 86	46.0	51.6	46.3	43.9	45.3	43.5
RRIC 101	66.6	53.8	51.5	50.5	50.2	46.8
RRIC 103	56.1	57.4	48.9	50.0	51.8	49.0

LSD 0.5 - 6.09

In clone PB 86 there was no significant difference in growth due to different spacings and densities. However, in clones RRIC 101 and 103 there was a significant reductions in growth with densities of planting over 400 trees/ha. (Chandra Samaranayake, L. S. S. Pathiratne and N. D. Yawanis)

Propagation

Stock-scion relationships

Stock-scion experiment, St. George (St. sc/75/4)

Clones RRIC 45, 52, PB 86 and Wagga 6278 have been budded on to clonal seedling rootstocks of RRIC 45, 52, PB 86 and Wagga 6278 in all possible combinations.

Yield data recorded for 1984 did not indicate a significant rootstock effect on yield, although in the previous year there was a significant stock x scion interaction on yield. There was no significant rootstock effect on growth either. (Chandra Samaranayake, R, B. Gunaratne, and K. A. G. B. Ameratunge)

Stock-scion experiment, Frocester (St. sc/80/6)

Clones RRIC 100, 101, 102, 103, 111, RRIC 52 and PB 86 have been budded on to seedling rootstocks of the same clones in all possible combinations. Growth in girth of scions measured 4 years from planting showed that there was no rootstock effect on girth. (Chandra Samaranayake, R. B. Gunaratne and U. S. Weerakoon)

Stock-scion experiment, Moralioya (St. sc/81/7)

Clones RRIC 100, 101, 103 PB 86 and CT 1 have been budded on to seedling rootstocks of the same clone in all possible combinations. Growth in girth at 3 years from planting showed no significant rootstock effect. (Chandra Samaranayake and L. S. Kariyawasam)

Crown budding

Crown budding experiment, St. George (CB/75/1)

The purpose of this experiment is to study the effect of different crowns on growth, yield and latex properties. The data collected so far have indicated that the crown is capable of significantly influencing the growth, yield and raw rubber properties of the latex collected from the trunk. (Chandra Samaranayake, L. S. Kariyawasam and K. A. G. B. Ameratunge)

Improvements in planting techniques

Plants in polybags, Belmont (RI/78/1)

Growth of plants raised in polybags up to the four to five whorl stage were compared with bare root budded stumps, after transplanting in the field. Polybagged plants reached tappability about 6 months earlier than bare root budded stumps in this experiment. (Chandra Samaranayake and L. S. Kariyawasam)

Stumped buddings, Neuchatel (RI/81/3)

Green budded stumps which serve as the control were planted in the field in May 1982 and stumped buddings in June 1983. Field establishment success of stumped buddings has been very high with less than 1% failures. Girth measurements recorded in 1984 showed that green budded stumps which were transplanted in the field 13 months prior to stumped buddings have a significantly better growth. (Chandra Samaranayake, K. A. G. B. Ameratunge and R. B. Gunaratne)

Comparison of planting techniques, Peenkande (GB/74/2)

Several methods of establishing rubber in the field were compared in this experiment. Growth of plants 4 years after planting in the field indicated that plants budded at stake in the field and seedlings grown and budded in polybags and then transplanted in the field were superior to bare root brown and green budded stumps. (Chandra Samaranayake and L. S. Kariyawasam)

Green budding in polybags and bare root stumps, Elston (PB/81/3)

Bare root green budded stumps and budded stumps raised in polybags for 6 months were compared after transplanting in the field. Bare root budded stumps which were transplanted in the field at the time of planting budded stumps in polybags, continued to show significantly better growth than the polybag grown plants which were transplanted in the field 6 months later. (Chandra Samaranayake, L. S. Kariyawasam and R. B. Gunaratne)

Brown buddings in polybags, Gallewatte (PB/81/4)

In this experiment polybag grown budded plants and bare root budded stumps transplanted in the field at the same time were compared. Growth of plants measured

3 years after planting showed that polybag grown plants were superior in growth to bare-root plants. (Chandra Samaranayake and S. Wilbert)

Green buddings vs brown buddings, Geekiyanakande (PB/81/5)

The growth of green and brown bare root stumps and green and brown budded stumps grown in polybags were compared after transplanting in the field. The bare root plants which were transplanted in the field at the time of planting budded stumps in polybags showed significantly better growth in the field than polybag grown plants transferred to the field 12 months later. (Chandra Samaranayake and K. A. G. B. Ameratunge)

Effect of a root stimulant on sprouting and growth of budded stumps

A proprietary formulation which is claimed to promote root initiation and growth was tested in a factorial experiment. Root stimulant had no significant effect on sprouting of buds or on the number of casualties.

Growth of new shoots and new roots at 3 months from planting did not indicate any significant beneficial effect due to treatment. However, at 4 months there were indications of a significant beneficial effect of the root stimulant on shoot growth of budded stumps with long taproots where the laterals were completely removed.

Significant beneficial effect on new root growth was seen in treatments where the taproot was pruned to 10 inches, leaving the laterals intact. This effect was not seen in the plants sampled at 6 months from planting. This experiment will be repeated to confirm whether this root growth stimulant could be used effectively to increase establishment success in polybags when taproots and laterals are pruned to accomodate budded stumps in polybags. (Chandra Samaranayake, R. B. Gunaratne and U. S. Weerakoon)

Clone characters

Field observations, Eladuwa (CC/77/1)

The purpose of this study was to investigate a number of clones in order to identify criteria, if any that could be used in the early selection of clones. The area came into tapping in 1983 and individual tree yeilds were recorded for more than a year. Data analysed so far indicated that first year microtapping yields did not have any relationship, with the actual yields obtained in the first year from the same tree. (Chandra Samaranayake and L. S. Kariyawasam)

REVIEW OF THE INTERCROPPING DEPARTMENT

By

L. B. CHANDRASEKERA

SUMMARY

During a 4-year period, intercropping *Hevea* replantings with banana and passion fruit has not shown statistically significant effects on growth of *Hevea* budgrafts during the immature period. Similarly intercropping with pineapples and pepper trained on to live *Gliricidia* posts has not suppressed the growth of *Hevea* budgrafts at the end of 3 years. Betel trained on to vertical wooden posts appear to be a promising intercrop for the wet zone. Attempts to grow coffee and papaw as intercrops have not been successful so far.

DETAILED REVIEW

Staff

Mr L. B. Chandrasekara, Head of Intercropping Department, and Messrs U. K. D. Lewis and W. T. Silva, Experimental Assistants, were on duty throughout the year.

Visits

The technical staff of the Department paid advisory visits to estates, smallholdings and to experimental areas where necessary.

Meetings

The Head of Department gave talks on intercropping at the following meetings :

Ratnapura District, Agricultural Advisers' Conference.

International Rubber Conference, 1984, Sri Lanka.

He also delivered a series of lectures on various aspects of intercropping to Estate Superintendents and Rubber Extension Officers.

Publications

Chandrasekera, L. B. (1984). Intercropping *Hevea* replantings during the immature period in the smallholdings. *Proc. Int. Rubb. Conf. Colombo*, 1984. (in press).

Reports

Chandrasekera, L. B. (1984). Review of the Intercropping Department.

Field Experiments

Intercropping with banana, passion fruit and coffee (IC/80/2 and IC/80/3)

The design of these experiments and cultural details are described on pages 23 and 24 of the Annual Review for 1981. One experiment /(IC/80/1) involving the same crops and located at Eladuwa Estate, Kalutara, was discontinued at the end of 1983 owing to extensive wind damage to passion fruit and banana plots.

The girth measurements of *Hevea* budgrafts in the various experimental plots taken at the end of 1984 at 4 years of age are summarized in Table 1.

Table 1. *Mean girth (cm) of* Hevea *budgrafts at 4 years of age in two intercropped experiments (IC/80/2, IC/80/3)*

Crop	Field experiments No. IC/80/2	 IC/80/3
	Mean girths (cm)	
Banana	26.6	38.1
Passion fruit	25.3	37.7
Coffee	28.3	38.2
Control	24.0	37.2

The differences in mean girth for the various treatments were statistically not significant in both experiments.

In experiment IC/80/3 which is located in the Kegalle District, all crops were shaded out in the fourth year by the heavy canopies of clone RRIC 100, and hence no yields were recorded in the fourth year of the experiment. In field experiment IC/80/2 which is sited in the Ratnapura District, only banana continued to grow in the fourth year of growth of clone PB 86. In this year a total of 92 banana clumps in the various experimental plots yielded 201 bunches with an estimated value of Rs. 3,585.00. From these experiments it may be concluded that intercropping with passion fruit could be carried out up to the end of the third year while bananas will yield up to the end of the fourth year from planting of *Hevea* budgrafts.

These experiments will be discontinued from 1985. (L. B. Chandrasekera, U. K. D. Lewis and W. T. Silva)

Experiments with passion fruit (IC/82/1)

This is a passion fruit density trial, the details of which are described on pages 24 and 25 of the Annual Review for 1982. The passion fruit vines in this experiment began to bear in 1983 at the end of approximately 9 months growth. In this trial, 350 passion fruit vines yielded 762.98 kg of fruit in the second year in 1984 averaging 2.18 kg of fruit per vine. The estimated value of the crop was Rs. 2,783.00. (L. B. Chandrasekera and W. T. Silva)

Experiments with papaw(IC/83/1)

Details of experiments in 1984 are given on page 29 of the Annual Review for 1983, attempts to grow papaw in these trials have been unsuccessful. (L. B. Chandrasekera, U. K. D. Lewis and W. T. Silva)

Experiments with pepper (IC/81/2, IC/83/2)

Details of these experiments appear on page 29 of the Annual Review for 1983.

In experiment IC/81/2 the average girth measurements of *Hevea* budgrafts at the end of 3 years in 1984 are summarised in Table 2.

Table 2. *The average girths (cm) of* Hevea *budgrafts intercropped with pepper at the end of 3-years*

Treatment	Average girth (cm)
Single row of pepper	21.7
Two rows of pepper	22.8
Control	21.6

The girth differences for the various treatments were not statistically significant.

The live *Gliricidia* trees in the inter-row area, on which pepper vines have been trained, have offered no competetion to rubber up to the end of the third year from planting. It has not been possible to evaluate accurately the yields of pepper owing to thefts.

In Experiment IC/83/2 pepper vines commenced bearing at the end of 1 year in 1984, although yields at this stage were meagre. (L. B. Chandrasekera, U. K. D. Lewis and W. T. Silva)

Experiments with pineapple (IC/81/3, IC/ 83/1)

Details of experiment IC/81/3 are described on page 26 of the Annual Review for 1982. In 1984 there was extensive damage to pineapple plants caused by the fungus *Ceratocystis paradoxa*. As a result of this the yield of fruit was insignificant. However the girth measurements of *Hevea* budgrafts in the trial at the end of 3 years of intercropping with pineapple are given in Table 3.

Table 3. *The average girth (cm) of* Hevea *budgrafts intercropped with pineapple at end of 3 years*

Treatment	Mean girth (cm)
One row of pineapple	16.60
Two rows of pineapple	16.42
Three rows of pineapple	16.30
Four rows of pineapple	17.95
Control	13.77

LSD 2.51

Intercropping with pineapple appears to have benefitted the growth of rubber.

In view of the spread of dry rot in pineapple in this trial, field experiment IC/83/1 was set down in 1983 where four rows of pineapple between each pair of rubber rows formed one of the treatment in a trial, that was replicated in four smallholdings in the Kalutara District. In these experimental plots, pineapple plants commenced bearing at the end of 10 months in 1984. However in these plots too there was reddening of leaves which are indicative of infections by the fungus *Ceratocystis paradoxa*. Intercropping with pineapple in the wet districts may therefore need to be done with caution. (L. B. Chandrasekera, U. K. D. Lewis and W. T. Silva)

Experiments with cacao (IC/81/1)

Experimental details of this proposed trial are given on page 32 of the Annual Review for 1981. The failure to establish cacao in this trial has been due to the lack of shade which cacao needs for establishment and early growth. With *Hevea* budgrafts in the fourth year of growth it is proposed to try to establish cacao in 1985 using shade provided by the rubber itself. (L. B. Chandrasekera and U. K. D. Lewis)

Experiments with annual-green gram and maize (IC/83/1)

These experiments are described on page 30 of the Annual Review for 1983. Repeated attempts to grow green gram and maize in experimental plots in the wet zone have failed. (L. B. Chandrasekera, U. K. D. Lewis and W. T. Silva)

Experiments with betel (IC/83/1)

These experiments are described on page 30 of the Annual Review for 1983. With regular application of fertilizer, the growth of betel vines in all experimental plots has been very satisfactory to date. Betel appears to be a promising intercrop for the future. (L. B. Chandrasekera, U. K. D. Lewis and W. T. Silva)

Smalholder trials

A majority of smallholder demonstration plots involving the two crops banana and passion fruit were planted during the years 1981 and 1982. These have now gone out of production due to shading by the rubber, leaving only the following demonstration plots.

District	Year planted	Crop	Extent (ha)
Kalutara	1983	Banana	0.25
Kalutara	1983	Pepper	0.25

It has therefore become necessary to set down new demonstration plots of recommended crops in 1985. In the past, these plots have served three purposes, namely as demonstrations for smallholders, benefit of visitors to the Institute and for training of Extension Officers in the Advisory Services Department.

REVIEW OF THE GENETICS AND PLANT BREEDING DEPARTMENT

By

N. E. M. JAYASEKERA

SUMMARY

The South American leaf blight resistant clone RRIC 121 continued to show good vigour and high yields.

The analysis of 6th year girth and 2nd year yields collected from ten clones planted in a genotype-environment trial showed significant genotype-environment interaction components for both characters.

Hundred clones from the *Hevea* germ plasm collection, made by the International Rubber Research and Development Board (IRRDB), were received by the Institute during 1984.

Laboratory investigations indicated that the percentage of pollen germination is highest at the time of flowering.

Three promising new selections made from 1975 hand pollinated seedlings were promoted to large scale testing.

DETAILED REVIEW

Staff

Dr N. E. M. Jayasekera was appointed Head of the Department with effect from 1 February, 1984.

Mr D. P. S. T. G. Attanayake assumed duties as Assistant Geneticist and Plant Breeder on 2 July 1984.

Miss S. C. Alagoda, Assistant Geneticist and Plant Breeder was on duty throughout the year.

Experimental Officer, Mr K. B. Karunasekera, Technical Officers, Messrs K. W. Rupatunga, I. D. M. J. Sarath Kumara, R. A. S. K. Rupatunga, Senior Experimental Assistant, Mr B. M. S. G. Peiris and Experimental Assistants Messrs D. S. Gamage and A. K. M. S. Senaratne were on duty throughout the year.

Research students

Miss I. D. N. Padmini from the Faculty of Agriculture, Ruhuna University, Mapalana worked from 25 June to 18 October 1984 under N. E. M. Jayasekera's supervision for her final year research project entitled " A study of the performance of 1974 selections in a small scale clone trial."

Visits

N. E. M. Jayasekera visited the Rubber Research Institute of Malaysia (RRIM) from 12 to 15 of June 1984. The main objective was to visit the gene pool garden maintained by the RRIM.

Technical staff made regular visits to experimental areas to collect data and make observations.

Meetings and Conferences

N. E. M. Jayasekera attended the IRRDB meeting on *Hevea* physiology, exploitation and breeding held from 9 to 12 July 1984 in Montpellier, France.

Staff of the Department attended the International Rubber Conference held at BMICH, Colombo to commemorate 75 years of rubber research in Sri Lanka.

N. E. M. Jayasekera attended two meetings on tissue culture work organized by the Ministry of Plantation Industries and also attended the last two meetings of the Scientific Committee of the Rubber Research Institute.

The Head of the Department spoke on RRIC 100 series clones at the visiting agents' meeting held at Talduwa Planters' Club.

Extension and training

The Head of the Department and the Experimental Officer, Mr K. B. Karunasekera and Experimental Assistant, Mr D. S. Gamage were involved in training Rubber Extension Assistants, Rubber Extension Officers and Superintendents who visited the Institute for training courses.

Publications

Fernando, D. M. (1984). RRIC 100 series clones : Potential and planting policy. *Proc. Int. Rubb. Conf., Colombo,* 1984. (in press)

Jayasekera, N. E. M. and Karunasekera, K. B. (1984). Effect of environment on clonal performance with respect to early vigour and yield of *Hevea brasiliensis. Proc. of IRRDB meeting on* Hevea *physiology, exploitation and breeding, July 1984, Montpellier, France.*

Jayasekera, N. E. M. (1984). Studies of genotype-environment interactions in *Hevea*. *Proc. Int. Rubb. Conf., Colombo,* 1984. (in press)

Jayasekera, N. E. M., Fernando, D. M. and Karunasekera, K. B. (1984). Identification of clones. *A Practical Guide to Rubber Planting and Processing,* p. 10–18. Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka : RRI.

Jayasekera, N. E. M. and Fernando, D. M. (1984). RRIC 100 series clones recommended for planting. *A Practical Guide to Rubber Planting and Processing,* p. 26–29. Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka : RRI.

Jayasekera, N. E. M. and Fernando, D. M. (1984). Progress of *Hevea* breeding and genetical studies in Sri Lanka. *International Rubber Conference and Exhibition Souvenir.* Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka : RRI.

කරුණාසේකර, කේ.බී. (1984). නව හිවියා (රබර්) ක්ලෝනයන් බිහිකිරීමෙ අරමුණු සහ එහි ප්‍රවේශය. **රබර් පුවත්, 10,** 5–9.

Reports

Fernando, D. M. (1984). Annual Review of the Genetics and Plant Breeding Department.

General

Issues and receipts of budwood

Local

The budwood nurseries at Kuruwita and Nivitigalakele issued a total of 2563 meters of budwood. The largest issue was of RRIC 103. Details are given in Table 1,

Table 1. *Details of issues of budwood*

Clone	Meters	
	Kuruwita	Nivitigalakele
RRIC 100	253	—
RRIC 102	2	—
RRIC 103	1203	10
RRIC 104	—	50
RRIC 110	72	—
RRIC 117	2	25
RRIC 118	120	25
RRIC 121	654	100
RRIC 126	2	—
RRIC 128	2	—
RRIC 130	17	—
RRIC 133	2	—
PB 86	12	—
BPM 24	—	12
Total	2341	222

Foreign

Budwood of four RRIC clones viz. RRIC 117, RRIC 121, RRIC 130 and RRIC 133 were despatched to Mexico in the first quarter of 1984.

Two meters of RRIC 131 budwood were sent to China and the Rubber Research Institute of Sri Lanka (RRISL) received 4 meters each of budwood, of the clones HAIKEN 1 and SCATC 88–13 from China.

Budwood of 100 clones from the germ plasm collection made by the International Rubber Research and Development Board (IRRDB) was received by us in late April, 1984.

Laboratory Investigations

Pollen gremination studies (FL/84/2)

Germination ability and growth of the pollen tube in different *Hevea* genotypes were studied using three *Hevea brasiliensis* cultivars, one *H. spruceana* cultivar and one *H. nitida* cultivar. Germination was done in double concavity glass slides using a liquid medium containing 15% sucrose, 0.06% calcium nitrate and 0.04% boric acid. Tube length was measured using a micrometer eye piece. The results are given in Tables 2 and 3.

Table 2. *Percentage pollen germination (FL/84/2)*

Clones	Replicates							Total
RRIC 102	10.75	8.25	13.25	12.00	16.00	9.75	11.25	81.25
RRIC 104	9.75	3.50	10.00	6.00	2.75			32.00
H. spruceana	38.00	31.75	25.25	30.75	30.50			156.25
GT 1	10.25	3.50	14.25	6.25	2.50			36.75
H. nitida	19.50	8.25	19.25	14.50				61.50

Table 3. *Mean pollen tube length (micrometer scale) (FL/84/2)*

Clones	Replicates							Total
RRIC 102	1.37	1.29	1.78	1.47	0.82	1.91	1.99	10.63
RRIC 104	0.67	0.71	0.64	0.66	0.40			3.08
H. spruceana	1.28	1.24	1.05	0.96	0.65			5.18
GT 1	0.58	0.88	0.75	0.54	0.64			3.39
H. nitida	1.24	0.69	0.67	0.93				3.53

The analysis of variance indicated significant differences between genotypes for pollen germination and length of the pollen tube (Tables 4 and 5).

Table 4. *Analysis of variance of percentage pollen germination*

Source	Degrees of freedom	Mean square	F value
Between clones	4	5.11	31.93***
Within clones	21	0.16	

Table 5. *Analysis of variance of pollen tube length*

Source	Degrees of freedom	Mean square	F value
Between clones	4	0.8005	10.47**
Within clones	21	0.0764	

Levels of significance

** = 1.0—0.1% *** = <0.1%

An experiment was conducted to study the germination of pollen collected before and after the opening of male flowers. Pollen from the clone KH 440 was collected at different time intervals during the day and germinated in a liquid medium. Percentage germination relevant to different time intervals is given in Table 6.

Table 6. *Percentage germination of pollen collected at different time intervals* (*FL/84/2*)

	Day					
Time	1	2	3	4	5	6
9.30 a.m.	4.93	2.75	6.18	0.06	8.43	1.66
11.30 a,m,	12.80	14.90	11.31	0.50	12.93	5.93
1.30 p.m.	9.00	13.08	16.75	7.87	22.87	10.87
2.30 p.m.	10.31	11.66	20.75	10.50	21.50	11.93

The original data were transformed to inverse sine and subjected to an analysis of variance. There was a significant difference, in germination, between the pollen collected in the morning and afternoon as shown in Table 7.

Table 7. *Analysis of percentage germination of pollen collected at different times of the day*

Source	Degree of freedom	Mean square	F value
Morning vs afternoon (9.30, 11.30 a.m.) (1.30, 2.30 p.m.)	1	351.19	10.76**
9. 30 a.m. vs 11.30 a.m.	1	72.1460	NS
1.30 p.m. vs 2.30 p.m.	1	24.6885	NS
Error	14	32.62	

This shows that pollen collected in the afternoon had a higher percentage germination. It was observed that in KH 440 peak time of flower opening is between 12 noon to 3 p.m. In other words observations indicate that the ability of the pollen grain to germinate is high at the time of flower opening. (Sumeda Alagoda and D. P. S. T. G. Attanayake)

Field Experiments

Breeding and selection

Hand pollination programme for 1984 (HPS/84/1)

The hand pollination programme for 1984 was carried out in the 1979 experimental area at Eladuwa State Plantation. The crosses made, the number of pollinations done in each cross, the number of pods and seedlings derived are given in Table 8.

Table 8. *The crosses and n umber of pollinations, pods and seedlings derived in each cross (HPS/84/1)*

Cross	No. of pollinations	No. of pods	No. of seedlings
GT 1 X RRIC 104	1420	3	6
RRIC 102 X RRIC 104	434	—	—
RRIC 104 X RRIC 102	473	—	—
GT 1 X RRIC 107	388	—	—
RRIC 102 X RRIC 107	245	—	—
RRIC 104 X RRIC 107	950	1	—
RRIC 107 X RRIC 102	140	—	—
GT 1 X RRIC 103	901	1	—
GT 1 X RRIC 102	860	—	—
GT 1 X *Nitida* 4	94	—	—
GT 1 X *Nitida* 3	149	—	—
RRIC 102 X *Nitida* 3	19	—	—
GT 1 X *Nitida* 1	66	—	—
GT 1 X *Nitida* 2	102	—	—
RRIC 102 *Nitida* 2	34	—	—
RRIC 107 X RRIC 104	488	1	3
Total	6763	6	9

Due to continued wet weather during the flowering season only a small number of pollinations was possible. The success of hand pollination was also very low, probably due to the extremely wet weather experienced during the flowering season. (N. E. M. Jayasekera and A. K. M. S. Senaratne)

Selection of 1974 and 1975 HP seedlings (HPS/74-75/1)

1974 selections: Four small scale trials were established in 1980 and 1981 to test 69 genotype selected from 1974 HP seedlings (for details see 1980 and 1981 Anual Reviews.)

Three of these trials have been established in 1980, at Moralioya, Yatadola and Perth State Plantations (SP).

Annual girth measurements were recorded in these trials.

The analysis of 1984 girth data collected from Moralioya showed that three control clones, RRIC 100, RRIC 103 and RRIC 121 are not significantly different from one another. Only two new clones, 74 – 93 and 74 – 141 had significantly better average girth than the best control clone RRIC 103.

The analysis of girth data from the small scale trial at Yatadola State Plantation showed that 74 – 166, 74 – 208 and 74 – 181 had significantly better mean girth than that of the best control clone RRIC 121.

In the trial established at Perth only one clone, 74 – 147, had significantly better average growth when compared to the best control clone which was RRIC 121.

In addition to the annual girth measurements these three trials at Moralioya Estate, Perth and Yatadola State Plantations have been test tapped in 1984 using the Morris-Mann technique.

Morris-Mann test tapping data collected from Moralioya had been analysed. Analysis of variance indicated significant genetic differences between clones.

Out of the four control clones, RRIC 121 had the highest mean yield.

Two new clones, 74 – 141 and 74 – 181 had significantly higher mean test-tapping yields than RRIC 121. The mean yield of 74 – 157 should have been significantly better than RRIC 121 if not for its large standard deviation. The analysis of girth data also showed that 74 – 141 and 74 – 181 are vigorous clones. These three clones (74 — 141, 74 – 181, 74 – 157) will be tested in large scale trials.

A girth measurement was recorded from the small scale trial established at Kuruwita Sub-station, in order to test 17 new selections made from 1974 HP seedlings. Again RRIC 121 recorded the highest mean girth and two new clones 74 – 22 and 74 – 140 recorded significantly higher mean values than RRIC 121. (N. E. M. Jayasekera, K. B. Karunasekera and K. W. Rupatunge)

1975 HP selections : These selections are tested in three small scale clone trials planted at Clyde, Sorana and Padukka State Plantations. A girth measurement was recorded in these trials in 1984.

Seven selections (from 1975 HP seedlings) which were not included in small scale trials planted in 1981, due to lack of sufficient budwood have been budgrafted. These selections will be included in small scale trials to be established in 1985 SW.

1976 HP selections (HPS/76/2)

Twenty nine selections from the 1976 HP seedling progeny have been budgrafted. These selections will be planted in two small scale trials to be planted in 1985. (N. E. .M Jayasekera and K. B. Karunasekera)

1978 HP selections (HPS/78/3)

Seven genotypes from 1978 HP seedling progeny will be tested in small scale trials to be established during the 1985 SW monsoon season. (N. E. M. Jayasekera and K. W. Rupatunge)

1979 to 1981 HP seedling populations (HPS/79/2, HPS/80/1, HPS/81/1)

HP seedlings derived from hand pollination programmes in 1979, 1980 and 1981 were scored for their girth and diameter. Observations were also made on incidence of *Oidium* leaf disease. (N. E. M. Jayasekera, K. W. Rupatunge and K. B. Karunasekera)

Clone evaluation in dry Districts

Kumarawatta State Plantation, Moneragala (V/65/9)

The mean yields and mean girths of the seven clones tested in this experiment are given in Table 9.

Table 9. *Mean girth and mean yield of selected clones (V/65/9)*
(Panel $B1_1$, tapped ½S, d/2)

Clone	Mean girth (cm)	Mean yield (g/t/t)
RRIC 101	64.7	16.17
RRIC 102	66.6	31.19
RRIC 103	74.0	25.54
RRIC 104	72.1	21.17
RRIC 45	67.5	19.24
IAN 45/710	65.4	14.28
RRIM 623	68.7	14.10

Clodagh Estate, Matale (VC/65/10)

In this trial five clones are evaluated ; their mean girths and mean yields are given in Table 10.

Table 10. *Mean girths and yields of clones (VC/65/10)*
(Panel $B1_1$, tapped ½ S, d/2)

Clone	Mean girth (cm)	Mean yield (g/t/t)
RRIC 103	77.1	37.8
RRIC 118	59.4	28.3
IAN 45/710	65.6	25.5
RRIC 116	71.8	20.7
1108	67.4	18.7

Bibile Group (V/67/20, V/67/37)

Mean girths and mean yields of the clones included in these trials are given in Tables 11 and 12.

Table 11. *Mean yield and girths of clones in (V/67/20)*
(Tapped ½ S, d/2)

Clone	Mean girth (cm)	Mean yield (g/t/t)
RRIC 103	77.7	58.3
IAN 45/710	80.5	56.0
RRIC 100	69.3	54.7
RRIC 112	72.2	54.1
RRIC 101	69.8	50.4
RRIC 45	72.7	40.9

Table 12. *Mean girth and yields of clones in (V/67/37)*
(Tapped ½ S, d/2)

Clone	Mean girth (cm)	Mean yield (g/t/t)
RRIC 117	58.7	52.5
RRIC 103	63.0	51.2
RRIC 102	59.6	51.2
RRIC 110	62.1	49.8
RRIC 112	61.4	46.5
1461	61.3	45.1
RRIC 104	66.1	41.9
506	53.5	22.0
RRIC 105	62.2	20.8

Considering the growth and yield data collected from the trials conducted in marginal areas, it is evident that the performance of RRIC 100 series clones is much better, in these areas, when compared with other clones. In this respect RRIC 100, 102 and 103 recorded consistantly high average girths and mean yields. These observations indicate the potential of these clones in establishing rubber in marginal areas like Bibile, Moneragala and Matale Districts. (D. S. Gamage, B. M. S. G. Peiris and R. A. S. K. Ranatunge)

Clone evaluation in wet Districts

Kalutara District

Clone trial at RRI, Dartonfield, Agalawatta (VC/65/8)

In this trial eight clones are evaluated. During the year under review, renewed bark was in tapping for the 2nd year. Mean girths and mean yields are given in Table 13.

Table 13. *Mean girths and yields of clones (VS/65/8)*
(Tapped ½ S, d/2)

Clone	Mean girth (cm)	Mean yield (g/t/t)
RRIC 102	72.6	30.7
RRIC 114	70.1	32.6
RRIC 117	82.9	50.1
RRIC 120	84.8	35.2
RRIC 121	93.7	48.6
RRIM 623	77.6	26.9
RRIC 45	72.9	34.2
IAN 45/710	81.1	30.6

In this trial RRIC 121 which has been found to be tolerant to South American leaf blight (SLAB) has shown the best growth. Another SALB resistant clone, RRIC 117 has recorded the highest mean yield, closely followed by RRIC 121. (D. S. Gamage)

Clone trial at RRI Sub-station, Nivitigalakele (VC/67/17)

This trial too is in the 2nd year of tapping on the renewed bark. Mean test tapping yield and mean girth for 1984 are given in Table 14.

Table 14. *Mean yield and girth (VC/67/17)*
(Tapped ½ S,d/2)

Clone	Mean girth (cm)	Mean yield (g/t/t)
RRIC 101	74.1	28.2
RRIC 102	75.8	27.8
RRIC 111	82.6	43.3
RRIM 623	76.6	29.0

In this trial RRIC 111 has recorded the best growth and highest yield. (D. S. Gamage)

Clone trial at Eladuwa State Plantation and Hedigalla State Plantation (VSM/69/29, VSM/69/30)

These two trials have the same clones and use the same experimental design. Every even numbered field position of these two trials is planted with the control clone, RRIC 45. Odd numbered field positions are fully randomized among the six test clones which include RRIC 100, RRIC 112, RRIC 103 and RRIC 101. The other two, 1173 and 1458, are unregistered clones.

The test tapping data and girth data collected in 1984 from Hedigalla were analysed. The t–tests showed that there are no significant differences between the control clone RRIC 45 and 1458, 81173 and RRIC 101. This was true for both characters.

On the other hand, RRIC 100, RRIC 102 and RRIC 103 had significantly better growth and yield than RRIC 45. (A. K. M. S. Senaratne and W. D. Armon)

Ratnapura District

Clone trials at Kuruwita sub-station (VSM/67/5, VSM/68/21, VSM/69/28)

All these three trials are small scale clone trials. In experiment No. VSM/67/5, RRIC 121 and RRIC 122 and seven unregistered clones are evaluated. RRIM 623 has been used as the control clone. The growth and yield figures of the clones are given in Table 15.

Table 15. *Mean girth and yield of clones (VSM/67/5)*
(Tapped ½ S, d/2)

Clone	Mean girth (cm)	Mean yield (g/t/t)
RRIC 121	102.3	105.3
10570	86.0	93.3
8794	84.8	64.4
RRIC 122	72.1	62.6
10727	77.3	56.3
RRIM 623	74.0	53.5
7281	82.0	52.8
5682	80.6	47.3
8501	98.2	33.6
8798	110.6	24.6

In this trial unregistered clone 8798 had shown the best growth. But it's yield is very poor as shown in the Table 15. RRIC 121 had given the highest yield and also had shown a satisfactory growth.

In the trial No. VSM/69/28, fifteen clones are evaluated of which seven are unregistered. In this trial the best growth and yield were recorded by RRIC 128.

In trial VSM/68/21 eleven RRIC 100 series clones are evaluated along with two unregistered clones and RRIC 45.

According to girth measurements recorded in 1984, RRIC 121 had the highest mean girth of 108.5 cm followed by RRIC 133 with a girth of 105.3. RRIC 133 was registered as a RRIC clone very recently.

With respect to yield, again RRIC 121 was the best with a mean yield of 138.7g per tree per tapping, followed by RRIC 110 and RRIC 130 with mean yields of 81.1 and 80.9 g per tree per tapping respectively. (B. M. S. G. Peiris and R. A. S. K. Ranatunge)

Matara District

Small scale trial – Menikwatta (VSM/79/53)

In this trial four Tjikadoe selections and a BPM clone are tested. RRIM 600 and RRIC 100 are used as controls. Mean girth measurements are given in Table 16.

Table 16. *Mean girths – Menikwatta (VSM/79/53)*

Clone	No. of plants planted	Vacancies	Mean girth (cm)
RRIM 600	25	1	32.1
RRIC 100	25	1	36.0
S 1	24	1	33.0
S 3	25	1	30.4
S 4	26	—	31.2
S 5	26	3	32.9
BPM 24	26	2	34.7

The best girthing was shown by RRIC 100 followed by BPM 24 which is an Indonesian clone. In Malaysia, BPM 24 has recorded the highest yield in the first year in the 1974 International Exchange Trial. (A. K. M. S. Senaratne)

Miscellaneous field trials

International clone trial – Belmont Estate (ICT/78/2, ICT/79/2)

Mean girth of the clones included in this trial are given in Tables 17 and 18.

Table 17. *Mean girth – Belmont Estate (ICT/78/2)*

Clone	Mean girth (cm) 1983	1984
RRIC 103	40.1	47.8
PR 306	35.6	42.8
RRIC 110	32.4	46.3
RRIM 703	36.0	43.5
RRIC 100	35.9	44.5
RRIM 600	34.9	41.1
RRIM 725	32.2	39.0
RRIC 105	32.8	34.6
RRIC 113	27.5	38.4

Table 18. *Mean girth – Belmont Estate (ICT/79/2)*

Clone	Mean girth (cm) 1983	1984
RRIM 717	24.2	33.9
BPM 24	22.3	29.3
RRIC 110	25.7	36.7
RRIC 118	23.3	31.5
RRIC 101	25.8	30.3
RRIM 712	21.7	27.2
RRIC 117	22.7	29.5
RRIC 107	25.4	35.0
RRIC 121	25.7	35.7
RRIM 600	19.7	27.0
BPM 22	29.1	35.8
BPM 3	19.8	32.43

It is evident from mean girth that, in general, RRIC 100 series clones are more vigorous than clones originating from other countries. Sumeda Alagoda and D. S. Gamage)

Rootstock – scion trial (SC/76/1)

The annual girth was recorded during 1984. Tapping in this experiment commenced in 1984. Arrangements have been made to test tap this experiment from January 1985. A random sample from each rootstock scion combination will be test-tapped to determine the effect of rootstock on the latex yields of the scion. (N. E. M. Jayasekera, K. B. Karunasekera and K. W. Rupatunge)

Testing of RRIC 100 series clones (CET/79/1)

A girth measurement was recorded in 1984. Mean girth of each clone in each experimental area is presented in Table 19 along with the mean girth when averaged over all four experimental sites.

Table 19. *1984 Mean girth (cm) – (CET/79/1)*

	Estate				
Clone	Eladuwa	Elston	Peenkande	Hathbawe	Clone mean
RRIC 100	42.8	50.4	47.1	44.2	46.1
RRIC 101	47.0	51.5	45.9	44.9	47.3
RRIC 102	47.7	53.0	47.0	47.5	48.8
RRIC 103	45.4	52.7	47.8	47.6	48.3
RRIC 104	49.3	52.8	49.5	48.4	50.0
RRIC 105	44.8	47.9	45.8	43.2	45.4
RRIC 107	47.2	53.8	52.0	48.1	50.2
RRIC 118	40.9	47.3	43.9	45.9	44.5
RRIM 600	39.6	44.0	39.4	41.2	41.0
PB 86	36.5	41.2	38.1	38.4	38.5
GT 1	40.5	48.2	38.1	41.8	42.1
Site mean	43.7	49.3	44.9	44.6	45.6

Table 20. *1984 mean yields (g/t/t) and number of test tappings (GE/75/1)*
(Tapped ½S, d/2)

Clone	Densworth	Miriswatta	Hunuwella	Golinda	Bentota	Monrovia	Bibile	Clone mean
	Estate							
RRIC 36	47.3	32.7	19.2	33.3	34.3	40.2	35.80	34.6
RRIC 52	34.4	27.1	18.4	25.7	26.2	26.4	22.68	25.8
RRIC 100	47.5	40.7	24.3	35.5	34.7	48.8	32.32	37.6
RRIC 101	78.3	51.1	40.3	44.8	36.6	61.6	44.37	51.0
RRIC 102	49.0	49.1	34.2	37.2	42.1	47.4	30.90	41.4
RRIC 103	45.8	42.2	26.2	28.7	37.6	47.6	29.17	36.7
RRIM 600	53.2	42.9	35.0	42.7	46.6	47.6	36.68	43.5
RRIM 623	49.8	40.8	23.2	21.1	23.4	40.0	35.98	33.4
PB 86	34.4	37.0	22.8	34.7	41.4	36.1	25.48	33.1
IAN 45/710	41.5	50.3	28.9	34.9	25.1	34.9	29.85	35.0
Site mean	48.1	41.3	27.2	33.8	34.8	43.0	32.2	37.2
No. of test -tapping	6	9	8	7	9	7	7	

As in previous years RRIC 104 and RRIC 107 have shown the best mean girth when averaged over all four sites. The lowest girth was recorded by PB 86 indicating its poor vigour. It can be seen from Table 19 that, in general, RRIM 600, PB 86 and GT 1 are less vigorous when compared with the vigour of RRIC 100 series clones. (N. E. M. Jayasekera, K. B. Karunasekera and K. W. Rupatunge)

Diallel progeny (*GEN/78/1*)

Seedlings, approximately 20 from each of the 16 families, have been cloned in order to establish a clone trial, to study the general and specific combining abilities of the four parental clones. (N. E. M. Jayasekera, K. Karunasekera and K. W. Rupatunge)

Genotype – environment interaction studies (*GE/75/1*)

This experiment was test-tapped during 1984 and mean yields in grammes per tree per tapping are presented in Table 20.

The annual girth measurement was commenced in December 1984 and will be completed in January 1985.

The girth measurement recorded at the end of the 6th year after planting and the total yield in the 2nd year (1983) of test-tapping were analysed.

The analysis of variance indicated significant genotype-environment interaction components, for both characters, as indicated by significant clones X site items (Tables21 and 22).

Table 21. *Analysis of variance of sixth year girth*

Source	Degrees of freedom	Mean square	F value
Clones	9	1839.14	18.14***
Sites	6	1136.46	47.17***
Clones x Sites	54	61.02	2.53*
Pooled error	550	24.09	

Table 22. *Analysis of variance second year test tapping yield*

Source	Degrees of freedom	Mean square	F value
Clones	9	2343.85	10.57***
Sites	6	4313.21	108.94***
Clone x Sites	54	216.00	5.40***
Pooled error	500	39.59	

Levels of significance

NS – Non-significant ; * = 1.0 — 5.0% ; ** = 1.0 — 0.1%
*** = < 0.1%

Interaction in both characters was found to be mainly linear and the regression lines of clones were found to intersect each other more or less at the same point. This was the case for both characters. With respect to yield, high yielding clones respond to improved environment better than the low yielding clones, as evident from significant correlations between mean yields of clones and their regression coefficients. (N. E M. Jayasekera, K. B. Karunasekera and K. W. Rupatunge)

Anthesis in Hevea — *FL/84/3*

Three species of *Hevea, H. brasiliensis* cultivar KH - 440, *H. spruceana* and *H nitida* were observed in 1984 to study the time of anthesis. Both male and female flowers were observed. Results indicated that in *H. brasiliensis* and *H. spruceana* the peak flowering occurred between 1200h and 1500h and in *H. nitida* peak flowering was between 0700h and 1000h. (D. P. S. T. Attanayake and Sumeda Alagoda)

REVIEW OF THE PLANT PATHOLOGY DEPARTMENT

By

A. de S. LIYANAGE

SUMMARY

Wintering and refoliation were delayed. The wet weather experienced during this period caused a severe attack of *Oidium* leaf disease. *Oidium* caused infection of flowers, as a consequence of which diseases caused by *Phytophthora meadii* were negligible. *Colletotrichum* leaf disease caused by *Colletotrichum gloeosporioides* was widespread, causing damage to immature leaves in replantings. White root disease is still the main cause of crop loss in estates. Damage caused by pests such as slugs and cockchafer grubs was reported from several estates.

Phytophthora species attacking *Hevea* varied from country to country. In Sri Lanka compatibility type A1 of *P. meadii* is the predominant species. The species of *Phytophthora* attacking rubber in Brazil is *P. palmivora* (MF_4 type). Isolates from Ivory Coast belonged to *P. palmivora* (MF_1) group and some resembled *P. megakarya*. Both *P. palmivora* and *P. botryosa* attack rubber in Malaysia. Isolates from India consisted of the two mating types of *P. meadii*.

A broth prepared by incorporating rubber petioles and 2% $CaCO_3$ was found to be suitable for chlamydospore production. Chlamydospores were produced best at low temperatures but they were also formed upto 20°C. However, oospores were formed at high temperatures of 28° and 30° C with the optimum being 20° C.

Isolates of *R. lignosus* showed variability in growth *in vitro* and differential pathogenicity.

Appressoria formation was detected 6 h after inoculation in both PB 86 and RRIC 52. A hypersensitive reaction was noted around the point of penetration in clone RRIC 52, while haustoria were detected in PB 86.

Histopathological studies revealed that *Xylaria thwaitesii* penetrated the roots intracellularly after forming a thick aggregate on the outer surface of the root. The internal spread was confined mainly to the cortical and phloem tissue. Discoloured bands were seen separating the infected tissue from healthy areas.

Zoospores of *P. meadii* did not germinate at 1%, 0.1% and 0.01% Difolatan and 1% Aliette and Ridomil. In the field panels treated with Ridomil showed no infection. Difolatan and Aliette were also significantly better than the control. Fifteen fungicides were assessed for their efficacy to control *C. gloeosporioides*.

Nitrogen fixation studies showed that Rhizobium cowpea complex is absent in virgin soils. Nodulation of *P. phaseoloides* when introduced to seedling agar, was inhibited at concentrations above 128 ppm of NH_4 NO_3 in sterile test tubes and addition of 200 ppm NH_4 NO_3 inhibited nodule formation in Homagama soils. It was also observed that only few nodules were formed by introduced strains.

The work on collection and cmputerisation of daily rainfall and yield data from estates was continued. The number of rain/dry days, the maximum number of consecutive rain/dry days in a given period, the occurrence of a sequence of events which signals a start or end of a rain spell and wet / dry spell probabilities have also been done for a few estates. Based on simple probabilities using rainfall data a crop-weather calendar for Dartonfield Estate has been worked out.

DETAILED REVIEW

Staff

The Head of the Department and Deputy Director (Research), Dr A. de S. Liyanage and Mr C. K. Jayasinghe, Assistant Plant Pathologist were on duty throughout the year. Mrs Indranee Liyanage, Assistant Plant Pathologist, returned to Sri Lanka on the 14 October, to undertake field investigations, after spending about an year at the Imperial College of the University of London in England.

Research students

Messrs R. Weerasinghe and A. R. Seneviratne joined the Institute on the 1 April and 1 October, respectively, as Temporary Research Assistants.

The Senior Technical Officer, Mr Z. E. Irugalbandara, Technical Officer Mr A. Dharmaratne who was promoted as Senior Technical Officer on 30 May and Technical Officers Messrs S. Wettasinghe, B. Fernando, S. S. Warnapura, E. A. T. Senadheera, Mrs Poson Wettasinghe and the Clerk/Typist Mrs Priyani Amarasekara were on duty throughout the year. Mr W. Amaratunga, Senior Technical Officer left for England on 2 September, for a training on audio visual equipment and photography.

Misses Niromee Nanayakkara and Anoma Samaranayaka from the Ruhuna University worked for 6 months under A. de S. Liyanage's supervision for their final year research projects entitled " Studies on the infection of roots by *Xylaria thwaitesii* " and variability of *Rigidoporus lignosus,* causal organism of white root disease of rubber.

Visits

The following visits were undertaken by the staff of the Department :

Experimental	76
Advisory	39
Miscellaneous	208
Total	323

Meetings

The Head of the Department served in the following committees.

Chairman of the Drafting Committee on Pesticides.

Member of the Pesticide Formulary Committee.

Committee member of Section B of the Sri Lanka Association for Advancement of Science (SLAAS).

Member of the Board of Study on Agricultural Biology at the University of Peradeniya.

Member of the Academic Syndicate of the Postgraduate Institute, University of Peradeniya.

Member of the Scientific Committee of the Rubber Research Institute.

A. de S. Liyanage participated at the International symposium on micro-computer application in developing countries held in Colombo from 4 – 9 November, and C. K. Jayasinghe gave the first seminar on nitrogen fixation organised by the Institute of Fundamental Studies, held at the University of Peradeniya on 10 March.

Training

The International Rubber Research and Development Board (IRRDB) has recognised the Plant Pathology Department as a Centre of Excellence to train Plant Pathologists from other rubber growing countries who are members of the IRRDB. Under this programme Mr Arief Budiman from the Research Institute for Estate Crops in Sembawa, South Sumatra, Indonesia arrived on the 17 October for a 6 month training period.

The Head of the Department and the Assistant Plant Pathologist, C. K. Jayasinghe conducted lectures for Superintendents and Assistant Superintendents of the JEDB and SLSPC. Assistant Pathologists, C. K. Jayasinghe and Indranee Liyanage took lectures and practicals for Rubber Extension Officers.

A. de S. Liyanage was appointed as a lecturer in Plant Pathology for the MSc. Forestry Course at Sri Jayewardenepura University.

Publications

Gibb, Ann., Liyanage, A. de S., Stern, R. D., Dale, I. C. and Abeysekera Savithri (1984). The collection and use of yield and climatic data from rubber estates in Sri Lanka. *Proc. Int. Rubb. Conf. Colombo,* 1984. (in press)

Gibb, Ann., Dale, I. C., Stern, R. D., and Liyanage, A. de S. (1984). Studying the relationships between rubber yield and climate. *Proc. Int. Rubb. Conf. Colombo,* 1984. (in press)

Jayasinghe, C. K. (1984). Nodulation of *P. phaseoloides* rhizobia in competition with naturalized strains in three different soils .*Proc. Int. Rubb. Conf. Colombo* (in press).

Jayasinghe, C. K. (1984). Pests of rubber. *A Practical Guide to Rubber Planting and Processing*. p. 163 – 168, Eds. A. de S. Liyanage & O. S. Peries. Sri Lanka: RRI

Liyanage, A. de S. (1983). Increasing production and productivity in the tree crop sector. *Proc. Sri Lanka Ass. Advmt. Sci.* **39** (2) 35 – 47.

Liyanage, A. de S., Peries, O. S., Dharmaratne, A. and Dantanarayana, D. M. (1983). Factors influencing establishment, spread and sporulation of *Phytophthora meadii* on rubber pods. *Jl. Rubb. Res Inst. Sri Lanka.* **61**, 41 – 48.

Liyanage, A. de S., Gibb, Ann., Weerasinghe, R. (1984). A crop-weather calendar for rubber. *Proc. Int. Rubb. Conf. Colombo* 1984. (in press)

Liyanage, A. de S., Peries, O. S. Warnapura, S. S., Senadheera, E. A. T. and Amaratunga, W. (1984). An integrated approach to control of white root disease in Sri Lanka. *Proc. Int. Rubb. Conf. Colombo* 1984. (in press)

Liyanage, A. de S., Liyanage, Indranee., Fernando, B., and Dharmaratne, A. (1984). Factors influencing spread of bark rot caused by *Phytophthora meadii. Proc. Int, Rubb. Conf. Colombo* 1984. (in press)

Liyanage, A. de S. (1984). Preparation of land. *A Practical Guide to Rubber Planting and Processing*. p. 30 – 31. Eds. A. de S. Liyanage & O. S. Peries. Sri Lanka: RRI

Liyanage, A. de S. (1984). Leaf diseases. *A Practical Guide to Rubber Planting and Processing*. p. 65 – 77 Eds. A. de. S. Liyanage & O. S. Peries. Sri Lanka: RRI

Liyanage, A. de S. (1984). South American leaf blight. *A Practical Guide to Rubber Planting and Processing*. p. 78 – 81 Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka: RRI

Liyanage, A. de S. (1984). Panel diseases. *A Practical Guide to Rubber Planting and Processing*. p. 96 – 101 Eds. A. de. S. Liyanage & O. S. Peries. Sri Lanka: RRI

Liyanage, A. de S. (1984). Root diseases. *A Practical Guide to Rubber Planting and Processing*. p. 136 – 148 Eds. A. de S. Liyanage & O. S. Peries. Sri Lanka: RRI

Liyanage, A. de S. (1984). Pesticide use and safety. *A Practical Guide to Rubber Planting and Processing*. p. 168 – 174 Eds. A. de S. Liyanage & O. S. Peries. Sri Lanka RRI

Liyanage, Indranee (1984). Disorders of non-parasitic origin. *A Practical Guide to Rubber Planting and Processing*. p. 149 – 152 Eds. A. de S. Liyanage & O. S. Peries. Sri Lanka : RRI

Liyanage, Indranee (1984). Conditions caused by physical injuries. *A Practical Guide to Rubber Planting and Processing*. p. 153 – 158 Eds. A. de S. Liyanage & O. S. Peries. Sri Lanka : RRI

Peries, O. S., and Liyanage, A. de S. (1984). The use of chemicals in rubber growing industry. *J. Nat. Inst. Plant. Mgmt*. 4(1) 9 – 21.

Peries, O. S. and Liyanage, A. de S. (1984). Systemic fungicides and their potential for use in tropical countries. *J. Nat. Inst. Plant. Mgmt*. 4(1) 67 – 76.

Liyanage, A, de S. (1984). Achievements in disease control methods of rubber in Sri Lanka. *In Souvenir publication for the International Rubber Conference and Exhibition*.

Abstracts

Jayasinghe, C, K. (1984). Symbiotic performance and persistance of introduced rhizobia in Lancelin Brown sand. Paper presented at the IFS seminar at the University of Peradeniya.

Liyanage, A. de S., Weerasinghe, R., Abeysekera, Savithri, Dale, I. C., and Gibb, Ann (1984). Application of micro computer in rubber research. Paper presented at the International symposium on micro-computer application in developing countries held in Colombo.

Reports

Liyanage, A. de S. (1983). Annual Review of the Plant Pathology Department.

Books

Liyanage, A, de S. & Peries, O. S. Editors (1984). A Practical Guide to Rubber Planting and Processing – Editors.

Liyanage, A. de S., & Peries, O. S. Editors (1984). Souvenir publication for the International Rubber Conference & Exhibition – Editors.

General

The wet weather that prevailed at the beginning of the year delayed the occurrence of wintering. In some areas it extended into April. Refoliation was uneven and protracted. Wet weather conditions favoured the spread of *Oidium heveae*, causing secondary leaf fall. There was a severe shortage of seeds as a result of *O. heveae* infecting the flowers. Consequently, incidence of *Phytophthora* leaf fall and bark rot was mild. *Colletotrichum* leaf disease caused by *Colletotrichum gloeosporioides* was widespread in immature clearings. White root disease is still the major problem causing heavy crop losses. Generally, pests are not a serious problem in rubber plantations but there were several reports of damage caused by slugs and grubs.

Laboratory Investigations

Biology

Biology of *Oidium* spore germination (0/74/1)

The varying influence of temperature 15°, 20°, 25°, 28°±2° (RT) 30°, 35°, 40° C and relative humidity (100%, 75% & 37%) on germinability of conidia and germ tube length of *O. heveae* were assessed at 2 h intervals upto 12 h commencing 2 h after inoculation, followed by a 24 h period of exposure to RT at 100% relative humidity. Spore germination was low at 15°C but showed a progressive increase upto 30° C but spore germination was completely inhibited at 40⁰ C, irrespective of the percentage of relative humidity. Good spore germination and germ tube growth were recorded even at low relative humidities. (A. de S. Liyanage and A. Dharmaratne)

Oidium heveae

Effect of temperature and relative humidity on spore germination and growth (0/76/2)

Germination of conidia of *O. heveae* on glass slides was studied at six temperatures (15°, 20°, 25°, 28°±2°, 30°, 35° C) and three relative humidities (100% 75% and 55%). Spore germination was assessed after exposure to different periods at various temperatures followed by an incubation period of 24 h at room temperature at 80% relative humidity. Spore germination was best around 28° ± 2° C at all relative humidities. There was a decline in spore germination at 35° C and it was totally inhibited at 40⁰ C. Germ tube growth was significantly lower at low relative humidities. (A. de S. Liyanage and B. Fernando)

Phytophthora meadii

Growth and sporulation characteristics (P/76/1)

A comparative study of different species of *Phytophthora,* collected from several rubber growing countries was done at Imperial College. For comparison some related species affecting other crops were also included in this study.

Phytophthora species attacking *Hevea brasiliensis* varied from country to country. A morphological study with isolates from various rubber growing countries showed that one or more species of *Phytophthora* could be present in a country with one species being predominant. The species attacking rubber in Sri Lanka is *P. meadii* of which only one compatibility type (A_1) is predominant currently. Therefore, the formation of oospores is very rare. Compatibility type (A_2) has been recorded in previous studies done several years ago.

The species attacking cacao in Sri Lanka is *P. palmivora* and belongs to the A_2 compatibility type. The A_1 compatibility type has still not been found and hence the formation of the sexual spore could be rare in this species too. However, work done in this study showed that oospores are formed when *P. meadii* (A_1 type) on rubber and *P. palmivora* (A_2) type on cacao are paired. The oogonial frequencies however, are less in these pairings than when *P. meadii* A_1 and A_2 types are paired. This is due to the incomplete fusion of the antheridium and the oogonium.

The results of crossing the various types are as follows :

P. meadii type A_1 x *P. meadii* type A_2 = 55.5 (Mean oogonial frequency)

P. meadii type A_1 x *P. palmivora* type A_2 = 15.5(Mean oogonial frequency)

It was also shown that oospores are formed by the A_2 compatibility types of both *P. meadii* and *P. palmivora* in the presence of *Trichoderma* species. The mean oogonial frequencies for *P. meadii* – A_2 type with *Trichoderma* species has been found to be only 23.32.

The species of *Phytophthora* attacking both rubber and cacao in Brazil is *P palmivora* morphological form 4 (MF_4). The isolates were all in the A_1 mating type and, therefore, sexual spore could be a rare occurrence.

The species of *Phytophthora* attacking cacao in Brazil was known to be *P. palmivora* MF_4 in previous studies. The present study showed that the same species was attacking rubber in Brazil. The species has long sporangial stalks upto 250 μm and the length breadth ratio of sporangia was nearly 2.0. This species was only found in Brazil on rubber. It has been also recorded on cacao in Cameroon.

Isolates from Ivory Coast on rubber, cacao, pineapple and citrus belonged to the *P. palmivora,* morphological form 1 (MF_1) group and some resembled *P. megakarya.* The presence of *P. casterneae* on cacao in this country was also detected. This species has not been recorded on cacao in Ivory Coast at the Cacao *Phytophthora* Workshop held at Rothamsted Experiment Station, in England in 1976.

Isolates from India consisted of the 2 mating types of *P. meadii,* which were morphologically similar to Sri Lankan isolates. The presence of two mating types increases the chance of sexual reproduction.

Both *P. palmivora* and *P. botryosa* were recorded from Malaysia and other species were not present.

Pedicel length is the best criterion in grouping *Phytophthora* isolates into different species. The shape and size of sporangia varied greatly in all species with less variation only in *P. palmivora* (MF_4), from Brazil. The zoospore size and the number of zoospores per sporangium have not been looked into as criteria in identifying species. However, an examination of these showed that both these criteria were not suitable as there was little variation between species. *P. botryosa* however, had a smaller zoospore size compared to that of other species. This is due to the smaller size of the sporangium in this species. The number of zoospores per sporangium varied from 28 - 40 in all species. Inter-specific mating is also possible between *P. meadii* isolates and species obtained from other countries. Oogonial sizes were comparable except in the combination *P. meadii* x *P. botryosa*, where they were slightly smaller.

The work done so far has shown that oospores are produced at low temperature only. However, this study has shown that oospores were produced at high temperature of 28° (room temperature) and 30° C, as well but the optimum temperature for oospore production for all species was at 20° C. (Indranee Liyanage)

P. meadii

Chlamydospore production (P/76/1)

A broth prepared by incorporating rubber petiole extract and 2% $CaCO_3$ was dark incubaed after inoculating with the mycelium of *P. meadii* for 24 h and then the flasks were incubated at different temperatures 10°, 15°, 20°, 25°, 28° and 30° for 6 weeks. Chlamydospores were formed at temperatures upto 20° C, but those formed at 10° C were very small. Sporangia were predominant at temperatures of 25°C, 30° C and at room temperature. (Indranee Liyanage and A. Dharmaratne)

Effect of temperature on zoospore germination (P/84/1)

Germination of the spores of *Phytophthora meadii* (No. 312) was studied under different temperatures viz. 15°, 20°, 25° and 30° and 28° C. In one set, duplicates were placed at room temperature while in the other, spores were incubated at the respective temperatures before placing them on slides. Minimum temperature for spore germination was 15°C and the maximum was 30°C. However, a greater number of spores germinated when kept for a short period at the respective temperatures, and allowed to germinate at room temperature. (A. de S. Liyanage and A. Dharmaratne)

Petioles of the clone PB 86 were also inoculated with a standardized spore suspension of the same culture, after leaving the suspension at different temperatures. The length of the lesions were measured after five days.

Rigidoporus lignosus

Growth characteristics and pathogenicity (F/75/1)

Twenty three isolates of *R. lignosus* collected from different rubber growing areas were grown on malt agar and incubated at different temperatures (15°, 20°, 25°, 30°, 28°, 35°, 40° C). Colony growth of these isolates differed with temperature but optimum temperature for growth of all the isolates was recorded around 28° — 30° C. The optimum for growth temperature was identical for all isolates. Most of the isolates did not grow at 15°C except one. On growth characteristics, isolates were grouped into three categories viz. fast, slow and medium, with most isolates falling into the latter group. Morphologically, the fast growing isolates differed from others in that they had very thin mycelium. It was observed that the interaction of isolates was significant at the higher temperature but not at the lower temperatures. This indicated that isolates were sensitive to the higher temperatures.

These isolates showed differential pathogenicity on the internal and external spread of both autoclaved and non-autoclaved healthy roots. The isolate which had the fastest rate of growth was the most virulent. (A. de S. Liyanage and Anoma Samaranayake)

Phytophthora palmivora

Nomenclature (IC/84/1)

So far seventy isolates have been collected from cacao pods affected by ***Phytophthora palmivora,*** in Kalutara, Kurunegala, Kandy and Matale Districts. This study was initiated to examine the species of ***Phytophthora*** that affect cacao, prior to it being tested on a large scale as an intercrop in rubber, in the wet low country districts. (A. de S. Liyanage and M. A. P. S. Seneviratne)

Host-parasite relationships

Oidium heveae

Histology (0/76/2)

Immature leaves of clones RRIC 52 and PB 86 were inoculated with conidia of ***Oidium heveae.*** The leaves were removed at 6 h intervals upto 48 h and then at 24 h intervals upto 96 h commencing 6 h after inoculation. Appressoria were detected 6 h after inoculation on both RRIC 52 and PB 86. A hypersensitive reaction was noted around the point of penetration in the clone RRIC 52. Haustoria were also detected in susceptible reactions. (A. de S. Liyanage and Z. E. Irugalbandara)

Xylaria thwaitesii

Method of penetration (X/75/1)

Roots of seedlings infected with the black root disease fungus *X. thwaitesii* were sectioned to examine the entry of the pathogen into host cells. It was observed that mycelia aggregated on the outer surface of the root as a thick mat but its thickness varied around the root. The fungus penetrated the host tissue intracellularly at certain points after forming a thick plate - like structure, but this was not observed from tissue sampled from the collar region. The internal spread of the fungus was confined mainly to the cortical and phloem tissue. Some infected cortical tissue had thickened walls. Xylem tissues were nearly free of the fungus. When infected the mycelium entered the vascular tissue through the pits. A discoloured band was sometimes seen separating the infected tissue from the healthy areas. (A. de S. Liyanage and Niromee Nanayakkara)

Control

Phytophthora meadii

Efficacy of fungicides (*P/84/1*)

Three fungicides; Difolatan, Ridomil and Aliette, were tested *in vitro* at three different concentrations (1%, 0.1% and 0.01% of active ingredient) on zoospore germination and germ tube growth of *P. meadii*. Spores did not germinate at all three concentrations of Difolatan and 1% Aliette and 1% Ridomil. At other concentrations both Aliette and Ridomil supported good germination and germ tube growth. (A. de S. Liyanage and B. Fernando)

Colletotrichum gloeosporioides

Efficacy of fungicides (*G/75/*1)

Fifteen fungicides were used at three concentrations (1%, 0.1% and 0.01%) to examine the effect on spore germination of *C. gloeosporioides*. Efficacy of fungicides was determined *in vitro* studies. The criteria used were ungerminated spores and lysed spores. Several fungicides including Antracol, Bavistin, Baycor, Benlate, Captan, Derosal, Difolatan, Mancozeb, Polyram and Thioton were effective at various concentrations. Their suitability for field scale use will depend on the cost of the fungicides and their behaviour in contact with the host tissue. (Arief Budiman and A. de S. Liyanage)

Field Experiments

Control

Oidium heveae

Control of Oidium *leaf disease* (*O/84/1*)

Calixin (Tridemorph) was sprayed using a Micronsprayer, Tiga and Leco fogging machines and compared with sulphur dusting and untreated controls. Calixin was sprayed at the rate of 10 litres per hectare. The disease was effectively controlled by sulphur dusting and fogging using the Leco machine. The use of the Micronsprayer and Tiga fogging machine did not give satisfactory results. (A. de S. Liyanage, S. S. Warnapura and E. A. T. Senadheera)

Phytophthora meadii

Efficacy of fungicides (*P/ 84/1*)

Three fungicides, Aliette, Difolatan and Ridomil, at concentrations of 0.8%, 1.2% and 1.6% were applied on the tapping panels using 20 ml of the fungicide for each tree on every alternate day. There were 30 trees for each treatment. The panels were inoculated using a zoospore suspension, standardized to give 10^5/ml, using the strip technique. The trees were rested for 3 weeks and another five applications of the fungicides were done. Ten of the control trees were scraped and infection traced, before the second application of fungicide the remaining trees were scraped at the same time. The results showed that panels treated with Ridomil had no infection. Difolatan and Aliette were also significantly better than the control, though not so effective as Ridomil. (A. de S. Liyanage and B. Fernando)

Rigidoporus lignosus

Treatment of infected patches and disease incidence (F/76/4)

This experiment carried out at seven sites for 3½ years indicated that the application of sulphur is not a substitute to proper removal of infected roots. Retention of infected roots without the application of sulphur led to a high incidence of the disease. Removal of two rows of plants on the periphery of infected patches gave good results in some locations while in others it was not so effective. (A. de S. Liyanage, S. S. Warnapura and E. A. T. Senadheera)

Effect of nitrogenous fertilizers and sulphur (F/81/12)

The application of a normal and a double dose of sulphate of ammonium and urea appears to have reduced the incidence of white root disease compared to the control. Urea was more effective than sulphate of ammonia. (A. de S. Liyanage, S. S. Warnapura and E. A. T. Senadheera)

Planting distance and disease incidence (F/80/1)

The cumulative loss of trees due to white root disease (Table 1) indicates that resiting the planting rows between replanting cycles can reduce the incidence of white root disease, except when a new row coincides with food bases left from the old stand. The incidence of the disease was generally high if replanting is done using the same spacing of the old stand. (A. de S. Liyanage, S. S. Warnapura and E. A. T. Senadheera)

Table 1. *Cumulative loss of trees at different planting distances (F/80/1)*

Planting distance (m)	Estate			
	1	2	3	4
(1) 4.6 x 4.9	3.0	2.3	2.4	0.1(1)*
(2) 3.7 x 6.1	2.7	4.3(2)*	5.8(2)*	0.4
(3) 3.1 x 7.3	2.9(3)*	3.4	0.7	0.2
(4) 2.4 x 9.2	1.3	2.7	5.8	0.8

* Planting distance of the old stand is shown in parentheses.

Efficacy of Calixin on viability of inoculum and infection (F/84/1)

Freshly collected pieces of infected roots were burried in three layers at three depths in the planting hole (viz. 25 cm, 50 cm, 75 cm). In addition, a healthy budded stump was planted in each hole. These were drenched with 2 litres of (0.5% ai) tridemorph and assessments on root viability and percent infection on plants were taken after 3 months. It was observed that there was no difference in viability and infection of treated plants when compared to the untreated control. Heavy rainfall recorded during this period may have lowered the efficacy of the fungicide which has proved to be effective in other countries. (A. de S. Liyanage and S. S. Warnapura)

Rhizobium spp.

Population studies of Rhizobium *cowpea complex in Sri Lankan soils (NF/84/1)*

This experiment was done, using soils collected from rubber estates and a virgin forest, to estimate the indigenous flora effective against *Pueraria phaseoloides.* The method used for counting rhizobia was the same as the five fold serial dilution plant infection technique of Brockwell (1963). Agar slopes were prepared using Jansen (1942) nutrient solution with trace elements.

Soils tested and the most probable estimated number of rhizobia are given in Table 2.

Table 2. *Number of* Rhizobium *cowpea complex present in Sri Lankan soils*

Soil type	Site	Number of nodule bacteria per ml of suspension at dilution level 1	
		Estimate	Confidence limits (95%)
Agalawatta	1	16.2	6.2 – 42.4
	2	6.5	2.3 – 18.0
	3	14.1×10^1	$5.3 - 38.1 \times 10^1$
	4	32.8	12.2 – 87.9
Avissawella	1	10.8×10^1	$4 - 28.7 \times 10^1$
Kottawa	1	0	
(Virgin forest)	2	0	
Dodangoda	1	43.6	16.6 – 114.2
	2	2.3	1.2 – 12.8
Yatadola	1	2.3	1.2 – 12.8
	2	30.2×10^2	$11.2 - 81.3 \times 10^2$

* Estimate could not be obtained from the table for soils collected from Nakiadeniya.

These results show that virgin forest soils in Sri Lanka are free from *Rhizobium* cowpea complex. (C. K. Jayasinghe, S. Wettasinghe and Poson Wettasinghe)

Effect of nitrogen on nodulation of P. phaseoloides *in seedling agar (NF/84/1)*

Seedlings of *P. phaseoloides* were introduced to seedling agar in sterile large test tubes. NH_4NO_3 was added in different concentrations viz. 0, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048 and 4096 ppm. In addition to the common cowpea complex strain CB 756 suspension was added to each test tube on the following day. Plants were maintained in the glasshouse under sterile conditions. Each treatment was replicated four times. The results are shown in Table 3.

Table 3. *Effect of different concentrations of NH_4NO_3 on nodulation*

Concentration of NH_4NO_3 (ppm)	No. nodulated plants	Growth
0	4	+
2	4	+
4	4	+
8	3	+
16	3	++
32	4	++
64	4	++
128	0	++
256	0	++
512	0	++
1024	0	++
2048	0	Brownish lesions on leaves
4096	0	Whole plant was dried

+ Good

++ Very good

The results show that nodulation of *P. phaseoloides* was inhibited at a concentration above 128 ppm of NH_4NO_3.(C. K. Jayasinghe, S. Wettasinghe and Poson Wettasinghe)

Effect of nitrogen on the nodulation of P. phaseoloides *in Homagama soils (NF/84/1)*

Basal nutrients without nitrogen were added to the Homagama soils and effect of nitrogen on nodulation was observed using NH_4NO_3 solutions equivalent to 0, 50, 100, 200, 400, 800, and 1600 ppm NH_4NO_3.

Nutrients were mixed with dry soil by shaking 50 times in a polythene bag, after which 4 kg of soil was placed in each plastic pot kept in the glasshouse. Acid treated *Pueraria* seeds were planted at about 2 cm depth. Each treatment was replicated four times. Observations made on yield, nodule weight and acetylene reduction efficiency are given in Table 4.

Table 4. *Effect of different nitrogen levels on dry matter yield, nodule weight and leaf nitrogen of* P. phaseoloides

Concentration of NH_4NO_3 (ppm)	Dry matter yield (g)	Wet weight of nodules (g)	Leaf nitrogen (%)
0	4.98	1.96	4.28
50	6.15	1.99	3.81
100	6.51	1.80	3.49
200	6.91	0.26	5.46
400	7.40	0.01	5.58
800	5.93	0.00	5.76
1600	4.71	0.00	7.57

It seems that addition of 200 ppm NH_4NO_3 inhibits nodule formation in Homagama soils. (C. K. Jayasinghe, S. Wettasinghe and Poson Wettasinghe)

Studies on competition of introduced rhizobia with indigenous flora (NF/84/1)

The ability of introduced *Rhizobium* cowpea complex strains to compete with naturalized strains in nodulating *P. phaseoloides* was studied in two types of Sri Lanka soils viz. Homagama and Agalawatta series soils. The ability of the inocula to form nodules was used as the criterion for competitiveness.

Marked strains of *Rhizobium* spp., distinguishable from other strains by antibiotic resistance or serological methods were introduced as a suspension (10^8 cells/ml) on the seedlings in soil containing naturalized populations.

Table 5 shows the percentage of occupancy by introduced strains.

Table 5. *Percentage of nodule occupancy by introduced strains in different soils*

Soil type	Strain	Occupancy by introduced strains (%)
Agalawatta	RRISL 09	35
	CB 756	25
Homagama	RRISL 09	30
	CB 756	20

It was observed that very few nodules were produced by introduced strains. (C. K. Jayasinghe, S. Wettasinghe and Poson Wettasinghe)

Pests

Cockchafer grubs

Efficacy of insecticides (P/84/1)

Three insecticides (viz. Intox 8, B.H.C., Carbofuran) were tested in a pot trial. On the basis of mortality of grubs Carbofuran appeared to be slightly better than Intox 8 or B.H.C. (C. K. Jayasinghe and E. A. T. Senadheera)

Miscellaneous

Rainfall – yield – disease relationships

Rainfall and crop data (RF/83/1)

This project envisages a study of three broad areas (1) the collection and computerization of daily rainfall and yield data from estates, (2) the tabulation and summary of such data including basic statistical analyses, (3) predictive work using different modelling approaches.

Rainfall data of Dartonfield, Peenkanda, Frocester, Yatadola, Urumeewela and Raiygama estates have been computerized edited and analysed. Using these data 5-day, 7-day and monthly total have been worked out for some estates. The number of rain/dry days in a given period, the maximum number of consecutive rain/dry days in a given period, the occurrence of a sequence of events which signals a start or end of a rain spell and wet/dry spell probabilities have been done for a few estates. Based on simple probabilities using rainfall data a crop-weather calendar for Dartonfield Estate has been worked out.

REFERENCES

Brockwell, J., (1963). Accuracy of a plant infection technique for counting populations of *Rhizobium trifolii*. *Appl. Microbiol,* **11**, 377 - 383.

Jensen, H. L. (1942). Nitrogen fixation in leguminous plants. I. General characters of root nodule bacteria isolated from species of *Medicago* and *Trifolium* in Australia. *Proc. Linn. Soc. New South Wales*, **66**, 98 - 108.

REVIEW OF
THE SOILS AND PLANT NUTRITION DEPARTMENT

By

N. YOGARATNAM

SUMMARY

The study of the responses of rubber trees to factors affecting the supply of nutrients and water and to soil management practices has been the main concern of the Department.

Fertilization of immature rubber at the currently recommended rates is considered adequate even for the more vigorously growing clones such as the RRIC 100 series. Fertilizer application at these rates can reduce the non-productive period of RRIC 100 series clones by about 18 to 24 months in comparison with PB 86. Yield increases in mature rubber can be obtained from existing plantations with increased applications of nitrogen in the form of urea. Some yield increases may also be obtained with applications of K but applications of P and Mg may not be always beneficial. It also seems possible to apply fertilizers at least to mature areas during the dry periods of January to April, if there had been approximately 1000 mm of rain during the north east monsoon in the previous year.

It is also important to consider the changes with time in the composition, particularly the contents of the sucrose and calcium of latex samples which could be used to predict the cropping potential and the incidence of " brown bast ."

Investigations on the use of mixed creeping and bush legumes indicate that species can be grown successfully and that the adverse effects of *Stylosanthus guyanesis* was not seen in areas with annual rain fall in the region of 3500 m m, possibly due to the absence of competition for moisture. K application direct to the rubber tree appears to be as efficient as its application to the ground covers in particular on K deficient soil.

Among the different soil management practices, dead mulch exhibited the highest soil moisture storage capacity in comparison with practices such as growing leguminous covers or naturals or leaving the land bare. Similar results were observed on leaf water potential, relative water content of the leaf and leaf water deficit. Girthing of plants also showed similar effect with plants in mulch growing more vigorously than the plants under other soil management practices.

The foliar survey programme which commenced in July, provided data for fertilizer recommendations to 8532 hectares. Fertilizer programming has been computerized and recommendations for a period of 3 years (1985, 1986 and 1987) were sent, based on the survey done in 1984.

Staff

The Head of the Department, Dr N. Yogaratnam, the Agricultural Chemist, Dr M. K. S. A. Samaraweera and the Assistant Soils Chemist Mrs L. Samarappuli were on duty throughout the year.

Mr S. M. Weerasuriya joined as a Temporary Research Assistant in April. He was registered for the MPhil degree of the University of Peradeniya and his work is supervised by N. Yogaratnam, Prof. M. Balasubramaniam of the Science Faculty and Prof. M. W. Thenabadu of the Agriculture Faculty, University of Peradeniya.

Miss S. Udurawana worked as a Temporary Research Assistant under an Atomic Energy Authority (AEA) fellowship on the physiology of latex production in *Hevea* under the supervision of M. K. S. A. Samaraweera until October, when she joined the Biochemistry Section of the Rubber Chemistry Department as an Assistant Biochemist.

The Experimental Officers Messrs W. C. Dayaratne, A. M. A. Perera and F. P. W. Silva and the Technical Officers I. Denawake, J. G. de Mel, C. Maheepala, S. N. Silva, H. V. K. Rodrigo, D. Udaratagedara and P. Karunadasa and the Clerk/Typist Miss L. Rupasinghe were on duty throughout the year.

Miss S. Gunasekera and Mr S. Wasanthadeva resigned their posts to join the Department of Education and the Ceylon Petroleum Corporation, respectively, Miss Anusha Jayaweera and Mr U. Mitrasena joined as Technical Officers in June and August, respectively, and Miss Champa Adikaram and Miss Manojie Dharmawardena joined as Temporary Technical Assistants in October. Mr M. A. Mendis was transferred to the Rubber Chemistry Department and Mr T. M. Ahamadeen from the Rubber Chemistry to this Department.

Research students

Research students from the Faculty of Agriculture, Peradeniya University and Ruhuna University worked on the following research projects in partial fulfilment of the requirements of the specialization course in soil science :

Dissanayake, D. M. A. P.	Some aspects of magnesium nutrition of *Hevea*
Hettiarachchi, N.	Some factors influencing the nitrogen, phosphorus and magnesium status of rubber plantations
Jayasundera, H. P. S.	Some aspects of potassium nutrition of *Hevea*
Sandiya Kumari, S. D.	A study of some factors influencing the trace elements concentration of rubber plantations.

Visits

The Departmental staff paid advisory visits to plantations and routine visits to experimental areas where necessary.

N. Yogaratnam attended the International Conference on Soils and Nutrition of Perennial crops, held in Kuala Lumpur in August 1984 and presented a paper entitled "Fertilizer responses in mature *Hevea* under Sri Lankan conditions "

The research and the technical staff of the Department attended the International Rubber Conference held at the BMICH from 17 to 19 September.

Consultancy

Dr. J. Tupy an IAEA expert worked in the Departmet for about 3 months as an advisor on the use of radioisotopes in plant physiological and biochemical studies in *Hevea.* He has also made it possible for M. K. S. A. Samaraweera to undergo a further training in plant nutrition for a period of 12 months at the Macauly Institute in Aberdeen, under an IAEA training programme.

N. Yogaratnam, served as a consultant in Soil Science/Agronomy to the Forest Resources Development Project of the Ministry of Lands and Land Development, funded by the World Bank.

Meetings

The research staff participated in the following :

Seminars and field days

Sri Lanka State Plantation Corporation (SLSPC) Agricultural Advisors Seminar, Colombo.

Third Biotechnology seminar of the Institute of Fundamental Studies (IFS) on " Drought resistance "

Symposium on " Weeds and weed control " organised by the Sri Lanka Association for Advancement of Science (SLAAS)

Training programmes

Rubber Extension Officers of the Advisory Services Department (ASD)

Rubber Smallholders under the Sri Lanka Rubber Rehabilitation Project (SRRP)
Agricultural Instructors of the Agriculture Deparment

Working groups and committees

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

Technical committee of the Tender Board of the Ceylon Fertilizer Corporation (CFC)

Technical committee of the Sri Lanka Standards Institution

Agriculture Group of the Atomic Energy Authority (AEA)

Publications

Samarappuli, L. (1984). Soil conservation. *A Practical Guide to Rubber Planting and Processing*. p. 33 – 36, Eds. A. de S. Liyanage and O. S. Peries, Sri Lanka : RRI.

Samarappuli, L. and Yogaratnam, N. (1984). Some aspects of moisture and soil conservation in rubber plantations. *Proc. Int. Rubb. Conf. Colombo,* 1984. (in press)

Samaraweera, M. K. S. A. (1984). Mineral deficiencies. *A Practical Guide to Rubber Planting and Processing,* p. 117 – 123. Eds. A. de S. Liyanage and O. S. Peries, Sri Lanka : RRI.

Samaraweera, M. K. S. A. (1984). The effect of major nutrients on the physiology of latex production. *Proc. Int. Rubb. Conf. Colombo* 1984. (in press)

Yogaratnam, N. and Weerasuriya, S. M. (1984). Fertilizer responses in mature *Hevea* under Sri Lankan conditions. *Proc. Int. Rubb. Conf. on Soils and Nutrition of Perennial Crops, Malaysian Society of Soil Science.* (in press)

Yogaratnam, N. and Silva, F. P. W. (1984). Effect of fertilizers on leaf composition of NPK in some *Hevea* cultivars. *Plant and soil.* (in press)

Yogaratnam, N, and de Mel, J. G. (1984). Effects of fertilizers on growth and tappability. *Plant and soil.* (in press)

Yogaratnam, N., Silva, F. P. W. and Weerasuriya, S. M. (1984). Recent development in the nutrition of the *Hevea* in Sri Lanka. *Proc. Int. Rubb. Conf. Colombo,* 1984. (in press)

Yogaratnam, N., Perera, A. M. and de Mel, J. G. (1984). Management of ground covers for optimum rubber production. *Proc. Int. Rubb. Conf. Colombo,* 1984. (in press)

Yogaratnam, N. and Samarappuli, L. (1984). Some aspects of moisture stress in *Hevea* plantations. *Proc. Third Biotechnology Seminar, Institute of Fundemental Studies, Sri Lanka.* (in press)

Yogaratnam, N. (1984). Weeds and weed control under *Hevea. Proc. of the Seminar on " Weeds and weedicides ", SLAAS,* September, 1984. (in press)

Yogaratnam, N. (1984). Fertilization of nurseries and polybag plants. A *Practical Guide to Rubber Planting and Processing.* p. 9, Eds. A. de S. Liyanage and O. S. Peries, Sri Lanka : RRI.

Yogaratnam, N. (1984). Ground covers and cover management. *A Practical Guide to Rubber Planting and Processing.* p. 37 – 39, Eds. A. de S. Liyanage and O. S. Peries, Sri Lanka : RRI.

Yogaratnam, N. (1984). Fertilizers to immature rubber. *A. Practical Guide to Rubber Planting and Processing.* P. 58 — 61, Eds. A. de S. Liyanage and O. S. Peries, Sri Lanka :RRI

Yogaratnam, N. (1984). Weeds and weed control. *A Practical Guide to Rubber Planting and Processing.* p. 62 — 64. Eds. A. de S. Liyanage and O. S. Peries, Sri Lanka : RRI.

Yogaratnam, N. (1984). Fertilizer use in mature ruber. *A Practical Guide to Rubber Planting and Processing,* p. 104 - 105, Eds. A. de S. Liyanage and O. S. Peries, Sri Lanka : RRI.

Yogaratnam, N. (1984). Sampling for soil analysis. *A Practical Guide to Rubber Planting and Processing,* p. 106 - 108, Eds. A. de S. Liyanage and O. S. Peries, Sri Lanka ; RRI.

Yogaratnam, N. (1984). Practical aspects of leaf sampling. *A Practical Guide to Rubber Planting and Processing,* p. 109 - 116, Eds. A. de S. Liyanage and O. S. Peries, Sri Lanka : RRI.

Yogaratnam, N. and Liyanage, A, de S. (1984). Wind damage. *A Practical Guide to Rubber Planting and Processing,* p. 124 — 128, Eds. A. de S. Liyanage and O. S. Peries, Sri Lanka : RRI.

Yogaratnam, N. (1984). Field experimentation in rubber. *A Practical Guide to Rubber Planting and Processing,* p. 159 — 162, Eds. A. de S. Liyanage and O. S. Peries, Sri Lanka : RRI.

Yogaratnam, N. (1984). Progress in research on *Hevea* nutrition. *International Rubber Conference and Exhibition, Souvenir* Eds. A. de S. Liyanag and O. S. Peries, Sri Lanka : RRI.

Reports

Yogaratnam, N. (1984). Annual Review of the Soils and Plant Nutrition Department.

General

Equipment received under the International Atomic Energy Agency (IAEA) and Canadian International Development Agency (CIDA) research programmes and from Professor James Bonner were installed and used.

Laboratory Investigations

Chemical analyses

Routine chemical analyses of soil and leaf samples from survey, experimental and advisory work of the Department were done. Requests from other Research Departments of the Institute, other Research Institutions, Universities, Janatha Estate Development Board (JEDB) Ceylon Fertilizer Corporation (CFC) Sri Lanka Standards Institution and the Forest Department were also carried out. In all, 3355 leaf 532 soil 24 rubber and 95 other samples were analysed. (A. M. A. Perera. D. Uderatagedara, H. V. K. Rodrigo, Anusha Jayaweera and T. M. Ahamadeen)

Soil – plant – water relations (SM/83/2)

The effects of four levels of moisture and two levels of fertilizer mixture NPKMg on growth and nutrient uptake in immature rubber plants were studied in a pot experiment. Soil water tension in the pots was maintained by tensiometers that were installed in each container. Assessments for leaf water potential, rate of transpiration and chemical composition of leaves were done. (L. Samarappuli and I. Denewake)

Studies on the content of calcium and sucrose and the transport of K and Ca in latex producing tissues in the rubber tree

Sucrose is the carbohydrate precursor for latex production and its glycolysis is regulated by the enzyme invertase. Thus, the availability of sucrose and the invertase activity in latex producing tissues are the two important factors that determine the cropping potential of a tree. This enzyme is activated by K and higher activities are seen at high pH. K is known to have a positive effect on the transport of sucrose. Using isotope techniques, we have studied the effect of K on the mobilities of other mineral ions, especially that of Ca, which is relatively immobile in plants and is essential for the stability of membranes and tissues.

Radioactive materials

^{45}Ca and ^{86}Rb used were purchased from the Radiochemical Centre, Amersham, England.

Plant materials

Regularly ½ s, d/3 tapped trees from a 1976 replanting at Eladuwa State Plantation were selected for uniformity of growth and yield.

The following three clonal types were used :

Clone A — high yielding and highly susceptible to the physiological disorder brown bast

Clone B — medium yielder, can stand intensive tapping and popular among the growers.

Clone C — average clone and its performance lies between A and B.

Application of radioactive materials

The trees were tapped by the conventional methods in the evening of the day before the application of radiotracers. There were at least three trees receiving the same treatment. In the early morning, horizontal grooves were made in the bark, using a sharp tapping knife, until the pale yellow layer of phelloderm was exposed. Special care was taken not to injure the vessels that carry latex. The grooves were either 2 cm or 5 cm in length. Solutions containing radioactive material(0.5/μ Ci/μl) were applied at the rate of 20 μl for the smaller and 50 μl for the larger grooves. When a solution is applied at the above rate, most of it is rapidly absorbed and to minimise the evaporation, the wound was covered with a piece of polythene, using petroleum grease as the glue.

Analytical methods

Sucrose contents were determined by " the anthrone method " using a Corning colorimeter 253.

K and Ca contents were determined by atomic absorption spectrometry using the Varian Techtron AA — 6 system fitted with an air-acetylene flame.

The radio-activity in ^{86}Rb and ^{45}Ca treated samples were assayed employing a TM Analytic Delta 3000 liquid scintillation system.

Collection of latex by conventional tapping

Latex samples were collected either into plastic cups containing small amounts of 25% ammonia or into vials placed in ice.

Collection of latex by micro-tapping

The bark of the tree was pierced with a pin and the flow of the latex was guided using a mini-gutter. Latex samples were collected into vials either placed in ice or containing small amounts of 25% ammonia. When the required amount of latex was collected a pin was placed in the hole to prevent further dripping.

Preparation of TCA extracts for the determination of mineral ions (K and Ca) and sucrose contents of latex

A sample of latex (1.0 ml) was diluted with 0.1% ammonia (4.0 ml) and 10% trichloroacetic acid (TCA) (2.5 ml) was added to this. The resulting mixture was kept in a refrigerator overnight and filtered. The filtrate, known as the TCA extract, was used for the analysis. Another latex sample (1.0 ml) of known fresh weight was dried at 85° C to a constant weight and cooled in a desiccator and the dry weight was recorded.

Preparation of TCA extracts for the determination of total radio-activity in latex

A sample of latex (10 — 20 drops) collected by microtapping was diluted with 0.1% ammonia (4.0 ml) and 10% TCA (0.4 ml) was added to this. The resulting mixture was left in a refrigerator overnight and filtered. The filtrate was mixed with a suitable volume of scintillation solution and radioactivity was assayed. When TCA was added the rubber coagulated ; the coagulum was dried and the dry weight recorded.

Method for the study of distribution of radioactivity in different fractions of latex

Ice cold 0.4 manitol (0.8 ml) was added to a latex sample (10 — 20 drops) collected in a centrifuge tube placed in ice, the contents were mixed and centrifuged at 12000 rpm for 15 minutes. During the process the latex is separated into three phases: rubber serum and lutoid. The serum thus obtained is not very clear. The rubber, was removed and the serum was transferred into another centrifuge tube using a syringe. After adding 1% Triton — X (1.0 ml) the lutoid particles were burst open by placing the tube on a vortex mixer. The contents were mixed with scintilation solution and radioactivity of the lutoid fraction was assayed. 10% TCA (0.5 ml) was added to the serum and the resulting mixture was kept in a refrigerator overnight and filtered. The radioactivity of the filtrate was assayed.

Experiment 1

Distribution of mineral ions in different components of latex : Latex from healthy trees were collected into vials placed in ice, centrifuged at 40,000 rpm and mineral ion contents in each phase were determined after destruction of the organic matter by using a perchloric acid : nitric acid (1 : 3) mixture.

Experiment 2

Mineral nutritional and sucrose status of rubber trees : Six trees from each of the clones A B and C were conventionally tapped (½s, d/3), latex samples were collected and the contents of mineral ions and sucrose were determined. The changes with time in the tree trunk were studied by analysing the latex samples collected by micro-tapping at different intervals from six different places on the tree trunk. Three trees from each clone were used and samples were collected from the following places;

1. The middle point of the virgin bark immediately under the tapping cut
2. A point 20 cm vertically below point 1
3. A point 40 cm vertically below point 2
4. A point diagonally opposite to the middle point of the bark under renewal, on the other panel.
5. A point 20 cm below point 4
6. A point 40 cm below point 5

Experiment 3

Kinetics of K uptake : Five equally spaced incisions (2 cm in length) were made in the virgin bark immediately below the tapping cut, with one at the mid point of the tappine cut. Four more incisions, vertically separated by 5 cm from the closest incision werg made in the virgin bark below th middle point of the tapping cut, thus there were nine incisions per tree. ^{86}Rb solutions containing different amounts of K and Rb (10^{-3} 10^{-2} and 10^{-1} Mol/l) were applied, to the cuts, latex samples were collected at regular intervals, by micro-tapping and the total radioactivity in them was determined. The experiment was replicated on three trees.

Experiment 4

Fate of externally applied K: ^{86}Rb solution, 10^{-2} M with respect to K and Rb was applied to three incisions (5 cm in length) on the virgin bark below the tapping cut. Latex samples were collected 4 h after applications of radioactive material, by micro-tapping, and the distribution of Rb in different phases was studied. Then the trees were conventionally tapped after 6 h, successive fractions of 20 ml of latex were collected and total radioactivity in them was determined.

Experiment 5

Fate of externally applied ^{45}Ca *:* A 10^{-2} M Ca solution containing ^{45}Ca and 10^{-2} M with respect to K was used in this study. The solution was applied to three incisions in the bark, latex samples were collected 72 h after application, by micro-tapping, and distribution of ^{45} Ca in different components was determined. Trees were then tapped and successive fractions of 20 ml of latex were collected and total radioactivity in each fraction was determined.

The composition of latex from different clones showed significant differences in contents of calcium and sucrose. This is particularly so between the two clones A and B, and A and C. The brown bast susceptible high yielding clone A, has lower calcium and sucrose in latex than clones B or C. Sucrose is the starting material for the biosynthesis of latex and in high yielding trees, the conversion is more efficient than low yielding trees. Thus in order to have a sufficient supply of sucrose to the latex producing vessels and to the area where there is a renewal of bark, the trees with low latex sucrose should be tapped at a low frequency. Whereas trees with high latex sucrose can be tapped at a high frequency or subjected to stimulation.

There is a steady decline with time of the calcium content of latex samples collected at different points of the tree trunk. The calcium content of latex of clone A is always lower than that of clone B. A gradual decrease was not seen either in sucrose content or in potassium content. While both potassium and sucrose are mobile in the phloem, calcium is relatively immobile. Hence there is no rapid replacement of calcium drained out from latex producing tissues. Thus there is a localized calcium deficiency in the tissues near the tapping cut, (*i.e.* in the so called drainage area).

When a solution of ^{86} Rb was applied to the bark it was taken up rapidly and there was a steady increase in the radioactivity seen in latex samples collected by micro-taping. An equilibrium state of the amount of ^{86} Rb penetrated was achieved within a short time (4 – 6 h) of application. Rapid and higher penetrations were seen in the area vertically below the mid point of the tapping cut. The uptake of ^{86} Rb increases with the increasing concentrations of K in solution.

When the trees are conventionally tapped 6 h after bark application of ^{86} Rb the radioactivity was equally distributed in all successive (20 ml) fractions collected during the flow of latex. However, when the trees are tapped 48 h after bark application, very high concentration of ^{86} Rb was seen in the first fraction.

Very slow and low uptake of ^{45}Ca was seen when latex samples collected by micro-tapping was assayed. The amount of radioactivity seen in successive fractions of latex collected by conventional tapping of trees after 72 h of application was also very low. It was also noticed that the mobility of Ca increases as the K concentrations in ^{45}Ca solution increases. This confirms that there are ion exchange sites in the bark and movement of Ca^{2+} is via these sites.

Physical data of latex showed that lutoid particles occupy a small portion (10%) of the total volume of latex. The actual volume of fluid (water) in the lutoid is much smaller than that. Lutoids are the vacuoles of the *cytoplasm* (Wiersum, 1974). The amount of K in serum is much higher than that in lutoid and thus the concentrations of K in both these media are in the same order. However, both the amount, and the concentration of Ca in lutoid are much higher than those in the surrounding medium the serum. But a greater proportion of Ca moves into the lutoid. This movement of Ca is against the concentration gradient, thus it requires metabolic energy.

The phloem exudates are alkaline and contain soluble carbohydrates, organic acids, organic phosphates inorganic ions (both cations and anions) and nitrogeneous solutes. Hence the calcium content in the serum (*i e.* the soluble fraction of the phloem exudates) is near its point of saturation or upper possible limit. Thus it cannot accomodate in soluble form, any more of externally applied calcium, and therefore it is difficuilt to correct any localized deficiency of this element.

Cultural practices such as tapping, stimulation and fertilizer application that could change the composition of cytoplasm would have to be carefully studied. This is particularly so because it is very important to have adequate amounts of calcium and sucrose in the area, where there is latex production and bark renewal.

Traditionally, the selections in a breeding programme or adaptability to an exploitation system of rubber trees, grown under different agroclimatic conditions, are done by studying the vigour, growth rate and latex yield. It is also important to consider the changes with time in the composition, particularly the contents of the sucrose and calcium of latex samples collected from different locations of the tree trunk. This information could be used to predict the cropping potential and the incidence of " brown bast.' (M. K. S. A. Samaraweera, S. Udurawana, W. C. Dayaratne, A. M. A. Perera and Chitra Maheepala)

Field Experiments

Response to fertilizers

NPKMg on growth of immature Hevea *(F/76/1, F/76/3, F/76/4 and F/76/5)*

Experiment F/76/1, started at Pembroke State Plantation compared the effectf of 5 levels of N, P, K and Mg on growth of PB 86 in Boralu soils, in a central composite second order design. Fitting of growth data obtained at the end of 1984 although indicated a significant 1st order term, as the 2nd order and lack of fit terms are also relatively high, it appears that the expected homogenity within the block does not exist. This appears to be a reason for the inconsistent results that have been observed over the past few years. (N. Yogaratnam and F. P. W. Silva)

In three other experiments (F/76/3, F/76/4 and F/76/5) application of N, P, and K fertilizers in the form of urea, muriate of potash and rock phosphate at the rate os 310 kg N, 160 kg P and 310 kg K per hectare during the 7 year unproductive period, significantly increased the respective leaf N, P and K concentrations in immature *Hevea* cultivars, PB 86, RRIC 100, RRIC 101 and RRIC 102. These responses have been due to each nutrient acting singly. Increases up to a maximum of 47.0%, 14.7% and 46.7% over no fertilizere controls have been obtained for N. P and K, respectively. However the lag between fertilizer application and changes in their respective leaf nutrient concentration were longer for P than N and K. Urea application decreased the K concentration in leaves and a similar depressive effect of K fertilizers on leaf Mg was also recorded.

Fertilization at the above rates has been shown to be an efficient and practical method of increasing the vigour of immature *Hevea* cultivars. Increasing the levels of nutrients beyond these levels did not give any additional benefit except with nitrogen under a mixed growth of naturals and legume ground covers. In such instances the level of nitrogen would be increased to approximately 380 to 620 kg N/ha. The response to NPK fertilization in terms of tappability of trees closely followed the girthing pattern and in general the clones RRIC 100 series have grown more rapidly than PB 86. Fertilizer application can reduce the nonproductive period of *Hevea* by about 18 to 24 months. (N. Yogaratnam, F. P. W. Silva and J. G. de Mel)

K/Mg nutrition (F/76/5, C/77/8, F/83/1, to 10 and F/84/1 to 7)

Field fertilizer experiments have been started to study some aspects of the K and Mg nutrition of *Hevea* and associated ground covers. These experiments are done in collaboration with the Canadian International Development Agency (CIDA).

Ten field experiments that were started in 1983 on four sites which were replanted in 1981 and showed severe K and Mg deficiencies were continued. The sites are located in Eduragala State Plantation in Ingiriya, Hedigalla State Plantation in Lathpandura and Mirishena State Plantation in Mahagama all on Agalawatta series soils and Anhettigama State Plantation in Deraniyagala on Homagama series soils. In these experiments, effects of four levels of K and Mg fertilizers on growth and leaf nutrient concentration of *Hevea* are being studied. Leaf samples were collected prior to the application of fertilizer, pretreatment and quarterly girth measurements were also recorded.

Another experiment (C/77/8) which had been in progress at Lowmont Division of the St. George State Plantation in Kalutara on Boralu series soils had been selected to study the effects of K on the N status of leguminous covers and its effect on the N status, growth and production of rubber, using clone PB 86. Girth measurements and leaf analysis for N, P, K, Ca and Mg were done prior to treatments and will be continued regularly hereafter. Tapping commenced in 1983 and regular yield assessments are being made which would include analysis of latex for N, P, K, Mg and Ca.

The experimental treatments are being tested in a 3 x 2 factorial design with five replicates. The treatment combinations are as follows :

K_0 — Nil potassium
Kr — Potassium to rubber only
Kc_1 — Potassium to cover only — Level 1
Kc_2 — Potassium to cover only — Level 2
Krc_1 — Potassium to rubber and cover — Level 1
Krc_2 — Potassium to rubber and cover — Level 2

Experiment F/76/5, that is in progress at Eladuwa State Plantation in Matugama on Boralu series soils, deals with the effects of three levels of potassium, K_0^2, K and K_2 and three tapping systems on the performance of clones PB 86, RRIC 100, RRIC 101 growing on Boralu series soils. The tapping systems tested are;

½ S d/2 – ½ spiral alternate daily
½ S d/3 – ½ spiral third daily
6 pg/100 d/2 – Puncture tapping I meter vertical band alternate daily

Another experiment (F/84/7) was started at Eladuwa State Plantation, Yatadola to study the effects of different sources of Mg namely, commercial epsom salt, kieserite and dolomite at three levels (Mg_0, Mg_1 and Mg_2) and K applied as muriate of potash at three levels (K_0, K_1 and K_2).

The design of this experiment is a split plot type with two replicates where the main plot treatments are the forms of Mg and sub- treatments are combinations of K and Mg. (N. Yogaratnam, M. Weerasooriya, A. M. A. Perera, F. P. W. Silva and G. de Mel)

Experiments (F/84/1 to 6)

Effects of some factors such as the planting hole treatment and the levels of K and Mg were studied in 1984 replantings.

Planting hole treatments are;

1. Control with no organic matter and no fertilizer, at the time of planting (T_1).
2. Application of K and insoluble Mg fertilizer before planting (T_2).
3. Application of rice straw (organic matter rich in K) twice a year for a period of 3 - 4 years (T_3).
4. Application of coir dust (organic matter that absorbs and retains water) twice a year for a period of 3 – 4 years (T_4).

K and Mg — four K levels with uniform applications of N and P.

Design

Split plot — confounded
Main treatments — T_1, T_2, T_3, and T_4
Sub treatments — K and Mg levels, *i.e.* 16 combinations.
There are 16 plots in each block with eight such blocks.

Visits were made to several properties of the JEDB and the SLSPC. A few sites were selected from different rubber growing areas of Sri Lanka. A preliminary soil survey was conducted at each location. The planting hole treatments and the fertilizer applications were made according to the design. There are 16 — 20 trees per plot and each plot is separated from the other by guard rows.

The experimental sites are as follows :

Eladuwa State Plantation (SLSPC) Payagala	(2 blocks)
Padukka State Plantation (SLSPC) Padukka	(1 block)
Divitura State Plantation (SLSPC) Athkandura	(2 blocks)
Panawatta Estate (JEDB) Yatiyantota	(1 block)
Atale Estate (JEDB) Kegalle	(1 block)
Pitiyakande Estate (JEDB) Mawathagama	(1 block)
Total	8 blocks

Soil samples were collected from every plot and the following analyses are being carried out :

1. Total N content
2. Organic carbon content
3. Cation exchange capacity
4. Total contents of N, P, K, Ca, Mg
5. Available K, Ca, Mg contents

Samples of leaves were collected from every plot and N. P. K, Ca, Mg contents are being assessed. (M. K. S. A. Samaraweera, W. C. Dayaratne, S. N. Silva, C. K. Maheepala, Champa Adikaram and Manojie Dharmawardene)

Different levels of N, P, K, and Mg on yield of mature rubber (F/61/1, F/62/1, F/76/8 and F/76/10)

Four experiments to study the effects of fertilizers on yield of mature rubber were in progress covering Boralu, Agalawatta and Parambe soils.

Information obtained indicated that yield increases in the existing plantations could be obtained with increased applications of nitrogen fertilizers in the form of urea. The level of application could be increased to double that of the currently recommended rate. Some yield increases were also obtained with applications of potassium. It has also been found that application of rock phosphate to mature rubber trees is not always beneficial. Similarly, applications of magnesium containing fertilizers to mature rubber should not also be made indiscriminately.

In general, it appears that fertilizer applications to mature rubber with complete NPKMg mixtures may not be economically justified particularly in the present context of fertilizer and rubber prices. (N. Yogaratnam, F, P. W. Silva and G. de Mel)

Efficiency of fertilizer application (F/76/2, and F/76/17)

These experiments to study the effects of different sources of nutrients on growth and yield of rubber was continued. The effects of Eppawala rock phosphate and imported rock phosphate, each at two levels of P on growth and yield of PB 86, growing on Boralu soils, were studied in experiment (F/76/17) at Eladuwa State Plantation. Yield data (Table 1) obtained in 1984 indicated a 10% increase in yield over no P control in the

Eppawala rock phosphate applied plots and there was no further increase in yield where the level of applied P was increased to double the currently recommended rate. Application of imported rock phosphate however, gave a 12% increase over control at level 1 and a further increase to 21% was obtained when P was applied at level 2. (N. Yogaratnam and G. de Mel)

Table 1. *Effect of Eppawala rock phosphate and imported rock phosphate on yield of PB 86 (F/76/17)*

Treatment		Mean yield (kg/ha/yr)	% increase over control
Nil phosphate		940	100
Eppawala rock phosphate	Level 1	1040	110
	Level 2	1034	110
Imported rock phosphate	Level 1	1051	112
	Level 2	1139	121

Covers and cover management

Types of covers (C/73/5 and C/77/6)

Studies on the effect of different leguminous cover species on growth were carried out at two sites. The control plots in these experiments were in naturals. In general, growth of trees (Table 2) in legumes was superior to the trees in naturals except in *Stylosanthus guyanensis* plots where the growth of *Hevea* has been poor.

Table 2. *Effect of legume covers on growth of PB 86 (F/77/6)*

Treatment	Girth (cm)	% increase over control
Naturals	53.1	100
Stylosanthus	53.4	100
Mimosa	57.8	108
Calapagonium	56.4	106
Pueraria	58.4	110
Centrocema	56.8	107
Desmodium	56.3	106

Nutrition of legumes (C/77/8)

The effect of applying potassium to covers on the growth and yield of *Hevea* was studied in experiment C/77/8. Application of K direct to rubber tree appeared to be as efficient as its application to the ground covers in K deficient soils. (N. Yogaratnam, M. Weerasooriya and F. P. W. Silva)

Soil-plant-water relations

In soil-plant-water relation studies, a neutron moisture meter was used to monitor soil water in field studies concerning the response of the plant to water stress, whilst plant physiological and micro-meteorological requirements were maintained on the above ground part of the system.

Location of access tubes (SM/82/1)

It appears that during dry periods distances varying from 1.2 m to 1.8 m from the trunk of the tree are suitable for assessing the water content of the soil profile, and also the process of depletion and recharging from the moist layers may be continuous in the profile close to the trunk. An incidental but important observation that emerges from this is that fertilizer application to immature rubber should be confined to areas approximately 60 cm from the base of the tree for efficient uptake. (L. Samarappuli and P. Karunadasa)

Available soil water in relation to rainfall (SM/82/4)

A clear relationship appears to exist between available soil water and total rainfall. It is evident that even during the most dry periods in 1983 *i.e.* in January, February and March, the available soil water had been in the region of 140 to 175 mm. Total precipitation in the preceding 3 months *i.e.* in October, November and December 1982 had been around, 1000 mm. It there fore seems possible to apply fertilizers, at least to mature areas, even during the dry periods of January to April, if there had been approximately 1000 mm of rain during the north east monsoon in the previous year. (L. Samarappuli and P. Karunadasa)

Water stress in relation to management practices on growth of immature rubber (SM/82/6)

This experiment was planned to study the effects of different soil management practices on water stress in immture rubber plantations. The ground cover treatments were :

- (*a*) bare (clean weeded)
- (*b*) naturals cover
- (*c*) mixed legumes
- (*d*) dead mulch

It appears possible to eliminate or at least minimise the adverse efects of moisture stress by mulching. Plots in dead mulch exhibited the highest soil moisture storage capacity (SMSC) of 27.64 cm in comparison with other practices such as growing leguminous covers or naturals or leaving the land bare. Similar results were observed with regard to other parameters such as leaf water potential (LWP), relative water content of leaves (RWC) and leaf water deficit (LWD).

Treatment	SMSC (cm)	LWP (bars)	RWC	LWD (%)
Bare (clean weeded)	18.3	26.7	0.814	18.6
Naturals	24.3	26.5	0.849	15.1
Legumes	21.7	27.4	0.820	18.3
Dead mulch	27.6	22.1	0.867	13.3

Girthing of plants also showed similar effects with plants in mulch growing moer vigorously with a girth of 19.49 cm at the end of 24 months as compared to a value of 17.25 cm in the plots in naturals. The cation exchange capacity of the soil was also increased by mulching.

Water stress on nutrient uptake by immature rubber (SM/83/1)

In this experiment the effect of water stress on nutrient uptake by immature rubber plants was studied in a three factorial design with three levels of N, P and K. Access tubes were installed in each plot (two per plot) and weekly assessments were made using a neutron meter. A pressure bomb was used to assess leaf water potential and chemical composition of leaves was also determined. (L. Samarappuli and P. Karunadasa)

Water stress on latex production in mature rubber (SM/83/3)

Effects of water stress on latex production will be studied in this experiment. Access tubes were installed in an on-going fertilizer experimental area, neutron moisture meter readings were made regularly and yield assessment were also made. It is too early to make any conclusive observations yet. (L. Samarappuli and P. Karunadasa)

Extension

Soil and foliar survey for discriminatory fertilizer recommendations

All rubber plantations managed by the SLSPC and JEDB are now fertilized on the basis of soil and foliar analyses. The foliar survey programme for 1983 commenced in July and estates covering 8532 ha were surveyed this year. Fertilizer programmes based on this survey were computerised and recommendations for the next 3 years (1985, 1986 and 1987) were sent to the estates for implementation. Urea was the only source of nitrogen recommended during this year. (N. Yogaratnam, L. Samarappuli, M. Weerasooriya, F. P. W. Silva, A. M. A. Perera, V. Rodrigo and D. Udaratagedera)

Nutrient deficiencies

Unlike in the previous years, nutrient deficiencies, in particular Mg deficiency ,have not been a common occurrence in commericial plantations, possibly due to regular application of Mg containing fertilizers as recommended by the Institute.

REFERENCES

Wiersum, L. K. (1984). The low calcium content of cellular system adopted to flow. *Experientia,* **30**, 476.

REVIEW OF THE RUBBER CHEMISTRY DEPARTMENT

By

S. W. KARUNARATNE

SUMMARY

The Rubber Chemistry Department which is the largest Research Department of the Institute was divided into five sections effective from the beginning of the year and the research work was carried out under the supervision of five sectional heads. Five research officers were on overseas study leave and several staff movements were seen. The normal work output was maintained by judicious deployment of staff and the Department continued to play a vital role in servicing the raw rubber manufacturing industry and the rubber products industry. Research on the improvement of the quality of crepe rubber has been progressing steadily and the use of novel bleaching agents for the manufacture of good quality crepe rubber is tested continuously. A planned programme of advisory visits in consultation with the State Sector Plantations was set in motion and this was further sterngthened by holding periodic lecture programmes for the benefit of all personnel in the plantation section. The Department also assisted the ASD in conducting training courses to the field staff. In the rubber products industry the Department has assisted in overcoming technical problems associated with the production of rubber products both for the local and export markets. Research on new applications for NR, new methods of presentation and new methods of vulcanization were continued during the year. The Department assisted in the manufacture of speciality grades of NR which fetch a premium price. Energy concervation in the drying of rubber was one of the main studies undertaken during the year. Steps were taken to double the solar collector area for the Dartonfield drying tower (capacity 2750 kg) but the construction work was delayed due to unforseen problems. The boiler-radiator system is found to be a very ineffiicient form of drying, averaging only about 30% efficiency in most instances.

Quality control of NR, especially the technically specified block rubber is done by the Central Specifications Laboratory which is controlled by the Specification and Analysis Section of the Department. Continuous testing is carried out and certificates of conformity are issued prior to export. A testing fee is levied to meet the expenses of this unit. Activities of the Department, as usual, resulted in substantial financial gains to the institute. The main avenues of such gains were from specification analyses, other miscellaneous analyses and quality certification, consultancy and miscellaneous charges for services rendered in rubber products manufacture including moulding and preparation of special rubber compounds.

Staff

The Head of the Department, Mr S. W. Karunaratne, the Head of the Polymer Chemistry Section, Dr A. Coomarasamy, the Head of the Specifications and Analysis Section, Dr L. M. K. Tillekeratne and Dr W. S. E. Fernando the Head of the rubber Technology and Development Section were on duty throughout the year. The Head of the Biochemistry Section went on sabbatical leave for a period of 6 months from the 7 October to Okayama University, Japan. The Raw Rubber Development Unit was over looked by the Head of the Department. Assistant Rubber Chemists, Mr M. C. S, Perera, Mr P. A. D. T. Wimalasiri and Mr E. D. I. H. Perera continued their post graduate studies overseas. Assistant Rubber Chemist, Mr M. D. R. J. Goonetilleke was on duty until he went for a further period of post graduate studies overseas on 6 October. Assistant Rubber Chemist, Miss N. M. V. Kalyani went on post graduate studies, overseas, on 5 February. Research Assistant, Mr L. B. K. Silva and Mr T. L. Gunaruwan Fernando, Assistant Development Officer, were on duty throughout the year. Assistant Development Officer, Mr D. D. N. B. Daya resigned from Office on 1 March. Assistant Rubber Chemist, Mr W. M. G. Seneviratne assumed duties on 25 June. Assistant Development Officers, Mr L Perera and Miss P. Sirimanne assumed duties on 2 July. Assistant Biochemist, Miss T. V. W. Goonesekera resigned from Office on 29 June. Miss N. Kulatillake joined the Biochemistry Section in May as a temporary research assistant. Experimental Officers, Messrs P. P. Jayasinghe, S. Kasinathan and K. A. R. M. Perera were on duty throughout the year. Experimental Officer, Mr H. N. K. K. Chandralal, returned in March after a training in radiation vulcanization in Indonesia. Experimental Officer, Mrs C. P. Ediriwickrema resigned from her post with effect from 1 March. Experimental Officer, Mr W. W. D. Y. Jayasinghe joined the Biochemistry Section with effect from 3 September. Senior Technical Officers, Mr D. D. Medagama and Mr A. S. Dekumpitiya were on duty throughout the year. Senior Technical Officer, Mr S. L. Weerasinghe returned in January after a training in rubber processing in Malaysia. Technical Officers Messrs W. D. Dharmasena, K. M. U. Mitrananda, P. H. Sarath Kumara, Mrs Manel Nilaweera, Mrs N. Baduge, Mrs S. Weeraman, Mrs W. C. M. Kuruppu, Mrs R. L. Wanigatunga, Mrs M. K. Mahanama, Mrs S. I. Yapa, Miss N. M. M. de Costa and Mr M. D. C. Seneviratne were on duty throughout the year. Specifications Assistants Messrs W. A. S. Wijesekera, A. T. S. Siriwardena, G. Wanigathunga, R. Wickremaratne, K. K. Austin, W. Nandasena, B. Gunasiri and P. D. J. Rodrigo were on duty throughout the year. Specification Assistant, Mr T. M. Ahamadeen, was transferred from the Department in March and Mr M. A. Mendis was transferred to the Department as Specification Assistant at the same time. Mr Mendis was granted no pay leave from 4 June 1984. Mr G. R. S. S. Gamlath, Mr L. G. Piyasena and Miss K. C. S. Dissanayake continued to work as Instrument Technicians throughout the year. They functioned mainly as Technical Officers within the Deparmtnet. The Stores Assistant, Mrs L. Rukmani was on duty throughout the year. Clerk/Typist Mrs Anusha Paranawithane, and Miss M. D. I. Premawathie were on duty throughout the year. Casual Typist, Miss Dilina Fernando resigned from the post in October. Clerk/Typist Mrs Thilaka Dantanarayana was transferred to the Department from the Head Office and assumed duties on 3 December.

Visiting Senior Research Officer Dr N. C. C. Walpita resigned from the post on the 31 November.

The Chinese student Mr Li Jiu Long completed his training and returned to his country in September.

Students

NDT student, Miss R. C. Nandadeva, started her in plant training in Rubber Technology from 1 June for a period of 6 months and NDT student, Miss A. B. Furlong, started her in plant training in electronic engineering from the 3 October for a period of 2 months. Several under graduates were given vacation training in the Department during the year. Seven Research Students following the MSc course in Polymer Science and Technology were assisted by the research staff of the Department to carry out research projects to complete their degrees.

Overseas visits

The Head of the Department, Mr S. W. Karunaratne, visited the Atomic Energy Centre in Batan, Indonesia, in April on the invitation of the International Atomic Energy Agency (IAEA) to deliver a series of lectures on latex chemistry and technology, emphasising the usefulness of the radiation vulcanization technique in the future development of technology of latex processing with respect to major end use applications. He visited the centre again in November on the invitaion of the IAEA to participate in the opening of the electron beam facility for wood processing and the Technical Review meeting on radiation processing. The Head of Department also visited UK in October as an International Rubber Research and Development Board (IRRDB) observer in the SMR review meeting held in MRPRA, Brickendewbury. The Head of Specifications and Analysis Section, Dr L. M. K. Tillekeratne participated in the ISO TC 45 meeting held in Bangkok in October and he took this opportunity to visit the RRIM and a few factories in Malaysia.

Meetings and Seminars

The Head of the Department attended the following meetings and seminars :

Marketing seminar organised by the Rubber Brokers Association during the 1st quater.

SLAAS Seminar on Technology Development and Transfer and participated in the panel discussion.

A joint discussion with Heads of Sections and chemical firms on the use and abuse of bleaching agents.

A Seminar on Technically Specified Rubber was organiesd by the Head of the Department and this was attended by all TSR manufacturers and other policy makers from Government Departments.

Seven meetings as a member of the Advisory Committee on Rubber.

Three meetings as a member of the Chemicals Divisional Committee of the Sri Lanka Standards Institution.

Three meetings of the drafting committees on rubber and rubber products of the Sri Lanka Standards Institution.

The Head, Rubber Chemistry Department and Heads of Sections presented papers at a work shop held on 6 April on the theme, " Chemistry in the Rubber Industry " organised jointly by the PRI and the Institute of Chemistry. The Head of the Department also chaired one session of another work shop organised by the PRI on basic rubber technology for the factory workers. The meeting was conducted in Sinhala.

The Head Specifications and Analysis Section addressed the planters of Sri Lanka State Plantation Corporation (SLSPC) III, IV and V on the use of new water soluble bleaching agents.

A 1 - day work shop on Energy Conservatio nand Management was conducted by N. C. C. Walpita.

N. C. C. Walpita and T. L. G. Fernando attended several meetings of the Sri Lanka Energy Management Association as members of the Board of the Association.

Committees

Head, Rubber Chemistry Department, S. W. Karunaratne, was elected to,

Chemicals Divisional Committee of the Sri Lanka Standards Institution.

Advisory Committee on rubber formed by the Export Development Board.

Committee member of the plastics and Rubber Institute. Head Specifications and Analysis Section was elected to,

The Committee of Sri Lanka Association for Advancement of Science (SLAAS), Section B.

Committee for the popularization of Sciences, SLAAS.

Training programmes

The Departmental staff participated in several training programmes organised by the Advisory Services Department (ASD) to train field Officers in raw rubber production methods and marketing. A full days training programme was organised at Tebuwana for the benefit of factory officers in SLSPC III plantations.

Lectures

Lectures were conducted by the following officers to NDT, Rubber Technology Students from Moratuwa University.

S. W. Karunaratne	30 lectures
L. M. K. Tillekeratne	35 lectures
L. B. K. Silva	30 lectures

These lectures were of 2 h duration.

Publications

Coomarasamy, A., Long, Li Jiu ; Silva, L. B. K., Samaraweera, Indrani., Chandralal, H. N. K. K. and Kasinathan, S. (1984). Antioxidants from cashew nut shell liquid. *Proc. Int. Rubb. Conf. Colombo* 1984. (In press)

Coomarasamy, A., Kasinathan, S., Kuruppu, Chitra., de Costa, Mangalika and Narayanaswamy, Ratnavathany (1984). Some aspects of compounding and vulcanization of polymer encapsulated granular rubber. *Proc. Int. Rubb. Conf. Colombo* 1984. (In press)

Coomarasamy, A., Chandralal, H. N. K. K., Nilaweera, Manel and Seneviratne, W. A. (1984). The use of tertiary butyl hypochlorite as and initiator polymerization. *Proc. Int Rubber Conf. Colombo* 1984. (In press)

Coomarasamy, A. (1984). Prospects of special types of natural rubber in Sri Lanka *International Rubber Conference and Exhibition Souvenir.* Eds. A de S. Liyanage and O. S. peries, Sri Lanka : RRI.

Coomarasamy, A. (1984). A cyclized rubber. *A Practical Guide to Ruber Planting and Processing.* p. 223. Eds. A. de S. Liyanage. and O. S. Peries. Sri Lanka : RRI.

Coomarasamy, A. (1983). Speciality rubbers, viscosity stabilized rubbers. *Handbook of Rubber Culture and Processing.* p. 315. Eds. O. S. Peries and D. M. Fernando. Sri Lanka : RRI.

Coomarasamy, A. (1983). Non-rubber resources. *Handbook of Rubber Culture and Processing.* p. 337. Eds. O. S. Peries and D. M. Fernando. Sri Lanka : RRI

Fernando, W. S. E., Yapa, P. A. J., Medagama, D. D. and de Silva, D. (1984). Technology properties of deproteinized natural rubber. *Proc. Int. Rubb. Conf. Colombo* 1984. (In press)

Fernando, W. S. E., Jayasinghe, P. P., Perera, K. A. R. M., and Long, Li Jiu. (1984). Rationalization of compound fromulation for tyre retreading. *Proc. Int. Rubb. Conf. Colombo* 1984. (In press)

Fernando, W. S. E. (1983). Five years of RRI 7. *Bull. Rubb. Res. Inst. Sri Lanka.* 1 – 6.

Fernando, W. S. E. (1984). Development of rubber products. *International Rubber Conference and Exhibition Souvenir.* Eds. A. de S. Liyanage and O. S. Peries, Sri Lanka : RRI.

Fernando, W. S. E. Centirfuged latex. (1983). *Handbook of Rubber Culture and Processing,* p. 329. Eds. O. S. Peries and D. M. Fernando. Sri Lanka : RRI.

Goonetilleka, M. D. R. J. and Weerasinghe, S. (1984). Problems involved in the manufacture of crepe rubber and the utilization of the existing resources for the manufacture of new forms of rubber in Sri Lanka. *Proc. Int. Rubb. Conf. Colombo* 1984. (In press)

Goonetilleka, M. D. R. J., Fernando, W. S. E. and Weerasinghe, S. (1984). Implementation of the colour coding system and the marketing of crepe rubber. *Proc. Int. Rubb. Conf. Colombo* 1984. (In press)

Goonetilleka, M. D. R. J. (1984). Manufacture of ribbed smoked sheets. *A Practical Guide to Rubber Planting and Processing.* p. 177, Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka : RRI

Goonetilleka, M. D. R. J. (1984). Manufacture of latex crepe rubber. *A Practical Guide to Rubber Planting and Processing.* p. 190, Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka : RRI.

Goonetilleka, M. D. R. J. (1983). Water used in raw rubber manufacture. *Handbook of Rubber Culture and Processing.* p. 267, Eds. O. S. Peries and D. M. Fernando. Sri Lanka : RRI.

Goonetilleka, M. D. R. J. and Walpita, N. C. (1983). Energy utilization in raw rubber manufacture. *Handbook of Rubber Culture and Processing.* p. 273, Eds. O. S. Peries and D. M. Fernando. Sri Lanka : RRI.

Karunaratne, S. W., Silva, L. B. K. and Chandralal, H. N. K. K. (1984). Identification and characterisation of phenolic substances in smoke deposits in RSS. *Proc. Int. Rubb. Conf.* 1984. (In press)

Karunaratne, S. W., Fernando, W. S. E., Sumathipala, Ransi and Mitrananda, K. M. U. (1984). Analysis of blooms by thin layer chromatography. *Proc. Int. Rubb. Conf. Colombo* 1984. (In press)

Karunaratne, S. W., Daya, D, D, N., Chandralal, H. N. K. K. and Nilaweera, Manel (1984) Properties of radiation vulcanized latex. *Proc. Int. Rubb. Conf. Colombo* 1984. (In press)

Karunaratne, S. W. (1984). Development in rubber manufacture. *International Rubber Conference and Exhibition Souvenir* Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka : RRI.

Karunaratne, S. W. (1984). Sorting, grading and packing of rubber. *A Practical Guide to the Rubber Planting and Processing.* p. 205, Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka : RRI.

Karunaratne, S. W. (1983). Latex collection. *Handbook of Rubber Culture and Processing.* p. 191, Eds. O. S. Peries and D. M. Fernando. Sri Lanka : RRI.

Karunaratne, S. W. and Goonetilleka, M. D. R. J. (1983). Ribbed smoked sheet. *Handbook of Rubber Culture and Processing.* p. 205, Eds. O. S. Peries and D. M. Fernando. Sri Lanka : RRI.

Karunaratne, S W. and Goonetilleka, M. D. R. J. (1983). Pale crepe and sole crepe. *Handbook of Rubber Culture and Processing.* p 227, Eds. O. S. Peries and D M. Fernando. Sri Lanka : RRI.

Karunaratne, S. W. (1983). Brown crepes. *Handbook of Rubber Culture and processing.* p. 257, Eds. O. S. Peries and D. M. Fernando. Sri Lanka : RRI.

Karunaratne, S. W. (1983). Chemicals used in raw rubber manufacture. *Handbook of Rubber Culture and Processing.* p. 261, Eds. O. S. Peries and D. M. Fernando. Sri Lanka : RRI.

Karunaratne, S. W. (1983). Defects in raw rubber. *Handbook of Rubber Culture and Processing.* p. 275, Eds. O. S. Peries and D. M. Fernando. Sri Lanka : RRI.

Karunaratne, S. W. (1983). Grading and packing of rubber. *Handbook of Rubber Culture and Processing.* p. 283, Eds. O. S. Peries and D. M. Fernando Sri Lanka : RRI.

Perera, M. C. S., Bradbury, J. H. and Elix, J. A. (1984). Epoxidized natural rubber. *Proc. Int. Rubb. Conf. Colombo* 1984. (in press)

Tillekeratne, L. M. K., Sarath Kumara, P. H., Weeraman, Sriyanthi and Mahanama, Manel (1984). Developments in the bleaching agents used in latex crepe manufacture. *Proc. Int. Rubb. Conf. Colombo* 1984. (in press).

Tillekeratne, L. M. K., Dekumpitiya, A. S. and Wanigathunga, Leela (1984). TSR manufacture in Sri Lanka. *Proc. Int. Rubb. Conf. Colombo* 1984. (in press).

Tillekeratne, L. M. K. (1984). TSR production in Sri Lanka, *International Rubber Conference and Exhibition Souvenir.* Eds. A. de S. Liyanage and O. S. Peries, Sri Lanka : RRI.

Tillekeratne, L. M. K. (1984). Metrolac estimation of dry rubber content. *A Practical Guide to Rubber Planting and Processing.* p. 175, Eds. A. de S. Liyanage and O. S. Peries, Sri Lanka : RRI.

Tillekeratne, L. M. K. (1984). Rectification of defects in smoked sheets. *A Practical Guide to Rubber Planting and Processing.* p. 187, Eds. A. de S. Liyanage and O. S. Peries, Sri Lanka : RRI.

Tillekeratne, L. M. K. and Vimalasiri, P. A. D. T. (1983). Technically specified block rubber, *Handbook of Rubber Culture and Processing.* p. 295. Eds. O. S. Peries and D. M. Fernando, Sri Lanka; RRI.

Walpita, N. C. C., Fernando, T. L. G. and Nandadewa, Rishani, (1984). Efficiency of a boiler/radiator heating system in a crepe drying tower. *Proc. Int. Rubb. Conf. Colombo,* 1984. (in press).

Walpita, N. C. C, Fernando, T. L. G. and Laelwala, P. (1984). Solar assisted crepe rubber drying. *Proc. Int. Rubb. Conf. Colombo,* 1984. (in press).

Yapa, P. A. J. and Yapa, Sriyani. (1984). Recent developments in the manufacture of deproteinised natural rubber. *proc. Int. Rubb, Conf. Colombo,* 1984. (in press).

Yapa, P. A. J. (1984). Effluent disposal, utilization and pollution control in rubber plantations in Sri Lanka. *Proc. Int. Rubb. Conf. Colombo,* 1984. (in Press)

Yapa, P. A. J. (1984). Advances in biochemical research. *International Rubber Conference and Exhibition Souvenir.* Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka : RRI

Yapa, P. A. J. (1984), Raw rubber properties of RRIC clones. *A Practical Guide to Rubber Planting and Processing.* p. 214. Eds. A. de. S Liyanage and O. S. Peries Sri Lanka : RRI.

Yapa, P. A. J. (1984). Effluent disposal. *A Practical Guide to Rubber Planting and Processing.* p. 218, Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka : RRI.

Yapa, P. A. J. (1984). Deproteinised natural rubber. *A Practical Guide to Rubber Planting and Processing.* p. 221, Eds. A. de S. Liyanage and O. S. Peries. Sri Lanka : RRI.

Yapa, P. A. J. and Walpita, N. C. C. (1983). Environmental pollution and treatment of effluent. *Handbook of Rubber Culture and Processing.* p. 341, Eds. O. S. Peries and D. M. Fernando. Sri Lanka : RRI.

Abstracts

Coomarasamy, A. (1984). The use of starch derivatives as encapsulating agents for granular natural rubber. *Proc. of the fortieth Annual Session of the SLAAS.*

Tillekeratne, L. M. K., Tillekeratne, L. M. V., de Silva, A. P. and Sarath Kumara, P. H. (1984). Mechanical action of alkaline metal thiols on the carotenoids present in NR latex. *Proc. of the fortieth Annual Session of the SLAAS.*

Tillekeratne, L. M. K., Karunanayake, E. (1984). Prevention of enzymatic discolouration of latex crepe rubber. *Proc. of the fortieth Annual Session of the SLAAS.*

Reports

Chandralal, H. N. K. K. Report on the 6 months training in radiation processing in Indonesia.

Karunaratne, S. W. Report on a visit to Indonesia in connection with the radiation processing programme of the IAEA.

Karunaratne, S. W. Report on a visit to U.K. to attend the MR work shop.

Tillekeratne, L. M. K. Report on the thirty-second session of the ISO/45 held in Bangkok.

Weerasinghe, S. Report on the 9 months training in rubber processing in Malaysia.

Patents

Fernando, W. S. E. Improvements in or relation to the caogulation of NR latex with carboxylic acids.

Miscellaneous

New laboratory

Most of the facilities to the new wing of the Rubber Chemistry Department is now provided and some Sections are used for research work. The auditorium in the new wing was used mainly by the National Institute of Plantation Management (NIPM) to conduct classes and examinations to the planters.

Central electronic servicing laboratory

Mr P. W. Dharmasena, Electronic Engineer from the University of Moratuwa was engaged, on a one day a week basis, to carry out urgent repairs to defective equipment with the assistance of the Research Assitant, L. B. K. Silva and other Instrument Technicians.

Exhibitions

The Rubber Chemistry Department helped the ASD in organising several Mahapola exhibitions throughout the year. In addition, the Department helped in a few school exhibitions.

Polymer Chemistry Section

Antioxidant studies

Binding of antioxidants on to NR

High ammonia centrifuged latex containing 1 phr of N (4 - aniline phenyl) malemide was subjected to 3.5 Mega rads with the view of cross linking/binding of the antioxidant. A control sample of high ammonia centrifuged latex containing no additive was also subjected to the same dosage of irradiation. Latex films, 0.2 cm, were prepared and tested for (600%) modulus. The sample containing the antioxidant had a modulus (600%) of about 13 kg/cm $^{-2}$ whereas the control sample without any additive had a modulus of about 5 kg/cm $^{-2}$. This indicates that the malemide antioxidant had induced crosslinking either by taking part in the crosslinking process directly or by action as a sensitizer. The CCl_4 sensitized samples of latex usually give a modulus of about 20 kg/cm $^{-2}$. There was no marked reduction in the 600% modulus values for the samples containing the malemide antioxidant, on ageing at 72°C for 24 h. The sample without the antioxidant (control) became very sticky on ageing. This work was done at CAIR, Indonesia. (A. Coomarasamy, S. W. Karunaratne and H. N. K. K. Chandralal)

Antioxidants based on CNSL

Tetra hydrocardanol was subjected to tertiary butylation using tertiary butyl urea in concentrated sulphuric acid medium at low temperature. The product obtained by ether extraction followed by washing and removal of solvent was subjected to TLC analysis using ethyl acetate : toluene (10 : 90) as the solvent. The sample was dissolved in cylco hexane. The spray reagent used was diazotised with p. nitro aniline. Two new spots appeared indicating the presence of two derivatives of tetra hydro cardanol. Preliminary evaluation of antioxidant properties of the sample was encouraging. This work was carried out with the assistance of Mr Li Jiu Long. (A. Coomarasamy and S. Kasinathan)

Maleimide antioxidants

Polymeric antioxidants containing hindered phenolic groups and diphenyl amino groups were synthesised by treating styrene maleic anhydride 1 : 1 copolymer with 4 methylol 2, 6 ditert butyl phenol and 4 amino di phenyl amine, respectively.

Structures of the synthesised polymeric antioxidants have been analysed by IR and NMR spectral data. These antioxidants are more compatible with nitrile rubber. (A. Coomarasamy, G. Seneviratne and S. Kasinathan)

Preparation of SP rubber

Processing characteristics of polymer encapsulated granular rubber

Granular rubber samples were prepared from field latex by mixing the sodium salt of polymeric acids such as poly acrylic acid, copolymer of methacrylic and acrylic acid and copolymer of styrene and maleic acid with NR latex at 10 phr and 20 phr followed by coagulation with a soluble aluminium salt solution. SP rubbers containing 10 and 20% sulphur prevulcanised rubber and control samples were also prepared using the standard procedure.

Cure characteristics extrusion properties and tensile properties of the vulcanizates using a standard formulation were measured. The results obtained on extrusion studies revealed that the die swell characteristics of the granular rubber samples were comparable to the SP rubber samples containing the same percentage of pre - vulcanised rubber. Cure characteristics and tensile properties of granular rubber samples are comparable to those of the control samples. Miss R. Narayaswamy, MSc student, assisted in this work. (A. Coomarasamy, L. B. K. Silva, S. Kasinathan, Chitra Kuruppu and Mangalika Costa)

Granular rubber samples were prepared using strach – calcium adduct, starch – aluminium adduct and starch – boric acid adduct at 20 parts on total weight of granular rubber. The raw rubber properties obtained were comparable to other granular rubber samples and the technological properties were satisfactory. The starch additives have been found to impart superior extrusion properties, similar to other encapsulating agents. The samples containing starch additives are being subjected to mould growth tests. A paper on this work was submitted to the SLAAS annual sessions. (A. Coomarasamy and S. Kasinathan)

Preparation of low viscosity rubber

Earlier it was found that phenyl hydrazine at 1 phr produced a drop in Mooney viscosity of 10 units. When phenyl hydrazine at 3 – 5 phr was used, it was found that a large drop in Mooney viscosity., of about 40 – 50 units was possible especially when an oxidising agent was used along with phenyl hydrazine. The other reagents such as the bleaching agents and hydroxylamine salts did not give the desired reduction in viscosity at the concentrations used in this study. The work on this project is being continued. (A. Coomarasamy, S. Kasinathan, Chitra Kuruppu and M. Mangalika)

Preparation of graft copolymers of NR and vinyl monomers

Initiations for polymerization

The standard initiator system for effecting graft copolymerization of methyl methacrylate monomer on to NR latex is a redox system based on either, the cumene hydroperoxide/tetra ethylene penatamine (TEP) system or the tertiary butyl hydroperoxide TEP system. The tertiary butyl hydroperoxide/TEP system produced tertiary butoxy radicals. The same type of radicals could be liberated from the tertiary butyl hypochlorite under certain conditions. The tertiary butyl hypochlorite could be synthesised quite readily and as such it was decided to investigate the possibility of using tertiary butyl hypochlorite /TBHC) as a radical generator for initiating polymerization. Our experiments revealed that it is possible to effect homopolymerization of MMA and graft copolymerization of MMA on to NR using a redox system based on tertiary butyl hypochlorite and a transitional metal salt. Kinetics of polymerization of MMA using TBHC/Cu^{++} system in emulsion form and graft copolymerization of emulsified MMA in NR latex have been studied. The results have revealed some useful new scientific information. (A. Coomarasamy, L. Perera, G. Seneviratne, H. N. K. K. Chandralal and Manel Nilaweera)

Reaction mechanism

To obtain more scientific evidence for the machanism of polymerization, using tertiary butyl hypochlorite/Cu^{2+} ion system, experiments were carried to decompose tertiary butyl hypochlorite under different conditions and the decomposition products formed are being analysed by GLC. (L. Perera, A. Coomarasamy, L. B. K. Silva and Chitra Kuruppu)

Preparation of papain coagulated rubber

Analysis of ash

Samples of papain coagulated rubber prepared under different treatments (such as dilution and fractionation) were ashed in a platinum crucible and analysed using the atomic absorption spectrometer for the determination of Ca^{2+}, Mg^{2+} and K^{+} ion contents. The results obtained revealed that only the calcium ion content varies with the treatment in the samples analysed. (A. Coomarasamy, Mangalika de Costa)

Use of catalyst AC as a latex coagulant

Catalyst AC is a white crystalline solid which has an observed m.p. of 196°C. It is very soluble in water forming a highly acidic solution. The trials carried out indicated that about 5 g of catalyst AC was needed for coagulation of 1 litre of latex. Coagulation was carried out at a pH of 4.5 after 1 : 1 dilution of field latex with water. The raw rubber properties obtained were quite comparable to the formic acid coagulated rubber. The colour of the crepe rubber laces also has been found to be quite good. (A. Coomarasamy, L. Perera, G. Seneviratne and Mangalika de Costa)

Preparation of positively charged latex

Several experiments have been carried out on the preparation of positively charged latex from fresh field latex. It has been found necessary to add a secondary stabilizer along with cetyl trimethyl ammonium bromide to obtain good quality latex. The secondary stabilizers tried out are boric acid, sodium pentachloro phenate, ammonia and hydroxyl amine salts. (A. Coomarasamy, Pushpa Sirimanne and Manel Nilaweera)

Rubber Technology and Development Section

Dynamic properties of DPNR

DPNR made by enzymatic deproteinisation of latex by pineapple juice, papain and coagulum soaking methods were studied for their dynamic properties at low extensions not exceeding 100% elongation.

i. Deproteinisation slows down the drying of raw rubber.

ii. Deproteinisation lowers the PRI of raw rubber.

iii. The reduction of nitrogen content reduces the water absorption of raw rubber.

iv. The dynamic properties are improved by deproteinisation.

v. The dynamic properties are strongly dependent on the method of deproteinisation, the papain coagulated rubber showing superior properties.

vi. For rubbers made by different procedures, the nitrogen content cannot be taken as a measure of their dynamic property improvement.

vii. The absorption of water by the raw rubber can be used as a measue to determine the dynamic property improvements, brought about by deproteinisation. This work was done partly by D. Silva, MSc student. (W. S. E. Fernando and P. A. J. Yapa)

Blooming of compounding ingredients

Thin layer chromatography was used in the identification of blooms of rubber vulcanised in the presence of CBS, DPG and sulphur. In vulcanizates containing high styrene resin, zinc salts of fatty acids and zincmercaptobenzothiazole were the major constituents in the blooms. This work was done partly by Ransi Sumathipala, MSc student. (S. W. Karunaratne, W. S. E. Fernando, K. A. R. M. Perera and D. D. Medagama)

Resin soling compounds

Fundamental studies with regard to boosted vulcanisation by a secondary accelerator were conducted to find a suitable cure system for highly loaded compounds. Influence of secondary accelerator on the cure behaviour of primary accelerators widely used such as MBTS and CBS were studied in gum compounds. The effect of fillers widely used in the shoe industry viz clay, and calcium carbonate on these systems are under investigation. It has been observed that :

(a) The use of clay, on its own, retards accelerated sulphur vulcanization of MBTS and CBS in the presence of DPG.

(b) In the presence of calcium carbonate this behaviour is reversed.

(c) Use of clay reduces the scorch time with secondary accelerators ZDC TMTD and TMTM.

(d) The level of stearic acid in gum compounds greatly influences the scorch time, cure time and reversion resistance when ZDC is used to boost MBTS accelerator. The Chinese student, Mr Li Jiu Long, assisted in this work. (W. S. E. Fernando, P. P. Jayasinghe and K. M. U. Mitrananda)

Copolymer blends

(a) PVA — Acrylic acid blends

These latices were obtained from an organisation specialising in industrial emulsion polymers. A 15% blend was made by latex blending. Physical properties of these blends are under investigation.

(b) Nitrile — NR blends

Studies conducted on partial replacement of nitrile rubber with natural rubber on oil resistance of vulcanisates showed that up to 15% of narural rubber could be blended with nitrile rubber without effecting its resistance to mineral oils. It was also observed that nitrile/NR blends offer the following advantages:

i. Processability of nitrile rubber is improved.

ii. Tensile properties, mainly tensile strength, is enhanced due to superior strength of NR.

These blends were recommended for commercial trials of oil resistant anti-vibration pads for export. The trials were conducted in the Rubber Technology Section and the vulcanisates satisfied the stringent specifications laid down by the consumer. A trial order of pads made from this blend has been despatched.

(c) NR — Polyurethane blends

In the production of gum boots, the green boot is dipped in a polymer solution to give a glossy water proof finish during cure. Our studies show a blend of compounded NR, polyurethane polymer and resin can give the above finish to green compounds. Factory trials are in progress to assess its potential as dipping solution for gum boots. (W. S. E. Fernando, K. A. R. M. Perera, P. P. Jayasinghe, D. D. Medagama and K. M. U. Mitrananda)

Tyre retreading compounds

Studies conducted so far suggest that the ultra accelerator ZDC can be successfully used to boost compounds containing MBTS as the primary accelerator, with suitable modifications in the compounding formulations. These systems have better scorch safety, plateau cure and excellent flow compared with MBTS/TMTD systems. (W. S. E. Fernando, K. A. R. M. Perera and P. P. Jayasinghe)

Industrial extension

(a) At Korea Ceylon Footwear Ltd., a transparent shoe sole compound was formulated. Factory trials are in progress.

(b) Oil resistant seals for raw rubber processing equipment were made using nitrile/natural rubber blends for C. W. Mackie & Co. Ltd.

(c) Assistance was given to Hettiarachchi & Co. Ltd., to formulate and prepare a very soft compound for printing rollers, using a PVC/nitrile rubber blend.

(d) Compounding of nitrile rubber to suit product requirements of the State Engineering Corporation with material provided by them has been continued.

(c) Oil seals and O rings with metal inserts were made to the specifications provided by two firms.

(f) Canvas reinforced oil resistant O rings (15 cm diameter) were made to specifications provided by a firm.

(g) Special finishing paint (dipping solution) curable at 140°C was formulated for applications in gum boot manufacture. The success of this innovation depends on the wear trials now being conducted.

(h) Latex bitumen mixes for water proofing applications were made from ammonia stabilised centrifuged latex. Large scale trials have been undertaken to assess their performance.

(i) Assistance was given to M/s Hettiarachchi & Company to produce anti-vibration pads for export. The pads of hardness 40, 50, 55, 60 and 90 were made from natural rubber and a nitrile rubber/natural rubber blend (85 : 15) was used in oil resistant, anti-vibration pads. This blend enabled us to achieve stringent tensile requirements laid down by the consumer. (W. S. E. Fernando, K. A. R. M. Perera, P. P. Jayasinghe, D. D. Medagama and K. M. U. Mitrananda)

Technological advice to Swed Lanka Ltd., coir products

A report has been submitted to Swed Lanka manufacturers of rubberised coir products, indicating the financial implications of a detailed programme of R & D in collaboration with the CISIR. (S. W. Karunaratue)

Two novel methods were tried out to determine the rubber content in rubberised coir.

(a) Ash content method
(b) Dirt content method

The Ash content method was an approximate method. Fairly consistent results were obtained from the dirt method where a peptiser was used to depolymerise the rubber and dissolve it in a solvent. The sample should be moisture free, and when the moisture content of coir is taken into consideration fairly accurate results of the rubber content can be obtained. Helpful suggestions from Dr L. M. K. Tillekeratne and Dr A. Coomarasamy are acknowledged. (S. W. Karunaratne and Pushpa Sirimanne)

Use of rice bran fatty acids (RBFA) as a latex stabiliser

MST of latex stabilised with RBFA were determined over a period of time using different levels of fatty acid. It was difficuilt to determine MST when the level of RBFA on latex was over 0.1%. (S. W. Karunaratne and Pushpa Sirimanne)

Three factory visits were made to Swed Lanka and monthly meetings were held to discuss various problems connected with the manufacture of quality rubberised coir for export. The matters for immediate attention are —

(a) Compression set

(b) Expansion after removal from oven

(c) Flammability and production of non-flammable rubberised coir. Tensile strength of the coir fibre is reduced by steaming, which is and important step in the retention of the springiness of the coir when uncoiled. (S. W. Karunaratne, W. S. E. Fernando and Pushpa Sirimanne)

Specifications and Analysis Section

TSR analysis

During the current year, the following block rubber samples were tested from TSR producers:

Code	Producer	No. of samples
AA	Sri Lanka (Cey) Rubber Manufacturing Co. Ltd., Natural Rubber Complex, Mawanella	1543
AB	Cenat Block Rubber Factory, Paiyagala	760
AC	Ceymac Rubber Co. Ltd., Colombo	814
ZD	Statcon Block Rubber Factory, Getahetta	2847
AE	Sherman Sons Ltd., Block Rubber Factory, Ingiriya	2476
	Sherman Sons Ltd., Block Rubber Factory, Colombo	528
AF	Ceymac Block Rubber Factory, Horana	4677
AH	Lanka Star Rubber Works Ltd., Block Rubber Factory, Parakaduwa	1053
AI	Associated Traders Ltd., Colombo 13	991

Analysis of masterbatches and miscellaneous samples

Altogether 20 masterbatch samples were analysed from Associated Motorways Ltd. and Mins Rubber Factory, Dehiwala.

In addition to this 663 miscellaneous rubber samples, 173 latex samples, 4 water samples and 17 samples of rubber chemicals were also analysed.

Inspection visits to TSR factories

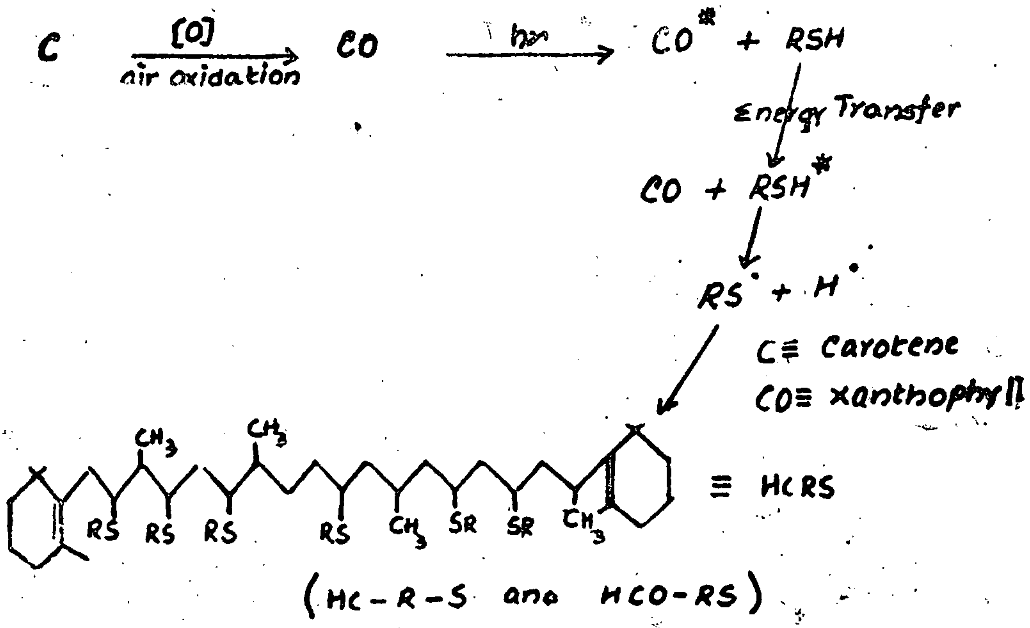
Several inspection visits were made by the Head of the Department and Head, Specification and Analysis Section. TSR manufacturers are beset with the problem of getting sufficient raw material to run their factories at full capacity. Most TSR factories use scrap grades for processing and problems such as availability and collection have dulled their enthusiasm in the production of TSR. Added to this, escalating fuel charges and labour costs have increased the cost of manufactures to the point of making it uneconomical. A recent seminar conducted by the Department highlighted there problems for speedy Government action to help the TSR producers. (S. W. Karunaratne L. M. K. Tillekeratne and A. S. Dekumpitiya)

Metal ion concentration in crepe rubber

When the sodium salt of a thiophenol is used as the bleaching agent in crepe manufacture the calcium and magnesium ion concentration in the rubber is reduced due to the leaching away of complexes formed by these ions with the thiayl radical. This could be the reason for the reduced storage discolouration in crepe rubber noted when using, the sodium salt of thiophenol as the bleaching agent. Ca^{++} and Mg^{++} in crepe rubber was determined using the atomic absorptiometer. (L. M. K. Tillekeratne and P. H. Sarath Kumara)

Mechanism of bleaching of latex carotenoids

Studies carried out with alkyl thiayl radical generators such as IZBN and MBT have shown that the thiayl radical is responsible for disrupting the conjugated structure of carotene. It is also shown that it is the oxidised carotene of the xanthophyll type and not the carotene itself, which reacts with thiols and the following mechanism is proposed.



Mould growth

Sodium benzoate, in concentrations of over 0.1% by weight on rubber, resists mould growth. The critical concentration to inhibit mould growth in different types of rubber is bieng studied. Humidity is the main cause for mould to grow as revealed by studies under artificial conditions inside controlled humidity chambers. Apart from humidity, the effect of sugars such as sucrose, glucose and milk proteins on mould growth clearly showed that the presence of milk proteins increased mould growth compared to the presence of sugars. NAB student, Reshani Nandadeve, assisted in this project. (L. M. K. Tillekeratne and P. H. Sarath Kumara)

Raw Rubber Development Section

This year the advisory visits to estates were stepped up in consultation with the regional officers of the JEDB and SPC. Discolouration of crepe rubber and precoagulation were acute problems during the unusually prolonged wet spell, experienced during the early part of the year. As a result there was a sharp drop in the percentage of No. 1 in crepe manufacture in most estates. Thorough supervision of anticoagulant addition in the field, the use of clean utensils, bulking and transporting tanks and periodic washing of all the utensils with a 1% solution of formaldehyde were recommended to ease the problem of precoagualtion. Resting of trees due to rain interference caused a build up of enzyme activity and this would have contributed to the severe discolouration of the crepe rubber in spite of taking the normal preventive measures. This situation, however, eased with the start of the dry spell. The performance of the bleaching agents was also unsatisfactory during the wet spell. (S. W. Karunaratne)

Bleaching agents for crepe manufacture

Several water insoluble and water soluble bleaching agents under different trade names but containing the same active ingredient, tolyl mercaptan were tested in field trials. Even though the water soluble bleaching agent, which is the sodium salt of tolyl mercaptan, is gradually introduced into the market under different trade names the interest in the use of the water insoluble bleaching agent has not waned.

Trials have also shown that p–tertiary butyl phenyl mercapton (PTBN) which is a liquid, even though it is versatile in its use as a bleaching agent, is not so effective in bleaching carotenoids as tolyl mercaptan (S. W. Karunaratne, M. D. R. J. Goonetilleka and S. Weerasinghe)

Drying of crepe rubber

Use of solar energy

The four solar collectors constructed at Dartonfield were found to be insufficient to heat up the crepe drying tower. Four additional collectors are being installed. In addition, heat storage experiments were conducted using a storage box module.

Boiler efficiency

The combustion efficiency of the boiler used at Dartonfleld with the radiators was only 30% and the overall efficiency of the drying tower was about 14%.

Heat exchanger

Design work was completed on an experimental heat exchanger and air heater. This device would be used as a back up heater to the solar heating system during cloudy weather, when solar energy is lower. (N. C. C. Walpita and T. L. G. Fernando)

Factory Development Subsidy Scheme

Several factories were assisted in factory modernisation efforts, plans of reorganisation of factories were provided, inspections were carried out and approval given to obtain the subsidy from the Rubber Controller. It is observed that the TSR factories have benefitted most from the factory development subsidy scheme. (S. W. Karunaratne, M. D. R. J. Goonetilleka, S. Weerasinghe, T. L. G. Fernando and L. B. K. Silva)

Projects

The following projects are being undertaken by the Raw Rubber Development Section :

(a) Design and construction of a suitable heating unit for the manufacture of air dried sheet (ADS.)

(b) Manufacture of RSS/CV rubber.

(c) Preparation of a pharmaceutical grades of latex crepe.

(d) Design of a mini type smoke box.

(e) Design of a crusher to handle coagulum in ribbon form.

(f) Reinforced sole crepe

Dimentional stability of sole crepe can be improved by sandwitching nylon netting or any suitable fibre netting during lamination. (M. D. R. J. Goonetilleka and S. Weerasinghe)

Biochemistry Section

Enzyme deproteinization of latex

Studies were continued to further reduce the ash content of DPNR by dilution and by a choice of proteolytic enzymes. A pharmaceutical grade of DPNR was prepared from fractionated latex. Samples were sent to a foreign buyer for evaluation. Further interest was shown in the purchase of DPNR by a German buyer and a few 1 tonne lots were despatched.

Attempts were made to prepare low nitrogen latex from ammoniated field latex. Nitrogen levels as low as 0.05% were obtained. (P. A. J. Yapa and Sriyani Yapa)

Effluent treatment and disposal

Preliminary studies on the biological control of pollution by rubber factory effluents, by using aquatic plants, were continued. Under this, green house experiments are being carried out with water hyacinth to establish a suitable stabilized system for the growth of water hyacinth with rubber serum. Water samples were collected and analysed to investigate the nutrient and micronutrient status. Experiments on the use of effluent as an additional fertilizer for rubber were conducted at Frocester State Plantation. Yield records of control blocks and effluent treated blocks are maintained for specific clones. The possibility of upgrading compost by treatment with latex serum was explored. The Head of the Biochemistry Section visited several estates in connection with effluent disposal. Isolation of quebrachitol from latex serum was carried out when the demand arose, especially during the last quarter of the year. (P. A. J. Yapa, Nishadi Kulatillaka and P. D. J. Rodrigo)

Latex proteins

Protein patterns in A–serum of *Rigidoporus* affected trees were studied by electrophoresis. A study of the protein patterns of A–serum of brown bast trees of clones RRIC 101 and RRIM 600 showed clear evidence of disappearance of several protein bands otherwise present in healthy trees. (P. A. J. Yapa and Sriyani Yapa)

Studies on brown bast

A greenhouse experiment was carried out to see the effect of controlled water stress on the protein content of leaves. Earlier studies have confirmed that the free protein content is increased in leaf and bark due to water stresses in brown bast affected trees. Polyethylene glycol was used to induce water stress in twinned seedlings used in the experiment. (P. A. J. Yapa, Thushine Goonesekara and Seetha Wickremasinghe)

REVIEW OF THE BIOMETRY SECTION

By

W. N. WICKREMASINGHE

SUMMARY

Routine statistical work was continued. Assistance was provided in the analytical work of scientific papers presented by research officers of the Institute in the International Rubber Conference.

A paper titled " Variability of commercial yields of clone PB 86 " was presented at the International Rubber Conference held in Colombo. Studies were initiated in December, on the estimation of leaf area in *Hevea.*

A micro computer was made available for assistance in statistical work.

Meteorology work was continued without interruption and the staff of the section remained unchanged.

DETAILED REVIEW

Staff

The Assistant Biometrician, Mr W. N. Wickremasinghe, Senior Technical Officer, Mr L. T. Pieries, Technical officers, Mr R. A. P. Abayapala and Miss J. D. Nandanie were all on duty throughout the year.

Publications

Wickremasinghe, W, N. (1984). Rubber statistics, *A Practical Guide to Rubber Planting and Processing*. p. 225 – 228, Eds. A. de S. Liyanage and O. S. Peries, Sri Lanka : RRI.

Wickremasinghe, W. N. (1983). Estimation of effects and their standard errors in a crossed mating design. *J. Rubb. Res. Inst. Sri Lanka,* **61**. 25 – 34.

Wickremasinghe, W. N. (1984). Variability of commercial yields of clone PB 86. *Proc. Int. Rubb. Conf. Colombo*. 1984. (in press)

Reports

Wickremasinghe, W. N. (1984). Annual Review of the Statistics Section.

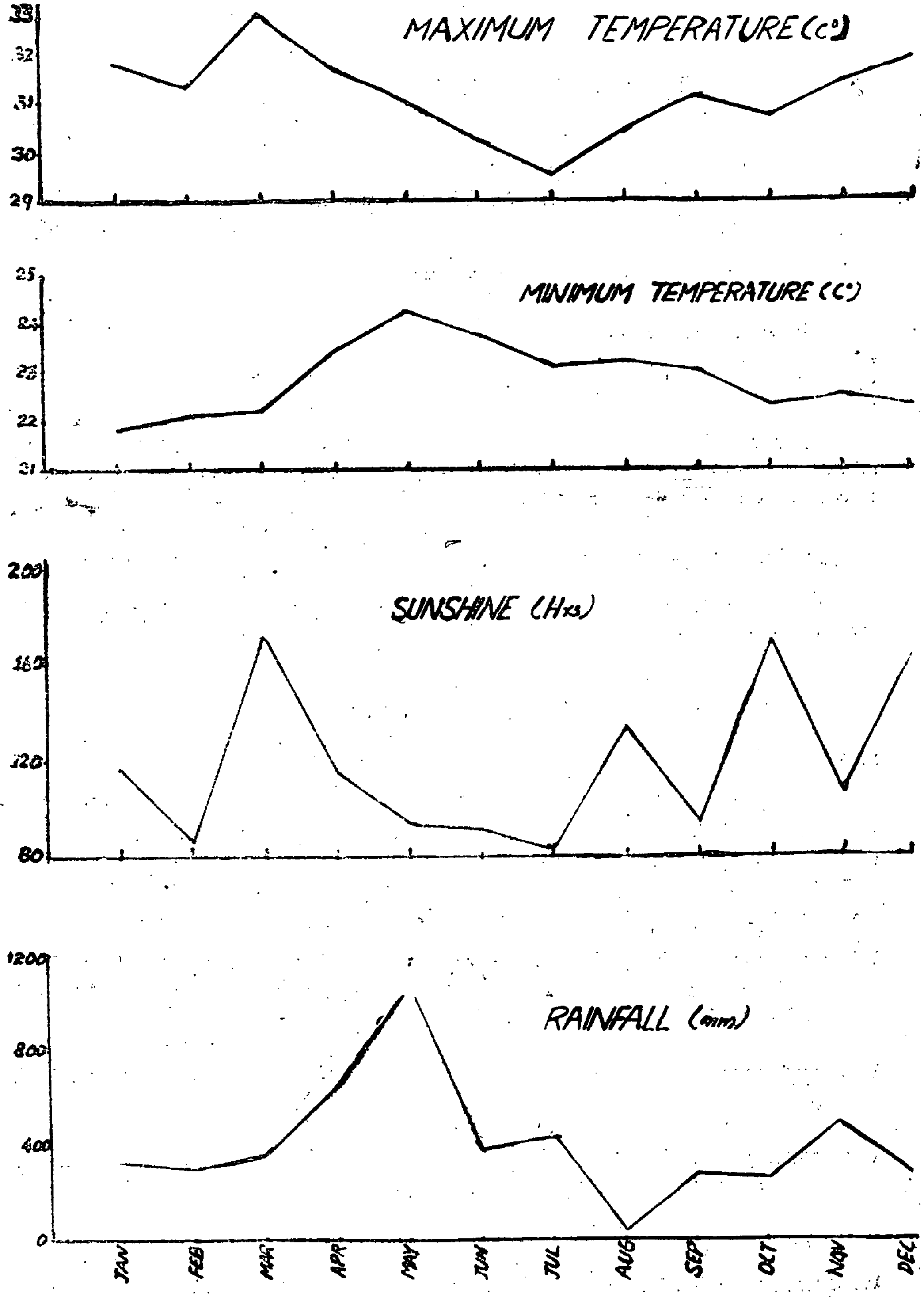


Fig. 1 :- *Rainfall, Duration of Sunshine & Temperature at Dartonfield.*

Routine statistical work

The routine work on planning, designing and analysing experiments of all the Research Departments continued without interruption.

During the second quarter of the year, considerable time was spent on a detailed analysis of a genotype–environment experiment with ten clones and seven sites, of the Plant Breeding Department and several other analyses of other Research Departments, all in view of the International Rubber Conference held in September. The analytical work on data from various Departments for scientific papers to be presented at the International Rubber Conference, continued in the third quarter as well.

Apart from Conference work, assistance was also provided in the analyses of Research Students attached to various Departments of the RRISL.

During the final quarter, the Section was busy with the analyses for the Annual Review for 1984.

Computer work

A micro computer (Data Genral, CS/5) was installed in January. Several programmes written in FORTRAN were developed by the Assistant Biometrician and Mr R. A. P. Abayapala (Technical Officer) to analyse data from commonly used designs. These programmes helped a lot in providing analyses for the Annual Review without delay.

Research work

In December, work was started on a short paper titled "On the estimation of leaf area of *Hevea* clones." This work, based on data from ten *Hevea* clones obtained from the Plant Science Department, will be continued in 1985. (W. N. Wickremasinghe, J. D. Nandanie and R. A. P. Abayapala)

Meteorology

Routine collection of meteorological data from Dartonfield and Nakiadeniya Estates was continued. Arrangements were made to computerize rainfall data obtained from Dartonfield. The graph of rainfall, temperature and sunshine duration at Dartonfield is shown in Fig 1.

Miscellaneous

The name of the Statistics Section was changed to Biometry Section with effect from February, this year. The designation of the Statistician was also changed to Biometrician. Mr R. A. P. Abayapala, Technical Officer, attended a 6-week course starting on December 3 on "Statistics in Agriculture", organised by the Statistics Department of the University of Colombo with the collaboration of the Department of Applied Statistics, University of Reading, UK.

REVIEW OF THE ESTATE DEPARTMENT

By

ASHLEY PERERA

SUMMARY

The Institute's estate, Dartonfield Group, comprises of Dartonfield and Gallewatta Divisions in Agalawatta and Nivitigalakele Division in Matugama consisting of 333.79 ha. The planted area is 277.80 ha of which 197.17 ha were in bearing during the year.

The weather conditions that prevailed during the year were unfavourable for harvesting of crop. The rainfall recorded this year was higher than that in 1983 and on 22 May it recorded the highest ever rainfall of 338.1 mm which caused several earthslips on the property. As a result about 3.24 ha of immature and mature areas were lost.

The incidence of *Oidium heveae* was visible this year and a fairly heavy leaf fall was noticeable. *Rigidoporus* affected trees were treated with Collar Protectant fungicide.

The demand for budwood was high and in particular for budwood of clones RRIC 100, 103 and 121. The budwood requirements of all estates and smallholders were adequately met.

All agricultural operations were carried out in mature and immature areas and nurseries of the Group.

The estate made a profit of Rs 1.70 per kilo during this season.

DETAILED REVIEW

Staff

Mr R. G. Siriwardane the Estate Superintendent resigned from the Institute on 30 November to join the Sri Lanka State Plantations Corporation. Mr Ashley Perera, the Accountant of the Rubber Research Institute was appointed to attend to the duties of the Estate Superintendent till a new Estate Superintendent is appointed.

The appointment of Mr A. A. Ariyaratne was confirmed as the Chief Clerk with effect from 01 January.

Mr K. K. P. Gunawardane the Junior Assistant Clerk was promoted as the Acting Senior Assistant Clerk with effect from 01 January.

Mr. C. N. Wickremasinghe, Junior Assistant Clerk left the estate on 31 December to take up duties as Specification Assistant in the Rubber Chemistry Department of the Rubber Research Institute.

Mr A. A. Ariyaratne, Chief Clerk, Mr K. K. P. Gunawardane, Acting Senior Assistatnt Clerk, Messrs K. D. Sumanasena and C. N. Wickramasinghe, Junior Assistant Clerks, Mr D. C. C. Jayasekara, Factory Officer, Mr D. S. K. Ranaweera, Assistant Factory Officer, Messrs N. L. D. Piyadasa, A. K. D. Hemapala, S. K. S. de Silva and H. M. Jayantha Premalal, Field Officers, Messrs J. A. Wimalasena and A. K. D. M. Wickremasinghe, Assistant Field Officers, Messrs T. Somaratne, S. R. Vadivel and W. D. D. Senanayake, Field Supervisors, Mr W. D. Sugathadasa, Tractor Driver and Miss C. S. Hettiarachchi, Creche Attendant were on duty throughout the year.

The Dartonfield Group cadre stood at 17 at the close of the year made up as follows :

Senior staff	—
Assistant staff	15
Minor staff	02
Total	17

Agricultural Adviser

Mr R. C. Peries, Director JEDB No. 1, the Agricultural Adviser visited the property twice during the year and reports on these visits were submitted to the Rubber Research Board.

A summary of the hectareage is given in Table 1.

Table 1. *Land distribution in Dartonfield Group*

	Dartonfield	Gallewatta	Nivitigalakele	Total
Mature area	27.70	125.55	43.92	197.17
Immature	15.47	51.33	4.48	71.28
Nurseries	3.42	1.80	4.13	9.35
	46.59	178.68	52.53	277.80
Paddy fields	—	1.25	—	1.25
Abandoned area	—	—	8.06	8.06
Swamps	—	—	1.21	1.21
Buildings	16.23	6.00	7.79	30.02
Roads	2.67	.50	.32	3.49
Streams/reservations	.03	—	—	.03
Uncultivated rocky and earthsliped areas	7.26	1.34	2.62	11.22
Jungle	—	—	.71	.71
Grand total	72.78	187.77	73.24	333.79

2.43 ha from 1961 field at Gallewatta Division was taken over by the Housing Authority to build houses for the villagers who were affected by earthslips.

Rainfall figures (mm) for 1984 and 1983 are given in Table 2.

Table 2. *Rainfall distribution for 1983 and 1984 in Dartonfield Group*

	Dartonfield		Gallewatta		Nivitigalakele	
	1984	1983	1984	1983	1984	1983
January	327.5	15.2	340.1	36.3	324.4	17.5
February	296.1	20.8	377.9	68.6	312.4	31.0
March	361.0	26.3	319.5	30.5	265.5	—
April	643.7	205.0	607.0	189.2	522.3	193.0
May	1070.5	381.8	832.1	367.8	891.0	395.5
June	375.3	351.5	397.5	382.0	405.7	393.7
July	432.8	300.0	424.1	330.7	530.4	230.5
August	33.4	308.7	30.0	352.5	30.0	456.0
September	273.1	514.4	308.6	625.9	185.0	508.9
October	256.1	180.3	309.6	220.2	159.2	255.7
November	493.0	438.9	425.7	374.1	235.0	360.9
December	275.8	464.4	310.9	528.0	145.3	624.2
	4838.3	3207.3	4683.0	3505.8	4006.2	3466.9
Total wet days	227	228	203	190	148	138

Crop

The crop for the year was 174264 kg, which fell short of the estimate by 22282 kg. However, 89% of the estimated crop was harvested inspite of the heavy and uneven distribution of rainfall during the cropping months, which caused the drop in crop.

The yield data for the last 5 years are given in Table 3.

Table 3. *Yield records from 1980 – 1984 (kg/ha)*

	1984	1983	1982	1981	1980
Dartonfield	865	838	772	818	858
Gallewatta	781	804	875	1233	1129
Nivitigalakele	924	667	864	953	944
Total	884	779	858	1105	967
Estimated	889	1052	1124	1064	983
Tapping (ha)	197	205	209	187	207

One hundred and five (105) days tapping were lost due to unfavourable weather conditions and recovery tapping was done on 45 days.

Tapping cuts were marked with appropriate guide-lines for bark consumption according to the systems of tapping adopted.

The tapping panels were treated with Antimucin and Red Powder.

Manufacture

A summary of manufacture records during the year is given in Table 4.

Table 4. *Details of manufactured crop in Dartonfield*

Latex grade	Total crop (Kg)	Total crop (%)
Pale crepe No. 1	180198	90
Pale crepe No. 2	900	—
Pale crepe No. 3	8089	04
Scrap crepe No. 1	7404	04
Scrap crepe No. 2	3883	02
Scrap crepe No. 3	531	—
Total crop maunfactured (inclusive of 26741 kg of bought latex)	201005	100

Ten M tons of thin crepe was contracted for and supplied.

Five M tons of constant viscosity crepe rubber and 05 M tons of papain coagulated rubber were manufactured and supplied on a special request made by Messrs Associated Traders.

The estate continued buying latex from the smallholders of the neighbourhood and the total bought latex manufactured at the end of the year was 26741 kg. The smallholders were paid a price alomost on par with net sales average.

Factory machinery

All machinery were in good order.

Agricultural operations

All the routine agricultural operations were carried out as required, to maintain a good standard of accepted agricultural practice.

Wind damage

The loss of trees due to wind damage and earthslips on Dartonfield, Gallewatta and Nivitigalakele were as foollows :

	Dartonfield	Gallewatta	Nivitigalakele
Wind damage	29	190	11
Earthslips	458	177	350

Replanting

The following replantings were completed during the season.
1984 Replanting – 4.50 ha Gallewatta Division.

Preliminary works on the following area was completed.
1985 Replanting – 5.50 ha Gallewatta Division.

Nurseries

Nurseries were established in Nivitigalakele and Dartonfield Division for 1984/85 replantings and to supply budwood for the smallholders were maintaind during the season.

Field and facotry experiments

The Research Departments were given the necessary assistance in carrying out their field and technological experiments.

Labour and health

The health of the entire estate population was satisfactory during the year.

The CARE Sri Lanka Branch continued to provide " Thriposha " free of charge under the medically selective programme for infants, and to natal and lactating mothers of the estates.

All non-working resident children over 01 year of age, below 13 years continued to be issued with ½ lb of bread per day per head. In addition, fortnightly cash payments were made in lieu of half cream milk to resident non-lactating mothers with infants under 01 year of age.

Three new cottage type quarters were constructed at Gallewatta Division and repairs to line rooms and lavatories were attended to, where necessary.

Wages were paid during the year in accordance with the Wages Board Ordinance in force. Festival advances were paid as required. Incentive bonus and the annual holiday pay wages were paid to the labour in accordance with the Ordinance.

Accounts

The final accounts for the year 1984 is in progress.

Estimates

Estimates for Capital and Revenue Expenditure for 1985 in respect of Dartonfield Group, were submitted to the Rubber Research Board and were approved.

REVIEW OF THE LIBRARY AND PUBLICATIONS SECTION

By

VIJITHA JAYARATNE

SUMMARY

The Library and Publications Section continued with its work in collecting and disseminating information on natural rubber, and processing and publishing of its regular publications.

To celebrate the 75th anniversary of rubber research in Sri Lanka the revised edition of the Handbook of Rubber Culture and Processing with all research findings of the Institute was released.

Agricultural Infromation Network (AGRINET) and the National Information System for Agricultural Science (AGRIS) continued their activities throughout this year too, by helping in obtaining current scientific information.

DETAILED REVIEW

Staff

Mrs V. S. Jayaratne, Librarian and Publications Officer, and Mr D. C. Thambawita who was promoted to Library Assistant and Assistant Publications Officer on 25 January were on duty throughout the year. Miss L. T. Ramanaden, Library Assistant and Assistant Publications Officer attached to the Colombo Office Library was on 1 year's no pay leave having accepted an assignment in Pakistan. Miss Ramani Mahakumara, was appointed as Clerk/Typist to the Library on 1 November.

Acquisitions

As more journals on tissue culture and rubber technology were urgently needed subscription for a few of the journals which were not so important were discontinued to enable to subscribe for these journals. In the wake of the increasing subscription rates, this year too we had to spend more on journals and curtail the number of text books.

Two hundred and thirty four titles of current periodicals including abstracting and indexing periodicals were obtained during this year.

	Local	Overseas
On subscription	—	87
On exchange/gratis	32	115

Inter library loans

We have been very successful in obtaining scientific information, needed by our Research Staff through the inter library loan scheme, whenever such was not available in the Institute's library.

Publications

The Institute's regular publications programme for all sectors of the NR was maintained. Other than our regular publications *i.e.* Annual Review, Journal, Bulletin, Rubber Puwath and Advisory Circulars, a Souvenir, Abstracts of Conference papers and a practical guide was published in connection with the International Rubber Conference. The Souvenir had very valuable research articles on all aspects of natural rubber, contributed by all Heads of Departments. The Practical Guide to Rubber Planting and Processing, edited by Drs A. de S. Liyanage and O. S. Peries, gives 43 chapters of practical research articles, a very useful guide to all planters of rubber. All participants of the conference was given a free copy each of this practical guide.

Revised edition of the Handbook of Rubber Culture and Processing with more detailed information on all aspects of natural rubber was released this year.

The following publications were printed during the year.

Publications	Volume
Annual Review	1983
Journal	60 & 61
Bulletin	17 & 18
Rubber Puwath (Sinhala)	10 & 11
Practical Guide to Rubber Planting and Processing	
Handbook of Rubber Culture and Processing (Revised ed.)	

The Publications Section of the Institute took the opportunity to exhibit all its publications at the International Rubber Conference and was successful in selling most of the publications.

A major undertaking by the Publications Section this year will be the publishing of the Proceedings of the International Rubber Conference held on September 17-19 1984. The Proceedings of the Conference is a collection of 86 papers presented at the above conference by experts on various topics relevant to rubber. We hope to publish these in two volumes.

Information service

Disseminations of information

One of th main objectives of the library is to collect organize and disseminate information required by the Scientific Staff. Contents pages of current scientific journals were photocopied and sent to all Research Officers to select articles that are of value to them. Relevant articles in abstracting journals were indexed for the use of the Research Staff. Agricultural Information Network (AGRINET) and the National Information System for Agricultural Science (AGRIS) helped in obtaining information which could not be obtained from the Institute Library.

Agricultural Information Network

An user serveyor was done by the AGRINET to help find information that is of use to the Research Staff of all Research Institutes.

Photocopies of contents pages of journals which are not available in the other Research Institutes attached to the AGRINET were sent and photocopies of contents pages that are of use to our Research Officers were received regularly.