THE
RUBBER RESEARCH INSTITUTE OF SRI LANKA

ANNUAL REVIEW FOR 1977

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Advisory Services Department & Economic Research Unit, Rubber Chemistry Department, Specifications Laboratory.

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Accounting Assistant	..	A. K. D. Amaradasa
Foreign Order Clerk	..	K. G. A. K. Dharmawardena
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Electrical Foreman	..	J. Weerakoon
Building Foreman	..	W. S. J. Benjamin
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Workshop Charge-hand	..	W. D. Dharmawardena
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Assistant Rubber Maker	..	S. Hettiarachchi

Kuruwita Sub-Station

Assistant Estate Superintendent	..	S. G. Fernando

RUBBER RESEARCH INSTITUTE OF SRI LANKA

DIRECTOR'S REVIEW FOR 1977

O. S. PERIES

The most interesting events of the year were the two highly successful Seminars held in May and September and the very popular Exhibition of the work of the Institute held in October. There were over 25,000 visitors to the Exhibition, which attracted favourable comment from Ministers of State, Members of the National State Assembly, Industrialists, Rubber Goods Manufacturers, the General Public and School Children. It would be most useful to hold an exhibition of this nature annually, except for the cost and the valuable time of Research Officers involved.

Globally, the prospects for Natural Rubber are extremely good, and we would venture to say, never better. Joseph P. Flannery, Executive Vice President, Uniroyal, has said "Expertise in growth chemicals and in tree cultivation has helped reduce the time between planting and tapping by 50 per cent, and has improved yields by more than 50 per cent. We have reached a point of efficiency where we can produce Natural Rubber at lower cost than Synthetic at current prices". Uniroyal owns six tyre factories in the U. S. A., two in Canada, two in Continental Europe, two in the U. K. and two in Brazil; and, in addition, has twelve rubber plantations in Malaysia, Indonesia and Liberia. Therefore, Mr. Flannery must know the gravity of his statement.

The other giant tyre manufacturer, Goodyear, believes that Natural Rubber will increase its share of the total rubber market from its current 30 per cent to over 40 per cent in the 1980s. The reasons for this are the high cost of the monomer to produce Synthetic Rubber and the high level of efficiency achieved by the Natural Rubber industry. One of the fears regarding rubber prices in the 1980's is the very real possibility that the Natural Rubber industry may not be able to produce the amount of rubber required by the world market, in the 1980s. In such an event, the price of Natural Rubber will go up, purely on the basis of supply and demand; then synthetics will again be in a position to compete with the natural product. This shows the extreme urgency for replanting with modern high yielding clones, and adopting all the agronomic techniques developed by painstaking research, to improve yields per acre. The Institute is always willing to visit rubber estates or smallholdings, to study the problems on them and advise on action necessary to improve yields. This facility must be fully utilized by the industry.

The other important method of increasing the earning capacity of the crop is to industrialise and export finished rubber goods. It is expected that there will be a great deal of interest shown in the production of rubber goods in the Free Trade Zone (FTZ). Rubber is one of the few industrial raw materials produced in this country, and every effort must be made to maximise the earning capacity of the product by encouraging industrial growth in this sector. The Rubber Research Institute is anxious to assist in the process of industrialisation, by providing advice and assistance, particularly in the area of quality control. The Institute is keen that quality control be given the highest priority in the production of rubber goods in the FTZ as anywhere else. Our goods should be of the highest quality, comparable with the best elsewhere; if the quality of our goods is low, or if rigid control is not exercised and quality tends to fluctuate, then our products will not command a world market. Therefore, we will lose in the end. Hence our anxiety about rigid quality control.

RESEARCH

The work of the Research and Extension Departments is summarised below:-

Botany

Ethrel trials, in which stimulation was carried out at two monthly intervals with tapping on the S/2 d/2 100% system, continued to show declining yields with time, and in the fourth year bimonthly Ethrel applications were generally uneconomic. Yield increases were maintained over 4 years only in one trial, where six stimulations were carried out and tapped on the S/2 d/3 67% system.

PB 86 has responded well to daily tapping over a period of 7 years and during this period, the average yield of the daily tapped area was 3161 kg/ha compared to 1720 kg/ha in the control plots, tapped alternate daily. Estates should now tap PB 86 areas daily, on a trial basis, keeping careful records of yield, the number of dry trees and the incidence of bark diseases.

Clones RRIC 5, 13, 36 & 48, IRCI 2 and 9, PR 252 and RRIM 600 have maintained high yields on both virgin and renewed bark on all large scale trials. These clones should increase the average yields to around 2000 kg/ha. Clone RRIC 100 has given steady yield increases with time. All these clones should now be planted, at least in trial plots of 10 ha each on large estates.

The presence of mycorrhizae enhanced the uptake of phosphorus from the soil by *Pueraria* spp. and *Stylosanthes* spp. Adding rock phosphate to the soil, increased uptake even further. The absorption of P from imported rock phosphate was superior to that from Eppawela apatite. There is evidence that mixing rock phosphate with small quantities of sulphur before application to the soil, increases the availability of P from rock phosphate

Interplanting rubber in its immature phase with perennial crops such as bananas, passion fruit and pineapple has not adversely affected the growth of rubber. The most profitable intercrop for rubber appears to be bananas, on the other hand growing passion fruit has been found to be uneconomic at present prices, mainly due to the expenditure on supports and the unsatisfactory marketing system for this crop.

Genetics & Plant Breeding

Twenty one more clones were registered during the year bringing cultivars up to 131. The more recent registrations include progeny of F, Fx and FB introductions to Sri Lanka in 1959. Genotype/environment studies were continued by the Geneticist; selections on the basis of vigour and micro-taping were also made on the 1975 hand pollination (H. P.) population. RRIC 100 and RRIC103 showed stable high yields on experimental assessment as well as examination of commercial intakes; RRIM 600 provided the closest comparison. A small holding planted in 1970 with RRIC 103 averaged 1400 Kg of dry rubber per hectare in the second year of tapping. Collaborative studies on dry trees with the Biochemist and Soils Chemist, and on disease resistance with the Plant Pathology Department, were initiated during the year. Twelve of the later RRIC selections were released to the Socialist Republic of Vietnam.

Plant Pathology

White Root disease caused by *Rigidoporus lignosus* is the most serious disease problem on *Hevea* in Sri Lanka. It has been shown that about 8–9% of the total area cultivated in the wet rubber growing districts is affected by this disease. Laboratory studies have shown that there is tremendous variation in the pathogen and

differences were also observed in the nature of its spread in different soil types. A number of experiments have been initiated to examine the most effective method for its control. This involves studies on different methods of clearing the land prior to replanting, and soil amendment, particularly with sulphur, to develop a biological method of control. Black Root disease, caused by *Xylaria* spp., was detected in a number of Estates in the Kegalle District. The application of Fomac on the healthy roots after removal of infected laterals has given good control of the disease.

It was observed that virgin bark is more susceptible to Bark Rot infection than renewed bark and also that the spread of the lesion appears to be better during wet than in dry weather periods. Although there were clonal differences in the rate of callusing of bark, application of various chemicals did not improve the rate of bark renewal. Bark Rot was effectively controlled by incorporating a wetting agent to low ammonia centrifuged latex containing phenyl mercuric acetate.

The phenolics produced in response to infection of rubber pods of RRIC 100 by *Phytophthora* spp., appear to be released from pre-formed conjugates. Susceptibility to Bark Rot at the nursery stage could be evaluated when the lesion area is measured. It was shown that some clonal seedlings were more resistant to *R. lignosus* than others.

Soils Chemistry

Although some of the RRIC 100 series clones grow more vigorously than PB 86, during the first year of planting, their requirements for major elements were similar to those of PB 86.

Sulphate of ammonia can be broadcast applied, but subsurface application is best for urea. The efficiency of nutrient uptake can be enhanced by the application of nitrogen and potassium either at the time of defoliation or refoliation, depending on weather conditions at the time.

Rock phosphate has been found to be a more effective source of phosphorus than Eppawela apatite. However, due to the importance of the Eppawala source to the economy of the country, further studies are being conducted to devise means of improving the availability of P from this material.

The trace element studies of the rubber growing soils appear to be satisfactory, especially with regard to Molybdenum, Zinc, Manganese, Copper and Iron. The availability of some trace elements e.g. Molybdenum can be improved by increasing the organic matter content and the pH of the soil. Application of high levels of magnesium has depressed yields, and this is a factor to be noted on many estates, where magnesium has been used regularly, over several years.

A low intensity detached soil survey of the Alutgama topographical sheet has shown the existence of several hitherto unidentified soil series in the rubber growing areas in Sri Lanka.

Rubber Chemistry

The Rubber Chemistry Department has given emphasis to providing advice and carrying out research on raw rubber processing and on the manufacture of rubber products. In raw rubber processing, a new system of crepe drying, using a finned air heater-blower arrangement was devised and is being operated commercially. Preservative systems for smallholders latex for conversion to RSS or to latex crepe have been tested, and steps are being taken to exploit these findings on a commercial scale.

There is a good market for sole crepe and a process for the manufacture of industrial sole crepe, using existing unutilised crepe equipment has been developed and steps are being taken for the large-scale manufacture of industrial sole crepe by this process. Steps to increase block rubber production by converting low grade RSS into SLR 5 and thin latex crepe into SLR EQ and SLR 5L have been formulated and the processes are being exploited at the Mawanella Block Rubber Factory.

Two complete Sri Lanka Patents have been filed for (1) formaldehyde stabilised centrifuged latex as an adhesive for cellulosic materials and (2) room temperature vulcanisation of sole crepe. The RRISL patent was used for the production of 30 tons of cyclised rubber, paying a royalty of 6 cts/lb. The projected production in 1978 of this cyclised rubber is 70 tons, and steps are being taken to achieve this target. The main use of cyclised rubber is as a reinforcing filler in rubber products and in paints. Another patent which has earned a royalty of over Rs. 2,000/- in 1977 is the use of formaldehyde stabilised centrifuged latex as an adhesive.

In research, room temperature and sunlight vulcanising formulations were developed for use in making vulcanised sole crepe and for rubberising cart wheels. A method of producing satisfactory rubberised fabrics using natural rubber latex has been devised and a provisional patent applied for. Investigations were carried out into various aspects of liquid rubber and rubber powder and the possibility of their commericial manufacture and uses explored. The possibility of the manufacture of deproteinised natural rubber from field latex and good quality rubber from skim latex were investigated. Assessment of industrial and ball clay as a filler for natural rubber was completed. Investigations were carried out into rubberising of coir belting and improving the clarity of feeding bottle teats.

Advisory Services

Thirty eight training classes were held for small holders. The attendance at these classes was 1154, out of which 377 trainees passed the examinations conducted. Special certificates will be issued to the successful participants.

The details regarding the construction and operation of Group Processing Centres are as follows :

In operation . .	93
Work completed and ready for opening . .	7
Under construction . .	2
Surveys completed . .	10
Surveys going on	2

Thirty nine Group Processing Centres were opened during the year. A comprehensive report giving details of the production of various grades of rubber at these centres has been prepared, and there is no doubt that the production of rubber by Smallholders can be upgraded by this scheme.

The Department took a keen interest in the Exhibition held in October and helped in the organisation of this event.

Economic Research

This Unit is conducting several surveys on the economics of producing rubber, resource use, Group Processing Centres and farm record keeping. The results of these surveys will be available shortly, and these will improve the economics of rubber production in Sri Lanka.

Statistics

During a selected dry weather period, data were collected on the height increments of young rubber plants and an analysis was presented in the paper "Regression analysis of height increments in young RRIM 603 *Hevea* plants".

Arrangements were made for a causative study between tree yield variations in some *Hevea* clones with the purpose of recommending economic measures of yield increase.

STAFF

It is a pleasure to report that five members of the staff of the Institute are reading for their Ph. D. degrees and 3 for M.Scs at present. This is the highest number of staff members that has ever done post graduate studies at the Institute, since its inception.

The Research Officers of the Institute read sixteen scientific papers at the Annual Sessions of the Sri Lanka Association for the Advancement of Science this year. This is the highest number of papers presented by any single Institution at these Sessions and we are justly proud of the achievement of our scientists.

The Director, the Heads of Departments and all the Senior and Intermediate Staff Officers of the Institute were on duty throughout the year.

Mr. M. Nadarajah, Head of Rubber Chemistry Department, Mr. S. W. Karunaratne, Chief Rubber Technologist, Dr. A. Coomarasamy, Rubber Chemist and Dr. M. R. N. Fernando, Rubber Chemist, attended the ninth rubber conference of Indian Rubber Manufacturers' Research Association in Cochin, India, from 9th to 19th February 1977.

Mr. C. G. Silva, Soils Chemist, went to the University of Missouri, USA, to follow a course of training in Plant Nutrition for one year from 1st May 1977.

Dr. N. E. M. Jayasekera, Geneticist & Plant Breeder, attended a Workshop on International Collaboration in *Hevea* Breeding and the Collection and Establishment of Materials from the Neo-Tropics, held at the RRIM, Kuala Lumpur, Malaysia, from 12th to 16th April 1977.

Dr. A. de S. Liyanage, Head of Plant Pathology Department, attended an Interregional Training Course on Plant Breeding for Disease Resistance, held in India from 14th November to 13th December 1977.

The Director visited Indonesia on a short term World Bank assignment for three weeks in November.

Dr. U. P. de S. Waidyanatha, Botanist, followed a course of training on a Post Doctoral Fellowship offered by the International Crop Research Institute for Semi Arid Tropics at Hyderabad, India, from 27th March to 23rd April 1977.

Mr. M. K. S. A. Samaraweera, Assistant Soils Chemist, continued his post graduate training at the University of Bristol, in the United Kingdom.

Mr. J. A. Amaraweera, Librarian & Publications Officer, followed the training course on Information Systems/AGRIS Methodology, held at the South East Asian Regional Center for Graduate Study and Research in Manilla, Philippines, from 1st June to 24th June 1977.

Mr. A. M. A. Perera, Technical Assistant of the Soils Chemistry Department, returned to the Island on 14.11.1977, after a course of training in Analytical Chemistry at the RRIM for 10½ months.

Mr. L. S. S. Pathiratne, Technical Assistant of the Botany Department, left the Island on a scholarship for 12 months to follow a course of training in Instrumentation and Biochemical Techniques at Bristol, England.

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

Officers in Grades I & II	26
Officers in Grade III	15
Officers in Grades IV to IX	241
Officers in Grades X to XIII	133
	415

VISITORS

Visitors to the Institute included :

Mr. Achilk Beneks, Switzerland University, Switzerland
Mr. Muiramia C. K. Ministry of Agriculture, Nairobi, Kenya
Mr. Kual Michel, Baghdad, Iraq
Mr. Tulay Golge, Ankara Nuclear Research Centre, Turkey
Mr. T. Winteringham, Austria
Dr. J. K. Tempelton, International Agricultural Development Service, U. S. A.
Mr. J. Broersma, Ceylon Fertilizer Corporation, Colombo
Mr. H. S. Holf, ODM, London
Mr. M. Bigger, ODM, London
Mr. G. W. Gee, UNDP, Colombo
Mr. Dang-van-Vinh, RRI of Vietnam.
Mr. Ngo-van-Hoang, RRI of Vietnam.
Dr. S. Kohjiya, Department of Chemistry, Kyoto Institute of Technology, Japan.
Mrs. M. Kohjiya, Kyoto, Japan.
Mr. S. Mani, Blue Star Ltd., Madras, India,
Mr. K. Arichandran, IBRD, 1818, H. Street, N. W. Washington, USA.
Mr. J. D. B. Robinson, ODM, London.
Mr. R. S. Lange, Goodyear Rubber Plantation Co., USA
A group of delegates from Japan.
Mr. B. Duncan, USA.
Mr. H. E. Ray, USA.
Mr. J. A. Ittah, Chairman, Governing Board, RRI, Nigeria.
Mr. C. I. Oshogwe, Member, Governing Board, RRI, Nigeria.
Mr. S. D. Agboola, Assistant Director, RRI, Nigeria.
Mr. P. J. Vant, Sales Executive, Philip Harris Ltd., Lynn Lane, Shenstone Staffs., England.
Mr. Hartlieb, A. H. B. Chemie Export & Import, Berlin, GDR.
A group of students from the Academy of Foreign Trade, USSR.
Professor M. Domros and a group of 30 students from Germany

Visiting Officers

Mr V. Abeywardena, Biometrician, Coconut Research Institute continued to visit the Rubber Research Institute regularly throughout the year to help us with statistical studies. We are very grateful to the Coconut Research Institute for the services rendered to us by this officer.

Several final year students of the Faculties of Agriculture, Science and Engineering from the various University Campuses were provided with short term courses of training at the Institute.

Facilities were also provided for the training of several other University students at the Institute.

Publications

The following papers were prepared by the Director for publication during the year:

PERIES, O. S. — Director's Review for 1976

PERIES, O. S. — The importance of developing rubber goods manufacturing industries in the economy of Sri Lanka. Paper presented at the Seminar on Rubber Products 19th September 1977 at ARTI, Colombo.

PERIES, O. S., LIYANAGE, A. de S. and LIYANAGE, N. I. S. Fungi associated with rubber growing soils in Sri Lanka. Proceedings 33rd Annual Session of the SLAAS, 6 - 9 December 1977, also submitted for publication in *Trans. Brit. Mycol. Soc.*

PERIES, O. S., LIYANAGE, A. de S. and DANTANARAYANA, D. M. A comparative study of the nutrition of *Phytophthora medii* and *P. palmivora*. Paper submitted for publication in *Trans. Brit. Mycol. Soc.*

LIYANAGE, A. de S., PERIES, O. S., DANTANARAYANA, D. M. and LIYANAGE, N.I.S. Studies on some factors influencing the growth and sporulation of *Phytophthora palmivora* from rubber. *Proc. 33rd Annual Session of the SLAAS*, 6 – 9 December 1977.

LIYANAGE, N. I. S., YAPA, P. A. J., PERIES O. S. and LIYANAGE, A. de S. Production of phytoalexins in *Hevea* pods in response to infection by *Phytophthora* spp. *Proc. 33rd Annual Session of the SLAAS*, 6 – 9 December 1977.

Institute Publications

General

Annual Review for 1976 (English)

Annual Report of the Rubber Research Board for 1975 (Trilingual) (in preparation).

RRISL Bulletin Vol. 12. No. 1, 1977 (in press) (Proc. of the Seminar on rubber culture, manufacture and marketing, 30th May 1977 at the Ceylon Chamber of Commerce, Colombo.)

RRISL Bulletin Vol. 12 No. 2. 1977 (in press) (Proc. of the seminar on rubber products, 19th September 1977 at the ARTI, Colombo.)

Journal of the Rubber Research Institute of Sri Lanka Vol. 54, Part I No. 1 (in press)

Journal of the Rubber Research Institute of Sri Lanka Vol. 54, Part I No. 2 (in press)

Journal of the Rubber Research Institute of Sri Lanka Vol. 54, Part II No. 1 (in press)

Proceedings of the Centenary International Rubber Conference, Sri Lanka December 1976.

Rubber Puwath Vol. 8 (in preparation)

Smallholdings Advisory Leaflet No. 17 - Sulphur Dusting for Control of *Oidium* (English)

Theses

FERNANDO, W. S. E. The stabilisation of acrylonitrile butadiene styrene resin against heat and light. *Thesis submitted for the Degree of Doctor of Philosophy of the University of Aston in Birmingham, U. K.* 1977.

Papers

ABEYRATNA, B. K. Incentives for increased rubber production. *RRISL Bulletin.* 12, (1) 1977 (in press).

AMARAPATHY, A. M. A. Possibilities of expansion of latex based products in Sri Lanka. *RRISL Bulletin,* 12 (2) 1977 (in press)

AMARAPATHY, A. M. A., NADARAJAH, M. and MANEL, M. G. The use of natural rubber latex for coating fabrics. *Proc. 33rd Annual sessions of the SLAAS, 6 – 9th December* 1977.

CHANDRASEKERA L. B. Potential for intercropping rubber lands in Sri Lanka. *RRISL Bulletin* 12 (1) 1977 (in press).

CHANDRASIRI, G. R. and GUNASEKERA, H. D. B. H. An economic evaluation of the state-aided fertilizer subsidy programme for rubber lands in Sri Lanka. *Proc. 33rd Annual Session of the SLAAS, 6–9th December* 1977.

COOMARASAMY, A. Usage of rubber derivatives and rubber seed oil in paints. *RRISL Bulletin,* **12 (2)** 1977 (in press).

COOMARASAMY, A. and KANTHASAMY, T. Epoxidation of rubber seed oil, *Karmantha,* January 1977.

COOMARASAMY, A., SILVA, L. B. K. and SURANIMALA, R. C. Some new antioxidants for natural rubber. *Rubber Reporter,* 2 **(3)** 7 – 13, *Sept/Oct.* 1977. *Paper presented at the 9th Indian Rubber Conference* 10–11, *February* 1977, *IRMRA, India.*

COOMARASAMY, A and SILVA, L. B. K. Modification of natural rubber. *Rubber Reporter* **2 (1),** May/June, 1977.

COOMARASAMY, A. and NADARAJAH, M. Commercial manufacture and uses of cyclised rubber. *Proc. 33rd Annual Session of the SLAAS,* 6–9 *December* 1977.

DE SARAM, C. S. The need for education for the rubber products manufacturing industry. *RRISL Bulletin,* **12 (2),** 1977 (in press).

DISSANAYAKE, A. B. Comments on the systems of accounting adopted in rubber plantations. *RRISL Bulletin,* **12 (1)** 1977 (in press).

FERNANDO, D. M. Recent developments in rubber planting materials. *RRISL Bulletin,* **12 (1)** 1977 (in press).

FERNANDO, D. M. Some aspects of *Hevea* breeding in Sri Lanka. *Proc. SLAAS Symposium on plant breeding in Sri Lanka. 13th May,* 1977, *Colombo.*

FERNANDO, D. M. Recent developments in rubber planting material. *Proc. 33rd Annual Session of the SLAAS,* 6–9 *Dec.* 1977.

FERNANDO, D. M., JAYASEKERA, N. E. M. and LIYANAGE, A de S. Resistance breeding of *Hevea* in Sri Lanka. *Paper presented at workshop on International Collaboration in Hevea breeding and the collection and establishment of materials from the Neo-Tropics,* 12–16, *April* 1977, *Kuala Lumpur.*

FERNANDO, M. R. N. Some practical applications of natural rubber formulations vulcanizing at room temperature. *RRISL Bulletin,* **12 (2),** 1977 (in press).

FERNANDO, M. R. N. and NADARAJAH, M. Vulcanising systems for low temperature and sunlight curing of natural rubber compounds. *Proc. 33rd Annual Sessions of the SLAAS,* 6–9, *Dec.* 1977.

FERNANDO, UPALI G., NADARAJAH, M. and PERERA, ROGER, W. A. Further development of natural rubber Portland cement mixes for engineering applications. *Proc.* 33rd *Annual Session of the SLAAS,* 6–9, *Dec.* 1977.

GOONASEKERA, G. A. J. P. R. A general regression equation for the estimation of leaf areas. *Proc. 33rd Annual Session of the SLAAS,* 6–9 *Dec.* 1977.

GOONESEKERA, H. D. B. H. Group production - Its possibilities in rubber smallholdings. *Paper presented at the 3rd Seminar and workshop organised by the ANRPC on development of smallholders, Cochin, India,* 24–30, *Nov.* 1977.

GUNASEKERA, SENA. Availability of foreign exchange and tax incentives for the establishment of new Rubber Industries. *RRISL Bulletin,* **12 (2)** 1977 (in press).

JAYASEKERA, N. E. M. and FERNANDO, D. M. *Hevea* introductions (Non-Wickham) into Sri Lanka. *Paper presented at the workshop on International Collaboration in Hevea breeding and collection establishment of materials from the Neo-Tropics,* 12–16 *April* 1977, *Kuala Lumpur.*

JOHNSEN, D. S. and YOGARATNAM, N. Effect of phosphorus sprays on the mineral composition and storage quality of Cox's Orange Pippin Apples. *Paper submitted for the Jl. Hort. Soci.,* 1977.

KANNANGARA, GAMINI. Extent of usage on natural rubber in shoe manufacture. *RRISL Bulletin* **12 (2)** 1777, (in press).

KARUNARATNE, S. W. and PATEL, M. Evaluation of locally produced clay in the Rubber Industry. *Proc. 33rd Annual Sessions of the SLAAS* 6–9 Dec. 1977.

KARUNARATNE, S. W. Strategy needed for the orderly development of the rubber goods manufacturing industry in Sri Lanka. *RRISL Bulletin,* **12 (2),** 1977 (in press).

KUMARANAYAGAM, S. The role of the Broker. *RRISL Bulletin,* **12 (1),** 1977 (in press).

LIYANAGE, A. de S. Economics of white root disease control. *RRISL Bulletin* **12 (1),** 1977 (in press).

LIYANAGE A. de S., WETTESINGHE, S. and DHARMARATNE, A. The distribution, spread and control of Black Root disease in Sri Lanka. *Proc.* 33rd *Annual Sessions of SLAAS* 6–9, *Dec.* 1977.

LIYANAGE, A. de S., PERIES, O. S., DANTANARAYANA, D. M. and LIYANAGE, N.I. S. Studies on some factors influencing the growth and sporulation of *Phytophthora palmivora* from rubber, cocao and coconut. *Proc. 33rd Annual Session of SLAAS,* 6–9 *Dec.* 1977.

LIYANAGE, G. W., HALANGODA, L. and FERNANDO, N. Studies on the spread of White Root disease in rubber. *Proc. 33rd Annual Session of SLAAS,* 6–9 *Dec.* 1977.

LIYANAGE, N. I. S., YAPA, P. A. J., PERIES, O. S. and LIYANAGE, A. de S. Production of Phytoalexins in *Hevea* pods in response to infection by Phytophthora spp. *Proc. 33rd Annual Session of SLAAS,* 6–9, *Dec.* 1977.

MENDIS, E. G. Quality control of sole crepe. *RRISL Bulletin,* **12 (1)** 1977 (in press).

MENDIS, L. P. Future of natural rubber industry. *RRISL Bulletin.* **12 (2),** 1977 (in press).

MUNAWEERA, D. Compounding processing and materials for tyre treads. *RRISL Bulletin,* **12 (2)** 1977 (in press).

NADARAJAH, M. An assessment of the potentialities of latex crepe manufacture in Sri Lanka. *RRISL Bulletin,* **12 (1),** 1977 (in press).

NADARAJAH, M. Possibilities of rubber products manufacture in Sri Lanka. *RRISL Bulletin,* **12 (2),** 1977 (in press).

NADARAJAH, M. and COOMARASAMY, A. Recent developments in the use of natural rubber in Sri Lanka. *Plastics & Rubber International,* **2 (6)** 1977.

PERIES, O. S. The importance of developing rubber goods manufacturing industries in the economy of Sri Lanka. *Paper presented at the seminar on rubber products, 19th Sept.* 1977, *at ARTI, Colombo.*

PERIES, O. S., LIYANAGE, A. de S., and DANTHANARAYANA, D. M. A comparative study of the nutrition of *Phytophthora meadii* and *P. palmivora*. Paper submitted for publication in *Trans. Brit. Mycol Soc.*

PERIES, O. S.. LIYANAGE. A. de S. and LIYANAGE, N. I. S. Fungi associated with rubber growing soils in Sri Lanka. *Proc. 33rd Annual Session of the SLAAS*, 6–9, *Dec.* 1977, and submitted to *Trans. Brit, Mycol. Soc.*

RAJAPAKSE, R. P. C. Services provided by the Industrial Development Board to small scale rubber industries, *RRISL Bulletin* **12 (2)**, 1977 (in press).

SILVA, P. A. Role of the Colombo Rubber Traders' Association. *RRISL Bulletin,* **12 (1),** 1977 (in press).

THARMALINGAM, R. Crepe Rubber Development Unit. *RRISL Bulletin,* **12 (1),** 1977 (in press).

THARMALINGAM, R. Mathematical model of a single screw extruder. *RRISL Bulletin,* **12 (2)** 1977 (in press).

TILLAKERATNE, L. M. K. Some problems of block rubber production, *RRISL Bulletin*, **12 (1)** 1977 (in press).

TILLAKERATNE, L. M. K., The scope of standardising rubber products in Sri Lanka. *RRISL Bulletin*, **12 (2)**, 1977 (in press).

TILLEKERATNE, L. M. K., FERNANDO, W. S. E. and de SILVA, A. J. S. K. Epoxidation of depolymerised natural rubber and industrial uses of its product. *Proc.* 33*rd Annual Session of the SLAAS,* 6–9 *Dec.* 1977.

WAIDYANATHA, U. P. de S. Mycorrhizal infection on growth of *Stylosanthes* and uptake of phosphorus from Eppawela apatite and imported Rock Phosphate. *Proc.* 33*rd Annual Session of the SLAAS*, 6–9 *Dec.* 1977.

WHITE, D. R. Importance of research in developing rubber goods to serve the local and export market. *RRISL Bulletin.,* **12 (2)** 1977 (in press).

YAPA, P. A. J., GOONASEKERA, G. A. J. P. R., and KASINATHAN, S. A biochemical basis for characterization of *Hevea* clones. *Proc.* 33*rd Annual Sessions of the SLAAS*, 6–9 *Dec.* 1977.

YOGARATNAM, N. Use of leaf analysis as a guide to manuring of rubber. *RRISL Bulletin,* **12 (1),** 1977 (in press).

YOGARATNAM, N., SHANMUGANATHAN, R. T., THENABADU, M. W. and ARSECULERATNE, B. The Molybdenum status of some rubber soils of Sri Lanka. *Proc.* 33rd *Annual Session of the SLAAS*, 6–9, Dec. 1977.

Social and Sports Activities

The Sports activities of the Recreation Club was confined mainly to Cricket during the year. In the Government Services Cricket Tournament our team won three matches losing three. In the Kalutara District Cricket Tournament, we were unfortunate in having had to concede a "walk over" to the opposing team after having reached the quarter final stage. This was due to the fact that the match had been fixed with insufficient notice, and with a limited number of players, due to official and personal commitments of members, the Club could not field their best team in any of these matches.

In Table Tennis Miss Preeth Swaris became the Junior Champion and the Women's National Champion of 1977. She was awarded the Maharajah Trophy for the best player for the year. She was also selected to captain the Sri Lanka Women's Table Tennis Team against the visiting Team from Nepal, during the year.

REVIEW OF THE BOTANY DEPARTMENT

L. B. CHANDRASEKERA

SUMMARY

Ethrel trials in which stimulation was carried out at two monthly intervals with tapping on the S/2, d/2, 100% system continue to show declining yield responses with time. Generally, in the fourth year the yield response declined to a level which appears to make Ethrel applications at two monthly intervals uneconomic. A change of tapping panels has increased the yield response, but this increased level of response was maintained only during the first year. In one trial yield increases were maintained over a 4 year period both in terms of yield per tapper and per hectare with six stimulations a year and tapping on the S/2 d/3 67% system. The use of 2% a.i. Ethrel has been less effective than 10% a.i. Ethrel. When trees are stimulated once a year, above cut applications of stimulant have been more effective than below cut applications.

Over a period of seven years, clone PB 86 has responded well to daily tapping on a half spiral cut. During this period, the daily tapped plots have averaged 3161 kg/ha of dry rubber per year as compared with 1720 kg/ha for the plots tapped alternate daily. The incidence of dry trees has so far remained within acceptable limits. The response of clone RRIC 45 to daily tapping has been poor with a high incidence of dry trees. Clone RRIC 52 has responded better to tapping on the 2S/2, d/4, 100% system than the S/2, d/2, 100% system. From the point of view of yields, there appears to be no advantage to be gained by an annual change over of tapping panels. In clone PB 86, recovery tapping on the S/2, d/2, 100% system, to compensate for tapping days lost due to rain, has had no adverse effects either on yield or the incidence of Brown Bast. However, tapping at higher intensities without recovery tappings has increased the incidence of Brown Bast. When tapping two cuts downwards on the same tree of clone RRIC 52, there was no advantage in keeping the two cuts far apart in order to increase the drainage area.

For clone RRIC 101, which generally gives high initial yields, S/2, d/2 and and S/2, d/3 tapping was superior to S/4 and S/8 cuts with Ethrel and puncture tapping with Ethrel. In the drier rubber planting districts, it has been possible to reduce the period of immaturity by approximately one year by tapping budgrafts at 45 cms girth on S/2, d/3,67% intensity for the first three years, followed by tapping at S/2, d/2, 100% intensity from the fourth year.

Clone PB 86 can now be regarded as a general purpose clone suitable for planting in all districts in Sri Lanka. It's average yields, under good management, have been around 1500 kg/ha. The clones RRIC 5, 13, 36, 48, IRCI 2, 9, PR 252, and RRIM 600 have maintained high yields on both virgin and renewed bark in all large scale trials. These clones should increase the average yields to around 2,000 kg/ha. Clone RRIC 100 has shown steady yield increases with time, while clone RRIC 101 has given very high yields during the first year of tapping, but this yield tends to decline in the second year.

Polyclone plantings continue to maintain higher yields than those recorded for monoclone plantings of the constituent clones. In one large scale polyclone planting the average yield during the third year has been around 1365 kg. of dry rubber per hectare. In the other small scale trial, the average theoretical yield in the fifth year of tapping has been around 3,000 kg dry rubber per hectare.

Seedlings of most recommended clones could now be used as root-stocks for budgrafting. In more precise trials, rootstocks of clones PB 86 and RRIC 45 have produced better scion growth in clones RRIC 103 and RRIC 45 than in clones PB 86 and Wagga 6278.

In tissue culture studies, callus cultures from clonal source material which were earlier found to be rather recalcitrant in sub-culture showed sustained growth when grown in a modified MS medium. Callus cultures grown at temperatures 26°–27°C showed good growth and the cultures remained fresh for long periods. At room temperature (29° –30° C) callus growth was retarded and turned brown after four weeks. Profuse root formation was observed in callus cultures established from embryos, when they were transferred from growth medium containing high levels of Auxin and Kinetin to a differentiating medium containing low levels of Auxin and Kinetin. Embryos with the cotyledons removed were successfully cultured asceptically on semi-solid media. Such embryos treated with 1.0 and 10.0 mg/l Colchicine developed into seedlings showing distinct changes in morphology.

Bioassay of extracts from "leaf buds" and "scale buds" have shown the presence of Absicic acid. There was a marked decline in the concentration of the inhibitor as the leaves in buds expanded.

With *Pueraria* and *Stylosanthes*, the presence of mycorrhizae enhanced the uptake of phosphorus from soil and added rock phosphate increased it further. There were differences in phosphorus availability and growth response of *Pueraria* to applications of Eppawela apatite and imported rock phosphate, the imported phosphate being superior. There is evidence that mixing rock phosphate with small quantities of sulphur, before application to the soil, increases the availability of P from rock phosphate.

In grass-legume mixtures grown among rubber, stoppage of nitrogen and addition of super phosphate increased the growth of the legume component. Growth of guinea grass (*Panicum maximum*) was better with *Pueraria* than with N_2 or *Centrocema*, whereas the opposite appears to be the case with *Brachiaria brizantha*. *Brachiaria miliformis* grew better when combined with *Pueraria* or when N_2 was added, but its growth with *Centrocema* is poor although the percentage of legume in the particular treatment is high. *Brachiaria brizantha* and *Brachiaria miliformis* responded to increased N_2, but not *Panicum maximum*. In terms of yields of dry matter, *P. maximum* was more productive than the other two grasses. Of the legumes, *Pueraria* was better than *Centrocema, B. brizantha* was more competitive with the rubber and *B. miliformis* the least competitive. The presence of legumes with the grasses reduced this competitive effect.

Interplanting rubber during the immature phase with perennial crops such as bananas, passion fruit and pineapple has not adversely affected the growth of rubber. Of these, the most profitable crop has been bananas followed by pineapple. Experiments carried out so far indicate the growing of passion fruit to be uneconomic.

DETAILED REVIEW

Staff

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

The senior Technical Assistant, Mr. W. G. V. Fernando, Technical Assistants Messrs. I. R. M. Amarakoon, D. K. Angammana, W. A. Ariyaratne, J. G. de Mel, L. S. Kariyawasam, T. C. Weerasinghe, Miss C. W. Ranasinghe, Senior Field

Assistant Mr. M. C. Perera and Field Assistants Messrs D. A. Brahmana, R. B. Gunaratne, S. Kodikara, U. K. D. Lewis, N. L. D. Ruban, W. T. Silva and S. Wilbert were on duty throughout the year.

Mr. L. S. S. Pathiratne, Technical Assistant, left for overseas training on 15.08.1977.

Miss C. N. Jagodarachchi, Technical Assistant resigned from the Department on 20.08.1977.

Miss E. M. A. I. Ekanayake assumed duties as Experimental Officer with effect from 01.08.1977. Messrs K. A. G. Bandara, L. B. Chandrasena and W. R. A. N. Ratnayake were appointed Technical Assistants during 1977.

Research Students

The following research students commenced work in the Department during the year 1977.

Mr. S. N. Dissanayaka on "Growing of grasses and legumes under young rubber".

Mr. M. H. Mendis on "Hevea Tissue Culture".

Dr. U. P. de S. Waidyanatha, Botanist spent four weeks in March 1977 at the International Crops Research Institute for the Semi-Arid Tropics, studying methods used in biological nitrogen fixation research.

Visits

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

Conferences and Seminars

The following papers were read by the Head of the Botany Department, Mr. L. B. Chandrasekera :–

1. "Intercropping" at the seminar organised by the Institute and held at the Sri Lanka Chamber of Commerce.

2. "Planting practices" to Project Managers of the Ambalangoda Co-operative Agricultural Settlement.

3. Two papers on "Recent Research development at the Rubber Research Institute of Sri Lanka" and "Application of Research Findings to Planting Practices" at a two day seminar organised by the Ministry of Plantation Industry.

The research staff of the Botany Departments partcipated in training programmes for the following students, during the year 1977.

1. Students from the National Apprenticeship Board.

2. Students from the Faculty of Agriculture, University of Sri Lanka, Peradeniya who are following advanced courses on Plantation Crop Production.

Publications

1. Annual Review of the Botany Department, 1976.

2. "Potential for intercropping rubber lands in Sri Lanka". L. B. Chandrasekera, R.R.I.S.L., Bult. Vol. 12, 1977.

3. "Mycorrhizae infection on growth of *Stylosanthes* and uptake of phosphorus from Eppawela apatite and imported rock phosphate" U. P. de S. Waidyanatha, Proc. 33rd Annual Sessions of SLAAS. 6th – 9th Dec. 1977.

YIELD STIMULATION EXPERIMENTS

Field Experiment No. 58 - *Ethrel stimulation Experiment - Malaboda Estate*

Ten percent Ethrel is applied to a 3.8 cm strip of scrapped bark below the tapping cut, once in two months, on panel D of clone PB 86 and tapped on the S/2, d/2, 100% system. The average yields recorded per tapping block for the first seven years are given in Table 1.

TABLE 1 - AVERAGE YIELDS OF ETHREL STIMULATED AND CONTROL BLOCKS IN kg DRY RUBBER (INCLUSIVE OF SCRAP)

Year	Treatment	
	Stimulated	Control
1971	12.80	5.67
1972	9.19	4.83
1973	8.46	4.93
1974	5.83	4.30
1975	5.70	5.13
1976	5.90	5.06
1977	5.22	4.40
No. of applications	6	—
No. of trees tapped, 1977	311–304	260–251
Percentage of scrap	8.8	8.0
Brown Bast cases		
Partially dry	16	5
Totally dry	10	11

In this trial, significant yield increases were recorded only up to third year of stimulation. (*L. D. Chandrasekera & D. A. Brahmana*)

Field Experiment No. 63 – *Ethrel stimulation experiment - Eladuwa Estate*

Ten per cent Ethrel applied six times a year on a 3.8 cm strip of scraped bark below the taping cut and tapped on the S/2, d/2, 100% is compared with unstimulated control plots of the same tapping intensity in clone PB 86. In 1975 the tapping cuts were changed over to panel E. The average yields recorded per 50 tree plot in the first seven years of the experiment are given in Table 2.

TABLE 2 - AVERAGE YIELD OF DRY RUBBER (INCLUSIVE OF SCRAP) IN g/TREE/TAPP. OF STIMULATED AND CONTROL PLOTS

Year	Treatment	
	Stimulated	Control
1971	76.6	39.3
1972	57.3	34.8
1973	58.3	32.2
1974	44.7	34.7
1975	53.7	33.0
1976	36.9	28.3
1977	40.0	31.2
No. of applications	6	—
No. of trees tapped, 1977	783-725	260-255
Percentage of scrap	21.4	9.4
Brown Bast cases, percentage		
Partially dry	3.2	0.8
Totally dry	2.7	1.9

In this trial, the stimulated plots continue to maintain satisfactory yield increases over unstimulated control plots in the seventh year. (*L. B. Chandrasekera & D. A. Brahmana*)

Field Experiment No. 73 – 1972 *Ethrel stimulation experiment - Eladuwa Estate*

In this experiment there are 12 treatments with 20 trees per plot randomised within a tapping task and replicated three times. Originally there were 12 treatments to include six above cut applications and six below cut applications. The application below the cut is on a 3.8 cm strip of scraped bark while above cut application is on a 2.5 cm band of renewing bark. In the sixth year of the experiment in 1977, the special formulation of Ethrel 70–90 K which contains a bark penetrant was not available. In its place the commercial 10 per cent formulation was used, thereby reducing the total number of treatments to eight. In 1977 the number of

applications too were limited to once a year. At present stimulation is being carried out on panel D of clone PB 86 for the second successive year. (*R. Satchuthananthavale & T. C. Weerasinghe*)

The yields recorded during the sixth year of the experiment in 1977 are given in Table 3.

TABLE 3–MEAN YIELDS OF DRY RUBBER FOR THE VARIOUS TREATMENTS IN 1977

	Treatment		Mean yield g/tree/tapp.	Mean yield as % of control
	Above cut application			
1.	S/2,d/2,100%	Unstimulated control	23.49	100
2.	,,	+Coconut oil	25.25	107.49
3.	,,	+5% Ethrel	31.04	132.14
4.	,,	+10% Ethrel	30.45	129.65
	Below cut application			
5.	S/2,d/2,100%	Unstimulated control	28.70	100
6.	,,	+Coconut oil	26.43	92.09
7.	,,	+ 5% Ethrel	33.40	116.39
8.	,,	+10% Ethrel	30.39	105.90

Generally, Ethrel applications above the tapping cut have given better yield responses than below cut applications. (*R. Satchuthananthavale & T. C. Weerasinghe*)

Field Experiment No. 80 – *Ethrel stimulation experiment - Talgaswela Estate*

This experiment, initiated in March 1974, compares three treatments applied to panel C of clone PB 86. The yield data recorded during the fourth year of the experiment are given in Table 4.

TABLE 4

YIELDS OF DRY RUBBER IN kg FOR THE VARIOUS TREATMENTS IN THE FOURTH YEAR IN 1977

	Tapped S/2,d/3,67% stimulated once in 2 months	Tapped S/2,d/2,100% stimulated once in 4 months	Tapped S/2,d/2,100% control
No. of Ethrel applications	5	2	—
Total yield (3 tapping tasks 1977)	2153	1802	1796
Average yield in kg/tapping block per day	10.71	5.67	5.49

The best yield response recorded in terms of total dry rubber harvested as well as yield per tapping block was for the tapping system S/2,d/3,67% and stimulated once in two months. (*L. B. Chandrasekera & D. A. Brahmana*)

Field Experiment No. 93 – *Ethrel stimulation experiment – Eladuwa Estate*

This experiment, started in 1976, compares 2% and 5% *a.i.* Ethrel applications below the tapping cut, under the S/2,d/2,100% tapping system on clone PB 86. Test tapping results during the second year of the experiment are summarised in Table 5.

TABLE 5 — MEAN YIELD OF DRY RUBBER FOR VARIOUS TREATMENTS IN 1977

	Treatment	Mean yield g/tree/tapp.	Mean yield as % of control
1.	S/2,d/2,100%—Unstimulated control	27.14	100
2.	,, +2% Ethrel	28.82	106.19
3.	,, +5% Ethrel	33.24	122.48

Only one application of Ethrel per year was made. Ethrel at 2% concentration has not been very effective. (*R. Satchuthananthavale & C. Weerasinghe*)

TAPPING EXPERIMENTS

Field Experiment No. 53 – *Tapping Experiment - Dartonfield*

Six tapping systems are compared on four clones on a randomised block design with 5 tree plots. The clones RRIC 7, 45 and 52 are replicated eight times and PB 86 six times. Tapping of all clones commenced in March 1968 on the S/2,d/2,100% system. The present tapping treatments were introduced in 1971. The data for 1977 are given in Table 6.

TABLE 6. YIELD (g/tree/tapp.) AND GIRTH INCREMENT (cm) FOR 1977 AND % BROWN BAST TO DATE

Tapping system	RRIC 45			RRIC 7			RRIC 52			PB 86		
	Yield	Girth increment	% BB	Yield	Girth increment	% BB	Yield	Girth increment	% BB	Yield	Girth increment	% BB
S/2, d/2, 100%	30.6	1.42	10.0	27.0	0.82	5.0	34.5	0.62	Nil	32.8	1.90	6.7
S/2, d/1, 200%	32.3	1.38	25.0	17.0	0.80	15.0	26.0	1.41	7.5	28.8	1.40	10.0
S/1, d/4, 100%	38.0	1.45	12.5	26.0	0.79	17.5	40.7	0.63	2.5	41.3	1.04	13.3
S/1, d/3, 133%	34.2	1.10	15.0	22.2	0.64	17.5	42.6	0.64	22.5	51.3	1.80	13.3
2S/2, d/4, 100%	45.5	1.26	10.0	30.8	0.66	5.0	41.4	0.77	17.5	60.9	1.46	10.0
2S/2, d/3, 133%	37.0	1.06	5.0	30.1	0.63	12.5	44.8	0.64	10.0	53.6	0.88	Nil

The clone PB 86 continues to respond well to daily tapping with incidence of dry trees remaining within acceptable limits. The rate of girth increments too has been satisfactory. During the seven years of daily tapping, clone PB 86 has recorded an average yield of approximately 3161 kg of dry rubber per ha as compared with 1720 kg/ha for the S/2,d/2,100% tapping system. This represents an average yield increase of 83 per cent over S/2,d/2,100% tapping. Yieldwise, clone PB 86 has also responded favourably to 2S/2,d/3, 133% tapping system with no dry trees, but apparently due to the presence of two tapping cuts, girth increments have been relatively low. (*U. P. de S. Waidyanatha & C. W. Ranasinghe*)

Field Experiment No. 59 – Tapping Experiment – Vogan Group

Comparisons are made of two tapping systems S/2,d/2,100% and 2S/2,d/4,100% and two tapping knives – the Michie – Golledge and the Jebong on clone RRIC 52. The average data recorded during seven years of this experiment from 1971 to 1977 are summarised in Table 7.

TABLE 7 — MEAN YIELD OF DRY RUBBER IN g/TREE/TAPPING AND MEAN THICKNESS OF BARK SHAVINGS IN mm.

Tapping knife	Yield in g/tree/tapp. S/2,d/2,100%		Mean thickness of bark shavings 2S/2,d/4,100%
M. G.	23.6	64.5	2.2
J	24.0	70.6	2.1

Clone RRIC 52 has responded better to double four tapping than the conventional alternate daily half spiral tapping. (*R. Satchuthananthavale & G. de Mel*)

Field experiment No. 74 – Tapping Experiment – Nivitigalakele

The treatments given in Table 8 are replicated 4 times in a randomised block design with 50 tree plots. The various treatments were introduced in April 1975.

TABLE 8 — YIELDS, GIRTH INCREMENTS FOR 1977 AND BROWN BAST TO DATE IN CLONE RRIC 45

	Annual panel change after the 3rd year of tapping S/2,d/2,100%	Tapping one panel to the graft union before change of panel S/2,d/2,100%	S/2,d/1,200%
Yield (g/tree/tapp.)	42.5	42.3	24.6
Girth increment (cm)	1.18	1.12	1.37
% Brown Bast	10	10	23

The above data continue to indicate that there is no advantage to be gained in an annual change over of tapping panels as is practised in some plantations. Unlike clone PB 86, the response of clone RRIC 45 to daily tapping has been poor. It has also recorded a very high incidence of Brown Bast. (*U. P. de S. Waidyanatha & S. Wilbert*)

Field Experiment No. 85 – *Tapping Experiment - Nivitigalakele*

The treatments given below were applied in November 1977 when tapping commenced, to clones RRIC 101, PR 252, AVROS 1734, RRIC 45, RRIC 13, WR 101 and RRIC 100.

Treatments

S/2,d/3,67%
S/2,d/2,100%
S/4,d/2,50% + Ethrel
M/1,d/3 + Ethrel
M/2,d/3 + Ethrel

M/1= Puncture tapping/1 metre long band with 10 punctures

M/2= ,, ,, of a 0.5 metre long band with 5 punctures.

Ethrel is applied at the rate of 1 g of a 5% formulation, once a month for the puncture tapped trees and once every two months for S/4,d/2 tapped trees. The experimental design is split plots with clones in the main plots, each replicated five times. Tapping treatments are applied to sub-plots, of 6 trees each. (*U. P. de S. Waidyanatha & S. Wilbert*)

Field Experiment No. 94 – *Tapping Experiment - Nivitigalakele*

Five tapping treatments are being investigated on 5 tree plots of clone RRIC 45 each replicated 7 times. The treatments commenced in July 1975. The yield and girth data for 1977 are summarised in Table 9.

TABLE 9 — YIELDS, GIRTH INCREMENT FOR 1977 AND INCIDENCE OF BROWN BAST TO DATE

Treatment	Yield (g/tree/tapp.)	Girth increment (cm)	% Brown Bast
S/2,d/2,100%	44.1	0.75	Nil
S/2,d/1,200%	41.0	1.47	5.7
S/2,d/2(2x2d/4) 100%	37.0	0.79	Nil
S/2,d/1,(2x2d/2) 200%	28.3	0.41	8.6
2S/2,d/2,200%	44.0	0.55	31.4

The data for 1977 indicate that yields for daily tapping of the same panel had been comparable with alternate daily tapping, but daily tapping with panel change had depressed yields. Tapping at 200 per cent intensity on the 2S/2,d/2 system has resulted in a very high incidence of Brown Bast. Considering all the above tapping systems, the highest yields on the basis of per hectare per year would be recorded for daily tapping of a half spiral cut. (*U. P. de S. Waidyanatha & S. Wilbert*)

Field Experiment No. 95 – *Tapping Experiment - Nivitigalakele*

The treatments given in Table 10 are applied to 7 tree plots of clone PB 86 each replicated 5 times. The treatments commenced in August 1975 and the data recorded for 1977 are given in Table 10.

TABLE 10 — YIELDS, GIRTH INCREMENTS FOR 1977 AND THE INCIDENCE OF BROWN BAST TO DATE

Treatments	Yield g/tree/tapp.	Girth increments (cm)	% Brown Bast
1. S/2,d/2,100%	28.5	0.68	5.7
2. S/2,d/1,200%	20.4	0.51	14.2
3. S/2,2d/3,133%	26.1	0.83	14.2
4. S/2,d/2,100%	30.1	1.04	8.5
(Recovery of lost tapping days by daily tapping in good weather)			
5. S/2,d/2,100%	26.1	0.66	5.7
(Maximum of 6 recovery tappings per month)			

The above data indicate that recovery tappings on the S/2,d/2,100% system in order to compensate for the tapping days lost due to rain has had no adverse effects either on yield or the incidence of Brown Bast. Tapping at higher intensities without recovery tappings, (a practice which some estates have adopted) has resulted in a higher incidence of dry trees. (*U. P. de S. Waidyanantha & S. Wilbert*)

Field Experiment No. 96 – *Tapping Experiment – Eladuwa Estate*

In this experiment, 6 tapping treatments are applied to 12 tree plots of clone RRIC 52. Each treatment is replicated 5 times. The high level cuts H_1 and H_2 were introduced at 53 and 106 cm above the existing half spiral cuts on the normal (L) panels which at the time of opening high level cuts were at an approximate height of 76 cm above the graft union. All cuts were tapped downwards starting from May 1976. The data recorded for 1977 are given in Table 11.

TABLE 11 — MEAN YIELDS FOR 1977

Treatments	Panel L	Panel H_1 or H_2 (g/tree/tapp).	(lb/ac/yr)
S/2,d/2,100% (Panel L))	14.2	—	700
S/2,d/1,200% (Panel L)	12.4	—	1222
S/2,d/1 (2x2d/2) 200% (Panel L or H_1)	13.1	11.1	646
S/2,d/1 (2x2d/2) 200% (Panel L or H_2)	13.2	8.5	1017
2S/2,d/2,200% (Panel L + H_1)	12.3	10.5	1129
2S/2,d/2,200% (Panel L + H_2).	13.4	9.0	1104

L — Normal (lower) panel.
H_1 — 2nd panel 53 cm above L.
H_2 — 2nd panel 106 cm above L.

On the basis of the above data, there appears to be no advantage in tapping two panels or in keeping the two panels far apart for the purpose of increasing the drainage area. The H_1 panel has given higher yields than the H_2 panel. (*U. P. de S. Waidyanantha & M. C. Perera*)

Tapping Experiment No. 103 – *Puncture tapping experiment – Nivitigalakele*

The following treatments are being tested on single tree plots of 5 clones. Each treatment is replicated in a randomised block design.

The treatments commenced on 27 July 1977. Ethrel is applied at the rate of 1 g. of a 5% formulation to the relevant treatments except treatment 4 where two 1 metre bands on opposite sides of the trunk are stimulated, each band receiving 1 g. The puncture tapped trees are stimulated monthly and the S/4 cuts bi-monthly. The puncture bands which are 1 cm broad are shifted bi-monthly by 1 cm around the trunk. The yield data for four months in 1977 are given in Table 12.

TABLE 12 — THE YIELD OF DRY RUBBER (G/TREE/TAPP.) FOR 4 MONTHS

Treatments	RRIC 100	RRIC 101	WR 101	AVROS 1734	RRIC 45
1. 2S/8,d/3,33%+E	34.2	43.4	19.5	27.2	27.1
2. S/4,d/3,33%+E	33.0	37.9	14.5	22.0	20.8
3. M_1 + E	25.7	24.0	16.5	22.1	21.0
4. (M_1 + M_1) + E	36.6	50.7	21.5	37.1	28.5
5. S/2,d/3,67%	35.0	47.5	22.3	24.2	27.8

(M_1 + M_1) = Puncture tapping 2 bands, each 1 m long placed on opposite sides of the trunk. Each band was tapped with 10 pricks.
E = Ethrel (1 g of 5% formulation per tree per application).

Except with clone AVROS 1734 where puncture tapping with two bands was superior to S/2,d/3 tapping, all other clones gave comparable yields for these two methods of tapping. There is also the indication that 2S/8,d/3+E was better than S/4,d/3+E particularly for clones WR 101, AVROS 1734 and RRIC 45. Tapping on 2S/8,d/3 with Ethrel stimulation also appears to be as good as S/2,d/3 tapping or puncture tapping of two bands. (*U. P. de S. Waidyanatha & S. Wilbert*)

Field Experiment No. 104 - *Tapping experiment - Eladuwa Estate*

The experiment consist of 5 single tree plots per treatment of clone RRIC 101 on a randomised block design. Ethrel is applied monthly on the puncture tapped trees and bi-monthly on others. The yield data for 1977 are given in Table 13.

TABLE 13 — YIELDS IN G/TREE/TAPP FOR 1977

Treatments	*Yield*
S/2,d/2,100%	39.5
S/2,d/3,67%	42.3
S/4,d/2,50%	18.2
S/4,d/2,50%+E	19.6
S/8,d/1,50%	11.9
S/8,d/1,50%+E	19.2
S/8,d/2,25%	15.1
S/8,d/2,25%+E	20.4
M_1,d/3,+E	9.28

M_7 = 1 metre band puncture tapped.
E = 1 g 10% Ethrel per cent per application.

It appears that for clone RRIC 101, S/2,d/3, and S/2d/3, tapping is superior to all other tapping methods. Stimulated S/4 or S/8 cuts and puncture tappings gave poor yields. (*U. P. de S. Waidyanatha & C. Angammana*)

CLONE EVALUATION TRIALS

Field Experiment No. 16 – 1956 *clone trial – Hedigalla*

All clones are planted in monoclonal blocks of 300 trees per clone. Tapping commenced in 1963 and the average yields for the best selections are given in Table 14.

TABLE 14 — YIELD OF DRY RUBBER IN kg PER TREE PER YEAR FOR 140 TAPPINGS (TAPP. ON s/2,d/2, 100% FROM 1963)

Year	CLONE			
	IRCI 9	PR 252	RRIC 48*	PB 86
1966	5.44	4.63	5.58	3.95
1967	5.13	4.81	5.81	4.13
1968	5.44	4.54	4.90	3.63
1969	4.72	3.90	5.17	3.76
1970	6.44	6.53	5.50	5.08
1971	5.90	6.94	4.85	5.81
1972	5.40	5.44	3.76	5.03
1973	6.12	4.72	5.72	4.54
1974	6.62	6.08	5.08	4.67
1975	4.72	4.13	5.49	4.76
1976	4.45	4.17	5.62	4.22
1977	3.57	3.63	5.84	4.23
No. of trees tapped, 1977	198-189	203-196	111-108	211-201
Average girth in cm 1977	79.6	72.2	70.4	82.9
B'Bast cases, 1977	7	6	3	8
Wind damage cases 1977	2	1	—	2

*Tapped in 1964.

Clones IRCI 9, PR 252 and RRIC 48 are now recommended for moderate scale planting in estates. (*L. B. Chandrasekera & W. T. Silva*)

Field Experiment No. 19 - 1962 *Clone Trial - Nivitigalakele*

All clones are planted at 150 trees per clone. The yields of the selections that have yielded better than the control clone PB 86 are given in Table 15.

TABLE 15 — YIELD OF DRY RUBBER IN kg PER TREE PER YEAR
(140 TAPPINGS) (TAPPED ON S/2,d/2,100%)

Year	CLONE			
	RRIC 93	RRIC 5	RRIC 39	PB 86
1969	4.72	3.54	3.95	4.17
1970	3.95	4.40	3.95	3.81
1971	5.58	5.53	4.67	3.72
1972	5.76	5.72	5.17	3.99
1973	6.67	7.85	7.21	4.81
1974	8.16	8.94	7.76	6.21
1975	7.62	6.58	5.49	5.22
1976	5.82	5.61	5.42	5.24
1977	5.33	5.63	5.32	5.15
No. of trees tapped in 1977	80	87-80	102-97	114
B' Bast 1977	—	6	5	—
W'damage cases 1977	—	1	—	—
Average girth 1977 in cm	65.8	76.2	71.7	76.4

Of the above clones, RRIC 5 is a vigorous grower with good vegetative characters. It is now recommended for moderate scale planting in estates. (*L. B. Chandrasekera & W. T. Silva*)

Field Experiment No. 23 – 1965 *Clone Trial – Dartonfield*

Clones in this trial are planted in 50 tree plots replicated three times. Test tapping results for the first five years are given in Table 16.

TABLE 16 — YIELDING DRY RUBBER PER TREE PER TAPP. (TAPPED S/2,d/2,100% FROM JUNE 1973)

Clone	Trees tapped 1977	Yield				
		1973	1974	1975	1976	1977
RRIM 600	128-126	43.5	42.5	35.7	41.0	42.8
RRIC 90	123-118	43.1	38.7	24.8	27.0	29.7
RRIC 91	112-93	27.4	27.4	21.8	24.4	25.0
RRIC 45	118	31.7	30.3	22.0	23.9	23.4
RRIC 88	118-111	21.6	23.5	23.3	23.6	22.3
RRIC 89	113-110	34.0	34.9	21.6	20.9	20.1

Clone RRIM 600 has continued to remain the best yielding clone in this trial. (*L. B. Chandrasekera & N. L. D. Ruban*)

Field Experiment No. 25 – 1957 *Clone Trial – Estate A - Kalutara District*

This is an exchange clone trial in which out of a large number of foreign clones, IRCI 2 has been the final selection. The yields of this clone are compared with clone PB 86 in Table 17. Tapping commenced in March 1965.

TABLE 17 — YIELD OF DRY RUBBER PER TREE PER YEAR (140 TAPPINGS) OF CLONE IRCI 2 COMPARED WITH CLONE PB 86 (TAPPED S/2,d/2,100% FROM MARCH 1964)

Clone	Girth 1977 cm	Yield in kg								
		1969	1970	1971	1972	1973	1974	1975	1976	1977
IRCI 2	76.1	6.72	6.67	8.04	6.53	6.38	7.26	5.76	5.22	4.52
PB 86	73.3	3.81	3.72	4.99	4.85	4.85	5.58	4.45	4.22	3.67

(*L. B. Chandrasekera & S. Wilbert*)

Field Experiment No. 27 – 1958 *Clone Trial – Estate B - Kalutara District*

All clones are planted at 300 trees per clone. Test tapping results of the best two selections, RRIC 36 and IRCI 2, are compared with the control clone PB 86, in Table 18.

TABLE 18 — YIELD OF DRY RUBBER PER TREE PER YEAR (140 TAPPINGS) OF THE BEST YIELDING CLONES (TAPPED S/2,d/2,100% FROM APRIL 1965)

Clone	Girth 1977	Yield in kg 1970	1971	1972	1973	1974	1975	1976	1977
RRIC 36	87.9	6.22	5.72	5.90	5.13	5.13	5.58	5.63	4.22
IRCI 2	67.7	5.45	6.04	5.35	5.94	4.26	4.76	4.24	3.14
PB 86	75.8	3.68	4.36	4.90	4.99	4.90	4.22	4.40	3.93

Clone RRIC 36, which is very susceptible to panel diseases in the wet zone is now recommended for large scale planting in the relatively dry districts.

(*L. B. Chandrasekera & S. Wilbert*)

Field Experiment No. 41 - 1966 *Yield Trial - Yatawatta Estate, Matale*

Four clones RRIC 36, 41, 86 and PB 86, are planted in 265 tree plots replicated three times. Tapping commenced in 1973 of all trees that had reached a girth of over 45 cm. The trees were tapped for the first three years on the S/2,d/3,67% system. The tapping system was changed to S/2,d/2,100% in the 4th year. The average yields recorded in this trial are given in Table 19.

TABLE 19 — YIELD IN g. DRY RUBBER PER TREE PER TAPPING (TAPPED S/2,d/3,67% FROM MARCH 1973)

Clone	Trees tapped 1977	Girth 1977 cm	Yield 1973	1974	1975	1976	1977
RRIC 36	710–686	59.6	27.3	28.8	29.3	26.9	25.9
RRIC 41	698–652	61.2	15.7	17.5	18.0	19.0	18.8
RRIC 86	660–599	57.7	14.1	16.5	18.3	15.7	15.7
PB 86	664–603	60.5	17.4	20.6	21.5	20.8	21.3

The district in which this trial is located receives an average annual rainfall of around 254 cm a year. Under such rainfall conditions the period of immaturity extends up to about 8 years. By tapping at reduced intensities of 67 per cent, it has been possible to reduce the period of immaturity by approximately one year. Clone RRIC 36 has been one of the best yielders under the relatively dry climatic conditions in Sri Lanka. (*L. B. Chandrasekera & N. L. D. Ruban*)

Field Experiment No. 44 - 1967 *Yield Trial - Udapolla Group - Polgahawela*

All clones are planted in 135 tree plots replicated three times. The yields recorded for the first five years in tapping are given in Table 20.

TABLE 20 — YIELD IN g. DRY RUBBER/TREE/TAPP. (TAPPED S/2,d/2,100% FROM AUGUST 1973)

Clone	Trees tapped 1977	Girth 1977 cm	Yield				
			1973	1974	1975	1976	1977
RRIM 600	323–299	65.7	31.5	31.1	38.0	39.3	50.0
RRIC 36	354–328	65.5	31.1	30.6	34.1	34.7	41.7
RRIC 45	315–302	65.6	21.4	24.8	31.8	31.9	39.1
RRIC 89	337–321	64.5	28.2	25.4	30.2	27.3	31.5

(*L. B. Chandrasekera & N. L. D. Ruban*)

Field Experiment No. 48 - 1969 *Yield Trial - Salawa Estate, Hanwella*

In this trial, four clones RRIC 45, 100, 101 and AVROS 1734 are planted in 135 tree plots replicated 3 times. They were first tapped in April 1976 when the trees reached a girth of 50 cm. Test tapping results for the two years are given in Table 21.

TABLE 21 — YIELD IN g DRY RUBBER PER TREE PER TAPP. (TAPPED S/2,d/2,100%)

	CLONE			
	RRIC 100	RRIC 101	RRIC 45	AVROS 1734
Yield 1976	25.4	45.3	24.0	28.9
Yield 1977	27.2	34.3	25.0	27.9
Trees tapped,1977	272–340	292–310	318–317	294–331
Girth 1977 cm	54.1	54.4	54.4	52.0

(*L. B. Chandrasekera & U. K. D. Lewis*

Field Experiment No. 49 - 1969 *Yield Trial - Vogan Group, Matugama*

Eight clones RRIC 45, 88, 89, 90, 91, 100, 101 and RRIM 600 are planted with clone PB 86 serving as the control in plots of 165 points per clone replicated three times. Tapping commenced on the S/2,d/2,100% system in July 1977 of all trees that had reached a girth of 50 cm. Average yields recorded during the first five months are summarised in Table 22.

TABLE 22 — YIELD IN g DRY RUBBER PER TREE PER TAPP. (TAPPED S/2,d/2,100%)

Year	CLONE								
	RRIC 91	RRIC 100	RRIC 101	RRIC 89	RRIC 88	RRIC 600	RRIC 45	RRIC 90	PB 86
Yield 1977	20.6	25.2	43.3	22.3	15.8	30.8	23.0	27.1	27.7
Trees tapped 1977	425	413	391	388	346	328	302	147	253
Girth 1977 cm	62.0	59.1	58.8	57.5	56.3	54.5	52.7	48.4	52.2

(*L. B. Chandrasekera & S. Kodikara*)

Field Experiment No. 69 - 1970 *Yield Trial - Govinna Estate - Govinna*

In this trial, four clones RRIC 45, 100, 101 and AVROS 1734 are planted at 150 points per clone replicated three times. Tapping commenced in March 1977 on S/2,d/2, 100% system of all trees that have reached a girth of 50 cm. The average yields recorded to end of 1977 are given in Table 23.

TABLE 23 — YIELD IN g. DRY RUBBER PER TREE PER TAPP. (TEST TAPPED FROM MARCH 1977) (S/2,d/2,100%)

	RRIC 101	RRIC 100	RRIC 45	AVROS 1734
Yield	30.5	20.5	17.0	23.4
Trees tapped 1977	297–361	330–404	110–203	169–249
Girth 1977 cm	55.1	55.6	47.2	47.5

Due to change in ownership of this estate, no fertilizer had been applied during the four years 1973 to 1976. It is of interest to note that in spite of this a very high proportion of trees, particularly of RRIC 100 had reached tappable girth in the 7th year. (*L. B. Chandrasekera & N. L. D. Ruban*)

SPACING TRIALS

Field Experiment No. 24 - *Spacing Trial - Kuruwita*

Each of three clones RRIC 41, 45 and 52 are planted in 150 tree plots at spacings of 2.4 m x 9 m and 3.6 m x 6.0 m and replicated three times. Tapping commenced in 1971. The average yields and girths of clones for the two spacings in 1977 are given in Table 24.

TABLE 24 — YIELD IN g. DRY RUBBER PER TREE PER TAPP. IN THE SEVENTH YEAR

Clone	Planting spacing 8'x30'		Planting spacing 12'x20'	
	Girth 1977 cm	Yield 1977 g	Girth 1977 cm	Yield 1977 g
RRIC 45	58.9	41.2	59.4	39.9
RRIC 41	65.8	44.6	65.9	41.5
RRIC 52	73.3	40.8	73.7	39.2
Mean	66.0	42.2	66.3	40.2

The difference of average rate of girthing of trees and yields of all clones for the two spacings have not been significant. (*L. B. Chandrasekera & J. D. Karunatilleke*)

POLYCLONE TRIALS

Field Experiment No. 83 – 1966 *Small scale polyclone trial - Dartonfield*

Twenty five local and foreign clones are planted as unreplicated single tree plots. Tapping commenced in 1973, and the data recorded during the fifth year of tapping are summarised in Table 25.

TABLE 25 — YIELDS OF DRY RUBBER (TAPPED S/2,d/2,100%)

Average yield (g/tree/tapp)	..	59.64
Average theoretical yield per tapping task of 250 trees		14.9 kg
Average theoretical yield/ha (140 tappings)	..	3085
Average girth of trees at 11 yrs. age	..	88.2 cm

(*L. B. Chandrasekera & D. M. Wickremasinghe*)

Field Experiment No. 86 - *Polyclone trial - Hedigalla*

Clones RRIC 41, 45, 86, 88 and 89 are planted as single tree plots replicated 90 times. Average yields recorded during the third year of tapping are given in Table 26.

TABLE 26 — YIELDS OF DRY RUBBER (TAPPED S/2,d/2,100%)

Average yield (g/tree/tapping)	—	26.4
Average theoretical yield per tapping task of 250 trees	—	6.6 kg
Average theoretical yield/ha (140 tappings)	—	1365 kg.
Average girth of trees at 10 yrs. age	—	58.2 cm

Considering the yield potential of clones that are planted in this trial, an average yield of 1365 kg/ha in the third year of tapping could be considered as very satisfactory. Clones RRIC 86, 88 and 89 are comparatively low yielders and are no longer recommended for commercial planting. (*L. B. Chandrasekera & W. T. Silva*)

Field Experiment No. 86 - 1975 *Polyclone trial - Yatawatta Estate, Matale*

The clones planted are RRIC 13, 36, IRCI 2, RRIM 600 and PB 86. Randomly distributed monoclonal plots of each of the clones serve as the controls and each treatment is replicated three times. It was difficult to establish this trial due to the dry climate in the district.

IMMATURE AREAS

TABLE 27

Field Exp	Year planted	Extent ha	Clones	Average girth in cm			
				1974	1975	1976	1977
64	1971	14.16	RRIC 13	18.0	25.4	32.1	35.9
			RRIC 45	20.3	28.1	34.5	37.9
			RRIC 48	18.8	26.3	33.2	38.1
			RRIC 50	17.1	23.7	29.7	38.1
			PR 252	20.3	29.3	35.2	39.1
			IRCI 2	17.8	25.5	31.8	35.7
			AVROS 1734	17.8	27.7	33.3	38.2
77	1971	4.05	RRIC 102			26.3	32.8
			RRIC 103			24.6	34.3
			IRCI 9			20.1	27.6
			PB 86			19.0	26.1
100	1977	4.05	RRIC 13				
			RRIC 101				
			RRIC 102				
			PB 86				
101	1977	4.05	RRIC 48				
			IRCI 7				
			IRCI 9				
			PB 86				

(*L. B. Chandrasekera & N. L. D. Ruban*)

STOCK EXPERIMENTS

These trials were laid down in order to evaluate the suitability of seed of the popularly planted clones in Sri Lanka for use as rootstocks. The results indicate that most of these seeds could be used for propagating rootstocks.

Field Experiment No. 34 - 1966 *Small scale stock experiment*

Seedlings of seven clonal families of *Hevea brasiliensis* and seedlings of *H. spruceana* are tested for their suitability as rootstocks for clone PB 86. Mean girth of trees at $10\frac{1}{2}$ years age and the yield in their sixth year of tapping are given in Table 28.

TABLE 28 — MEAN GIRTH AND YIELD OF PB 86 ON DIFFERENT ROOTSTOCKS

Rootstock	Mean girth cm	Yield g/tree/tapp.
Tjir 1	69.3	33.4
RRIC 7	77.1	36.4
RRIC 88	73.1	35.1
RRIC 89	68.9	40.5
RRIC 86	72.9	40.5
RRIC 52	70.1	41.0
RRIC 41	71.0	35.0
H. spruceana	59.1	22.3

Growth and yield of clone PB 86 on all rootstocks except *H. spruceana* have been satisfactory. (*A. C. I. Samaranayake & W. T.Silva*)

Field Experiment No. 47 - 1968 *Small scale stock experiment - Nivitigalakele*

In this trial, clone RRIC 45 is budgrafted on rootstocks of seven clonal families. Mean girth of trees at the age of 9½ years and the yield in the third year of tapping are summarised in Table 29.

TABLE 29 — MEAN GIRTH OF CLONE RRIC 45 ON DIFFERENT TYPES OF CLONAL ROOTSTOCKS

Rootstock	Mean girth cm.	Mean yield g/tree/tapp.
RRIC 7	56.1	18.1
RRIC 41	56.3	19.1
RRIC 52	59.2	20.1
RRIC 86	58.5	19.6
Tjir 1	55.4	18.7
Gl 1	57.6	18.5
Wagga 6278	53.6	18.8

The growth and yield of clone RRIC 45 on all rootstocks under test have been satisfactory. (*A. C. I. Samaranayake & W. T. Silva*)

Field Experiment No. 61 - 1967 *Stock experiment - Nivitigalakele*

Clone RRIC 45 is being tested on rootstocks of six clonal families. The average girths of trees at 8½ years age and yield in the second year of tapping are summarised in Table 30.

TABLE 30 — MEAN GIRTH AND YIELD OF CLONE RRIC 45 ON DIFFERENT TYPES OF CLONAL ROOTSTOCKS

Rootstocks	Mean girth cm	Mean yield g/tree/tapp.
RRIC 5	55.2	20.8
RRIC 52	54.1	23.8
RRIC 89	53.1	20.1
RRIM 623	55.9	23.7
RRIC 41	56.5	23.5
Tjir 1	52.4	18.9

Growth and yield of clone RRIC 45 on all rootstocks have been better than on Tjir 1 rootstocks. (*A. C. I. Samaranayake & W. T. Silva*)

Field Experiment No. 88 - 1975 *Stock experiment - St. George Group*

In this experiment, four scion clones RRIC 45, RRIC 103, Wagga 6278 and PB 86 were budgrafted on to clonal seedlings of RRIC 45, RRIC 103, Wagga 6278 and PB 86. The mean girth of scions after two years from planting are summarised in Table 31.

TABLE 31 — MEAN GIRTH OF SCIONS IN CM AT TWO YEARS FROM PLANTING

Scion	ROOTSTOCKS				
	PB 86	RRIC 45	RRIC 103	Wagga 6278	Mean
PB 86	18.57	18.44	17.89	17.51	18.10
RRIC 45	19.43	19.22	18.04	17.91	18.66
RRIC 103	20.29	20.29	19.49	19.73	19.95
Wagga 6278	18.20	17.35	17.83	17.56	17.76
Mean	19.13	18.84	18.33	18.18	18.61

LSD = 0.49

Rootstocks of PB 86 and RRIC 45 have given the best scion growth. Among scion growth, clone RRIC 103 showed the most vigorous growth followed by clone RRIC 45.

Another aspect of investigation in this experiment will be the analysis of foliar nutrient status.

(*A. C. I. Samaranayake, R. B. Gunaratne & L. S. Kariyawasam*)

Field Experiment No. 78 - *Intercropping trial - Yatawatta Estate, Matale*

In this trial, bananas were interplanted with rubber. Clone RRIC 45 is planted at spacings of 2.4 mx9m. A single row of bananas were planted centrally between each pair of rubber rows spaced 3.6, m. along the row. Three plots of 250 trees each not interplanted, serve as the controls. The average girth of rubber trees in the intercropped and control lot at the end of four years, is given below.

Average girth of rubber at 4 *years of age*

Area interplanted with bananas	— 21.6 cm
Control (rubber only)	— 20.6 cm

Intercropping with bananas, under the conditions of this experiment, has not adversly affected the growth of rubber.

During the fourth year of the experiment, increasing competition for soil moisture between rubber and bananas was apparent. This experiment was sited in Matale, which is a fairly dry district in Sri Lanka. During a long dry spell of around 8 months in 1977, there was extensive dieback of bananas, apparently due to competition with rubber for soil moisture. All banana plants outside the rubber area remained unaffected.

In October 1977, all banana clumps were uprooted and the entire area interplanted with Coffee at spacings of 6 m x 2.4 m to give a stand of approximately 667 Coffee plants per hectare. (*L. B. Chandrasekera & N. L. D. Ruban*)

Field Experiment No. 79 - 1973 *Intercropping trial, Yatawatte Estate, Matale*

This trial serves to investigate the possibility of establishing Cacao under mature rubber in the dry planting districts. The clone PB 86 is planted at spacings of 2.4 m x 9 m. A single row of Cacao seedlings is planted between each pair of rubber rows spaced two metres along the row. Cacao was first established in polybags before transplanting in the field, and was fertilised at regular intervals. The establishment and growth of Cacao had been very satisfactory except for one plot that is exposed to strong winds, where the growth is retarded.

A further 8 hectares of mature rubber (clone PB 86) was interplanted with Cacao seedlings at spacings of 2.4 m x 9 m in December 1976.

(*L. B. Chandrasekera & N. L. D. Ruban*)

Field Experiment No. 87 - 1975 *Intercropping trial - Hatbawe Group*

In a block of 4 ha planted with rubber at spacings of 2.4 m, x 9 m three randomised plots totalling 2 ha in extent were interplanted with Coffee in the same year in which rubber was planted in the form of budded stumps. Coffee was raised in polybags before transplanting in the field. A single row of Coffee seedlings spaced 1.2 m along the row. are planted to be thinned out later to spacings of 2.4 m along the row. The Coffee plants flowered at the end of two years in November 1977. (*L. B. Chandrasekera & U. K. D. Lewis*)

Field Experiment No. 90 - *Establishemnt of forage grasses and legumes in rubber*

This experiment tests the productivity and the effects on *Hevea* of *Panicum maximum*, *Brachiaria brizantha* and *B. miliformis* planted singly or in combination with *Pueraria* and *Centrocema* at two levels of nitrogen or phosphorus. The experiment commenced in July 1975 and details and design of the experiment was given in the Annual Report for 1975.

Yields of grasses and legumes were poor in early 1977 and grasses showed severe nitrogen deficiency symptoms. Therefore the nitrogen for grass only plots was increased from 20 to 100 (N_1) and 80 to 200 (N_2)kg/ha in April 1977. For plots of legumes and grass mixtures, nitrogen was completely stopped and phosphorus as superphosphate was applied at 30 ("N_1") and 60 ("N_2") kg/ha to encourage legume growth. These ($N_1$and N_2) treatments will now be referred to as P_1 and P_2respectively. Further P was applied as superphosphate to all other plots at 30 kg/ha and muriate of potash to all plots at 100 kg/ha as before.

The effects of amended treatments indicated in the dry matter yields for two cuts taken on 24th October and 5th December 1977 (Table 32).

Stoppage of nitrogen and addition of superphosphate to legume grass plots increased the growth of the legume component. Growth of guinea grass (*P. maximum*) was better with *Pueraria* than with nitrogen or *Centrocema* whereas the opposite appears to be the case with *B. brizantha*. *B. miliformis* grew better when combined with *Pueraria* or when nitrogen was added, but its growth with *Centrocema* is poor although the percentage of legume in this treatment is high. *B. brizantha* and *B. miliformis* responded to increased nitrogen but not *P. maximum*.

TABLE 32 — DRY MATTER YIELDS (kg/ha) FOR TWO CUTS (24/10 and 05/12) OF GRASSES AND LEGUMES AND THEIR EFFECTS ON GROWTH OF *Hevea*

		Dm yield (kg/ha)		Girth (cm)	
		N_1 or P_1	N_2 or P_2	N_1 or P_1	N_2 or P_2
P. maximum (P.m.)		1830	1815	13.2	12.3
	grass	1647	2080		
P.m. + Centro.	legume	130	92	13.6	14.7
P.m. + Puero.	grass	2615	2617	13.9	14.2
	legume	408	440		
B. brizantha	(B.b)	1579	2042	10.9	10.8
B.b. + Centro.	grass	1021	1026	12.1	11.6
	legume	127	156		
B.b. + Puer.	grass	1014	871	12.9	12.8
	legume	266	192		
B. miliformis	(B.m)	1377	1733	14.4	14.9
B.m. + Centro.	grass	510	381	14.7	15.5
	legume	169	328		
B.m. + Puer.	grass	792	996	15.5	14.8
	legume	510	408		
Puer. cover		—		17.0	
Naturals		—		16.9	

P. maximum was more productive than the other two grasses and of the legume *Pueraria* was better than *Centrocema.*

B. brizantha was the most competitive and *B. miliformis* the least, on *Hevea.* The presence of the legumes with the grasses decreased the competitive effect. On the whole, growth was better with the uncut *Pueraria* cover or naturals than with grasses and legumes subjected to cutting. (*U. P. de S. Waidyanatha & S. Wijesinghe*)

Field Experiment No. 91 - *Varietal experiment with forage grasses - Eladuwa Estate*

The grass species given in Table 33 are being tested at 50 or 100 kg N/ha/yr. The DM yields and percentage crude protein for 1977 are given in Table 33.

TABLE 33 — YIELDS OF DRY MATTER

	DM yield kg/ha		% Crude protein	
	N_1	N_2	N_1	N_2
B. Miliformis	3400	4162	8.6	7.9
B. ruzizensis	7770	8958	5.9	5.9
B. mutica	3347	4222	7.4	7.4
B. dactyneura	11835	12881	6.5	7.1
Setaria anceps	5738	6791	8.5	8.7
Paspalum plicatulum	6693	13255	6.0	6.2
Pennisetum purpureum (NB 21)	4618	4968	10.4	10.1
P. maximum (guinea B)	13882	12396	9.6	9.9
P. maximum (guinea A)	17102	17065	8.8	8.6
P. maximum (green panic)	5237	5753	8.2	8.4

The yields are rather low except for the guinea grasses and *B. dactyneura*, and the response to nitrogen has been poor. (*U. P. de S. Waidyanatha & S. Wijesinghe*)

Field Experiment No. 99 - *Smallholder demonstration trial - Meegahatenna*

In an extent of 1.2 ha planted with rubber at spacings of 2x8.2 m, 0.6 ha was interplanted with Bananas and 0.4 ha was interplanted with Pineapple in November 1976. This planting serves mainly as a demonstration plot for smallholders in the area. However, the response from the smallholders to date has been very poor.

In Banana plots, a single row of Bananas was planted between each pair of rubber rows spaced 3.7 m along the row. The Bananas were kept circle weeded and regularly fertilized. Flowering commenced towards the end of 1977. The costs of maintenance of 200 banana plants, inclusive of the costs of planting material and planting to end of 1977 was Rs. 951. This appears to be a profitable crop for the smallholder.

In the Pineapple plots, a total of 4000 pineapple suckers were planted at four rows of pineapple spaced 0.45 m x 1.2 m. between each pair of rubber rows . Planting was confined to flat land and the Pineapple plots were kept clean weeded and regularly fertilized. The total expenditure at the end of one year from planting was Rs. 1959, the heaviest item of expenditure being the costs of weeding.

Field Experiment No. 98 - *Passion fruit trial - Dewalakande Estate*

Approximately 1 acre of rubber planted at spacings of 2.4 x 9 m was interplanted with Passion fruit in 1975. During the two years of the trial in 1976 and 1977 a total crop of 1543 kg was harvested. This realised an income of Rs. 1438 as against a total expenditure of Rs. 5008. The heaviest expenditure incurred was in respect of posts and wire. As this trial has proved the growing of Passion fruit to be uneconomic, it was discontinued at the end of 1977. (*L. B. Chandrasekera & U. K. D. Lewis*)

Field Experiment No. 102 - *Coffee trial - Elston Estate*

The purpose of this trial was to evaluate the effects of shade on the initial establishment of Coffee seedlings among rubber. Three areas, replanted with rubber in 1971, 1973 and 1977 were selected to represent dense shade, light shade and no shade. Approximately 300 Coffee seedlings were planted under rubber in each of the replanted areas, the Coffee being confined to a single row between each pair of rubber rows spaced 10 ft along the row. This trial would also provide data on the effects of root competition from rubber on the establishment of Coffee. (*L. B. Chandrasekera & U. K. D. Lewis*)

OTHER INVESTIGATIONS

Rainguards

A large scale Rainguard trial was started during 1977 at Eladuwa Estate in 1963 replanting on five clones, with three tapping tasks each. Two tapping tasks in each clone were fitted with rubber rainguards while one task without rainguards serve as the control. Details of tapping days and yields per tapping task for the two treatments from May to November 1977 are given in Table 34.

TABLE 34.—DETAILS OF TAPPING ROUNDS AND CROP INTAKE PER TAPPER FROM MAY 1977 TO NOVEMBER 1977

Month	Possible tapping days	CONTROL			RAINGUARD			Additional tappings		
		Days tapped	Days not tapped	Mean crop/ tapper/day/	Days tapped	Days not tapped	Mean crop/ tapper/day	Days	Total crop	Mean crop/day
May	31	17	14	—	23	8	2.63 kg.	6	86.18 kg	2.86 kg
June	30	23	7	3.35 kg	29	1	3.50 ,,	6	97.07 ,,	3.22 ,,
July	31	28	3	4.26 ,,	29	2	4.17 ,,	1	17.24 ,,	3.45 ,,
August	31	27	4	4.50 ,,	28	3	4.63 ,,	1	25.85 ,,	5.17 ,,
September	30	28	2	4.17 ,,	29	1	4.76 ,,	1	19.05 ,,	3.87 ,,
October	31	19	12	4.08 ,,	25	6	4.44 ,,	6	128.82 ,,	4.40 ,,
November	30	25	5	4.81 ,,	26	4	4.81 ,,	1	31.30 ,,	6.26 ,,

The rainguarded tasks recorded 22 tappings more than the control tasks giving a total of 405.52 kg dry rubber. The average yield per tapping task per day for the additional tapping days varied from month to month, the lowest recorded being 2.86 kg, in May (a low yielding month) and the highest being 6.26 kg in November. There was no observable difference in the average yield per tapping task per day between rainguarded and control tasks.

In the small scale trial at Dartonfield, blocks fitted with rainguards were tapped on 13 extra days in 1977, giving an additional 50 kg dry rubber. (*R. Satchuthananthavale, C. Weerasinghe & I. R. M. Amarakone*)

Tissue Culture

Hevea callus cultures were established from different source materials like seedling stem explants, clonal stem explants, embryos, cotyledons and endosperm callus cultures established from seedling stem explants and embroys and cotyledons were successfully sub-cultured on modified Murashige & Skoog's modified (MS) medium.

Callus cultures from clonal source material which were earlier found to be rather recalcitrant in sub-culture showed sustained growth vigour when grown on the modified MS medium.

Callus cultures were grown in different temperature regimes in the dark. Cultures grown at 26 - 27° C showed very good growth and cultures remained fresh for long periods. At lower temp. 24 - 25° C callus growth was slow, but the callus remained fresh and white in colour. At room temp. *ca.* 29-30° C callus growth was retarded and the material turned brown after about four weeks and then growth ceased. At temp. *ca.* 32 - 35° C, callus turned dark brown in a weeks time and degenerated.

Profuse root formation was observed in callus cultures established from embryos, when they were transferred from a growth medium containing high levels of auxin and kinetin to a differentiating medium containing low levels of auxin and kinetin.

Decotylised embroys (embryos in which cotyledons were removed) were successfully cultured aseptically on semi-solid medium. The embryos developed into small seedlings which although normal in appearance were much smaller than those developed from seeds. Growth of the embryos was vigorous up to the primary leaf stage, but later development was very much retarded. Attempts are being made to modify and develop a suitable medium that will sustain the growth of the seedlings.

Preliminary studies were carried out on the effect of colchicine on decotylised embryos. Colchicine at different levels varying from 0, 0.1, 1.0, 10.0, 100.0 and 1000.0 mg/ l was added to the growth medium and decotylised embryos were grown aseptically for three days. They were then transferred to the growth medium without colchicine. Embryos developed as normal embryos in 0 and 0.1 mg/I colchicine treatment. Embryos treated with 1000.0 mg/l colchicine failed to develop. Embryos treated with 100.0 mg/l colchicine showed only root development in some embryos. Shoot development was suppressed. Embryos treated with 1.0 and 10.0 mg/l colchicine developed into seedlings showing definite changes in morphology. The stems and petioles were elongated and the leaflets were much larger when compared with those grown on a medium lacking colchicine.

Attempts to transfer these seedlings to soil proved unsuccessful. The successful transfer of plants developed from *in vitro* culture of embryos could open a way for mutation breeding of *Hevea* through chemical means and irradiation techniques.

(*R. Satchuthananthavale, C. Weerasinghe & M. H. Mendis*)

Physiology of disease resistance

Preliminary studies were carried out using thin layer chromatography for the separation of polyphenols from *Hevea* leaves. The work is to be continued. (*R. Satchuthananthavale & I. R. M. Amarakone*)

Growth Substances in Hevea

Bioassay of methanolic extracts of "leaf buds" and "scale buds" showed the presence of a germination inhibitor. This inhibitor has now been identified as Abscisic acid (ABA). The indications are that the scale buds may have a higher level of ABA than leaf buds.

A preliminary study was made on the growth inhibitor level of emerging buds and expanding leaves of *Hevea* at different stages of growth after "wintering". There was a marked decline in the level of the inhibitor as the leaves expand.

Preliminary studies carried out on the effect of growth substances like IAA, GA and kinetin on the growth of *Hevea* seedlings indicate that GA and kinetin at low concentrations enhance stem elongation and leaf growth.
(*A. C. I. Samaranayake in collaboration with R. Satchuthananthavale and assisted by L. S. Kariyawasam*)

Reduction of the period of immaturity

Attempts are being made to reduce the period of immaturity in plantations by the use of stumped buddings and polybag plants. An aspect under special study is their costs and practicability for large scale planting. (*A. C. I. Samaranayake & R. B. Gunaratne*)

Growth variability in field plantings of budded stumps

This experiment investigates the possibility of reducing the tree to tree variability in growth within a clone by the use of various planting techniques. The following methods are being compared:–

1. A single brown budded stump per planting point planted bare root.
2. A single bare root green budded stump per planting point planted bare root.
3. Two brown budded stumps planted bare root in one planting hole and the weaker one eliminated later.
4. Two green budded stumps planted bare root in one planting hole and the weaker one eliminated later.
5. Green buddings in polythene containers with one hardened whorl of leaves.

This experiment was set down at Eladuwa Estate, Matugama in June 1976, in a completely randomized design with 12-tree plots, replicated six times.

A hundred percent success in establishment was obtained with green buddings in polybags on transplanting in the field. Lowest establishment success was for Brown budded stumps.

Data recorded so far show that variation within each treatment is not significantly different between different treatments. The height of scion recorded at 14 months and the girth of scion at 16 months after planting are given in Table 35.

TABLE 35 — GROWTH RATE OF BUDGRAFTS FOR VARIOUS TREATMENTS

Treatments	Mean height 14 months cm	Mean girth 16 months cm
T_1	278.25	10.38
T_2	278.96	10.40
T_3	264.24	9.84
T_4	286.29	10.26
T_5	309.27	10.68

Green buddings with one whorl of leaves showed better growth over the other treatments upto 14 months from planting and the indications are that this superiority may not be maintained later. (*A. C. I. Samaranayake, R. B. Gunaratne & L. S. Kariyawasam*)

Use of buds from mature trees and from budwood nurseries

It was observed that the rate of emergence of buds in clone LCB 870 budgrafts was much slower than in other clones. Budgrafts carried out from budwood of mature trees and from budwood nurseries gave the following results.

TABLE 36 — TYPE OF BUD USED AND THE TIME TAKEN FOR EMERGENCE

Type of bud	Mean time in days for emergence
From mature trees	34.5
From budwood nurseries	36.7

The difference in the rate of emergence is not significant.

(*A. C. I. Samaranayake, R. B. Gunaratne & L. S. Kariyawasam*)

Effects of hormones and placement of fertilizer on root induction and root development in budded stumps

Roots of 18 budded stumps were dipped in:-

a) 50 ppm IBA for 18 h

b) Water for 18 h

c) 2000 ppm IBA for a few seconds.

These were planted completely at random in the field. For half of the stumps in each treatment the fertilizer is placed on the surface and for the rest the fertilizer is placed at a depth of two feet from the surface. The spread and development of the root system will be studied after one year. Another set of 18 plants treated in the same way were planted in a nursery for studies on development of the root system after two years. (*A. C. I. Samaranayake, S. Wilbert in collaboration with U. P. de S. Waidyanatha*)

Crown budding

Budgrafts of clones RRIC 45, 48, 101 and RRIM 600 on Tjir 1 rootstocks were planted in June 1975 as 12 tree plots on a completely randomised design. There are 16 treatments each replicated five times. They were then crown budded with clones RRIC 45, 48, 100, 101, 102, PB 86, RRIM 600 and clone No. 2473 to get the following combinations:-

Trunk	*Crown*
RRIC 101	RRIC 101, 102, PB 86, 2473
RRIC 45	RRIC 45, 102, PB 86, 2473
RRIC 48	RRIC 48, 102, PB 86, 2473
RRIM 600	RRIM 600, RRIC 102, PB 86, 2473

(*A. C. I. Samaranayake & R. B. Gunaratne*)

Characterisation of clones

The purpose of this investigation is to study a large number of clones to identify criteria that could be used in the early selection of clones.

Ten clones of varying yield potentials were selected and fifty budded stumps of each clone were planted in a field at Eladuwa Estate, Matugama in June 1977. Ten clones were planted in single tree plots completely randomized in the field at the normal spacing of 30x8ft. In between two rows, an additional row of plants was planted with the same clones, so that plants could be removed for destructive sampling at different stages of growth leaving a normal stand of plants for long term observations.

Rate of emergence of the buds, maturation of the leaf flushes and the growth of the scion were recorded.

The data recorded so far show that the rate of emergence of the bud varies with different clones (Table 37).

TABLE 37 — PERCENTAGE SPROUTING - WEEKS AFTER PLANTING

Clone	3rd week	4th week	5th week	6th week
RRIC 88	64	84	84	88
RRIM 600	62	76	84	86
IRCI 2	56	62	72	76
RRIC 101	42	60	70	76
RRIC 52	38	52	62	64
RRIC 45	36	52	62	68
RRIC 100	36	48	62	82
GT 1	30	52	70	84
PB 86	26	48	52	60
LCB 870	10	28	36	42

Heights of scions at 5 months after planting are summarised in Table 38.

TABLE 38 — MEAN HEIGHTS OF SCIONS

Clone	Mean height of scion (cm)
RRIC 45	139.36
RRIC 52	96.69
RRIC 101	110.77
RRIC 88	125.75
RRIC 100	96.88
RRIM 600	158.70
GT 1	109.74
LCB 870	101.26
PB 86	136.17
IRCI 2	95.00

Clone RRIC 52 which is one of the most vigorously growing clones shows the least vigour of growth along with IRCI 2 and RRIC 100 in this experiment. All the clones are grafted on to RRIC 52 seedlings rootstocks.

(*A. C. I. Samaranayake, in collaboration with U. P. de S. Waidyanatha assisted by L. S. Kariyawasam & R. B. Gunaratne*)

Brown Bast studies

In the 1969 Replantation of RRIC 101 at Eladuwa Estate, some 30 trees were affected by Brown Bast during the first half of 1977. These trees were selected to test certain treatments aimed at ascertaining whether the spread of the disease on a tree can be curtailed and whether the trees can be exploited on unaffected bark. Four trees were allocated for each treatment. The treatments and yield data to date are given in Table 39.

TABLE 39— YIELD (g/TREE/TAPP.) FOR 8 TAPPINGS OF BROWN BAST AFFECTED TREES FROM OCTOBER TO DECEMBER 1977

	Treatment	g/tree/tapp.
1.	Resting of affected trees	—
2.	Removal of affected bark and application of kankerdood	—
3.	Resting of affected panel but tapping at 100 inches on new cut on opposite side	41.5
4.	Isolation of affected bark with grooves and tapping as in (3)	37.7
5.	Tapping at 100 inches on opposite side without any treatment of affected bark	39.9
6.	Continution of normal tapping of affected bark	21.2

It is evident that tapping of unaffected bark has given higher yields to date than affected bark. There is no indication that treatment of the affected bark has influenced the yield of unaffected bark. (*U. P. de S. Waidyanatha, M. C. Perera & C. Angammana*)

Nitrogen fixation

Measurements of nitrogenase activity were interrupted until the end of the year because the gas chromatograph was out of order. The Rhizobial strain evaluation programme was therefore temporarily halted.

In the above experiment, the four legumes, *Pueraria, Centrocema, Stylosanthes* and *Siratro* are grown with rhizobial inoculation and nitrogen at 0, 80, 360 or without inoculation and nitrogen. The design is a split plot with inoculation and nitrogen treatments in the main plots and legumes in the sub-plots. Each main or sub-treatment is replicated four times.

A plot of grass (*Panicum maximum*) is accommodated in each block to ascertain the amount of nitrogen available from the soil.

Each sub-plot measuring 2x3 m will be cut back regularly and dry matter content and nitrogen estimated.

This experiment has suffered a set back from rabbit damage and growth has therefore been poor so far except for the grass and *Siratro*. (*U. P. de S. Waidyanatha, W. A. Ariyaratne & S. Wijesinghe*)

Cover crop experiment (*Field Experiment No.* 92)

This experiment was described in detail in the Annual Reviews for 1975 and 1976.

The nitrogen treatments were increased from 50 to 100 kg N/ha but this has not affected the growth of the rubber. The girth increments of trees for 1977 are given in Table 40.

TABLE 40 — ANNUAL GIRTH INCREMENT

Treatment	Girth increment cm
Pueraria, inoculated	4.6
Pueraria not inoculated	4.5
Pueraria + 100 kg N/ha	4.9
Calopogonium, inoculated	4.8
Calopogonium, not inoculated	5.2
Calopogonium + 100 kg N/ha	5.1
Naturally established legumes	5.1
Naturals (without *Mikania*)	5.0
	N.S.

(*U. P. de S. Waidyanatha, L. S. S. Pathiratne & L. B. Chandrasena*)

Mycorrhizal Studies

Several species and strains of VA mycorrhizal fungi were received from USA., UK and New Zealand. These are being multiplied for evaluation against cover legumes and *Hevea*. These include Endogone types - Yellow Vacuolate and E_3 *Glomus fasciculatus* and *Glomus etunicatus*.

A study on mycorrhizal infection on growth and nitrogen fixation of *Pueraria* and *Stylosanthes* and uptake of phosphorus from Eppawela apatite and imported rock phosphate was completed and a paper was presented to the 1977 SLAAS annual session.

Growth and nodulation of *Pueraria* and *Stylosanthes*, and also nitrogenase activity of *Pueraria* grown in methyl bromide treated soil were severely suppressed unless the plants were infected with vesicular arbuscular (VA) mycorrhizae or given large amounts (500 mg/kg of soil) of rock phosphate. Mycorrhizae also enhanced uptake of phosphorus, and added rock phosphate increased it further.

Comparison of the two rock phosphates, Eppawela apatite and imported rock phosphate, revealed differences in terms of phosphorus availability and growth responses; the imported source being superior.

These observations refer in particular to *Pueraria*, the treatment effects being less distinct with *Stylosanthes*, perhaps because the uninoculated plants were contaminated with mycorrhizae, although to a significantly lower extent than the inoculated. The data are summarised in Table 41. (*U. P. de S. Waidyanatha & W. A. Ariyaratne in collaboration with N. Yogaratnam, Soils Chemist*)

TABLE 41.—EFFECT OF MYCORRHIZAL INFECTION AND ROCK PHOSPHATES ON PLANT GROWTH, % ROOT INFECTION, NODULE WEIGHT, NODULE ACTIVITY AND % P

Treatments	PUERARIA Dry matter yield(g/pot)	% Root* infection	Nodule dry dry wt. (g/pot)	moles C_2H_4 /pot/h	% P*	STAYLOSANTHES Dry matter yield (g/pot)	% root infection	Nodule dry wt. (g/pot)	% P*
Nil	2.36	0	0.0004	0.17	0.180	3.32	14.3	0.04	0.270
M	28.78	75.7	1.279	55.04	0.269	10.77	39.2	0.12	0.321
$M+S_1$	31.00	65.1	1.504	69.12	0.284	10.52	41.0	0.11	0.339
$M+S_2$	35.76	73.7	1.929	123.39	0.318	12.09	33.9	0.11	0.331
S_1	3.90	11.3	0.010	1.65	0.253	3.59	10.6	0.04	0.300
S_2	24.60	0	0.214	24.83	0.254	10.92	15.6	0.12	0.327
$M+A_1$	30.38	65.1	1.202	59.64	0.259	10.75	37.6	0.12	0.306
$M+A_2$	30.44	56.1	1.547	74.88	0.259	10.32	33.8	0.14	0.315
A_1	2.36	0	0.0002	0.22	0.166	2.96	19.2	0.04	0.270
A_2	3.06	0	0.0008	0.14	0.205	6.76	18.3	0.06	0.291
LSD 5%	4.30	9.3	0.293	28.19	0.073	2.73	10.4	0.07	N.S.

M = Mycorrhizal inoculum S = Imported rock phosphate A = Apatite

1 and 2 devote 100 and 500 mg phosphate/kg soil respectively * = Transformed values

Rock phosphate solubilization studies

There is now evidence that mixing of rock phosphate with small quanitities of sulphur, before application to soil, increases availability of P from the rock phosphate. This is brought about by the action of sulphur bacteria in the soil which converts the sulphur to sulphuric acid, the acid dissolves the rock phosphate. This is more effectively accomplished by pelletising rock phosphate, sulphur and a soil inoculum containing sulphur bacteria.

An attempt is being made to improve availability of phosphorous from Eppawela apatite by using such techniques.

A pot experiment was initiated in October 1977 comparing the following treatments --

1. 250 mg apatite — 50 mg sulphur /kg soil
2. 500 ,, — 100 ,,
3. 250 mg apatite only ,,
4. 500 mg apatite ,, ,,
5. 50 mg sulphur ,, ,,
6. 100 mg ,, ,,
7. 250 mg apatite + 625 mg gypsum
8. 625 mg gypsum only ,,

(*U. P. de S. Waidyanatha in collaboration with N. Yogaratnam, Soils Chemist*)

The author wishes to record his appreciation of the services rendered by Mr. W. G. V. Fernando, the Senior Technical Assistant, in the analysis of field experimental data.

Index to Field Experiments

experiment No.	*Description*	*Distinct/Site*
16	1956 Clone Trial	— Hedigalla
19	1962 Clone Trial	— Nivitigalakele
23	1965 Clone Trial	— Dartonfield
24	1965 Spacing Trial	— Kuruwita
25	1957 Clone Trial	— Estate A - Kalutara District
27	1958 Clone Trial	— Estate B - Kalutara District
34	1966 Stock Experiment	— Nivitigalakele
41	1966 Yield Trial	— Yatawatte Estate, Matale
44	1967 Yield Trial	— Udapolla Group, Polgahawela
47	1968 Stock Experiment	— Nivitigalakele
48	1969 Yield Trial	— Salawa Estate, Hanwella
49	1969 Yielded Trial	— Vogan Group, Matugama
53	1971 Tapping Experiment	— Dartonfield
58	1971 Ethrel Trial	— Malaboda Estate, Matugama
59	1970 Tapping Experiment	— Vogan Group, Matugama
61	1969 Stock Experiment	— Nivitigalakele
63	1971 Ethrel Trial	— Eladuwa Estate, Paiyagala
64	1971 Yield Trial	— Farnham Estate, Puwakpitiya
69	1970 Yield Trial	— Govinna Estate, Govinna
73	1972 Ethrel Trial	— Eladuwa Estate, Paiyagala
74	1973 Tapping Experiment	— Nivitigalakele
77	1973 Yield Trial	— Mirishena Estate, Govinna
78	1973 Intercropping Trial (Banana/Coffee)	— Yatawatta Estate, Matale

79	1973 Intercropping Trial (Cacao)	—	Yatawatta Estate, Matale
80	1974 Ethrel Trial	—	Talgaswela Estate, Talgaswela
83	1966 Polyclone Trial	—	Dartonfield
84	1967 Polyclone Trial	—	Hedigalla
85	1970 Tapping Experiment	—	Nivitigalakele
86	1975 Polyclone Trial	—	Yatawatta Estate, Matale
87	1975 Intercropping Trial		Hathbawe Estate, Rambukkana
88	1975 Stock Experiment	—	St. George Group, Matugama
89	1975 Crown budding Experiment	—	St. George Group, Matugama
90	Establishment of Forage Grasses and Legumes under Rubber		
91	Varietal Experiments with Forage Grasses in Rubber		
92	Cover Crop Experiment	—	Padukka Group, Padukka
93	Ethrel Trial	—	Eladuwa Estate, Paiyagala
94	Tapping Experiment	—	Nivitigalakele
95	Tapping Experiment	—	Nivitigalakele
96	Tapping Experiment	—	Eladuwa Estate, Paiyagala
99	Intercropping, Smallholder demonstration Trial	—	Meegahatenna
100	1977 Yield Trial	—	Elston Estate, Avissawella
101	1977 Yield Trial	—	Halpe Group, Tummodera
102	1977 Intercropping Coffee Trial	—	Elston Estate, Avissawella
103	Puncture Tapping Experiment	—	Nivitigalakele
104	Tapping Experiment	—	Eladuwa Estate, Paiyagala
105	Tapping Experiment	—	Dartonfield
106	Tapping Experiment	—	St. George Group, Matugama.

REVIEW OF THE GENETICS AND PLANT BREEDING DEPARTMENT

D. M. FERNANDO

SUMMARY

Genotype/environment studies on 10 modern clones, initiated in 1975 by the Geneticist, were continued. Twenty one more clones were added to the RRIC series and twelve of this latter series were released to the Socialist Republic of Vietnam. RRIC 103 and RRIC 100 displayed the best allround characteristics of the earlier 100 series : RRIC 103 yielded over 1400 kg of dry rubber per hectare in the second year of tapping in a smallholding at Ratnapura.

DETAILED REVIEW

STAFF

Mr. D. M. Fernando, Head of the Department, and Dr. N. E. M. Jayasekera, Geneticist & Plant Breeder were on duty throughout the year. N. E. M. Jayasekera attended a Workshop on International Collaboration in *Hevea* breeding and the collection and establishment of materials from the Neo-tropics held at Kuala Lumpur from 12th to 16th April 1977.

Dr. C. M. B. Ratnayake, Asst. Geneticist tendered his resignation after completing his Ph. D. in the U. K. during the year. The Rubber Research Board has not accepted his resignation, pending the resolution of his service bond. The services of Mr. H. B. H. de Silva, Senior Field Assistant, were terminated by the Board during the year.

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

PUBLICATIONS

1. D. M. Fernando, Review of the Genetics & Plant Breeding Department for 1976,

2. D. M. Fernando, N. E. M. Jayasekera and A. de S. Liyanage. Resistance breeding of *Hevea* in Sri Lanka. Workshop on International collaboration in *Hevea* breeding and the collection and establishment of materials from the Neo-tropics. 12–16th April, 1977. Kuala Lumpur.

3. N. E. M. Jayasekera and D. M. Fernando, *Hevea* introductions (non-Wickham) into Sri Lanka. Workshop on International collaboration in *Hevea* breeding and the collection and establishment of materials from the Neo-tropics. 12–16th April, 1977. Kuala Lumpur.

4. D. M. Fernando, Some aspects of *Hevea* breeding in Sri Lanka. SLAAS Symposium on Plant Breeding in Sri Lanka 13th May 1977 - Colombo.

5. D. M. Fernando, Recent development in rubber planting material. SLAAS Sessions 6–9th December, 1977. Colombo.

6. Jinks J. L., Jayasekera, N. E. M. and Bonghay, H. Joint selection for both extremes of mean performance and of sensitivity to a macroenvironmental variable. *Heredity* (1977) **39** (3) 345–355.

GENERAL

Yields from RRIC 100 and RRIC 101 from commercial estates were above most other clones and approximated closest to RRIM 600. Twenty one more clones from RRIC 111to RRIC 131, were given RRIC numbers during the year. Details of these clones are given in Table 1. Twelve of these latter clones were released to the Socialist Republic of Vietnam for the rehabilitation of their rubber industry. Yields of some of these clones were depressed owing to removal of branches for budwood.

TABLE 1 — DETAILS OF RRIC 111 TO RRIC 131

Clone	Parentage	Original number	H. P. Year	Clearing
RRIC 111	RRIC 52xPB 5/139	815	1957	'62 N'kele, '67 Peenkande
RRIC 112	RRIC 41xCh 26	1305	1959	'61 Kuruwita, '68 Kur.
RRIC 113	RRIC 52xRRIC 36	3221	1961	'64 N'kele, '68 Kur.
RRIC 114	RRIC 45xFx 4098	2417	1961	'65 D. F.
RRIC 115	RRIC 45xFx 4098	2418	1961	'63 Clodagh
RRIC 116	RRIC 88xFx 4098	2462	1961	'65 Clodagh
RRIC 117	RRIC 45xIAN 873	2473	1961	'65 D. F.
RRIC 118	RRIC 52xRRIC 52	4011	1961	'63 Kur.
RRIC 119	IAN 3434xRRIC52	5329	1962	'65 Clodagh
RRIC 120	RRIC 36 x Fx 516	6306	1962	'65 D. F., 68 Kur.
RRIC 121	PB 28/59xIAN 873	6182	1962	'65 D.F., 67 Kur. 68 Kur.
RRIC 122	LCB 1320xRRIC 52	8811	1963	'67 Kur.
RRIC 123	IAN 710xCh 26	6–704	1966	'68 Kur.
RRIC 124	Ch 26xRRIC 111	7–1078	1967	'69 Kur.
RRIC 125	RRIC 102xRRIC 89	7–1185	1967	'69 Kur.
RRIC 126	RRIC 103xCh 26	6–507	1966	'69 Kur.
RRIC 127	Ch 26x1458	7–1029	1967	'69 Kur.
RRIC 128	RRIC 102xCh 26	7–1201	1967	'69 Kur.
RRIC 129	Ch 26xRRIC 100	7–1238	1967	'69 Kur.
RRIC 130	IAN 710xRRIC 52	5–270	1965	'68 Kur.
RRIC 131	PB 86xF 1633	6433	1962	'68 Kur.

VISITS

The technical and field staff of the Department paid visits to experimental areas as well as to commercial estates for observations and collection of data.

EXTENSION

Students of the National Apprentice Board were given instructions in relevant aspects of rubber breeding.

RESEARCH INVESTIGATIONS

Mutation breeding Seedlings of selected vigorous clones were treated with 1% Colchicine for 24 h and planted in individual polythene bags. Promising seedlings were further treated by wetting the apical buds using polythene caps packed with cotton wool soaked in Colchicine solution. Some leaf and stem abnormalities were observed but the seedlings tended to normalize when treatment ceased. Root-tips and leaf primordia were collected for cytological study. (*N. E. M. Jayasekera & P. Samaranayake*)

Clone evaluation: Estates which had planted extents of RRIC 100 and 101 after initial distribution of budwood from the RRI in 1969, 1970, were visited to evaluate comparative performance. Intake figures were collected in the field or the average intake figure was obtained from the estate. With present enhanced wages an actual intake figure affords a simpler appraisal of production levels. It was found, as shown in Fig. 1, that RRIC 100 was readily brought into tapping 5 years after planting and the yields of this peaked after the first four years of tapping with negligible dry trees. The closest comparison among standard clones was RRIM 600 which is predominantly used in current Malaysian planting. RRIC 103 showed later high yields. The yields of RRIC 101 were below experimental expectations possibly owing to lack of fertilizer which appears necessary for this clone to show optimum yields. In many instances estates which have RRIC 100 or RRIC 103 in tapping tended to replant extensively with these clones. (*D. M. Fernando, B. M. S. G. Peiris & D. S. Dedduwakumara*)

Genotype/environmental interaction studies;

A girth measurement was recorded from all sites except Matale. The Matale site had to be abandoned owing to the high percentage of casualties. Leaf samples were collected from all sites and were used to study the variation in stomatal density in different clones. (*N. E. M. Jayasekera, P. Samaranayake & K. B. Karunasekera*)

1979 *Hand pollinated seedlings:* Progeny obtained from the 1979 programme have been screened for growth and yield. Selected genotypes have been budded to establish a multiplication prior to establishment of clone trials. The 1975 H. P. population was also screened : girth was used as an index of growth while micro-tapping and latex estimate of petioles have been used as indices of yield potential. (*N. E. M. Jayasekera, & K. B. Rupatunge*)

Root-Stock trial: Four clones, RRIC 52, RRIC 100, 1004 and RRIC 111 were included in this trial. Growth date of seedlings were recorded in the field and the scions will be used in all possible (16) combinations. Arrangements were made to plant this experiment in mid-1978 in two sites in two different districts.
(*N. E. M. Jayasekera, P. Samaranayake & K. B. Karunasekera*)

Resistance screening: In collaboration with the Plant Pathology Department a large number of cultivars were screened at nursery level for resistance to *Oidium*, *Colletotrichum* and *Phytophthora* diseases. RRIC 113, 115 and 117 showed appreciable all-round resistance. (*D. M. Fernando, collaborating A. de S. Liyanage*)

Dry trees: The susceptibility of RRIC 101 to dryness in some areas led to an investigation in collaboration with the Soils Chemistry and Rubber Chemistry Departments. Oil content was found to decrease in trees prone to drying. Analysis of stem apices was found to be a more effective index of nutrient imbalance than leaf or latex analysis. These investigations are continuing on twinned plants at Nivitigalakele. (*D. M. Fernando, W. D. Gunadasa, collaborating N. Yogaratnam & P. A. J. Yapa*)

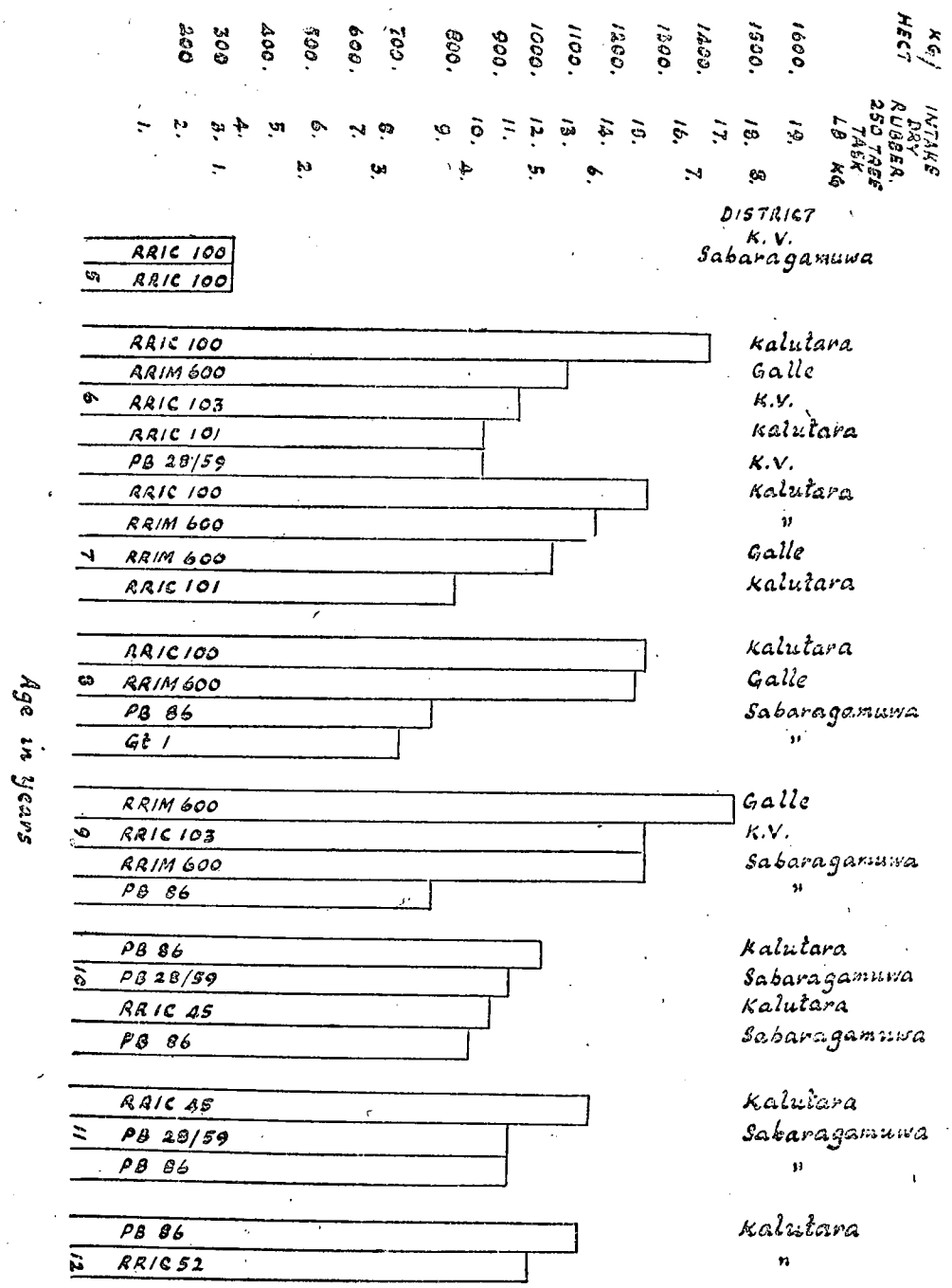

Fig. 1 Comparative intake figures from some commercial estates)

Latex/wintering inhibition: In view of recent reports that silver nitrate offsets the effect of ethylene, 50 to 3000 ppm of this chemical were sprayed at near wintering. Inhibition of wintering was noted with twin plants as controls. Observations on the effects in inhibiting yields are continuing. (*D. M. Fernando, P. Samaranayake, K. W. Rupatunga collaborating P. A. J. Yapa*)

Hand pollination programme: An attempt was made to combine different sources of SALB resistance. Differring flowering times permitted only one such cross viz;

IAN 710 (PB 86 x F 409) x RRIC 116 (RRIC 88 x Fx 4098)

69 seedlings were obtained for further study. (*D. S. Gamage*)

DISEASE RESISTANCE

Oidium

1965 *Experiment No.* 10 - *Matale* RRIC 103 maintained satisfactory yields. The RRIC 52 selfed clone, RRIC 118, showed slight susceptibility to *Colletotrichum* leaf-fall which possibly depressed yields (Table 2).

TABLE 2 — EXPERIMENT NO. 10 - 1965 CLONE TRIAL - MATALE YIELD OF CLONES TAPPED: S/2,d/2, 100%

Clone	Parentage	Trees tapped	Mean Girth cm		Yield g/tree/tapp.				Dry
			1976	1977	1974	1975	1976	1977	trees
RRIC 103	RRIC 52xPB 86	12	58.7	63.3	35.5	35.1	35.8	29.1	
RRIC 118	RRIC 52xRRIC 52	68	55.5	*53.2	28.1	39.7	34.2	26.4	
IAN 710	PB 86xF 409	52	55.0	56.5	20.1	31.6	18.0	22.4	
1108	RRIC 52xRRIC 7	29	58.0	59.8	20.5	22.0	21.0	21.0	
2427	RRIC 45xFx 4098	75	54.0	54.3	24.6	33.8	17.6	19.3	
RRIC 116	RRIC 88xFx 4098	58	58.3	60.1	24.8	26.7	20.0	18.2	

* Change in number of trees tested

(*D. S. Gamage*)

South American Leaf Blight

1965 *Experiment No.* 8 - *Dartonfield*

RRIC 117, reported resistant to SALB Race 1 by the RRIM Unit at Trinidad, showed the best yields. RRIC 102 was attacked by *Colletotrichum* which probably caused the drop in yields. Collaborative work with the Plant Pathology Department indicated that RRIC 117 has resistance at nursery level to *Oidium* leaf disease and partial-resistance to *Colletotrichum* and Bark Rot. This clone was further multiplied for planting on a larger scale. (*D. S. Gamage & G. D. Chandrasena*)

Seedling selection Ten thousand seedlings were collected from the 1967, '68, '69 clearing at Kuruwita involving SALB resistant parents and planted according to female parent; 2000 seedlings were selected from this population on the basis of microtapping and growth and further studies are in progress. (*B. M. S. G. Peiris*)

TABLE 3 — EXPERIMENT NO. 8 - 1965 CLONE TRIAL - DARTONFIELD YIELDS OF CLONES TAPPED S/2, d/2, 100% FROM 1974

Clone	Parentage	Trees tapped	Mean girth cm		Yield g/tree/tapp			
			1976	1977	1974	1975	1976	1977
RRIC 117	RRIC 45xIAN 873	13	68.5	69.5	41.8	38.6	36.2	58.5
1461	RRIC 52 x T 792	11	74.0	75.3	32.8	33.7	32.6	49.3
RRIC 114	RRIC 45 x Fx 4098	14	61.6	*60.5	49.7	46.6	52.4	39.7
RRIC 120	RRIC 36 x Fx 516	8	70.3	71.5	42.7	47.6	'37.4	39.2
5352	RRIC 52 x IAN 710	13	81.5	82.5	—	24.6	22.6	38.6
RRIC 121	PB 28/59 x IAN 873	13	76.8	78.3	32.5	27.0	32.8	38.4
RRIM623	PB 49 x PilB 84	12	67.1	67.8	26.2	27.6	23.0	36.9
2885	Ch 26 x RRIC 52	13	79.8	83.4	30.5	32.5	32.1	32.2
IAN 710	PB xF 409	13	65.3	65.3	22.6	24.7	26.3	27.6
5326	RRIC 51 x F 4542	10	72.2	*66.2	—	27.0	24.2	27.3
RRIC 45	RRIC 8 x Tjir 1	13	63.7	@70.6	27.0	28.4	25.6	24.2
RRIC 102	RRIC 52 x RRIC 7	8	63.2	63.7	51.7	50.4	51.5	21.7

* No. of trees tapped increased in 1977
@ No. of plots tested decreased

CLONE TRIALS

1963 *Experiment No. 6 - Kuruwita*

As shown in Table 4 RRIC 109 showed the best yields. Reversible drying was shown on one tree of RRIC 105.

TABLE 4 — EXPERIMENT NO. 6 - 1963 CLONE TRIAL - KURUWITA YIELDS OF CLONES TAPPED: S/2, d/2, 100%

Clone	Parentage	Trees tapped	Mean girth cm	Yield g/tree/tapp.				Dry trees
			1977	1974	1975	1976	1977	
RRIC 109	Ch26 x RRIC 36	6	86.4	58.4	54.9	83.2	73.2	
RRIC 105	RRIC52 x Tjir 1	5	84.8	64.0	78.9	54.5	60.3	1
RRIC 118	RRIC 52 x RRIC 52	7	77.2	63.6	57.1	47.6	59.3	
PB 86		55	74.7	39.0	40.5	43.1	45.5	2
RRIC 108	RRIC 36 x Ch26	7	68.4	44.4	44.9	53.8	40.1	

(*W. A. C. Wijesinghe*)

TABLE 5 — EXPERIMENT NO. 7 - 1964 CLONE TRIAL - KURUWITA
YIELD OF CLONES TAPPED : S/2, d/2, 100%

Clone	Trees tapped	Mean girth cm		Yield g/tree/tapp.				Dry trees
		1976	1977	1974	1975	1976	1977	
RRIC 110	12	77.7	78.5	73.5	74.3	64.9	77.3	1
266	18	84.5	85.6	53.4	65.6	58.5	63.4	1
RRIC 102	72	70.0	70.7	62.3	59.9	46.5	58.5	7
1152	13	75.7	77.0	45.6	43.3	38.1	44.4	3
PB86	27	59.9	60.8	—	31.6	33.1	31.7	3

1964 *Experiment No.* 7 - *Clone trial - Kuruwita*

RRIC 110 showed the best yields (Table 5) and RRIC 102 yields were satisfactory, both clones yielding appreciably more than PB 86. The yields of RRIC 110 in the 1968 clone trial at Kuruwita were similar to the early yields of this clone in the 64 clearing. (*W. A. C. Wijesinghe*)

1965 *Experiment No.* 9 - *Moneragala* – RRIC 102 showed the best yields (Table 6). There is some variation in this clone according to locality but the resistance to *Oidium* leaf disease stabilises the yields to some extent when considered as an average. RRIC 112 which yields very well in the wet zone (Experiments No. 21 and 29) showed a sudden drop at Moneragala. (*D. S. Gamage*)

TABLE 6 — EXPT. NO. 9 - 1965 CLONE TRIAL – MONERAGALA
YIELD OF CLONE TAPPED : S/2, d/2, 100%

Clone	Percentage	Trees tapped	Girth cm	Yield g/tree/tapp.			
			1977	1974	1975	1976	1977
RRIC 102	RRIC 52xRRIC 7	15	62.1	20.0	30.3	26.1	38.0
1307	RRIC 41xCh 26	19	57.6	19.0	18.1	16.5	31.0
RRIC 103	RRIC 52xPB 86	18	61.5	19.1	26.4	26.1	27.4
RRIM 623	PB 49xPilB 84	29	57.8	18.1	20.1	11.0	25.2
RRIC 101	Ch 26xRRIC 7	23	54.8	30.9	32.3	17.7	25.1
1487	Nab 20xRRIC 7	12	58.7	28.7	27.2	21.6	25.0
RRIC 104	RRIC 52xTjir 1	17	56.5	20.0	32.6	22.3	23.3
266	Mil 3/8xTjir 1	24	57.2	13.6	19.7	15.0	23.2
RRIC 45	RRIC 8xTjir 1	26	56.9	16.5	17.1	23.1	21.2
IAN 710	PB 86xF 409	27	52.1	15.5	18.1	29.1	16.8
RRIC 112	RRIC 41xCh 26	21	57.5	22.6	34.5	22.3	9.9

Experiment No. 19 - 1966 *Clone Trial - Moneragala* – RRIC 103 (Table 7) showed improved yields particularly on a kg/ha basis in 1977. The canopy of this clone also controlled *illuk* more effectively than other clones planted in this field. Average yields in the drier areas correspond closely with commercial intake figures and an intake of over 8 kg of dry rubber on a task of 250 trees represents a comparatively stable income in these areas.

TABLE 7 — EXPERIMENT NO. 19 - 1966 CLONE TRIAL - MONERAGALA
YIELD OF CLONES TAPPED : S/2, d/2, 100%

Clone	Trees tapped	Mean Girth cm		Yield g/tree/tapp.		Yield kg/ha	
		1976	1977	1976	1977	1976	1977
RRIC 103	266	65.0	67.1	21.1	34.3	647	987
RRIM 623	187	57.2	60.3	13.4	33.4	286	815

(*D. S. Gamage*)

Experiment No. 12 - 1966 *Clone Trial, Nivitigalakele* - There were no additional trees affected by wind damage or drying during the year. RRIC 103 (Table 8) showed the increase in yields associated with increase of girth after tapping. RRIC 45 yields dropped after an attack of *Oidium* leaf disease during the year.

TABLE 8 — EXPERIMENT NO. 12 - 1966 CLONE TRIAL - NIVITIGALAKELE
YIELD OF CLONES TAPPED: S/2, d/2, 67%

Clone	Trees tapped	Yield g/tree/tapp.				kg/ha	
		1974	1975	1976	1977	1976	1977
RRIC 103	186	74.2	70.6	54.8	54.4	2155	2139
1004	175	42.7	43.5	33.7	33.4	1340	1328
RRIC 45	149	50.0	30.2	30.8	16.2	1184	622

D. Rodrigo

Experiment No. 11 - 1966 *Clone trial - Kuruwita* - RRIC 103 again showed increased yields (Table 9), similar to that in Experiment 12 at Nivitigalakele.

TABLE 9 — EXPERIMENT NO. 11 - 1966 CLONE TRIAL - KURUWITA
YIELD OF CLONES TAPPED: S/2, d/2, 100%

Clone	Trees tapped	Mean Girth cm	Yield g/tree/tapp.				Dry trees
			1974	1975	1976	1977	
RRIC 103	123	74.1	61.9	56.9	68.5	73.6	—
RRIC 101	187	61.6	61.6	33.9	51.1	45.1	5
RRIC 45	134	67.4	45.4	40.9	38.5	40.2	3

(*B. M. S. G. Peiris*)

Experiment No. 14 - 1967 *Clone Trial - Nivitigalakele* - All clones showed a drop in yields in 1977 but a satisfactory yield of 1117 kg/ha was shown by RRIC 102 (Table 10).

TABLE 10 — EXPERIMENT NO. 14 - 1967 CLONE TRIAL - NIVITIGALAKELE
YIELD OF CLONES TAPPED: S/2, d/3, 67%

Clone	Trees tapped	Yield g/tree/tapp				Yield kg/ha
		1974	1975	1976	1977	1977
RRIC 102	294	55.9	54.6	37.4	28.4	1117
RRIC 101	319	70.3	53.4	32.0	26.2	995
RRIC 111	377	26.5	41.2	21.4	18.4	715
RRIM 623	146	26.5	20.3	20.0	16.9	65.7

(*K. Sumanadasa*)

Experiment No. 20 - 1967 *Clone trial - Bibile* – It was not possible to make satisfactory arrangements for test tapping this area during the latter part of 1977 hence the results in Table 11 refer to the first three months of 1977. Again RRIC 112 showed unsuitability for the Dry Zone. A shift to lower intensity tapping in 1977 did not necessarily depress yields in 1977. RRIC 101 showed a number of dry trees indicating a nutrient imbalance consequent on very high initial yields.

TABLE 11 — EXPERIMENT NO. 20 - 1967 CLONE TRIAL - BIBILE
YIELD OF CLONES TAPPED: S/2, d/2, 100% UPTO'76, S/2, d/3, 67% IN '77

Clone	Trees tapped	Yield g/tree/tapp.			Yield kg/ha		Dry trees
		1975	1976	1977	1976	1977	
RRIC 101	294	33.6	33.7	55.4	15.81	1782	53
RRIC 100	262	18.2	21.3	46.2	626	1362	—
RRIC 103	202	19.2	19.0	36.1	891	1339	11
RRIC 112	280	25.4	29.7	25.8	1338	850	20
RRIC 45	279	18.8	17.1	19.1	663	614	26
IAN 710	214	16.2	20.3	17.4	686	645	6

(*H. B. H. de Silva*)

Experiment No. 16 - 1967 *Clone trial - Gikiyanakanda* – The yields in this area improved in 1977, and RRIC 103 (Table 12) showed the best growth and yields with however 10% dry trees which were not shown in clearings started on 67% intensity for the first three or four years of tapping, such as the 1966 clearing at Nivitigalakele (Experiment No. 12).

TABLE 12 — EXPERIMENT NO. 16 - 1967 CLONE TRIAL - GIKIYANAKANDA
YIELD OF CLONES TAPPED: S/2, d/2, 100%

Clone	Trees tapped	Mean girth cm	Yield g/tree/tapp.				Dry trees
			1974	1975	1976	1977	
RRIC 103	384	72.8	36.4	43.7	42.5	66.8	39
1004	316	70.6	21.8	31.5	32.9	60.2	11
RRIC 102	239	66.1	33.9	41.6	40.6	49.0	20
RRIM 623	267	65.5	31.9	34.6	37.5	48.5	16

(*S. S. Senaratne*)

Experiment No. 17 - 1967 *Clone trial - Peenkande* – The yields of RRIC 111, subsequent to above average girthing after tapping, were best in 1977; with RRIC 100 being almost as good.

(*W. D. Armon*)

TABLE 13 — EXPERIMENT NO. 17 - 1967 CLONE TRIAL - PEENKANDE
YIELD OF CLONES TAPPED: S/2, d/3, 67% UPTO SEPTEMBER 1975, S/2,d/2,100% THEREAFTER

Clone	Trees tapped	Mean girth cm		Yield g/tree/tapp.			
		1976	1977	1974	1975	1976	1977
RRIC 111	371	79.1	83.9	46.9	53.4	48.6	65.9
RRIC 100	399	67.1	71.9	48.8	57.7	55.6	65.6
RRIC 101	412	60.0	63.7	58.9	66.8	48.2	62.6
1004	297	67.0	72.4	34.9	52.2	47.1	58.6
RRIM 623	393	62.9	67.1	44.8	54.0	44.0	51.1
RRIC 45	286	58.0	62.2	33.3	45.9	33.3	43.9

Experiment No. 19 - 1967 *Clone trial - Hedigalla* - RRIC 101 and RRIC 103 gave rather similar yields in this clearing (Table 14).

W. D. Armon

TABLE 14 — EXPERIMENT NO. 19 - 1967 CLONE TRIAL - HEDIGALLA
YIELD OF CLONES TAPPED: S/2, d/2, 100%

Clone	Trees tapped	Mean girth cm		Yield g/tree/tapp.		
		1976	1977	1975	1976	1977
RRIC 101	97	57.6	58.7	47.3	36.4	26.7
RRIC 103	217	65.4	68.1	31.4	30.0	24.5
RRIC 45	195	54.4	55.3	29.4	24.4	17.6

Experiment No. 15 - 1967 *Clone trial - Kuruwita* - Extremely high yields in clone 10570 (Table 15) were accompanied by a very high incidence of dry trees, some with a severe nodulation reaction. RRIC 121 showed very favourable growth and percentage of trees tapped.

TABLE 15 — EXPERIMENT NO. 15 - 1967 SMALL SCALE CLONE TRIAL – KURUWITA YIELD OF CLONES TAPPED: S/2, d/3, 67%

Clone	Parentage	Trees tapped	Mean girth cm		Yield g/tree/tapp.		Dry trees
			1976	1977	1976	1977	
10570	RRIC 45xPB 28/59	14	68.7	68.9	51.7	75.7	8
RRIC 122	LCB 1320xRRIC25	4	64.6	64.8	39.6	57.2	
RRIC 121	PB 28/59xIAN873	19	74.3	75.9	38.9	56.6	
7281	IAN 873xRRIC 52	16	67.2	67.3	27.1	51.7	
10727	RRIC 52xPB 86	16	64.6	65.9	27.6	40.8	
5682	Fx 25xCh 26	21	66.6	68.9	28.3	40.5	1
RRIM 623	PB 49xPilB 84	36	62.3	63.9	22.5	34.8	5
8794	RRIC 52xIAN 6167	8	66.5	68.9	27.7	30.7	3

(*W. A. C. Wijesinghe*)

Experiment No. 22 - 1968 *Clone trial - Kelani Valley* – The clone C 695 (Table 16) imported from Liberia in 1959 showed yields which matched RRIC 103 in this clearing. In other experiments, now terminated, C 695 did not yield significantly above controls.

TABLE 16 — EXPERIMENT NO. 22 - 1968 CLONE TRIAL - KELANI VALLEY YIELD OF CLONES TAPPED: S/2, d/2, 100%

Clone	Trees tapped	Yield g/tree/tapp.			
		1974	1975	1976	1977
C 695	687	24.4	30.3	31.9	34.4
RRIC 103	818	26.6	32.1	34.3	33.1
RRIC 45	780	25.3	26.9	28.9	28.9
1173	671	28.8	27.7	29.6	26.9
82	820	21.0	21.7	25.4	26.4

(*W. A. C. Wijesinghe*)

Experiment No. 23 - 1968 *Clone trial - Hedigalla* – In this experiment (Table 17) RRIC 101 and RRIC 103 were significantly above control yields.

TABLE 17 — EXPERIMENT NO. 23 - 1968 CLONE TRIAL - HEDIGALLA YIELD OF CLONES TAPPED: S/2, d/2, 100%

Clone	Trees tapped	Mean girth cm		Yield g/tree/tapp.		
		1976	1977	1975	1976	1977
RRIC 101	220	56.7	58.6	49.1	40.8	33.5
RRIC 103	279	61.1	64.0	27.9	29.5	31.4
RRIC 45	221	52.2	53.3	25.6	23.8	20.4

(*W. D. Armon*)

Experiment No. 21 - 1968 *Small scale clone trial - Kuruwita* – A number of clones involving SALB resistant parentage were found with high yield potential. Three ten tree plots gave an accurate idea of yield potential which corresponded closely with earlier trial figures for clones RRIC 104, 110 and RRIC 45; RRIC 131, 130, 123 were promising from aspects of growth, yield and canopy.

TABLE 18 - EXPERIMENT NO. 21 - 1968 SMALL SCALE CLONE TRIAL - KURUWITA YIELD OF CLONES TAPPED : S/2, d/3, 67%

Clone	Parentage	Trees tapped	Mean girth cm	Yield g/tree/tapp.	
				1976	1977
RRIC 130	IAN 710xRRIC 52	10	62.4	—	118.8
RRIC 112	RRIC 41xCh 26	13	68.5	—	88.3
RRIC 131	PB 86xF 1633	13	69.3	—	81.5
RRIC 123	IAN 710xCh 26	17	69.4	35.4	77.9
RRIC 102	RRIC 52xRRIC 7	23	66.1	48.9	74.8
RRIC 110	LCB 1320xRRIC 7	20	68.9	61.2	74.8
RRIC 104	RRIC 52xTjir 1	26	72.2	35.2	67.1
RRIC 121	PB 28/59xIAN 873	17	54.2	37.9	62.8
7263	Fx 3482xRRIC 52	20	67.4	32.4	55.7
RRIC 120	RRIC 36xFx 516	20	59.4	37.6	55.6
RRIC 45	RRIC 8xTjir 1	19	58.8	32.1	53.6
5 – 90	IAN 710xRRIC 45	16	80.5	31.4	52.8
RRIC 113	RRIC 52xRRIC 36	20	64.7	—	52.7
6 – 541	RRIC 36xRRIC 36	18	63.6	28.6	37.1

(*B. M. S. G. Peiris*)

Experiment No. 26 - 1969 *Clone trial - Sirikandura* – In this experiment (Table 19) RRIC 101 showed depressed yield in 1977, RRIC 103 and 102 showed more satisfactory yields, well above the control clone.

TABLE 19 - EXPERIMENT NO. 26 - 1969 CLONE TRIAL - YIELDS AT SIRIKANDURA

Clone	Trees tapped	Yield g/tree/tapp.			Yield kg/ha	Dry trees
		1975	1976	1977	1977	
RRIC 103	169	20.5	22.1	27.4	1440	3
RRIC 102	186	28.1	26.1	25.3	1472	1
RRIC 101	122	33.0	31.0	19.1	980	31
RRIC 45	169	21.7	27.0	18.2	876	4

(*K. Sumanadasa*)

Experiment No. 28 - 1969 *Small scale clone trial - Kuruwita* – Combinations of the RRIC 100 series with other clones in this experiment did not prove as good as outcrosses to F and Fx materials in the 1968 trial. RRIC 128 and 129 showed satisfactory secondary characters.

TABLE 20 — EXPERIMENT NO. 28 - 1969 SMALL SCALE CLONE TRIAL - KURUWITA
YIELD OF CLONES TAPPED: S/2, d/3, 67%

Clone	Parentage	Trees tapped	Mean girth cm	Yield g/tree/tapp. 1976	1977
7–1189	RRIC 102xRRIC 89	16	59.6	43.1	68.7
RRIC 128	RRIC 102xCh 26	22	65.0	36.4	62.8
RRIC 124	Ch 26xRRIC 111	19	58.2	41.7	59.7
7 – 1415	RRIC 89xCh 26	23	49.5	37.0	55.8
RRIC 129	Ch 26xRRIC 100	21	55.7	34.0	55.7
7 – 1413	RRIC 89xCh 26	19	61.9	34.0	55.4
RRIC 127	Ch 26x1458	16	60.4	48.2	51.9
RRIC 125	RRIC 102xRRIC 89	18	52.8	43.1	47.6
7– 1176	Ch 26xRRIC 111	24	64.5	30.0	43.7
RRIC 45	RRIC 8xTjir 1	9	60.4	28.7	43.2
RRIC 126	RRIC 103xCh 26	19	63.0	28.3	39.4
7 – 1218	RRIC 102 x Ch 26	20	64.9	30.2	38.6
7 – 1176	Ch 26xRRIC 111	22	68.7	30.0	32.7

(*B. M. S. G. Peiris*)

Experiment No. 25- 1968 *Clone trial - Matale* - Grown entirely without fertilizer the trees in this clearing took 9 years to come into tapping. As usual RRIC 101 showed the best first year yields (Table 21). All clones were free of *Oidium* leaf disease except RRIC 45.

TABLE 21 — EXPERIMENT NO. 25 - 1968 CLONE TRIAL - MATALE
YIELDS OF CLONES TAPPED : S/2, d/2, 100%

Clone	Trees tapped	g/tree/tapp. 1977
RRIC 101	40	34.4
RRIC 102	85	28.6
IAN 710	167	28.0
RRIC 103	76	26.0
1004	151	24.7
RRIC 100	80	21.1
RRIC 45	134	17.9

Experiment No. 29 - 1969 *Clone trial - Eladuwa* – In this fully randomized (single tree) trial with 31 replications the yields of RRIC 101 and RRIC 112 were satisfactory. The trees of RRIC 101 in this estate are under detailed investigation for the causes of dryness.

TABLE 22 — EXPERIMENT NO. 29 - 1969 CLONE TRIAL - ELADUWA
TAPPED : S/2, d/2, 100% IN 1976; S/2, d/3, 67% IN 1977

Clone	Trees tapped	Mean girth cm		Yield g/tree/tapp.		Dry trees	Wind damage
		1976	1977	1976	1977		
RRIC 101	24	57.3	57.7	51.1	29.4	2	1
RRIC 112	27	58.4	60.9	29.6	29.3		1
RRIC 100	27	49.7	51.4	26.4	25.4		1
RRIC 103	28	57.5	60.9	23.3	24.4		
82	27	53.8	57.0	28.0	23.5		
RRIC 45(Control)	144	49.0	52.1	21.8	20.7	2	4
1458	28	50.8	52.2	25.2	18.4		

(*S. S. Senaratne*)

TABLE 23 — EXPERIMENT NO. 30 - 1969 CLONE TRIAL - HEDIGALLA
TAPPED: S/2, d/3, 67%

Clone		Trees tapped	Mean girth cm		Yield g/tree/tapp.		kg/ha
			1976	1977	1976	1977	1977
RRIC 101		500	56.8	58.9	46.7	37.3	1167
,,	(randomized)	24		55.4		49.8	
RRIC 100		274	55.1	57.3	29.2	30.1	1210
,,	(randomized)	24		53.3		27.3	
RRIC 102		188	53.0	55.3	19.9	27.9	872
,,	(randomized)	26		52.1		29.1	
RRIC 103		420	61.2	64.4	24.5	27.3	854
,,	(randomized)	25		54.3		25.7	
RRIC 45		357	48.7	50.6	16.8	19.7	440
,,	(randomized)	94		50.6		20.1	
1173	(randomized)	21		50.8		21.6	
1458	(randomized)	23		56.6		25.7	

Experiment No. 30 - 1969 *Clone trial - Hedigalla* – Planted at the same time and with the same layout as the 1969 trial at Eladuwa the yield drop (Table 30) of RRIC 101 was less noticeable and the number of dry trees in all clones was nil. As this is more recently claimed land from the forest the reaction of a very high yielding clone such as RRIC 101 in this climate and soil type is interesting. The most uniform clone was RRIC 100. (*W. D. Armon*)

Commercial clearings - 1972 *Planting* - *Eladuwa* - Five acre clearings were monitored for yields in three 25 tree plots. The initial yields are shown in Table 24. Further investigations are continuing.

TABLE 24 — 1972 CLEARING - ELADUWA YIELD OF CLONE TAPPED: S/2, d/3, 67%

Clone	g/tree/tapp. 1977
RRIC 101	51.8
PB 86	30.3
RRIM 623	28.8
RRIC 100	24.2

(*N. E. M. Jayasekera & P. Samaranayake*)

Smallholding Assessment - *Ratnapura* 1970 *planting*—A five acre planting was monitored for yields and RRIC 103 was outstanding.

TABLE 25 — SMALLHOLDING ASSESSMENT - RATNAPURA - (1970 PLANTINGS) YIELD OF CLONES TAPPED: S/2, d/2, 100%

Clone	Trees tapped	Mean girth cm		Yield g/tree/tapp.		kg/ha		Dry trees
		1976	1977	1976	1977	1976	1977	
RRIC 100	198	45.2	56.5	29.9	44.1	639	914	4
RRIC 103	320	47.7	53.2	25.6	42.6	872	1478	3

(*W. A. C. Wijesinghe*)

Index to field experiments :

Field experiment	*Description*	*District/site*
6	1963 clone trial	Kuruwita
6A	1963 ,, ,,	Matale
7	1964 ,, ,,	Kuruwita
8	1965 Sm. sc. cl. trial	Dartonfield
9	1965 Clone trial	Moneragala
10	,, ,, ,,	Matale
11	1966 ,, ,,	Kuruwita
12	,, ,, ,,	Nivitigalakele
13	,, ,, ,,	Moneragala
14	1967 ,, ,,	Nivitigalakele

Field experiment	*Description*	*District/site*
15	1967 Sm. sc. cl. trial	Kuruwita
16	„ Clone trial	Gikiyanakanda
17	„ „ „	Peenkande
19	„ „ „	Hedigalla
20	„ „ „	Bibile
21	1968 Sm. sc. cl. trial	Kuruwita
22	„ Clone trial	Pannagula
23	„ „ „	Hedigalla
24	„ „ „	Bibile
25	„ „ „	Wariapola
25A	„ Supply planting	Sirikandura
26	1969 clone trial	„
28	„ Sm. sc. cl. trial	Kuruwita
29	„ cl. trial	Eladuwa
30	„ „ „	Hedigalla
34A	Stock/scion experiment	Nivitigalakele
35	1972/Seedling experiment	„
39–48	Genotype/ environment experiment	9 sites
49	1976 dialled stock/scion	Nivitigalakele

REVIEW OF THE PLANT PATHOLOGY DEPARTMENT FOR THE YEAR 1977

A. de S. LIYANAGE

SUMMARY

The incidence of leaf and panel diseases was low. The weather conditions that prevailed during this period were inimical to the establishment and spread of the causal organisms. White Root disease appears to be the most serious disease of *Hevea* in Sri Lanka. It has caused extensive damage in most of the rubber estates in the wet rubber growing districts. Black Root disease was recorded from a few more estates in the Kegalle and Kurunegala Districts.

The phenolics produced in response to infection of rubber pods of RRIC 100 by *Phytophthora* spp., appear to be released from pre-formed conjugates.

Pathogenicity studies using a number of isolates of *Gloeosporium alborubrum* revealed that although some isolates were capable of causing a high percentage of leaf infection, the total leaf area damage was small. However, a few isolates caused more leaves to be infected together with a high leaf area damage.

Isolates of *Rigidoporus lignosus* collected from different fields within estates showed morphological and physiological differences.

There appears to be no relationship between the bark moisture content of the clone PB 86 and susceptibility to Bark Rot caused by *Phytophthora* spp. However, the spread of the infection is greater during the wet months of the year than in dry months. *Phytophthora* spp. spreads more rapidly in virgin bark than in renewed bark.

The bark of RRIC 52, RRIM 513 and PB 86 calluses faster than RRIC 7 and RRIC 45. Although there appears to be an initial response to the application of some of the water-proof panel dressings, none of them appear to differ significantly from the control, about 8–10 months after their application, except Santar which retards bark renewal.

A reliable estimate of the susceptibility of clones to Bark Rot can be obtained with plants in the nursery stage using lesion area as the parameter but not the lesion length.

Some clonal seedlings appear to be more resistant to *R. lignosus* than others. The mortality rate was higher when a virulent isolate was used than an a virulent one.

Two peaks of secondary leaf-fall caused by *Oidium hevea* were observed in clones RRIC 7 and RRIC 45 but only one peak was noticed in clone PB 86 and RRIC 52.

Generally, there was a reduction in the yield when trees were defoliated at high intensities. However, at a lower intensity there was a substantial increase in the yield.

The development of pods of PB 86 occurred rapidly until mid-April, thereafter the increase was negligible and at maturity there was a reduction in the size due to loss of moisture. The rubber pods that had favourable weather conditions during the incubation period, showed early establishment of the disease. Such pods produced a large number of sporangia over a longer period than those subjected to an incubation period with unfavourable weather conditions.

Eleven isolates of *R. lignosus* grew well in Matale, Boralu and Homagama soils at two moisture regimes. Most isolates grown in Agalawatta, Ratnapura and Parambe soils showed better growth at 30% than at 70% mositure holding capacity.

The infection of trees by the Black Root disease caused by *Xylaria* spp. was initiated by old infected root debris lying in the soil and the subsequent spread of the disease was by root contact.

The addition of sulphur to the soil appears to lower the pH upto 6 weeks after the treatment. When the fungal population was assessed, *Trichoderma* spp., showed an increase in the surface soil with a concomitant reduction of *Aspergillus* spp. However, species of *Penicillium* were more abundant at lower depths. When Tillex was added to the soil there was an immediate increase in the number of bacterial colonies and *Trichoderma* spp. was the fungus commonly isolated.

A few species of Penicillia were directly antagonistic to *R. lignosus* but a majority of them prevented growth of the parasite by smothering its growth.

Although there were slight differences in the soil pH and soil moisture holding capacity, not much difference was found between the fungal species that occur in different soil types.

Schizophyllum spp., appears to be the earliest colonizers irrespective of the treatment of the cut stumps. Thereafter, species of *Trametes* and *Daldinia* occur abundantly.

Examination of decaying one year old stumps in the field indicated that the wood decaying fungi spread horizontally covering a wide area but the vertical spread was slow.

The decay of stumps under natural conditions showed that termites and other soil fauna were mainly responsible for the degradation of the woody tissues. Leguminous ground covers appear to enhance the decay of rubber wood.

The application of Fomac as a prophylactic measure was more effective than mere removal of infected roots in reducing the incidence of Black Root disease. The root regeneration from the tap root was better when both sulphur and Fomac were applied. The application of sulphur alone did not help either in the control of the disease or regeneration of the roots.

DETAILED REVIEW

GENERAL

STAFF

The Head of the Department, Dr. A. de S. Liyanage and Mr. G. W. Liyanage who was promoted as Plant Pathologist with effect from 1st July 1977 were on duty throughout the year.

The Experimental Officer, Mrs. N. I. S. Liyanage, Senior Technical Assistant, Mr. Z. E. Irugalbandara and Technical Assistants, Messrs D. M. Dantanarayana, L. Halangoda, W. Amaratunga, S. Wettasinghe, A. Dharmaratna, B. Fernando and N. Fernando were on duty throughout the year. Mr. N. W. Dissanayake was appointed as a Technical Assistant and assumed duties on the 3rd October 1977. Messrs S. S. Jayasooriya and L. Halangoda left the services of the Institute on the 16th May and 31st December 1977, to take up appointments in the National Paper Corporation and the State Plantations Corporation, respectively.

VISITS

The following visits were made by the Departmental Staff in connection with experimental, advisory and other work.

Experimental	–	302
Advisory	–	11
Miscellaneous	–	30
		343

MEETINGS

The writer attended the following meetings :–

Administrative Committee Meeting	–	1
Formulary Committee meeting	–	2
Committee Meeting of the Section B of the SLAAS	–	2
Pesticide Committee Meeting	–	1

TRAINING COURSES

The Head of the Department attended the second FAO/IAEA/SIDA Inter-regional course on "Plant Breeding for disease resistance including, the utilization of induced mutation techniques" held at the Nuclear Research Laboratory, Indian Agricultural Research Institute, New Delhi, India, from 14th November to 13th December, 1977.

LECTURES

The Head of the Department delivered ten hours of lectures on the control of diseases of Rubber to the final year Agriculture students of the Faculty of Agriculture, University of Sri Lanka, Peradeniya.

RESEARCH STUDENTS

Mr. V. Pakiyasothy, a final year student in the Faculty of Agriculture completed a research project entitled "Factors influencing the growth and sporulation of *Phytophthora palmivora* from rubber, cacao and coconuts".

PUBLICATIONS

The following publications were prepared by the staff of the Plant Pathology Department during 1977.

Annual Review of the Plant Pathology Department for 1977.

O. S. Peries, A. de S. Liyanage and N. I. S. Liyanage
Fungi associated with rubber growing soils in Sri Lanka
(Paper presented at the 33rd Annual Session of the SLAAS).

O. S. Peries, A. de S. Liyanage and D. M. Dantanarayana
Nutrition of *Phytophthora meadii* and *P. palmivora,* a comparative study.
(For presentation to the Transactions of the British mycological Society).

D. M. Fernando, N. E. M. Jayasekera and A. de S. Liyanage
Resistance breeding of *Hevea* in Sri Lanka.
(Paper presented at the Workshop on International collaboration in *Hevea* breeding and the collection and establishment of material from the Neotropics held at Kuala Lumpur, Malaysia).

N. I. S. Liyanage, P. A. J. Yapa, O. S. Peries and A. de S. Liyanage
Production of Phytoalexins in *Hevea* pods in response to infection by *Phytophthora* spp.
(Paper presented at the 33rd Annual Session of the SLAAS)

A. de S. Liyanage, O. S. Peries, D. M. Dantanarayana and N. I. S. Liyanage
Studies on some factors influencing the growth and sporulation of *Phytophthora palmivora* from rubber, cacao and coconuts.
(Paper presented at the 33rd Annual Session of the SLAAS)

A. de S. Liyanage, S. Wettasinghe and A. Dharmaratna
The distribution, spread and control of Black Root disease in Sri Lanka.
(Paper presented at the 33rd Annual Session of the SLAAS).

A. de S. Liyanage - Economics of White Root disease control.
(Paper presented at the Seminar on rubber culture, manufacture and marketing organised by the RRI at the Ceylon Chamber of Commerce).

G. W. Liyanage, L. Halangoda and N. Fernando - Studies on the spread of White Root disease in rubber.
(Paper read at the 33rd Annual Session of the SLAAS).

General disease pattern

The incidence of *Oidium* leaf disease was extremely low during 1977, except in isolated areas where wintering had been delayed, as such very little money was expended in the control of this disease.

As a result of the mild attack of *Oidium* rubber pods were produced in abundance. However, the weather conditions during the South-West monsoon period were not conducive for the propagation and spread of the fungus. Consequently, the incidence of *Phytophthora* leaf-fall and Bark Rot was almost negligible.

Although *Gloeosporium* leaf disease is not a serious problem, there were a few instances where it had caused severe damage to young plants, often retarding the growth of the plants.

White Root disease is causing serious economic losses in mature clearings in most estates. Although the incidence of the disease was generally low in immature clearings, there were estates where the infection was high.

There were two more records of the occurrence of Black Root disease in the Kegalle District. It appears to be causing some concern to the Planters in this District.

LABORATORY INVESTIGATIONS

Diseased specimens

The following diseases were identified on specimens sent to the Institute:-

Identity of the diseases	*No. of specimens*
(a) Fungi	
Oidium heveae	1
(b) Other causes	
Malformation of tissue	1
Total	2

BIOLOGY

Phytophthora spp.

Nomenclature – Although culture No. 86, 126, 361, 379, 404 and 405 were selected for a detailed study, single zoospore isolates were obtained only from culture No. 126, 361, 379 and 404. Isolate No. 86 and 405 did not produce sporangia in sufficient numbers to enable single zoospore cultures to be obtained. Several attempts were made to replace the isolate No. 86 with any other suitable culture from the Group II, without any success. Isolate No. 405 which is a *Phytophthora palmivora* obtained from the Commonwealth Mycological Institute, failed to yield sporangia freely. Therefore, an attempt was made to revitalize this culture and encourage its sporulation by passing through cacao pods, but this too was a failure. Since it was difficult to select representative isolates from the culture collection, fresh isolates were collected this year. It was possible to obtain only eleven new isolates from estates in Kalutara, Galle and Kelani Valley Districts, due to the extremely low incidence of *Phytophthora* leaf-fall. (*O. S. Peries & D. M. Dantanarayana.*)

Paper chromatography of rubber pod diffusates – The pod cavities of six clones *viz.* RRIC 40, RRIC 52, RRIC 100, RRIC 101, RRIM 623 and PB 86 were inoculated with a *Phytophthora* zoospore suspension, standardized to give 10^4 zoospores/ml. The pod diffusates kept for 1 h in pod boats were examined by paper chromatography for their phenolic constituents. Eight phenolic compounds were detected with p-nitroaniline in pod diffusates of the clone RRIC 100, whilst only five phenolics were detected with the sulphanilic acid and $K_3Fe(CN)_6$ - $Fe\,Cl_3$ reagents. Three of the eight phenolics present in the pod diffusates of RRIC 100 (spots 4, 5 & 7) were absent in the clone PB 86. The spots 4 & 5 of RRIC 100 were absent in RRIC 101, RRIM 623 and PB 86. However, a distinctly different spot which was not present in other clones was observed in RRIM 623. Clones RRIC 40 and RRIC 52 had phenolics somewhat similar in chromatographic behaviour to spots 4 and 5 of RRIC 100, but there were differences in colour reactions to both p-nitroaniline and sulphanilic acid reagents.

A bright blue spot was observed when chromatograms of pod diffusates were examined under ultra violet (uv) light. This was found in all six clones investigated. However, this particular spot did not stain for phenolics in two dimensional separations. In one dimensional chromatograms, a violet spot was observed after treatment with diazotized p-nitroaniline for phenolics, in the same position as this u v blue spot. Two dimensional runs, however, revealed that this was due to overlapping of two compounds.
(*O. S. Peries, N. I. S. Liyanage & A. de S. Liyanage in collaboration with P. A. J. Yapa*)

Bioassay of elutes – The additional spots of RRIC 100 (spots 4, 5 & 7) were eluted from paper with 95% ethanol and the results of bioassay tests carried out with these elutes on zoospore germination are shown in Table 1.

Table 1—INHIBITORY ACTIVITY OF SUBSTANCES LOCATED ON CHROMATOGRAMS OF POD DIFFUSATES OF CLONE RRIC 100

Spot No.	Rf.	%Germination
7	0.73	38
5	0.57	10
4	0.44	11
2	0.21	33
Control*	–	85
Sterile distilled water	–	98

*An eluate from a blank area of the chromatogram.

The high inhibitory activity was observed with eluates of spots 4 and 5. Less inhibition was noticed in spot 7 and also in spot 2 which too was tested due to its slightly different chromatographic behaviour when compared with PB 86. (*N. I. S. Liyanage, O. S. Peries & A. de. S. Liyanage in collaboration with P. A. J. Yapa*)

Bioassay of unfractionated pod diffusates – This was also investigated and the results are presented in Table. 2.

TABLE 2—INHIBITORY ACTIVITY OF NON-INOCULATED POD DIFFUSATES FROM SIX DIFFERENT CLONES

Clone	Pod diffusate (unfractionated)	Control (sterile distilled water)
RRIC 40	2	92
RRIC 52	3	88
RRIC 100	0	91
RRIC 101	54	88
PB 86	13	89
RRIM 623	1	92

A strong inhibition of zoospores was observed in clones RRIC 40, RRIC 52, RRIC 100 and RRIM 623 when compared to PB 86. The highest zoospore germination was seen with the diffusate from the clone RRIC 101. These results suggest that the spot No. 4 and 5 of the clone RRIC 100 play a role in the inhibition of zoospore germination (*O. S. Peries, N. I. S. Liyanage & A. de S. Liyanage in collaboration with P. A. J. Yapa*)

Amino acids in pod tissues – Analysis of amino acids by paper chromatography revealed that only one amino acid was present in clone PB 86 whereas clone RRIC 100 had six amino acids. (Table 3).

TABLE 3—AMINO ACIDS IN POD DIFFUSATES OF CLONES PB 86 AND RRIC 100

Clone	Number of Amino acids	Visual estimation
Clone 100	Aspartic acid	++
	Glutamic acid	++++
	Asparagine	+++
	β-Alanine	+++++
	Hydroxyproline	++
	Valine	++
PB 86	Glutamic acid	++

It was observed that glutamic acid and β-aniline are present in relatively larger quantities than the others. Synthetic solutions of amino acids detected in the diffusates were bio-assayed at a concentration of 50 ppm by the usual method. A slight inhibition was observed with all individual synthetic amino acids examined. However, slightly increased inhibition was observed when different combinations of amino acids were tested (*O. S. Peries, N. I. S. Liyanage & A. de S. Liyanage in collaboration with P. A. J. Yapa*)

Phenolic content of pod tissues - The total pre-formed phenolic content of the pod tissue of some clones is given in Table 4. It shows that the phenolic content of the clone PB 86 was higher than that of RRIC 100 (*N. I. S. Liyanage, O. S. Peries & A. de S. Liyanage in collaboration with P. A. J. Yapa*)

TABLE 4—TOTAL PHENOLIC CONTENT IN EXTRACTS OF POD TISSUES

Clone	Phenolic content mg/g dry tissue
RRIC 40	8.0
RRIC 52	9.6
RRIC 100	29.0
RRIC 101	18.0
PB 86	38.0

Gloeosporium alborubrum

Pathogenicity of different isolates – The Pathogenicity of a number of isolates collected from different rubber growing areas was studied by spraying a standardized conidial suspension to apple green leaves of the clone PB 86. The sysmptoms appeared in 2–3 days. The percentage leaf infection and leaf area damage, in respect of each isolate are shown in Table 5.

It was observed that several isolates were capable of causing a moderate to high degree of leaf infection, but only a few were able to cause severe leaf area damage. Some isolates showed an inverse relationship between percent leaf infection and leaf area damage. (*A. de S. Liyanage & A. Dharmaratna*)

TABLE 5—PERCENTAGE OF LEAVES INFECTED AND LEAF AREA DAMAGED, 3 DAYS AFTER INOCULATION

Isolate	Estate	District	Leaves infected (%)	Leaf area infected (%)
1	Moralioya	K. V.	0	0
2	Urumutta	Matara	89.4	52.7
3	Nakiadeniya	Galle	63.2	28.0
4	Pelmadulla	Ratnapura	82.2	44.3
5	Peenkanda	Ratnapura	82.5	50.3
6	Golinda	Kegalle	58.1	36.7
7	Padukka	Colombo	56.3	19.7
8	Wariyapola	Matale	84.4	50.7
9	Gampola	Kandy	65.2	44.9
10	Bibile	Badulla	78.0	29.9
11	Monaragala	Badulla	81.8	58.1
12	Dartonfield	Kalutara	92.1	77.2

Rigidoporus lignosus

Effect of temperature on growth - The isolates obtained from Peenkande Estate, Uda Karawita were generally slow growing compared to those collected from Woodend Estate, Dehiowta (Table 6).

TABLE 6—MEAN RADIAL GROWTH (mm) OF *R. lignosus* ISOLATES ON MALT AGAR AT DIFFERENT TEMPERATURES, 3 DAYS AFTER INOCULATION*

Temperature °C	Isolate							
	Peenkande				Woodend			
	1	2	3	4	1	2	3	4
15	0	0	0	0	4.0	3.7	0	0
20	4.5	2.0	1.2	8.1	13.3	12.8	8.9	6.1
25	14.7	13.1	14.0	20.6	26.0	27.1	28.3	22.1
30	26.9	29.6	21.6	35.5	28.2	38.2	31.3	28.1
35	7.8	11.4	10.5	15.7	18.0	16.5	1.6	3.0

*Mean of five replicates

However, in the former estate some isolates showed a fast rate of growth while in the latter some slow growing isolates were detected. Generally, all the isolates grew poorly at extreme temperature conditions. The maximum growth was recorded at 30°C. (*G. W. Liyanage, A. de S. Liyanage, W. Amaratunga & N. W. Dissanayake*)

Effect of pH on the growth – The growth of different isolates was determined at pH values ranging from 3—9 (Table 7).

TABLE 7. MEAN COLONY DIAMETER (mm) OF DIFFERENT ISOLATES OF *R. lignosus* ON MALT AGAR, 3 DAYS AFTER INOCULATION*

pH	Isolate							
	Peenkande				Woodend			
	1	2	3	4	1	2	3	4
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	13.6	18.3	11.2	18.5	4.0	11.1	17.2	12.3
6	34.0	35.8	20.3	28.0	21.0	27.5	30.8	26.6
7	36.2	40.0	25.5	38.5	22.1	34.7	36.6	32.0
8	33.1	42.3	29.0	38.5	21.6	39.6	40.1	36.1
9	37.1	49.3	28.8	40.6	17.7	40.5	41.3	30.1

*Mean of five replicates.

Isolates obtained from both estates did not grow at pH 3 and 4. All the isolates grew better under alkaline conditions, with most isolates showing maximum growth at pH 9. (*G. W. Liyanage, A. de S. Liyanage, W. Amaratunga & N. W. Dissanayaka*)

Effect of light and dark on growth – All isolates grew well in continuous darkness than when exposed to continuous light (Table 8).

TABLE 8. EFFECT OF EXPOSURE TO CONTINUOUS LIGHT AND DARK CONDITIONS ON THE GROWTH OF EIGHT ISOLATES OF R. *lignosus*, 3 DAYS AFTER INOCULATION*

Estate	Isolate	Dark	light
Peenkande	1	23.2	14.8
	2	35.5	13.2
	3	27.3	14.3
	4	32.2	14.0
Woodend	5	24.3	18.8
	6	30.1	19.5
	7	38.5	27.2
	8	33.2	14.8

*Mean of five replicates

Slow growing isolates were seen amongst the isolates collected from Woodend Estate, while relatively fast growing ones were found at Peenkande. This shows that the rate of spread could differ in different fields. (*G. W. Liyanage, A. de S. Liyanage, W. Amaratunga & N. W. Dissanayaka*).

HOST-PARASITE RELATIONSHIPS

Oidium heveae

Histological basis of resistance – Copper brown leaf discs of several clones were inoculated with 24 h old inoculum on the adaxial surface. These were incubated under optimum environmental conditions and removed at different intervals to examine the pre-penetration and post-penetration behaviour. These studies are partially completed and further progress could not be made due to non-availability of certain chemicals. (*A. de S. Liyanage & B. Fernando*)

HOST—PARASITE RELATIONSHIPS

Bark moisture status of different clones - The bark moisture content of the clones RRIC 45, RRIC 52, RRIM 513 and PB 86 is generally low compared to that of RRIC 7 and RRIC 88. The moisture content appears to be less during the dry months of the year, than during the wet period, although this effect is not marked. (Table 9).

TABLE 9. PERCENTAGE BARK MOISTURE CONTENT OF SIX CLONES*

Clone	Period												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
RRIC 7	61.0	61.0	60.8	62.4	60.8	60.9	61.8	61.9	61.3	60.7	62.1	60.3	61.3
RRIC 45	61.0	55.0	55.4	57.2	58.3	58.0	58.4	58.0	56.7	58.0	54.6	55.4	57.2
RRIC 52	58.9	57.6	58.0	57.7	57.5	58.2	58.1	59.1	57.8	58.1	57.7	56.4	57.9
RRIC 88	59.6	59.4	59.8	62.2	61.4	61.7	62.1	62.2	62.9	61.2	60.2	61.1	61.1
RRIM 513	57.9	57.1	58.8	58.4	58.1	58.5	57.2	58.2	58.5	58.7	58.7	57.0	58.1
PB 86	60.3	59.1	59.9	57.4	60.1	59.4	59.4	58.8	58.9	58.9	58.3	59.6	59.2

*Mean of five replicates

There is very little difference between the moisture content of clones susceptible to Bark Rot *e.g.* RRIC 45, RRIM 513 and a resistant clone like RRIC 52. (*O. S. Peries & Z. E. Irugalbandara*)

Bark moisture on disease spread - Ten trees of clone of PB 86 at Galewatta Estate, were inoculated monthly at the tapping panel and about 2 m from the ground, using the strip and disc inoculation methods, respectively.

The inoculation could not be done in the months of April, May and June 1977 as the fungus had lost its ability to produce sporangia and it had to be passed through the host twice to rejuvenate the culture. The results are presented in Table 10.

TABLE 10. BARK MOISTURE CONTENT OF THE CLONE PB 86 IN RELATION TO LESION DEVELOPMENT*

Month of Inoculation	Moisture Content (%)	Lesion area (cm^2)	
		Tapping cut	2 metres from the ground
December 1976	—	10.6	14.6
January 1977	59.2	5.9	14.5
February	60.0	1.1	10.0
March	62.5	4.3	15.5
April	62.1	—	—
May	—	—	—
June	—	—	—
July	61.8	29.9	18.6
August	60.8	12.8	22.9
September	58.3	23.3	16.7
October	59.9	5.8	23.7
November	60.4	24.5	24.8

*Mean of three replicates

TABLE 15—EFFECT OF DIFFERENT PANEL DRESSINGS ON THE RATE OF CALLUSING (cm) OF BARK OF PB 86*

Date of wound measured	Panel dressings															
	Shell TB 192		Kankerdood		Santar		Candarsan		Cowdung I		Cowdung 2		Cowdung 3		Control	
	SW	AC	SW	AC	SW	AC	SW	AC	SW	AC	SW	AC	SW	AC	AC	AC
17.9.76	8.67		8.85	—	8.61	—	9.07	—	8.71	—	9.02	—	9.67	—	8.65	—
19.12.76	8.50	0.10	8.05	0.80	9.46	0.85	7.95	1.12	9.27	–0.56	8.33	–0.69	8.15	1.52	8.24	0.41
17.4.77	7.78	0.72	7.56	0.49	8.58	0.88	7.27	0.68	8.59	0.69	7.75	0.58	7.01	1.14	7.23	1.01
19.8.77	4.43	3.35	5.27	2.29	7.16	1.42	4.41	2.86	6.29	2.29	5.81	1.94	4.166	2.85	4.82	2.39
20.12.77	2.76	1.67	3.02	2.25	5.73	1.42	1.75	2.66.	4.14	2.15	3.59	2.22	2.61	1.51	1.72	3.10
Amount callused		5.84		5.83		2.88		7.32		4.57		5.43		7.02		6.91

SW — size of wound
AC — Amount callused
* — Mean of five replicates

The application of Candarsan and CD_3 (cowdung + earth) has resulted in a slight improvement in the rate of callusing when compared to the control, but these differences do not appear to be significant (Table 15). The application of Santar markedly reduces bark renewal. Bark scorch was observed initially where Santar and CD (copper sulphate + sulphur + cowdung) were applied.

(Table 15-see page 78)

It was observed that 60% of the trees on which Shell TB 192 has been applied, showed complete callusing of the wound. It was also apparent that the initial growth of the tree influences the rate at which the trees callus.

When circular wounds of PB 86 were treated with various formulations in another experiment, initiated in April (Table 16), it indicated that, at the end of 8 months after treatment, Shell TB 192 appears to be superior to the other formulations in enhancing the rate of callusing. Santar again proved to be inferior. In this experiment the maximum amount of callusing occurred between 4 and 6 months after the commencement of the experiment. It therefore appears that callusing occurs rapidly when the bark is removed during wet weather periods.(*O. S. Peries, N. I. S. Liyanage & B. Fernando*)

(Table 16-see page 80)

Influence of different chemicals on the callusing of irregular wounds in virgin and renewed panels of PB 86 – The observations taken four months after initiation of the experiment revealed that callusing occurs mostly along the length of the trunk. Hence, to evaluate the influence of different chemicals on bark renewal the wounds must be of a similar shape and size. (*A. de S. Liyanage, O. S. Peries, N. I. S. Liyanage & B. Fernando*)

TABLE 16—THE MEAN SIZE OF CIRCULAR WOUNDS (cm) AND THE RATE OF CALLUSING OVER DIFFERENT PERIODS IN THE CLONE PB 86

Date of wound measurement	Shell TB 192		Kankerdood		Santar A		Candarsan		Barkosan		Control	
	SW*	AC**	SW	AC	SW	AC	SW	AC	SW	AC	SW	AC
21.4.77	9.01	—	9.15	—	9.02	—	9.45	—	9.04	—	8.93	—
23.6.77	8.47	0.54	8.60	0.55	8.81	0.21	9.01	0.44	8.46	0.58	8.80	0.13
23.8.77	7.52	0.95	7.65	0.95	8.24	0.57	7.97	1.04	7.49	0.97	8.34	0.46
24.10.77	5.73	2.21	6.1	1.55	7.17	1.07	6.81	1.16	5.95	1.54	7.28	1.06
21.12.77	4.71	1.02	5.36	0.74	6.89	0.28	5.88	0.93	5.19	0.76	6.63	0.65
Amount callused		4.72		3.79		2.13		3.57		3.85		2.30

* SW — size of wound
AC — amount callused
* Mean of five replicates

Rigidoporus lignosus

Evaluation of rootstocks resistant to Rigidoporus – On a preliminary pot experiment seedlings of 21 clones were tested for rootstock resistance to *R. lignosus.* The inoculum was prepared by multiplying the isolate obtained from Dartonfield (avirulent) on sterlized rubber wood blocks, 1½ kg of inoculum was buried 7.5 cm below the surface of the soil before transferring the germinated seedlings. Fifteen seedlings were planted in each pot. There were three replicates. The results are shown in Table 17.

TABLE 17—PERCENTAGE MORTALITY OF SEEDLINGS OF DIFFERENT CLONES TO *R. lignosus**

Clone	Dead Seedlings (%)
RRIC 9	13.3
RRIC 36	24.4
RRIC 40	24.4
RRIC 41	6.6
RRIC 43	8.8
RRIC 45	28.8
RRIC 52	4.4
RRIC 100	6.6
RRIC 103	20.0
Wagga 6278	64.4
RRIM 612	15.5
RRIM 623	2.2
RRIM 701	8.8
PB 86	17.7
PB 5/51	0
WR 101	6.6
LCB 1320	4.4
GT 1	11.1
Tjir 1	28.8

*Mean of 45 seedlings

Assessment of infection 1 year after commencement of the trial indicated that, seedlings of most clones, except Wagga 6278 were only slightly affected by the disease.

Another trial was initiated in 1977, using a virulent isolated obtained from Woodend Estate. The methods used were identical to that described in the previous experiment. Seedlings of 35 clones were evaluated and the results obtained three months after initiating the experiment are shown in Table 18.

TABLE 18—PERCENTAGE MORTALITY OF SEEDLINGS OF DIFFERENT CLONES TO *R. lignosus**

Clone	Dead seedlings (%)
RRIC 7	53.3
RRIC 9	22.2
RRIC 36	62.2
RRIC 37	15.5
RRIC 40	33.3
RRIC 43	15.5
RRIC 45	13.3
RRIC 46	11.1
RRIC 52	24.4
RRIC 87	13.3
RRIC 100	24.4
RRIC 101	6.6
RRIC 102	60.0
RRIC 111	37.7
RRIM 501	11.1
RRIM 513	6.6
RRIM 600	82.2
RRIM 623	8.8
PB 5/51	20.0
PB 5/63	2.2
PB 5/78	13.3
PB 86	51.1
LCB 1320	6.6
GT 1	13.3
AV 231	35.5
PB 252	11.1
PR 255	55.5
IRCI 9	2.2
TR 1548	33.3
GPM	71.0
PTB 137	75.5
1004	62.2
1010	0
1108	37.7

*Mean of 45 seedlings

Most of the clones tested show a high degree of susceptibility, but a few clones *e.g.* IRCI 9, PB 5/63, RRIC 101, RRIM 513, LCB 1320 and RRIM 623 showed less than 10% infection. Clone No. 1010 was immune to infection. This experiment is continuing and firm conclusions cannot be made yet. (*A. de S. Liyanage, G. W. Liyanage & W. Amaratunga*)

Oidium heveae

Pattern of wintering and incidence of Oidium – The pattern of wintering and the incidence of secondary leaf-fall caused by *O. heveae* were recorded on clones PB 86, RRIC 7, RRIC 45 and RRIC 52 from December 1976 to April 1977 at Dartonfield. The results shown in Table 19 indicate that wintering commenced around the end of November and was completed between weeks 2-3 in February.

TABLE 19—PATTERN OF WINTERING AND THE INCIDENCE OF SECONDARY LEAF-FALL DUE TO *Oidium*

	Onset of defoliation	Completion of defoliation	Onset of *Oidium*	Completion of *Oidium*	Maximum leaf-fall 1st peak	2nd peak
RRIC 7	Nov 1976	9 Feb	8 Feb	6 May	21 Feb	15 Apr
RRIC 45	Nov 1976	19 Feb	13 Feb	8 May	24 Feb	23 Apr.
RRIC 52	Nov. 1976	15 Feb.	13 Feb.	2 Apr.	23 Feb.	—
PB 86	Nov. 1976	9 Feb.	8 Feb.	6 Apr.	16 Feb.	—

There was hardly any difference in the commencement of secondary leaf-fall (SLF) caused by *O. heveae*. It occurred between 8-13 February, but the date of completion of SLF in RRIC 52 and PB 86 was around the first week of April, while that of RRIC 7 and RRIC 45 was around the first week of May. There were two peaks of SLF in clones RRIC 7 and RRIC 45 and only one peak in RRIC 52 and PB 86. (*A. de S. Liyanage*)

Trapping of Oidium *spores* – Rod traps were used with sellotape as the trapping surface. The highest number of spores was observed on the 18th February and 18th April. Maximum spore germination on the trapping surface was also observed on these two days. (*A. de S. Liyanage*)

Phenology of different clones – Ten shoots were selected from each of the clones RRIC 7, RRIC 45, RRIC 52 and PB 86. The development of the bud was assessed on the basis of ten stages of growth. The pattern of the disease development was also noted. (*A. de S. Liyanage*)

Phytophthora spp.

Pod development in Hevea – Several flowers of clone PB 86 were tagged on the 1st February 1977. Circumference of 57 pods developed from these flowers were measured at weekly intervals from the 15th March until pod maturity. The results are shown in Table 20.

TABLE 20—MEAN POD CIRCUMFERENCE IN CLONE PB 86*

Weeks after flowering	Average pod circumference (cm)	Difference (cm)
6	1.47	—
7	2.27	0.80
8	4.05	1.78
9	8.42	4.37
10	12.61	4.19
11	15.11	2.50
12	18.47	3.36
13	19.26	0.79
14	19.26	0
15	19.28	0.02
16	19.32	0.04
17	19.36	0.04
19	19.34	-0.02
21	19.33	-0.01

*Mean of 57 pods.

It was observed that pod development occurred rapidly until about 19 April, the average increase being about 5 cm over a period of one month, after which the pods continued to increase at a very slow rate for about 2 weeks. A reduction in the pod size was noticed when they were mature and approaching dehisence. This is probably due to the loss of moisture from the epicarp of pods. (*O. S. Peries, A. de S. Liyanage & N. I. S. Liyanage*)

Factors influencing establishment of infection and spourulation on rubber pods – Six mature pods of clone NAB (crown budded) were selected on each week day commencing from the 14 June to 27 June 1977. These pods were inoculated on the lower side, with a *Phytophthora* zoospore suspension (10^4 zoospores /ml). A device was set up soon after the experiment was started to collect the water that runs off the pods during each shower, until 20th July when the experiment was terminated. The water collected in the flasks after each shower, was measured and the total number of sporangia were counted. Observations were kept on the time taken for lesion development and in addition lesion areas were measured.

When pods were inoculated under favourable environmental conditions (*i.e.* high humidity, rain, low temperature and no sunshine). The incubation period extended from 5–6 days but when conditions were unfavourable, it took about 7–9 days for the establishment of the disease. In the former case, the pods continued to produce large number of sporangia over a longer period (5 weeks) while in the latter the pods ceased to produce sporangia within 3 weeks after inoculation. (*A. de S. Liyanage, O. S. Peries, D. M. Dantanarayana & A. Dharmaratna*)

Rigidoporus lignosus

Spread of different isolates in seven soil types – Seven soil types were selected to study the spread of eleven isolates of *R. lignosus* at 30% and 70% moisture holding capacity (MHC). The results are shown in Table 21. When the overall pattern is considered, all the isolates grew well in Matale, Boralu, Homagama soils at both moisture regimes. Most of the isolates grown in Agalawatta, Ratnapura and Parambe soils showed more growth at 30% MHC than at 70% MHC. There was very little or no growth in deniya soils. (*G. W. Liyanage, A. de S. Liyanage & N. W. Dissanayake*)

TABLE 21—MEAN LINEAR GROWTH (mm) OF ELEVEN ISOLATES OF *R. lignosus* IN SEVEN TYPES OF RUBBER SOILS, 5 DAYS AFTER INOCULATION

Soil type	Moisture holding capacity %	Isolates A	B	C	D	E	F	G	H	J	K	L
Agalawatta	30	41.3	44.5	36.4	32.3	47.7	34.4	37.6	39.1	36.2	45.0	43.7
Ratnapura		40.6	44.8	36.3	27.5	48.0	33.0	44.1	49.5	33.0	37.9	38.3
Parambe		46.0	49.1	49.1	40.5	48.3	47.5	48.6	42.8	42.5	42.6	44.5
Matale		37.6	43.3	47.8	41.5	47.6	40.5	44.0	51.5	45.0	46.6	43.3
Boralu		49.5	50.1	48.3	41.3	45.6	48.3	48.3	45.5	45.6	43.3	42.1
Homagama		41.8	43.0	46.1	28.8	42.0	30.0	35.0	47.5	35.0	26.1	34.0
Deniya		0.60	0	4.6	2.5	0	0	4.1	2.5	0	1.3	
Agalawatta	70	45.6	40.0	44.2	27.8	27.8	36.2	40.6	47.8	35.2	37.6	42.0
Ratnapura		27.2	28.6	29.6	28.8	28.8	4.6	11.6	3.0	8.8	14.2	8.2
Parambe		46.6	37.0	42.2	42.4	42.4	40.8	40.6	41.8	37.4	37.0	36.4
Matale		60.0	50.4	46.2	50.0	50.0	41.4	46.6	61.6	40.2	48.2	52.2
Boralu		66.6	59.0	57.6	53.6	53.6	53.6	58.2	68.6	61.8	53.0	46.2
Homagama		59.4	50.2	50.0	53.8	53.8	38.0	49.4	68.6	47.8	45.0	40.4
Deniya		0.2	0	0	0	0	0	0	0	0	0	0

Spread from a known source of inoculum – A five acre block at Nivitigalakele was planted with the clone PB 86 on Tjir 1 rootstocks, at a spacing of 6.97x3.65m(20'x12'). Infected root pieces were buried at two distances from the base of the tree. The treatments replicated four times, are given below :–

(1) stumps at a distance of 61 cm (2') from the plant

(2) ,, ,, ,, ,, of 1.8 m (6') ,, ,, ,,

(3) large laterals at a distance of 1.8 m from the plant and buried at a depth of 0.9 m (3')

(4) large laterals at a distance of 1.8 m from the plant and buried at a depth of 0.9 m.

(5) small laterals at a distance of 1.8 m from the plant and buried at a depth of 30 cm.

(6) small laterals at a distance of 1.8 m from the plant and buried at a depth of 0.9 m.

This trial planted during the South-West monsoon is in progress. (*O. S. Peries, A. de S. Liyanage, N. I. S. Liyanage & W. Amaratunga*)

Natural spread – The third census of the number of trees infected was taken one year after initiation of the experiment in the estates where several patches were demarcated to study the natural spread (Table 22).

TABLE 22—THE RATE OF SPREAD OF WHITE ROOT DISEASE IN SEVERAL ESTATES

Estates	District	No. of sites Within each Estate	Infection (%)
Muwankanda	Kurunegala	14	36.3
Peenkanda	Ratnapura	11	4.1
Doloswela	Ratnapura	12	—
Moralioya	Kelani Valley	14	28.6
Urumutta	Matara	10	13.2
Glassel	Kelani Valley	12	20.7
Ambadeniya	Kegalle	13	28.3
Golinda	Kegalle	12	29.9
Galewatta	Kalutara	10	—
Dartonfield	Kalutara	17	20.7
Kiriwanaketiya	Kalutara	12	32.9
Padukka	Colombo	12	20.0
Stockesland	Galle	—	NT

NT — Census not taken

The area in each of the patches selected for this study was surveyed to identify the soil type.

It is observed that generally the spread of infection was high in most estates. In Peenkande Estate the spread was exceptionally slow. This experiment is still continuing. (*G. W. Liyanage, L. Halangoda & N. Fernando*)

Size of food base in relation to infection – A small scale field experiment was initiated to determine the effect of different sizes of infected roots in the planting hole on the incidence of the White Root disease. The following treatments were replicated four times in this trial.

1. large laterals
2. small laterals
3. pencil thick roots (0.7 cm)
4. thick roots (1.3 cm)
5. control

In all the cases the root pieces were 30 cm long and buried at a depth of 30 cm. In the treatments 1 & 2 only 4 pieces of roots were buried on four sides of the plant. Treatments 3 & 4 received 6 and 8 pieces of roots, respectively. This trial is still in progress. (*O. S. Peries, A. de S. Liyanage, N. I. S. Liyanage & W. Amaratunga*)

Xylaria spp.

Pattern of spread – Excavation of the soil in an area in the 1958 PB 86 clearing at Parambe Estate, revealed that the spread of the disease was initiated by root contact with the old infected root debris, left in the soil at the time of clearing the old stand. Once the disease is established subsequent spread of the disease was by root contact. Therefore, the affected patches were seen to occur in groups. (*A. de S. Liyanage, S. Wettasinghe & A. Dharmaratna*)

Rate of spread – Six healthy trees, in which the roots were unaffected by any root disease, were selected from the 1958 PB 86 clearing at Parambe Estate. Standard pieces of inoculum (5x15 cm), obtained from the leading edges of infected roots were buried in the following manner after excavation of the soil around the plants. Three trees were selected for each treatment.

(1) Placed against lateral roots at a distance of 1.8 m.

(2) Placed against the bole of the tree at the collar region.

The root system of trees inoculated in this manner were exposed on the 20th May 1977, 2 years 8 months after the experiment was laid out. It was observed that in treatment (1) the mean spread of infection towards the bole of the tree was around 60 cm. In treatment (2) the fungus had spread about 5–20 cm along the tap root. The infection had also progressed along the laterals, away from the collar region, to cover a distance of about 20 cm. In some instances the infection had encircled the tap root.

It was observed that some roots became diseased but the invaded tissues were cut off by wound barrier formations, while infection did not occur in others. The development of adventitious roots, in advance of the decay of roots was also noted. Most of the pieces of inoculum buried in the soil were completely decayed (*A. de S. Liyanage, S. Wettasinghe & A. Dharmaratna*).

CONTROL

Oidium heveae

Nitrogen fertiliser on the incidence of Oidium – Replicated field trials were laid out in Ambadeniya, Hunuwella, Kiribathgala and Parambe estates. The fertilizers could not be applied immediately after wintering due to the failure of suppliers to provide the fertilizers to the estates. A leaf and a soil sampling was done to determine the pre-treatment nitrogen level. (*A. de. S. Liyanage in collaboration with N. Yogaratnam*)

Economics of controlling Oidium *leaf-fall* – Twenty five and ten acres were selected at Galewatta and Frocester Estates, respectively. Three rounds of sulphur dusting were carried out at weekly intervals using 8 lb/ac/round. An equal area in the respective estates served as controls. A census of the number of trees affected with Bark Rot and damaged by wind were taken in the dusted and undusted plots at both estates (Table 23).

TABLE 23—PERCENT TREES AFFECTED BY BARK ROT AND DAMAGED BY WIND

Estate	Treatment	Trees counted	Bark rot infection (%)	Wind damage (%) uprooted	trunk snap	branch snap
Galewatta	With sulphur	3000	0.5	0.1	0.27	0.57
	Without sulphur	3000	0.2	0.3	0.2	0.37
Frocester	With sulphur	2153	0.09	0	2.46	3.2
	Without sulphur	2994	0.33	0	1.04	2.10

There was no difference between the sulphur dusted and undusted plots in relation to any of the observation taken. The incidence of *Oidium* leaf disease was mild and hence a useful result could not be obtained. (*A. de S. Liyanage, O. S. Peries & Z. E. Irugalbandara*)

Defoliation on the yield of rubber – Twenty five trees of clone RRIM 600 selected from Eladuwa Estate, were defoliated at 25%, 50%, 75% and 100% and compared with a control. There were five trees for each treatment. Twelve pre-treatment yield records were obtained prior to defoliation on 28 November 1977. Fifteen post-treatment yield records were also obtained. The results are presented in Table 24.

TABLE 24—EFFECT OF VARIOUS LEVELS OF DEFOLIATION ON THE YIELD OF RUBBER

Level of defoliation	*Pre-treatment yield (g/tree/tapp.)	**Post-treatment yield (g/tree/tapp.)	Difference
100	28.99	33.11	4.12 (-0.53)
75	27.79	34.13	6.34 (+1.69)
50	33.67	37.59	3.92 (-0.73)
25	29.25	36.26	7.01 (+2.36)
Control	33.10	37.75	4.65

based on *ten, **fifteen yield assessments

The difference between the pre-treatment and post-treatment yield assessments could be considered to represent the increase due to a seasonal effect. Therefore, if this overall increase (*i.e.* 4.65 g/tree/tapping) is deducted from the difference between the pre-treatment and post-treatment yield records of the plots subjected to defoliation, it shows the actual increase or decrease due to the treatment.

The results so far obtained indicate that at 100% and 50% defoliation there was a reduction in the yield but the increase in yield at 75% is difficult to explain at this stage. The yield increase over the control at 25% defoliation could probably be due to an increase in the photosynthetic efficiency of the remaining leaves. This experiment is still continuing. (*A. de S. Liyanage & Z. E. Irugalbandara*)

Phytophthora spp.

Control of Bark Rot - Low ammonia centirifuged latex with phenyl mercuric acetate (PMA) as a secondary preservative was prepared by centrifuging field latex containing 0.35% (w/w) ammonia. Nonidet T and Antimucin were also added. A field trial was carried out at Galewatta Estate, to test the efficacy of a number of treatments :

(1) the base latex formulation
(2) base latex formulation with PMA at two dilutions
(3) water + with PMA at two concentrations
(4) water (control)

Seven fungicidal applications were given prior to inoculation with a standardized zoospore suspension. Observations taken one month after inoculation revealed that increasing the PMA content over 0.1% did not give improved results. (*A. de S. Liyanage & D. M. Dantanarayana in collaboration with M. Nadarajah*)

Rigidoporus lignosus

Incidence of White Root disease in different districts – The extent of damage caused by *R. lignosus* was assessed in a number of estates in different rubber growing areas. So far 32 estates covering 15,869 hectares have been surveyed. The results are shown in Table 25.

TABLE 25—ASSESSMENT OF THE INCIDENCE OF WHITE ROOT DISEASE IN DIFFERENT DISTRICTS

District	No. of estates surveyed	Area surveyed ha	Area infected ha	Area infected (%)
Kegalle	2	357.25	7.25	2.02
Galle	1	255.06	10.19	3.99
Kurunegala	1	288.46	12.08	4.17
Kalutara	7	3576.61	287.52	8.09
Kelani Valley	12	6831.78	563.06	8.24
Ratnapura	9	4560.56	412.87	9.05
	32	15869.72	1292.97	8.1

The incidence of the disease is low in dry districts but as much as 8-9% of the total area planted is infected with the disease in the wetter areas.

When the percentage infected area in different districts is classified according to the year of planting as shown in Table 26, it appears that the incidence of the disease is low in the immature clearings in all the districts. This suggests that if proper control methods are adopted the spread of the disease can be curtailed. However, the damage is heaviest in the mature clearings and this tends to increase with the age of the plantation.

TABLE 26—PERCENT INFECTION IN FIELDS CLASSIFIED ACCORDING TO AGE

District	No. estates surveyed	Year of planting 77–72	71–67	66–62	61–57	56–52	51–47	46–42
Kegalle	2	0.03	1.00	1.76	4.40	3.99	1.67	—
Galle	1	—	0.04	1.12	3.61	4.13	3.35	4.91
Kurunegala	1	0.42	2.24	1.51	3.24	7.94	19.18	15.04
Kalutara	7	0.57	1.78	3.03	7.31	16.47	15.66	9.42
Kelani Valley	12	0.96	2.12	3.61	7.93	16.81	18.93	8.84
Ratnapura	9	1.09	2.30	3.05	9.82	22.06	30.12	22.76

Pre-planting, planting and post-planting treatments on the incidence of Rigidoporus - Girth measurements were continued. The incidence of White Root disease was low.

Some stumps were selected from the experimental area at Woodend Estate, to study the decay of stumps under natural conditions. The stumps buried under the cover (*Pueraria*) for over two years, were in an advanced state of decay. The

heart wood region was almost reduced to humus, while the remaining part could be easily broken, on the application of slight pressure. Extensive termite activity was also evident. Various types of wood inhabiting insects, larval stages were also found. Species of *Trametes* and *Daldinia* were the main colonizers with many other unidentified basidiomycetes forming soft cup-shaped sporophores. (*A. de S. Liyanage, G. W. Liyanage & W. Amaratunga*)

Methods of clearing on the incidence of Rigidoporus – Five more experiments were laid out at Yogama, Moralioya, Muwankanda, Hatbawa and Galewatta estates during the period under review. The stumps were treated in the manner described in the 1976 Annual Review. Growth measurements were continued. Twenty stumps were selected at random from each plot in the 1975 clearing at Woodend Estate to assess the rate of decay.

The decay of one year old stumps selected from the 1976 clearing at Woodend Estate was observed by examining transverse and longitudinal sections of stumps. Examination of such sections revealed the advancing lesions of several wood decaying fungi. The edges were marked and well defined. These sections also showed that the fungus could spread horizontally covering a wider area while the vertical spread was rather slow. Fructifications of *Trametes* belonging to at least two species were most abundant on the exposed cut ends. Other species like *Daldinia* and *Xylaria* were also detected. (*A. de S. Liyanage, G. W. Liyanage & W. Amaratunga*)

Control of White Root disease in mature clearings – The field experiments laid out last year in twelve estates in different agro-climatic zones were continued.

A replicated field trial was carried out at Dartonfield on the control of *Rigidoporus* in order to assess, (1) the sterilising and desiccating action of sunlight on the pathogen (2) whether removal of inoculum from infected trees help in the recovery of trees affected by the pathogen (3) the minimum dosage of Fomac '2'. The following treatments were given:

(1) Exposed the root system. Scraped off the rhizomorphs from the laterals and left them open without covering with soil.

(2) As in (1) but covered with soil.

(3) As in (1) but removed diseased wood from infected laterals and the tap root, applied tar on exposed wood and left the roots uncovered.

(4) As in (3) but covered with soil.

(5) As in (3) with limited application of Fomac 2.

(6) As in (5) but covered with soil.

(7) Usual estate practice but roots left exposed.

(8) As in (7) but covered with soil.

This experiment is still in progress (*G. W. Liyanage, L. Halangoda & N. Fernando*)

Treatment of patches affected with Rigidoporus *and its effect on root disease incidence*– Four large patches were selected from mature clearings that are to be uprooted in 1981/82 in Padukka, Glassel, Urumutta, Golinda, Ambadeniya, Kiriwanaketiya, Galewatta and Muwankanda Estates. The following treatments were given prior to planting the patches.

(1) Infected root debris removed.
(2) As in (1) with the addition of 114 g of sulphur to the soil after planting.
(3) Infected root debris not removed.
(4) As in (3) but with the addition of 114 g of sulphur to the soil after planting.

In addition, the state of the decay of root debris in each patch was also assessed. This trial is continuing. (*A. de S. Liyanage, G. W. Liyanage, L. Halangoda & N. Fernando*)

Effect of sulphur on the pH, soil microflora and antagonism to R. lignosus The change in soil pH, eleven months after the addition of sulphur to undisturbed soil is shown in Table 27.

TABLE 27—EFFECT OF ADDITION OF SULPHUR ON SOIL pH, AT DIFFERENT LEVELS

Weeks after addition of sulphur	Depth of sampling (cm) 0	15	30
Before addition of sulphur	5.06	4.69	4.50
2 days	4.61	4.52	4.41
1	4.35	4.63	4.50
2	3.66	4.17	4.33
6	3.48	3.46	3.67
8	3.56	4.07	4.13
10	3.41	4.15	4.03
12	3.92	4.22	4.10
24	4.41	4.20	4.19
40	4.50	4.09	4.06
44	4.64	4.55	4.13

The lowest pH was recorded 6 weeks after the addition of sulphur, thereafter it increased gradually but the pH has not reached the original level, even eleven months after the addition of sulphur,

The fungal population before and 6 weeks after the addition of sulphur was determined by the soil dilution plate method. The results shown in Table 28 indicate that only three fungal species were predominant at all levels.

TABLE 28—TOTAL FUNGAL COLONIES BEFORE AND AFTER THE ADDITION OF SULPHUR

Fungal species	Depth of sampling (cm) 0		15		30	
	A	B	A	B	A	B
Penicillium	53	37	42	78	10	69
Aspergillus	33	5	19	4	6	8
Trichoderma	29	76	18	20	1	3
Unidentified	17	15	22	17	15	6
	132	133	101	119	32	86

A — before the addition of sulphur
B — after ,, ,, ,, ,,

At the surface the number of clonies of *Trichodermn* spp. increased sharply while that *Aspergillus* spp. decreased 6 weeks after the addition of sulphur. At 15 and 30 cm depths, *Penicillium* spp. were more abundant than the species of *Aspergillus* and *Trichoderma*.

A total of 130 and 78 isolates respectively of *Penicillium* spp. and *Trichoderma* spp. were tested for antagonism. The majority of *Penicillia* could be classified into 3 categories on testing for antagonistic effects against *R. lignosus*.

(1) Antagonistic to *R. lignosus*

(2) produce numerous colonies in a very short period (approximately 2–3 days) thereby restricting the growth of the pathogen

(3) Allow the mycelium of *R. lignosus* to grow over and smother them.

The majority of *Penicillium* spp. (87 colonies) belonged to the second category. Some were antagonistic but a few (25 colonies) allowed *Rigidoporus* mycelia to grow over them. All *Trichoderma* isolates excepting two showed very rapid growth and smothered the hyphae of *Rigidoporus* but none of them showed any antagonistic effect. (*O. S. Peries, N. I. S. Liyanage & B. Fernando*)

Effect of sulphur and Tillex on soil pH, microflora, growth and antagonism of R. lignosus. The planting holes (61x61x76 cm) dug in Dartonfield Estate were treated with (1) 114 g of sulphur (2) 5 litres of 1% Tillex. The pH, fungal and bacterial population were recorded at 10 day intervals, from 10 days after treatment to 90 days.

The changes in soil pH after the addition of sulphur and Tillex are indicated in Table 29.

TABLE 29—SOIL pH IN SOILS TREATED WITH SULPHUR AND TILLEX*

Days after treatment	Sulphur		Tillex		Control	
	Range	Mean	Range	Mean	Range	Mean
10	3.8–4.7	4.22	4.2–4.3	4.25	3.9–5.0	4.22
20	3.8–4.4	4.15	4.1–4.7	4.34	3.8–5.4	4.33
30	4.0–4.5	4.26	4.4–4.8	4.58	4.0–5.4	4.34
45	3.2–3.5	3.36	4.1–4.5	4.33	4.0–5.3	4.40
60	2.9–3.4	3.19	4.0–4.7	4.34	3.7–5.2	4.34
90	4.9–5.9	5.50	4.8–6.5	5.88	4.8–6.1	5.81

*Mean of ten replicates

These results show that 60 days after the addition of sulphur to the soil, the pH dropped to 3.19, However, addition, of Tillex did not markedly affect the pH. In both cases the pH reverted to normal within 90 days after application of the fungicides. The reason for this is not quite clear but further experiments are needed to confirm these results.

The effect of addition of sulphur and Tillex on the fungal and bacterial population is given in Table 30.

TABLE 30—MEAN TOTAL NUMBER OF* FUNGI AND BACTERIA IN SOILS TREATED WITH SULPHUR AND TILLEX

Days after treatment	Sulphur		Tillex		Control	
	F	B	F	B	F	B
10	5.0	54	5.3	47	8.0	34
20	4.2	20	3.0	59	5.2	15
30	5.6	44	4.4	59	7.0	40
45	7.0	27	4.2	40	3.2	35
60	4.3	93	5.0	32	6.0	30
90	—	20	—	26	—	20

*$X10^4$ per g air dried soil
Mean of 15 replicates

F = fungi
B = bacteria

The fungal population in the sulphur treated soil reached a maximum in 45 days while the bacterial population did not show a consistent pattern,but the maximum number of colonies was recorded 60 days after treatment. The addition of Tillex also did not affect the fungal population, although there was a slight drop in their number even at 60 days after treatment. However, there was an immediate increase in the number of bacterial colonies, but it returned to normal levels about 30–45 days after treatment.

The spread of the fungus in soils treated with Sulphur and Tillex was studied using a soil tube technique. It was observed (Table 31) that the growth of the fungus was minimal in soils collected about 45–60 days after treatment. In the case of soils treated with Tillex there was an immediate suppression of growth but this affect did not last more than 20–30 days after treatment.

TABLE 31—MEAN LINEAR GROWTH (mm) OF *R. lignosus* IN SOILS TREATED WITH SULPHUR AND TILLEX, 5 DAYS AFTER TREATMENT*

Days after treatment	Sulphur	Tillex	Control
10	42.1	13.9	43.0
20	44.0	28.9	55.1
30	50.0	41.2	53.7
45	4.0	44.3	44.0
60	0(0)	46.2 (24.6)	54.6 (30.4)
90	26.7	47.7	41.4

*Mean of ten replicates
Figure in parentheses are growth of the fungus in autoclaved soils.

The absence of growth in autoclaved, sulphur treated soils suggests, that the acidity of the soil prevents the growth of the fungus, but these results would be confirmed later.

Trichoderma spp. was the dominant fungus in Tillex treated soils but species of *Penicillium* and *Aspergillus* were more commonly found in sulphur treated soils. When these fungi were screened for antagonism five types of reactions were noted. *viz;*

(1) inhibition of growth (2) supression of growth (3) no effect on the growth of *R. lignosus* (*G. W. Liyanage, L. Halangoda & N. Fernando*)

Mycroflora in different soil types – The fungal population in four soil types *i.e.* Agalawatta, Boralu, Parambe, Homagama was assessed prior to the establishment of covers. The soil samples were obtained at three depths (0, 15, 30 cm). In addition, the pH of the soil, and its moisture holding capacity (MHC) were also determined.

The fungi commonly isolated from these soils were species of *Penicillium, Aspergillus, Trichoderma,* other types of fungi such as *Botrytis, Cunninghamella Acremonium, Fusarium* and *Gliocladium* were also present. Some forms of mucorales were also detected in fair numbers in these soils. Black, grey and yellowish sterile mycelia were also isolated. The soil pH and MHC are shown in Table 32.

TABLE 32. THE SOIL pH AND MOISTURE HOLDING CAPACITY OF FOUR SOIL TYPES AT THREE DEPTHS.

Soil type	pH			MHC		
	Depth of sampling (cm)					
	0	15	30	0	15	30
Boralu	4.60	4.60	4.60	58.29	55.02	41.69
Agalawatta	4.94	4.54	4.49	47.73	46.64	45.90
Parambe	4.62	4.56	4.47	57.92	51.38	51.90
Homagama	4.60	4.38	4.28	52.31	51.63	50.96

These results show that there is not much difference in the pH except that Agalawatta soil recorded the highest pH at the surface. pH of Homagama soil was the lowest recorded at all three depths.

Agalawatta soils retained less moisture than the other soil types in Parambe and Homagama soils, moisture retention was high even at a depth of 30 cm. (*O. S. Peries, A. de S. Liyanage, N. I. S. Liyanage & B. Fernando*)

Fungal and bacterial population under covers and bare soil – Fungal and bacterial populations were determined from soils collected from an area where *Pueraria* was grown as a cover crop. For comparison, soils from an area left bare was also taken. Soil samples were taken at two depths; 1–5 cm and 20–25 cm. The pH, nitrogen and carbon contents were also determined. The total number of colonies of bacteria and fungi were assessed on the first and third day, respectively. Five types of interactions were identified by pairing the fungi isolated with *R. lignosus.* This trial is being repeated. (*G. W. Liyanage & N. Fernando*)

Fungal succession in healthy rubber trunks – Healthy tree trunks, 75 cm long, were buried in an upright position, leaving about 20–25 cm of wood exposed above the soil surface, under a mixed cover at Dartonfield. The fungal colonies which appeared three and eight months after placing the rubber trunks, expressed as a dry weight are shown in Table 33.

TABLE 33. MEAN DRY WEIGHT (g) OF FUNGAL SPOROSPHORES THAT APPEARED ON RUBBER STEMS*

Species	Period of exposure (months) 3		8	
	Total number	Dry weight	Total number	Dry weight
Schizophyllum spp.	NC	0.6	Nil	Nil
Trametes spp.	,,	432.8	136	94.7
Daldinia spp.	,,	10.1	16	13.7
Type I	,,	5.9	63	27.6
,, II	,,	1.5	12	1.7
,, III	,,	Nil	12	10.1
Rigidoporus	,,	Nil	25	37.8
Unidentified	,,	Nil	19	5.8

*Total number that appeared on 30 logs.
NC — Not counted.

Schizophyllum spp. was the earliest to colonize the wood pieces but were soon replaced by species of *Trametes* and *Daldinia* which became dominant. Some unidentified species were also detected. Fructifications of *Rigidoporus* also appeared on the logs, originating probably from basidiospores. (*G. W. Liyanage*)

Fungal succession of stumps treated with various chemicals - In the experiment designed to evaluate the economics of new methods of land clearing, the trees were cut at their bases, leaving the stumps *in situ*. The cut surfaces of the stumps were separately treated with urea, 2,4,5–T and Borax, to enhance the decay and also to prevent colonization by basidiospores of *Rigidoporus*. This study was carried out at Muwankande and Yogama Estates.

Schizophyllum was the commonest species found on all stumps irrespective of the treatments. It was soon replaced by *Daldinia* and *Trametes* spp. The latter species proliferated in abundance. Two types of cup forming Agarics, other fleshy fungi and *Xylaria* spp. were commonly found. (*G. W. Liyanage, A. de S. Liyanage & W. Amaratunga*)

Decay of rubber wood—The decay of rubber wood under leguminous covers, *Pueraria* and *Centrocema* and naturals was examined. Two sizes of wood blocks were used. 2.5x2.5x15 cm (small) and 5x5x15 cm (large). The loss in dry weight, which is the index of the rate of decay, 6 and 9 months after the commencement of the experiment is shown in Table 34.

TABLE 34. THE INFLUENCE OF COVERS ON THE RATE OF DECAY OF RUBBER WOOD

Type of cover	Block size: Small		Large	
	Period of exposure (months) 6	9	6	9
Pueraria	14.2	18.9	66.2	102.4
Centrocema	24.8	16.9	58.0	97.7
Naturals	13.0	27.8	45.6	87.7

The small wood blocks had disintegrated into humus, 9 months after being buried in the soil. In the large blocks extensive termite attack was evident, particularly in the heart wood region. Covers appear to enhance the decay of large wood blocks. (*G. W. Liyanage*)

Rhizosphere & rhizoplane mycroflora - One hundred and twenty plants of the clone PB 86, RRIC 45, RRIC 52 and RRIC 100 were planted with and without the addition of inoculum for rhizosphere and rhizoplane microflora studies. (*O. S. Peries, N. I. S. Liyanage & B. Fernando*)

Xylaria spp.

Control of Black Root disease - Four hundred infected trees were selected in April 1974, from the 1958 PB 86 clearing at Parambe Estate. They were blocked out into forty plots, each plot consisting of ten trees. The following treatments were replicated eight times, in a fully randomized design.

(1) Excavation of the root system, excision of infected roots, removal of the food bases, if any, scraping off the infected tissue from the tap root and tracing the healthy roots to their ends. If healthy lateral roots cannot be traced to their ends, they were cut leaving a gap of about 30 cm, to prevent the spread of the infection towards the bole of the tree, Fomac, a formulation based on Quintozene (PCNB), was applied on the surface of the remaining healthy lateral roots and the tap root. All the roots were covered with soil ensuring that infected roots were excluded.

(2) Same as (1) and 0.45 kg of sulphur was sprinkled on the surface of the soil to cover an area of about one square meter.

(3) Same as (1), without the application of Fomac on healthy lateral roots and the tap root but 0.45 kg of sulphur was sprinkled on the surface to cover an area of about one square meter.

(4) Same as (1), but without the application of Fomac on the tap root and laterals and addition of sulphur to the soil.

(5) Excavation of the root system, counting the number of healthy and infected roots recording whether the tap root is infected or not and refilling with the same soil (control).

The results given in Table 35 indicate that removal of infected roots alone is significantly better than the control, in reducing the incidence of the disease and decay of roots. However, the application of fungicides was more effective in reducing the number of roots infected, but the application of fungicides without the removal of infected roots is not effective in arresting the decay of roots.

TABLE 35—PERCENTAGE TOTAL NUMBER OF ROOTS INFECTED AND DECAYED

Treatment	Infected †Mean	Infected L. S. D.	Decayed †Mean	Decayed L. S. D.
Without Fomac	13.2	5.4*	5.1	NS
With Fomac	7.7		4.5	
Without sulphur	10.9	NS	5.5	NS
With sulphur	9.4		4.2	
T_4 Vs T_1 to T_3				
T_4	15.4	6.0*	5.4	NS
T_1 to T_4	8.4		4.7	
T_5 Vs T_4				
T_5	25.5	7.6*	28.5	5.6**
T_4	15.4		5.4	

† arc sine transformed data
NS not significant
T_1 to T_4 see text
* denotes significance at 5% level.
**denotes significance at 0.1% level.

In the absence of any treatment, the regeneration of roots appears to be significantly less than when infected roots were removed. (Table 36)

TABLE 36—TOTAL NUMBER OF REGENERATED ROOTS

Treatment	†Mean	L.S.D.
Without Fomac	2.0	NS
With Fomac	2.0	
Without sulphur	2.0	NS
With sulphur	2.0	
T_4 Vs T_1 to T_3		
T_4	2.0	NS
T_1 to T_3	2.0	
T_5 Vs T_4		
T_5	1.8	0.1*
T_4	2.0	

† log transformed data
NS not significant
* denotes significance at 5% level

However, the use of Fomac or sulphur singly or in combination has not shown any overall significant effect on the regeneration of roots.

It was also observed that application of Fomac without sulphur or sulphur without Fomac lowers root regeneration from the tap root, the application of sulphur together with Fomac restores root regeneration to a level equal to or perhaps higher than that observed when infected roots had been removed only.

There was evidence to show that a significant reduction in the infection of regenerated roots with the application of Fomac only or sulphur only, both of which had an identical influence, with no extra reduction when both Fomac and sulphur were used. (*A. de. S. Liyanage, S. Wettasinghe & A. Dharmaratna*).

REVIEW OF THE SOILS CHEMISTRY DEPARTMENT

N. YOGARATNAM

The main concern of the Department is the study of the responses of rubber trees to factors affecting their supply of nutrients. Although some of the RRIC 100 series clones grew vigorously in comparison with PB 86, during the first year of planting, yet there were no differences in their requirement of major nutrients, during this period. There were also indications of higher yields with applications of NP and K. The magnitude of the responses appeared to be greater in the *Boralu* and *Agalawatte* soil series than in the *Parambe* soils. Yield increases in the range of 25 to 28% have been recorded in some experiments. *Ratnapura* series soil showed greater response to phosphate application in comparison with the other soil series. Clone RRIC 45 appeared to show greater fertilizer responses than the other clones especially PB 86. Application of high levels of magnesium depressed yields.

In a long term experiment (5 years) on *Boralu* series soils, ammonium sulphate appeared to be more efficient than urea when both were broadcast as surface applications. The effect of sub-surface application of urea was, however, comparable with that of surface applied sulphate of ammonia. In general, with sulphate of ammonia broadcast applications appeared to be more efficient than sub-surface placement, but with urea the reverse effect holds good. With regard to sources of phosphate, imported rock phosphate appeared to be, more efficient than Eppawela apatite in their long term effects. Efficiency of applied nutrients especially nitrogen could be further improved if both N and K fertilizers are applied either at defoliation or at refoliation of mature rubber. Foliar applications of nutrients *e.g.* manganese may also help in efficiently regulating the nutrition of young *Hevea* trees.

In fertilizer recommendations based on foliar analysis, factors such as clone, soil and climatic conditions may also have to be considered as there can be differences in leaf nutrient levels. Moreover, it is likely that Ca concentration in leaves could be used to correct for leaf age. It appears that in general NPK fertilizers should continue to be applied for mature rubber, but Mg may be withheld for sometime.

Some cover management practices such as establishment of legumes and fertilizing them with phosphate, continued to show beneficial effects. The initial performance of legumes may also depend on the type of legumes and possibly the soil type.

In general, most soil characteristics appear to show increases in their values with increase in depth, but no differences due to the positions in the slope except for available phosphorus and exchangeable calcium. Trace element status of the rubber soils appear to be satisfactory especially in Molybdenum, Zinc, Manganese, Copper and Iron. Availability of some trace elements *e.g.* Molybdenum could be improved by increasing the organic matter content and the pH of the soil.

A low Intensity Detailed Soil Survey of the Alutgama topographical sheet showed the existance of several unidentified soil series in the rubber growing areas. Nine out of the ten series recognised in the North Western quadrant of this sheet in the present study, were not identified in the earlier classification.

STAFF

The Director continued to be in overall charge of the Department. Mr. C. G. Silva, Soils Chemist proceeded to the USA on one year's study leave and is attached to the College of Agriculture at Columbia in Missouri, USA. Mr. M. K. S. A. Samaraweera, Assistant Soils Chemist, is now working for his Ph.D (University of Bristol) at the Long Ashton Agricultural Research Station in UK under the guidance of Professor C. Bould. Mr. A. M. A. Perera, Technical Assistant, returned to Sri Lanka after his training in analytical work at the Rubber Research Institute of Malaysia.

Mr. F. P. W. Silva was appointed as an Experimental Officer on 1st February and Mr. K. U. C. Perera and Miss D. I. R. Denawaka and Messrs V. Ravindran and P.S.R.A. Samarakone as Technical Assistants on the 27th September, 24th October and 15th November, respectively.

Messrs G. Jayawardena, C. G. Weerawansa and S. P. A. R. de Silva, Technical Assistants resigned from the services of the Institute to join the State Distilleries Corporation, CISIR and the Faculty of Agriculture, University of Sri Lanka, respectively. All other staff were on duty throughout the year.

VISITS

The Soils Chemist, Dr. N. Yogaratnam, paid 95 experimental visits, 5 advisory visits and 10 other visits. Routine visits to the experimental areas and 3 advisory visits were made by the Experimental Officer, Mr. F. P. W. Silva.

WORKING GROUPS AND COMMITTEES

N. Yogaratnam, served on the following working groups and committee.

1. Working group on soil moisture studies, sponsored by the Atomic Energy Authority of Sri Lanka.

2. Working group on phosphate fertilizer efficiency studies, sponsored by the Atomic Engergy Authority of Sri Lanka.

3. Committee on fertilizer mixtures, sponsored by the Sri Lanka/West German fertilizer promotion project.

SEMINARS, CONFERENCES AND WORKSHOPS

N. Yogaratnam presented papers entitled, (1) "Use of leaf analysis as a guide to manuring of Rubber" at the Seminar on rubber culture, manufacture and marketing, held on the 30th May 1977 and (2) "Molybdenum status of some rubber soils of Sri Lanka" at the Annual Sessions of the SLAAS, held in December.

N. Yogaratnam, participated in a workshop on fertilizer usage, organised by the Sri Lanka/West German fertiliser promotion project, held in Colombo. F. P. W. Silva, Experimental Officer, participated in a three day Workshop on "Improvement of fertilizer marketing for small farmers" organised by the FAO/ESCAP/CFC, and held in Colombo.

VISITORS

Scientific visitors to the Department included Dr. K. B. Mistry of the Bhabha Atomic Research Centre, Bombay, in his capacity as a consultant to the International Atomic Energy Agency, Dr. J. P. Andriesse, Head, Mineralogy/Pedogenetic Research Station, Royal Tropical Institute, Amsterdam, Dr. G. W. Gee, consultant in Soil Moisture, IAEA, Dr. K. M. Pretty, President, Potash Institute of Canada, Dr. Agr. Cord Tietzen, consultant in Organic fertilizers, FAO and Professor N. W. Hudson, consultant in Soil Conservation, FAO.

RESEARCH

FERTILIZERS

Growth of immature rubber:

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

In an experiment, *F*/76/1, started on Pembroke Estate, effects of 5 levels of NPK and Mg on Clone PB 86 growing on *Boralu* series, was studied in a central composite second order design. The results appeared to show that application of nitrogen, phosphorus, and potassium increased growth of immature PB 86 during the first year of planting, but there were no differences between levels of nutrients.

Two other experiments, *F*/76/3 and **4** laid down to study the effects of three levels of nitrogen, phosphorus and potassium on growth of immature PB 86, RRIC 100, 101 and 102 in *Agalawatta* and *Homagama* series soils did not reveal any significant nutrient effect on growth during the first year. However, the rate of growth of all RRIC 100 series clones were generally greater than that of PB 86.

Another experiment, *F*/76/5, laid down on *Boralu* soils compared the effects of three levels of potassium on clones PB 86, RRIC 101 and RRIC 102. Provision was also made in the experimental design to compare the effects of three tapping systems during the mature phase. Diameter measurements made at the end of 12 and 15 months from planting (Table 1) showed a significantly greater rate of growth of RRIC 101 and RRIC 102 in comparison with PB 86. There was a significant response to application of K at the first level (presently recommended rate), but no further response was observed when K was increased to level 2 (double the presently recommended rate). Moreover, there was no significant interaction between clones and levels of K indicating that the presently recommended rate of potassium is sufficient even for more the vigorously growing clones like RRIC 101 and 102, during the first year of planting.

TABLE 1. EFFECT OF THREE LEVELS OF POTASSIUM ON GROWTH OF PB 86, RRIC 101 AND 102 ON BORALU SERIES

Clone	Diameter (cm)		Levels of potassium	Diameter (cm)	
	July	Nov.		July	Nov.
PB 86	2.18	3.43	k_0	2.26	3.52
RRIC 101	2.49***	3.88***	k_1	2.42**	3.85***
RRIC 102	2.46***	3.95***	k_2	2.45**	3.88***

, * significant at the 1% and 0.1% levels, respectively.

In general, there appears to be some improvement in growth of immature rubber with applications of N, P and K, but there were no differences in effect between different clones. (*N. Yogaratnam, K.S.A.C. Peiris & S. Wijeratne*)

Growth and yield of mature rubber

Eight experiments studying the effects of fertilizers on growth and yield of mature rubber were in progress covering *Boralu, Agalawatta, Ratnapura* and *Parambe* series soils. Experiment, *F*/61/1 in progress at the Kuruwita Sub-station, compared the effects of two levels of N, P and K on the performance of Clone PB 86 in *Boralu* soils. Growth measurements (Table 2) made in November 1977 (sixteen years after planting) showed that applications of nitrogen, phosphorus and potassium increased growth by 5%, 2%,and 7% respectively, the effect of potassium being significant at the 5% level. Yield data obtained in 1976 and 1977 showed significant positive responses to applications of N, P (P 0.01) and K (P 0.001), the magnitude of the increase being 20%, 21% and 28% with N, P and K respectively.

TABLE 2. RESPONSE TO TWO LEVELS OF NITROGEN, PHOSPHORUS AND POTASSIUM IN BORALU SERIES SOILS (PB 86)

Treatment	Girth, 1977 (cm)	Relative girth (%)	Yields, 1976 and 1977 (g/tree/tapp.)	Relative yields (%)
n_0	66.34	100.0	50.39	100.0
n_1	69.51	104.8	60.82**	120.7
P_0	67.47	100.0	50.23	100.0
p_1	68.38	101.5	60.98**	121.4
k_0	65.57	100.0	48.76	100.0
k_1	70.28*	107.2	62.45***	128.1

*, **, *** significant at the 5%, 1% and 0.1% levels respectively.

Girth measurements made in November 1977 (Table 3) from another experiment, *F*/61/2, in the same site, comparing the effects of three levels of N and P showed that application of N at the lower level gave a 4% increase in girth and that a further increase in N application increased the girth only by 1%. With regard to P, application at the first level gave a 3% increase in girth and a further 2% increase with a further increase in the level of P. With regard to the yields obtained in 1976 and 1977, a similar tendency was shown. Application of N at the first level gave a 28% increase ($P < 0.05$) in yield and no further increase was obtained by increasing the level of N. Similarly, a 25% increase($P < 0.05$) in yield was obtained with the application of P at the first level and no further increase at the higher level.

(*N. Yogaratnam & K. S. K. Wijeratne*)

TABLE 3—RESPONSE TO THREE LEVELS OF NITROGEN AND PHOSPHORUS

Treatment	Girth, 1977 (cm)	Relative girth (%)	Yields, 1976 and 1977 (g/t/tapp.)	Relative yields (%)
n_0	67.82	100.00	60.41	100.0
n_1	69.11	101.1	77.39*	128.1
n_2	69.87	103.0	76.28*	126.3
p_0	67.05	100.00	61.60	100.0
p_1	69.30	103.4	77.20*	125.3
p_2	70.44	105.1	75.28*	122.2

*Significant at the 5% level.

Experiment, *F*/76/6, was started in 1976 at St. George Estate (Annasigala Division), using Clone RRIC 45 from a 1969 replanting in *Boralu* series. In this experiment the effect of four levels of N, P and K are being studied in a 4^3 factorial design. Girth measurement made after one year did not show any treatment effect on growth. With regard to the yields (Table 4), application of N did not show any effect, but application of P and K at the highest level gave yield increases of 18% and 9%, respectively, over that of the control. (*N. Yogaratnam & M. Abeysinghe*)

TABLE 4— FERTILIZER RESPONSES IN BORALU SOILS WITH RRIC 45

Treatment	Girth, 1977 (cm)	Yield, 1977 (g/t/tapp.)	Relative yields (%)
n_0	54.1	28.8	100.0
n_1	53.8	28.2	97.7
n_2	53.5	28.2	97.9
n_3	53.9	29.1	101.1
p_0	52.9	27.4	100.0
p_1	53.3	27.8	102.1
p_2	53.9	27.5	100.4
p_3	55.0	32.4	118.3
k_0	54.0	28.0	100.0
k_1	54.3	28.9	103.0
k_2	53.5	29.0	103.6
k_3	53.4	30.4	108.6

Effects of three levels of N, P, K and Mg on Clone RRIC 45 growing in *Agalawatta* series was studied in another experiment, *F*/76/8. This experiment was started in 1976 in a 1967 replanting at Rayigam Estate. Girth measurement made in November 1977 did not indicate any treatment effect on girth (Table 5). But yield data showed 10 and 12% increases in yield with the application of N and K respectively. But application of Mg at the highest level showed a significant reduction in yield.

(*N. Yogaratnam & A. D. M. Karunaratne*)

TABLE 5— GIRTH AND YIELD DATA FOR 1977 (RRIC 45, AGALAWATTA SERIES)

Treatment	Girth, 1977 (cm)	Yield, 1977 (g/t/tapp.)	Relative yields (%)
n_0	51.27	17.19	100.0
n_1	52.00	17.90	104.1
n_2	51.95	18.96	110.3
p_0	51.56	17.76	100.0
p_1	51.93	17.53	98.7
p_2	51.71	18.75	105.6
k_0	51.96	17.01	100.0
k_1	51.64	18.01	105.9
k_2	51.60	19.03	111.9
mg_0	52.03	18.34	100.0
mg_1	51.54	19.20	104.6
mg_2	51.64	16.51	90.0

Experiment, *F*/76/10, compared the effects of three levels of N and Mg and two levels of K and P in a $3^2 \times 2^2$ factorial design on Clone PB 86 in *Parambe* series. This experiment was started in 1976 in a 1964 replanting at Hatbawe Estate, Rambukkana. Girth and yield data for 1977 (Table 6) did not show any treatment effects.

TABLE 6— GIRTH AND YIELD DATA FOR 1977 (PB 86, PARAMBE SERIES)

Treatment	Girth, 1977 (cm)	Yield, 1977 (g/tree/tapp.)
n_0	71.09	25.77
n_1	71.72	25.72
n_2	71.92	24.41
p_0	71.59	24.84
p_1	71.57	25.75
k_0	71.80	25.31
k_1	71.35	25.28
mg_0	70.81	24.26
mg_1	71.39	25.97
mg_2	72.52	25.68

Another experiment, *F*/76/11, started in a 1967 replanting on *Parambe* series soils at Muwankande Estate, Mawatagama, compared the effects of three levels of N, P and K and two levels of Mg on Clone RRIM 623. Data presented in Table 7 showed that there was a 6% increase in yield when nitrogen was applied. Increasing the level of nitrogen further, did not result in any further increase in yield. There was no other nutrient effects.

TABLE 7— YIELD DATA FOR 1977 (G/TREE/TAPP.)

Treatment	Yield, 1977	Relative yield
n_0	25.33	100.0
n_1	26.88	106.1
n_2	26.94	106.4

(*N. Yogaratnam & K. S. A. C. Peiris*)

In experiment *F*/76/9, effects of three levels of N, P and K were studied in *Ratnapura* series soils using plants of Wagga 6278 from a 1965 replanting at Kiribathgalla Estate, Nivitigala. Yield data (Table 8) showed a 3% increase in yield in comparison with the control when phosphorus was applied and a further increase to 13% was observed with a further increase in the phosphorus level. Application of potassium was also found to give a 9% increase in yield.

TABLE 8—FERTILIZER RESPONSES IN RATNAPURA SERIES SOILS

Treatment	Girth, 1977 (cm)	Yield, 1977 (g/tree/tapp.)	Relative yield (%)
n_0	64.71	29.68	100.0
n_1	64.20	29.21	98.4
n_2	64.38	31.50	106.1
p_0	64.41	28.64	100.0
p_1	63.20	29.47	102.9
p_2	65.70	32.28	112.7
k_1	64.27	28.62	100.0
k_2	65.41	31.28	109.3
k_3	63.61	30.48	106.5

(*N. Yogaratnam & M. A. Mendis*)

In general, there are indications of the possibility of obtaining greater yields with applications of N, P and K. The magnitude of the responses is likely to be greater in the *Boralu* and *Agalawatte* series soils than in Parambe. Yield increases ranging from 25 to 28% have been recorded in some experiments. *Ratnapura* series soils showed greater response to phosphate application than the other soils. With regard to the performance of different clones, RRIC 45 is likely to show greater responses to applied nutrients than other clones. especially PB 86. Applications of Mg at higher levels can cause a depreciation in yields. (*N. Yogaratnam*)

Bark renewal

The effects of three levels of N, P and K on bark regeneration in clone RRIM 623 was studied in an experiment, *F*/71/1, laid down in Lowmont Estate, Kalutara. Assessment of bark thickness (Table 9) appeared to indicate that application of phosphorus and potassium is likely to improve bark renewal.

TABLE 9—EFFECT OF NUTRIENTS OF BARK RENEWAL

Treatment	Bark thickness (mm)	Relative thickness
P_0	7.66	100.0
p_1	8.26	107.8
p_2	8.19	106.9
k_1	7.60	100.0
k_2	8.01	105.4
k_3	8.16	107.4

(*N. Yogaratnam & M. A. Mendis*)

Rubber after Tea

An experiment, *F*/71/2, was started in 1971 at Neuchatel Estate, Neboda, to study the effects of three levels of the fertiliser mixture R 463 + Mg, on growth of rubber (Clone PB 214) planted in areas previously under tea. Girth measurements recorded (Table 10) in November 1977 (six years after planting) showed that applications of fertilizers improved growth over that of the trees that did not receive any fertilizers, but there was no significant difference due to the two doses of the fertilizer mixture.

It seems possible that for rubber planted in areas previously under tea, fertilizers at rates lower than the current recommendation may be sufficient for normal growth.

TABLE 10—MEAN GIRTH OF PLANTS : NOVEMBER 1977

Treatment	Girth (cm)	Relative girth (%)
Nil fertilizers	47.94	100.0
R 463 + Mg: level 1	51.97*	108.4
R 463 + Mg:level 2	52.73*	110.0

* Significant at the 5% level.

(*N. Yogaratnam & M. A. Mendis*)

Stimulation

An experiment, *F*/60/1, was started in a 1949 replanting of PB 86 in *Boralu* series soils at Eladuwa Estate, Matugama, to study the effects of four levels of R 463 + Mg, in a randomised block design. In 1977, each plot was subdivided to accommodate two levels of Ethrel stimulant. Pre-treatment yield assessments were completed. (*N. Yogaratnam & M. Abeysinghe*)

EFFICIENCY OF FERTILIZER UTILIZATION

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

Sources and placement of nutrients

An experiment, *F/76/2*, was laid down on *Boralu* soils of Pembroke Estate, Kalutara, to study the effects of three forms of nitrogen *viz.* Sulphate of ammonia, Urea, and Ammonium chloride, three forms of potassium, *viz.* Imported Rock phosphate, Eppawela apatite and concentrated super phosphate and three forms of magnesium *viz.* Commercial Epsom salt, Kiesrite and Dolomite on immature PB 86, from the time of planting. Girth measurements made at the end of one year did not indicate any significant treatment effect. Nevertheless, Sulphate of ammonia gave a 3% increase in growth (Table 11) over that of nil nitrogen plots; and urea and ammonium chloride 2% increases. With regard to phosphorus, imported rock phosphate and concentrated super phosphate gave a 3% increase over the nil phosphorus plots, but Eppawela apatite did not give any increase in growth.

TABLE 11—SOURCES OF NITROGEN AND PHOSPHORUS ON GROWTH OF IMMATURE PB 86 IN BORALU SOILS

Treatment	Girth, 1977 (cm)	Relative girth (%)
Nil nitrogen	7.31	100
Sulphate of ammonia	7.53	103
Urea	7.47	102
Ammonium chloride	7.48	102
Nil phosphorus	7.34	100
Imported Rock phosphate	7.54	103
Eppawela apatite	7.33	100
Concentrated super phosphate	7.57	103

(*N. Yogaratnam & K. S. A. C. Pieris*)

Another experiment, F/73/1, started at Dartonfield compared the effects of imported Rock phosphate and Eppawela apatite on growth of immature rubber (Clone RRIC 101) from the time of planting (1973). Results obtained in the fourth year (Table 12) showed that with imported Rock phosphate there was a 15% increase in growth in comparison with the control (nil phosphorus), as against a 3% increase with Eppawela apatite. Relative girth increment data for the last two years (1975 to 1977) also showed a significant girth increase ($P. < 0.05$) with Rock phosphate in comparison with the control and with Eppawela apatite. Poor girthing with Eppawela apatite may have been due to the leaf necrosis followed by defoliation that was observed in 1976 in plots treated with this fertilizer.

(*N. Yogaratnam & M. Abeysinghe*)

TABLE 12—EFFECTS OF PHOSPHATE FERTILIZERS ON GROWTH OF IMMATURE RRIC 101 IN AGALAWATTA SOILS

Treatment	Girth 1977 (cm)	Relative girth (cm)	Relative girth increment, 1975 to 1977 (%)	Increase over the control (%)
Nil phosphorus	30.77	100.0	62.01	100.0
Imported Rock phosphate	35.25	114.6	66.13*	106.6
Eppawela apatite	31.77	103.3	57.85	93.3

*Significant at the 5% level.

The effects of different levels of phosphate with imported Rock phosphate and Eppawela apatite as the sources of phosphate were studied in another experiment, *F*/76/17, on immature PB 86 in Boralu series soils. This experiment was sited at Eladuwa Estate, Matugama, in a 1974 replanting and was started in 1976. Although the girth measurements recorded at the end of November 1977 (Table 13) did not indicate any significant differences between the sources and levels of phosphorus, the relative girth increment over the last one year showed an increase of 20% and 22% with imported rock phosphate at levels 1 and 2, respectively. But with Eppawela apatite the girth increments were only 11% and 15% with low and high levels of P respectively. (*N. Yogaratnam & K. S. K. Wijeratne*)

TABLE 13—EFFECT OF PHOSPHATE FERTILIZERS ON GROWTH OF IMMATURE PB 86 IN BORALU SOILS

Treatment	Girth, 1977 (cm)	Relative girth increment, 1976 to 1977 (%)	Increase over the control (%)
Nil phosphorus	28.9	24.8	100.0
Imported Rock phosphate			
level 1	31.1	29.7	120.0
level 2	31.8	30.3	122.2
Eppawela apatite			
level 1	31.4	27.5	110.9
level 2	29.4	28.4	114.5

Experiment, *F*/72/2, started in 1972 compared the effects of Sulphate of ammonia, broadcast, and Urea, broadcast and forked-in, as sources of nitrogen and methods of placements for mature PB 86 in *Boralu* series. Girth data obtained in the sixth year (November 1977) did not indicate any treatment effect on growth. But, the yield data (Table 14) showed that with Sulphate of ammonia (broadcast) there was an increase in yield of 7% over the control (nil nitrogen) as against a 2% increase with Urea. Urea when forked-in, however, gave an increase in yield of 5% over the control.

TABLE 14—EFFECTS OF NITROGENOUS FERTILIZERS ON GROWTH AND YIELD OF PB 86 IN BORALU SERIES

Treatment	Girth, 1977 (cm)	Yield, 1977 (g/tree/tapp.)	Relative yield (%)
Nil nitrogen	71.6	45.93	100.0
Sulphate of ammonia, broadcast	72.2	48.96	106.5
Urea, broadcast	72.9	46.22	101.6
Urea, forked-in	72.6	48.33	105.2

(*N. Yogaratnam & J. Wijenayake*)

Sulphate of ammonia and Urea each at two levels of nitrogen and two methods of placement *viz.* broadcast (soil surface) and forked-in (sub-surface) were tested in another experiment, *F/76/7*, on mature RRIC 45 in *Agalawatta* series soils. Experimental plots were sited at Annasigala Division of St. George Estate, Matugama, in a 1969 replanting. Girth measurement made in November did not appear to show any treatment effects. The yields obtained in 1977 (Table 15), did not reveal any difference between Urea and Sulphate of ammonia in their effects. But, forking-in Sulphate of ammonia gave a 13% lower yield than broadcasting, on the other hand there was a 16% increase in yield when urea was forked-in as compared to broadcasting . Lower yield with broadcast application of urea may have been due to greater volatilization losses of N, and with Sulphate of ammonia as there is very little volatilization losses, distributing the fertilizer over a wider area may help in greater absorption of N. Nevertheless, this result may only be applicable to areas with undulating terrain, as in this experimental area.

TABLE 15—EFFECT OF NITROGENOUS FERTILIZERS ON YIELD OF RRIC 45 IN AGALAWATTA SOILS (g/T/TAPP.)

Treatment	Sulphate of Ammonia n 1	n 2	Mean	Relative yield	n 1	n 2	Mean	Urea Relative yield
Broadcast	28.8	33.4	31.1	100.0	28.3	26.8	27.6	100.
Forking-in	25.8	28.9	27.0	86.9	33.5	30.3	31.9	115.8
Mean	27.7	30.9	29.1	—	30.9	28.6	29.7	—
Relative yields	100.0	113.0	—	—	100.0	92.4	—	—

(*N. Yogaratnam & M. Abeysinghe*)

Tracer-Aided phosphate : Fertilizer efficiency studies were also carried out, using ^{32}P as the tracer, to study the effectiveness of Eppawela apatite as a source of P for rubber. An experiment, *P 32/76/1*, in nursery beds using 6 months old *Hevea* seedlings (Clone PB 86), was undertaken during May 1976 in *Boralu* series soils. Eppawela apatite and imported rock phosphate at three levels of P, were applied as surface placement around the seedlings. ^{32}P - labelled super phosphate was subsequently applied to all plants. Leaves sampled at 4 weeks after incorporation of labelled supper phosphate did not indicate any significant differences between the control and the two rock phosphates. But, at the second sampling date (after 8 weeks), uptake of P from Eppawela apatite was significantly greater (Table 16) than from imported rock phosphate. More experiments will be carried out in order to determine the long term effects.

TABLE 16—EFFECTS OF PHOSPHATE FERTILIZERS ON PHOSPHATE UPTAKE BY *HEVEA* SEEDLINGS GROWN IN THE FIELD NURSERY

Treatment	A value (kg P_2O_5 /ha) 4 weeks	8 weeks
Control	52.3	63.9
Eppawela apatite		
level 1	38.9	87.6
level 2	35.5	77.6
Imported Rock phosphate		
level 1	49.4	55.2
level 2	37.1	58.1
LSD	NS	15.5

Root activity pattern: A field experiment, *P*-32/76/2, using P as the tracer, ^{32}P was laid down on Pembroke Estate, Kalutara, to study the root activity pattern of mature rubber. This study was undertaken to obtain information on the most efficient method of placement of fertilizers. The experiment was done on 6 year old RRIM 605, using the soil injection techniques. Five lateral distances namely, 0.75 m, 1.50m, 2.25 m, 3.0 m, and 3.75 m, and two vertical distances, namely, 15 cm, and 30 cm were included in a factorial design. ^{32}P was introduced in 16 equi-distant holes around each tree at the required lateral and vertical distances. Light and shade leaves and latex were sampled at 4 and 8 weeks after injection of the radioisotope for ^{32}P activity. Radioassay did not reveal any measurable ^{32}P activity in any of the leaf samples at 4 and 8 weeks sampling dates. How ever, latex assay at 8 weeks (Table 17) indicated significantly higher root activity at a lateral distance of 0.75 m as compared with that over greater lateral distances up to 3.75 m. The data also indicated significantly higher root activity at 15 cm depth than at 30 cm depth. From this preliminary work, it appears that under the conditions of this experiment, the most effective method of fertilizer placement for mature rubber tree is at 0.75 m away from the tree at 15 cm depth. (*C. G. Silva & B. Arsecularatne with K. B. Mistry of the IAEA*)

More experiments will be carried out, as these results do not support the results obtained from the conventional type of field fertilizer experiments especially with regard to the depth of placement. Moreover, the use of ^{32}P in these tracer studies can be a major disadvantages if the affinity of *Hevea* trees for phosphorus is low. Therefore, the feasibility of using ^{15}N as alternate tracers in such studies will be looked into. ^{15}N, a stable isotope of nitrogen, has the advantage of being non-radioactive and can be determined by mass spectrometry or emission spectrometry.

(*N. Yogaratnam*)

TABLE 17—ROOT ACTIVITY PATTERN OF RRIM 605 IN BORALU SERIES SOILS (8 WEEKS AFTER ^{32}P INJECTION)

Distance		Activity in latex (Cpm/10 ml)
vertical (m)	lateral (m)	
15	0.75	38.3±2.9
15	1.50	29.3±1.7
15	2.25	34.3±1.0
15	3.00	29.7±4.3
15	3.75	27.0±2.5
30	0.75	31.7±1.9
30	1.50	25.3±2.4
30	2.25	20.3±1.0
30	3.00	22.7±0.5
30	3.75	25.3±1.7

Timing of fertilizer application

Two experiments, *F*/76/13 *and* 16, were started to study the effects of NPK application at defoliation, at refoliation and after hardening of leaves, on nutrient uptake of mature rubber. One experiment, (F/76/13))was at Glassel Estate on *Parambe* soils, using Clone PB 86 and the other, F/76/16, at Padukka Estate, Padukka,

on *Boralu* series soils using Clone RRIM 623. Leaf samples collected from experiment *F*/76/16 showed that uptake of nitrogen is equally effective when nitrogenous fertilizers are applied at defoliation and at refoliation (Table 18) but not after the leaves have hardened. Nitrogen in this experiment was applied on 4 February (at defoliation) 28 February (at refoliation) and on 19 August (after hardening of leaves.)

TABLE 18—EFFECT OF TIME OF APPLICATION OF FERTILIZERS ON NUTRIENT UPTAKE

Treatment	Leaves sampled, 5 April	
	Nitrogen content (%)	Relative increase (%)
Nil Nitrogen	3.56	100.0
Nitrogen at defoliation	3.93	110.4
Nitrogen at refoliation	4.05	113.8

Significant NK interaction (Table 19) observed in leaves sampled on 5th May revealed (not reported so far) that for efficient uptake of nitrogen at defoliation and at refoliation, potassium may also have to be applied at defoliation and at refoliation, respectively.

TABLE 19—EFFECTS OF TIME OF APPLICATION OF N AND K ON LEAF NITROGEN CONCENTRATIONS, MAY 1977 (%)

Treatment	Nitrogen		
	Nil	at defoliation	at refoliation
Potassium: Nil	3.44	3.36	3.34
at defoliation	3.48	3.65	3.70
at refoliation	3.35	3.78	3.66

(*N. Yogaratnam & A. D. M. Karunaratna*)

FOLIAR NUTRITION

Experiments, *FN*/77/1, 2 *and* 3, were started in August 1977, to study the effects of foliar nutrient sprays containing Zn, B, Fe, Mo and Mn and at different concentrations on nutrient uptake and growth of immature PB 86. It is hoped to assess the effect of treatments on yield by micro-tapping. The spray treatments were applied to single tree plots in randomized block layouts with sufficient replicates. All sprays were applied from a knapsack sprayer, to the 'run-off' stage. A proprietory wetting agent (Teepol) was added to each spray solution and a control treatment, water + wetter, was also included in each experiment.

Foliar uptake experiments were also carried out, in order to establish that foliar applied nutrients are absorbed by leaves of *Hevea* growing in the field. In one experiment, (*FN*/77/4) 1% solution of ammonium phosphate, as a source of phosphorus and in the other (*FN*/77/5) 0.1% manganese sulphate as a source MN were used. Leaves were collected at various intervals and analysed for their P and Mn contents. Preliminary results obtained (Table 20) from these experiments indicate that nutrients are absorbed by leaves of *Hevea* from foliar sprays.

All experiments were carried out in Pembroke Estate, Kalutara, on one to three month old plants of Clone PB 86, in Boralu series soils.

TABLE 20—EFFECT OF $MnSO_4$ SPRAYS ON MANGANESE CONTENT OF LEAVES (PPM)

Treatment	Time of sampling			
	8 h	Relative increase (%)	24 h	Relative increase (%)
Control (water + wetter)	51.4	100.0	55.3	100.0
Sprayed ($MnSO_4$)	58.0	112.8	65.0	117.5

(*N. Yogaratnam & W. C. Dayaratne*)

FOLIAR SURVEY

Factors influencing leaf nutrient levels

Variation with clones, soil and climate: Leaf samples were collected for this study from an experiment started by the Genetics & Plant Breeding Department, on Genotype-Environmental interaction studies. Leaves collected cover different planting, materials *viz.* PB 86, RRIC 45, RRIC 52, RRIC 36, RRIC 100, RRIC 101, RRIC 102 RRIC 103, RRIM 623 and RRIM 600, different soil series *viz. Boralu, Agalawatta, Homagama, Parambe, Ratnapura* and *Matale* and different planting districts (climatic zones), *viz.* Galle, Kalutara, Ratnapura, Kelani Valley, Kegalle, Bibile and Matale. The results of chemical analysis for N, P, K, Ca and Mg appear to show differences in leaf nutrient composition due to planting materials. soil and climatic zone. A detailed statistical analysis (multivariate) is being done in order to study the correlation between leaf nutrient contents and growth of immature plants from the second year of planting. (*N. Yogaratnam & B. Arsecularatne with N. E. M. Jayasekera*)

Variation with clone: A study of leaf variation in mature rubber was also in progress. Leaf samples were collected from another experiment of the Genetics & Plant Breeding Department and analysed for N, P, K and Mg. This study appears to show a(Table 21) that the critical leaf nutrient levels for optimum yield of more vigorously growing clones such as RRIC 100, 101 and 103 may be different from that of RRIC 45.

TABLE 21—YIELD AND LEAF NUTRIENT LEVELS OF SOME RRIC CLONES

Clone	Yield 1977 (g/t/tapp.)	Relative yield (%)	N (%)	P (%)	K (%)	Mg (%)
RRIC 45	20.7	100	3.40	0.20	0.826	0.268
RRIC 100	25.4	123	3.01	0.21	0.848	0.344
RRIC 101	29.4	142	2.96	0.19	0.808	0.260
RRIC 103	24.4	118	2.75	0.23	0.776	0.345

It seems to suggest that either it is possible to obtain comparatively higher yields with RRIC 100 series clones at low leaf nutrient levels or on the other hand, still higher yields may be obtained by attempting to raise the leaf nutrient levels of the RRIC 100 series clones to the levels of RRIC 45, possibly with higher rates of fertilizer applications. (*N. Yogaratnam & B. Arsecularatne with D. M. Fernando*)

Variation with age: The influence of age of leaves on leaf nutrient contents was studied from an existing fertilizer experiment, *F*/76/16. The leaf calcium levels (Fig. 1) showed a rapid increase with age, suggesting that if these results are repeated, leaf calcium content can be used to estimate leaf age; and corrections to the other nutrients can be made accordingly under Sri Lanka conditions as well. (*N. Yogaratnam & A. D. M. Karunaratne*)

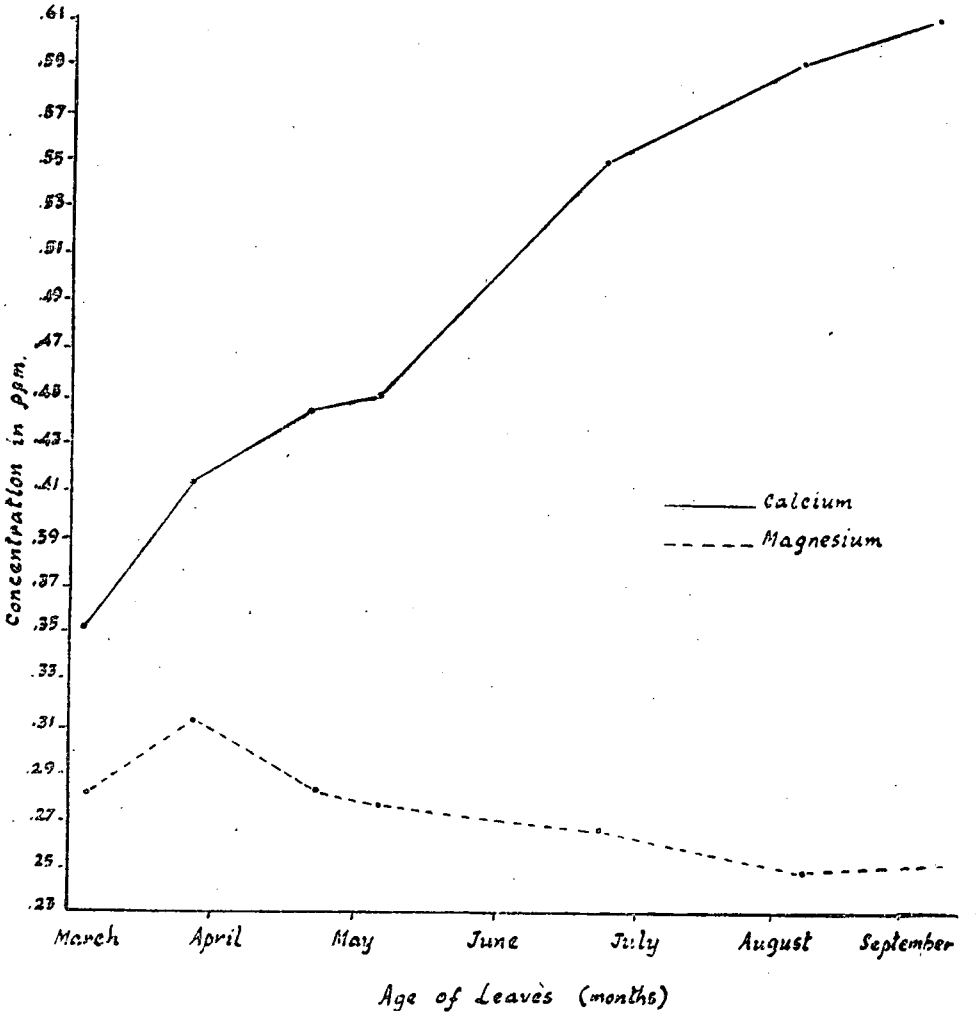

Figure. 1 Variation of leaf calcium and magnesium Concentration with age in clone RRIM 623

Discriminative fertilizer recommendations:

A re-survey of all the estates surveyed in 1973/1974 was done in order to study, the changes in leaf nutrient composition that may have occurred during the last 3/4 years as a result of fertilizer applications based on the initial foliar survey. Foliar survey of some estates that were not surveyed earlier, was also carried out. In all twelve estates were covered during this year.

Fertilizer recommendations based on the discriminatory approach was started in 1973 and a total of 35,713 acres have been covered so far and out of this, 25,056 acres were in PB 86. The result of the PB 86 areas surveyed indicated that (Table 22) almost the entire acreage should continue to receive nitrogenous fertilizers out of which 88% of the area should receive more N than the normally recommended rate. Similar results were observed for potassium. With regard to phosphorus. 86% of the areas should continue to receive P out of which 40% should receive more than the presently recommended rate. On the other hand with regard to Mg, it appears that 61% of the areas need not receive any magnesium fertilizers for a few years.

TABLE 22—PERCENTAGE OF THE TOTAL PB 86 AREA SURVEYED IN EACH LEAF NUTRIENT RANGE CLASS

Nutrient	Very low	Low	Medium	High	Very high
N	55	33	11	1	1
P	50	24	17	6	4
K	22	18	46	6	8
Mg	13	5	21	8	53

(*N. Yogaratnam, F. P. W. Silva, B. Arsecularatne & T. A. C. S. Wasanthadeva*).

COVERS AND COVER MANAGEMENT

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

Types of Covers

In experiment, *C*/72/2, started earlier (Annual Review 1973, p 84), an attempt was made to determine whether legumes are superior to naturals in promoting growth of immature rubber. If so, whether application of extra nitrogen to covers with non-legume covers could improve growth during immaturity and yield during early maturity. Girth measurements made in November 1977 showed that girth of trees (Table 23) in the sown legume plots was still greater than ($P < 0.001$) the trees in the plots under naturals. The trees in natural cover areas with supplementary nitrogen to rubber also showed a similar effect ($P < 0.05$). But, the relative girth increment data for the period 1976 to 1977 showed a much greater growth of trees in the naturals than those that were in legumes, during the last one year. It, therefore, appears that the differences in girth observed now are actually due to the initial differences seen in 1976. Moreover, although the P concentration in leaves of trees in the legume plots (Table 25) is significantly greater than the rest, yet this did not influence the growth of plants during this year.

TABLE 23—EFFECT OF COVERS ON GROWTH AND LEAF NUTRIENT COMPOSITION OF IMMATURE RUBBER

Treatment	Girth 1977 (cm)	Relative girth increment (%)	Increase over the control (%)	Leaf N (%)	Leaf P (%)
Naturals (Control)	32.91	24.43	100.0	2.76	0.16
Legumes	46.64***	16.47	67.4	2.75	0.28***
Elimination of non-legumes	41.87**	20.47	83.8	2.57	0.18
Naturals with extra N	39.34**	25.88	105.9	2.55	0.17
Naturals with extra N based on leaf analysis	35.59	26.92	110.2	2.57	0.14

***, ** Significant at the 0.1% and 1% levels respectively.

Studies on the effect of various leguminous covers *viz. Pueraria phaseoloides, Calpagonium muconoides, Desmodium ovalifolium, Mimosa invisa, Centrosema pubescens* and *Stylosanthus guyanensis* (gracilis) on growth and production of *Hevea*, were in progress in *Agalawatta series* at Mirishena Estate, Mahagama (*C*/77/1), on *Boralu Series* at Eduragala Estate, Ingiriya, (*C*/77/2), on *Boralu series* at Lowmont Estate, Kalutara, (*C*/77/3), on *Parambe series* (low mica) at Moralioya Estate, Rauwanwella, (*C*/77/4), on *Parambe series* at Parambe Estate, Undugoda, (*C*/77/5), and on *Homagama series* with mica at Muwankande Estate, Mawatagama, (*C*/77/6). The control plots in these experiments are in naturals. Visual assessment of growth, of covers six months after sowing of seeds, on a scale 0 to 10 (0, no growth and 10, very vigorous) appeared to indicate that *Stylosanthus* is the most vigorous grower and *Desmodium* the poorest, during this period. This effect was seen irrespective of the type of soil in which the legumes were growing. There also appeared to be differences in initial growth of legumes between different sites, growth in the Muwankande experiment in Homagama series with mica (soils not identified in the classification of Silva[1] (1969) is in general much better than in the other sites. Performance in the Parambe experiment is comparatively better than in Moralioya and Lowmont. The reasons for such differences are being investigated.

Another experiment (*C*/77/7), on the effects of leguminous ground covers *viz. Pueraria phaseoloides, Desmodium overlifolium* and *Calapogonium muconoides*, grown singly and in combination with each other, was started using a 2^3 factorial design, with treatments replicated four times. This experiment is in progress in *Homagama series* soils at Artherfield Estate, Avissawella.

Nutrition of Legumes

Phosphate : The effect of phosphate application to covers was studied in an experiment, (*C*/70/2)(Annual Review 1970, p 63) started in 1970. The ground cover treatments ceased to exist from 1974. Growth data for 1977 showed that girth of trees (Table 24) that were in leguminous covers were still greater ($P < 0.05$) than those trees in naturals.

[1]Silva, C. G. (1969) Provisional classification of rubber soils of Ceylon and their relationship to Malayan soils. *J. Rubb. Res.Inst. Malaya*, 21, 217 - 224.

TABLE—24 EFFECT OF GROUND COVERS ON GROWTH OF RUBBER

Treatment	Girth, 1977 (cm)
Naturals	50.52
Legumes	51.91*

* Significant at the 5% level.

With regard to phosphate, trees that received phosphate still continued to show superiority over the trees that did not receive any phosphate during the immature phase. This effect was shown irrespective of the type of cover grown. Moreover, application of P to covers has resulted in significantly better girthing as indicated by the girth increment observed between 1976 and 1977(Table 25) than its application direct to the tree. It appears that the residual effect of phosphate applied during the initial four year period still persists, for three years.

TABLE—25 EFFECT OF PHOSPHATE APPLICATION ON GROWTH OF RUBBER (CM)

Treatment	Girth 1977 (cm)	Girth increment 1976 to 1977 (cm)	Relative girth increment (%)
Nil phosphate	47.85	2.35	100.0
P to rubber	50.61*	3.91	166.4
P to cover	53.68***	3.88	165.1
P to rubber and cover	53.76***	3.86	164.3

*, *** significant at the 5 and 0.1% levels respectively.

These results emphasise the importance of phosphate application to immature rubber and that greater benefits are likely to be obtained when applied to the ground covers.

Potassium : The influence of Potassium on the N status of leguminous covers and its effect on the N status and growth of *Hevea*, was studied in an experiment, *C/77/8*, started in *Boralu series* soil at Lowmont Estate, Kalutara. The experimental treatments that were studies in a 3x2 factorial design. treatments replicated five time are:-

K_0 — Nil potassium

K_r — Potassium to rubber only

K_1 — Potassium to cover only - level 1

K_2 — Potassium to cover only - level 2

K_{rc_1} — Potassium to rubber and cover - level 1

K_{rc_2} — Potassium to rubber and cover - level 2.

(M. Yogaratnam. F. P. W. Silva, A. D. M. Karunaratne, M. A. Mendis & K. S. A. C. Peires).

SOIL CHEMISTRY AND FERTILITY

A study of some characteristics of rubber soils of Sri Lanka was carried out. This study included all seven soil series identified earlier and also considered the effect of slope (terrain) on the soil characteristics.

Soil samples were collected from three sites in each series and included samples from three slopes *viz.* top, middle and bottom at two depths *viz.* 0—10 cm and 10–20 cm. The characteristics that were studied are moisture content (of air dry soils), soil pH, organic matter, total nitrogen, available phosphorus (HCl and NH_4F), exchangeable cations (NH_4OAc), cation exchange capacity (CEC), sulphur and some trace elements molybdenum, zinc, iron, copper and manganese.

Major elements, pH, moisture, organic matter and CEC

Soil series

In general the *Parambe* and *Matale* series soils appear to possess good soil characteristics (Table 26) in comparison with the rest of the series. Matale soils recorded the highest pH which may possibly help in greater availability of nutrients specially the trace elements.

Soil depth

In general all soil parameters showed a decrease in their contents with increasing depth (Table 27) irrespective of the soil type.

TABLE 27—DISTRIBUTION OF SOIL CHARACTERISTICS BY DEPTH

Depth (cm)	pH	Organic matter (%)	Moisture (%)	Total N(%)	Available P(%)	Exchangeable cations (meq/100 g) K	Ca	Mg	CEC
0–10	5.35	1.50	3.76	0.134	62.53	0.065	2.300	0.545	5.42
10–20	5.27**	1.27***	3.90	0.112	37.24**	0.045*	1.906	0.409	5.18

TABLE 26—SOME CHARACTERISTICS OF THE SOIL (0 – 20 CM)

Soil	pH	Moisture content (%)	Organic matter (%)	Total N (%)	Available P (ppm)	Exchangeable cations (meq/100 g) K	Ca	Mg	CEC (meq/100g)
Boralu	5.06	2.94	1.33	0.122	59.31	26.23	66.37	17.84	4.00
Agalawatte	5.22	3.44	1.39	0.138	67.17	40.53	126.21	27.15	4.89
Homagama	5.13	2.61	1.37	0.110	28.24	37.92	90.83	18.65	3.83
Ratnapura	5.12	3.00	1.21	0.97	7.78	22.73	45.59	12.09	3.19
Parambe	5.14	5.94	1.33	0.125	26.39	87.53	339.12	93.16	6.57
Matale	6.32	7.39	1.67	0.168	103.11	61.16	228.74	225.31	13.06
Deniya	5.18	1.61	1.39	0.101	57.17	25.42	53.14	12.07	2.43

Slope

The slope of the land considered in this study (maximum of 45 ot 50%) did not in general appear to have influenced the soil characteristics discussed here, except the available phosphorus and exchangeable calcium (Table 28). Available P and exchangeable Ca values were found to be the highest at the bottom of the slope.

TABLE 28—EFFECT OF SLOPE ON SOIL CHARACTERISTICS

Slope	pH	Organic matter (%)	Moisture (%)	Total N (%)	Available P (%)	Exchangeable cations (meq/100 g))			CEC (meq/100g)
						K	Ca	Mg	
Top	5.31	1.41	3.70	0.126	26.57	0.128	1.781	0.556	5.50
Middle	5.26	1.40	3.80	0.124	52.84***	0.093	1.661	0.409	5.30
Bottom	5.36	1.34	4.10	0.120	70.26***	0.109	2.867***	0.467	5.11

(*N. Yogaratnam, H. A. Seemon, L. Wickremasinghe & Ajith de Silva*)

Trace elements—Molybdenum: The molybdenum status of the rubber soils was studied by determining the total, available and water soluble molybdenum (discussed under analytical methods) from the seven soil series as discussed earlier.

Series: The total (acid extractable) molybdenum content of soil (Table 29) showed significant differences between soil series. The *Parambe* series has the highest molybdenum followed by *Ratnapura* series. On the other hand, *Matale* and *Boralu* soils were comparatively low and *Deniya* soils had the lowest molybdenum. Although available molybdenum did not show significant differences between soil series, yet *Matale* soils which recorded the highest pH of 6.32, contained the highest available molybdenum. *Homagama, Matale* and *Parambe* soils showed a high water soluble molybdenum content compared to Ratnapura and Boralu series.

TABLE 29—AVERAGE MOLYBDENUM CONTENTS IN DIFFERENT SOIL SERIES

Soil Series	Molybdenum content (ppm)		
	Total	Available	Water soluble
Agalawatta	50.44	4.11	0.68
Boralu	38.52	4.62	0.37
Parambe	89.69	3.77	0.75
Homagama	46.64	3.96	0.96
Ratnapura	82.28	4.01	0.33
Matale	40.45	5.61	0.88
Deniya	16.40	4.97	0.55
LSD	16.69	1.33	0.30
Mean	52.06	4.44	0.65
C V%	18.63	5.66	4.48

Depth: The general effect of increases in all fractions of molybdenum with increase in depth of soils (Table 30) may suggest that molybdenum tends to leach down the soil profile from thre upper to the lower horizons.

TABLE 30—VARIATION OF MOLYBDENUM CONTENTS WITH DEPTH OF SOILS

Depth (cm)	Molybdenum contents (ppm)		
	Total	Available	Water soluble
0 - 10	50.66	4.28	0.64
10 - 20	53.46*	4.59*	0.66

*Significant at the 5% level.

Slope: Slope of the land had no influence on any molybdenum fraction in the soils.

Soil characteristics: Study of the relationship between molybdenum contents and some soil characteristics showed that (Table 31) exchangeable calcium, organic matter content and the pH of the soils are positively related ($P. < 0.05$) to the available molybdenum in the soil.

This study showed that the rubber soils are generally rich in molybdenum. If at all there is going to be any deficiency, it may be possible to alleviate this by increasing the pH and organic matter content of the soil. This could be achieved possibly by some agronomic practices such as changes in fertilizer practices, liming, mulching, and re-establishing leguminous covers. Increasing the depth of planting may also help in this regard. (*N. Yogaratnam,* [1]*R. T. Shanmuganathan & B. Arescularatne*)

TABLE 31—RELATIONSHIP BETWEEN MOLYBDENUM CONTENTS AND SOME SOIL CHARACTERISTICS

Soil Characteristics	Molybdenum contents (ppm)		
	Total	Available	Water soluble
Moisture (%)	+.3537	+.3002	+.4696
Total Nitrogen (%)	-.1050	+.5302	+.5130
Exchangeable Potassium (meq/100 g)	+.4779	-.0972	+.5852
Exchangeable Magnesium meq/100 g)	+.0340	+.5979	+.5224
Exchangeable Calcium meq/100 g)	-.1231	+.7245*	+.4786
Organic matter (%)	-.4536	+.7920*	+.6259
pH	-.2095	+.7818*	+.4646
CEC (meq/100 g)	+.0311	+.5717	+.5412

* Significant at the 5% level.

[1] Research student from the Faculty of Agriculture, University of Sri Lanka.

Zinc, Copper, Iron and Manganese

The total (acid extractable) Zn, Cu, Mn, and Fe contents of the soil (Table 32) indicated that in general, *Matale* soils appear to contain the highest concentrations of Zn, Cu, Mn and Fe, followed by *Ratnapura* series. The lowest contents were found in the Deniya soils followed by *Boralu* soils. A detailed statistical analysis of the total, available and water soluble trace elements data is being done and the results will be published separately. (*N. Yogaratnam, A. M. A. Perera, B. Arsecularatne & T.A.C.S. Wasanthadeva*)

TABLE 32.—ZINC, COPPER, IRON AND MANGANESE CONTENTS OF RUBBER SOILS

Soil	Zn (ppm)		Cu (ppm)		Mn (ppm)		Fe (%)	
	0 – 10 (cm)	10 – 20 (cm)	0–10 (cm)	10–20 (cm)	0–10 (cm)	10–20 (cm)	0–10 (c))	10–20 (cm)
Agalawatte	14.73	14.17	16.15	15.40	27.47	27.12	3.07	3.45
Boralu	11.62	10.75	6.21	5.43	21.73	22.39	2.71	3.26
Parambe	22.46	20.14	26.62	28.81	247.19	281.52	3.52	3.95
Homagama	8.46	8.46	5.32	5.60	14.91	47.40	2.14	2.26
Ratnapura	2145	26.63	33.14	40.76	603.25	689.12	4.44	4.53
Matale	41.87	48.16	54.62	63.64	1419.48	1945.82	5.03	5.46
Deniya	6.33	6.06	5.30	4.80	14.76	13.59	0.59	0.64

SOIL CONSERVATION

An experiment, *SC/77/1*, was started at Eladuwa Estate, Matugama, to study the effect of some soil management practices on surface run-off and soil erosion in rubber lands. Run-off plots were constructed at slopes of 35 to 40%. Each run-off plot consisted of four planting points (PB 86 plants) surrounded by plot boundaries made of brick walls. At the bottom end of the slope, a conveyance channel helped the water to flow through a "H–flume" device into a collection tank *via* a multislot diviser. Run-off recorders fixed along the "H - flume" device measures the rate of flow of water into the multislot diviser. The collection tank at the end measures the total volume of water and soil collected. The run-off plots were calibrated in order to correct for pre-treatment differences.

The experimental treatments that will be compared are; leguminous covers, naturals, bare (clean weeding), bare+mulch, bare+formaldehyde stabilized field latex, bare+formaldehyde stabilised field latex + oil and bare+prevulcanised compounded latex. (*N. Yogaratnam & W. C. Dayaratne with M. Nadarajah*)

SOIL MOISTURE

A working group for studies related to the use of Neutron moisture probes for assessing availability and conservation of soil water in plantation crops in Sri Lanka, was established by the Atomic Energy Authority of Sri Lanka. N. Yogaratnam, Soils Chemist, was nominated to this group.

Three research projects were planned. 1. Studies on the effect of soil water stress on growth of immature rubber. 2. Studies on the effects of soil water stress on yield of mature rubber and 3. Studies on moisture competition between immature rubber and intergrown leguminous covers and natural vegetation. On the recommendation of the IAEA Consultant on soil moisture studies, Dr. G. W. Gee, a request was made to the AEA for an outright loan of a Neutron moisture probe to be used in these investigations. (*N. Yogaratnam*)

SOIL MICROBIOLOGY

Phosphate availability

Mycorrhiza : Work done on this subject with Dr. U. P. de S. Waidyanatha, Botanist, revealed that mycorrhiza helps in increasing phosphate uptake by *Pueraria phaseoloides* and *Stylosanthus guyanensis* (gracilis). This work also showed that there was greater uptake of phosphate from imported (Jordanian) phosphate than Eppawela apatite during the first three months of growth (reported in detail by U. P. de S. Waidyanatha). A paper was prepared for publication.

Biosuper-Biological superphosphate : Biosuper is a biological form of super phosphate which relies on thiobacilli to oxidize elemental sulphur to $H_2 SO_4$, that in turn partially dissolves rock phosphate. The objective of this project is to find out whether availability of phosphate from Eppawela apatite could be improved by pelletizing Eppawela apatite with sulphur and soil containing thiobacillus bacteria, and applying the pellets to the soil. Innoculation with thiobacilli is expected to accelerate the oxidation of S and release of P particularly in soils deficient in native sulphur oxidizers.

Pellets containing some soil, Eppawela apatite and gypsum were successfully prepared. This will be compared with NR coated pellets (discussed under encapsulation of fertilizers) for its slow release effects.

(*N. Yogaratnam & L. Wickremasinghe with U. P. de S. Waidyanatha of the Botany Department*)

SOIL SURVEY AND CLASSIFICATION

Soil survey of experimental areas

Detailed soil surveys of all the new experimental areas were carried out. Soils were separated at the series level and then sub-divided on the basis of texture, slope and depth.

It was observed during this survey that within an area of 20 acres, sometimes more than one soil series (according to the existing classification) was found. Moreover, within a soil series marked differences due to texture, slope and depth were also observed suggesting that sometimes differences within a soil series, may have a greater effect on the performance of rubber than differences between series.

In an estate in the Kurunegala District (Muwankande Estate, Mawatagama) a new series was identified, *Homagama* type with mica in the parent material. In a few other places, differences in the occurrence of mica in the parent material was also observed *e.g.* Parambe type of soils with low mica was identified at Moralioya Estate, Ruwanwella, as against the typical Parambe soil with high mica found in the Parambe Estate, Undugoda.

These observations suggest the need for a revised soil classification of the rubber soils. (*N. Yogaratnam, F. P. W. Silva & T. A. C. S. Wasanthedeva*)

Classification of the rubber soils

A joint project was started in collaboration with the Royal Tropical Institute, Amsterdam, to characterise and classify the main rubber soils of Sri Lanka, to investigate their mode of formation with the aim to evaluate their nutrition to *Hevea*. Soil samples (undisturbed and disturbed) collected from three depths (0 - 17, 17 - 60 and 170 - 200 cm) of *Agalawatte* series (buried phase), *Boralu* series, *Parambe* series and *Homagama* series were sent to Amsterdam for mineralogical analysis, pF (moisture retention capacity) determination and total analysis. (*C. G. Silva & F. P. W. Silva with Dr. J. P. Andriesse*)

Soil survey of the Alutgama topographical sheet (Land Use Division/RRISL)

In the provision classification of the rubber soils of Sri Lanka, in 1969, differences in parent material was used as the only criterion. But, as pockets of unknown and unidentified soil types existed, an attempt was made to recognise these by considering some soil forming factors such as land form, slope and morphological characteristics. As the area coming under the Alutgama Topographical sheet is predominantly a rubber growing area, a Low Intensity Detailed soil survey of this area was started. Field work of the North Western quadrant was completed and mapping was also completed on 22,300 ha (55,000ac).

Analysis of the aerial photographs of 1:25,000 scale, lead to the recognition of 7 landform patterns *viz*. Coastal Beach Plain, Costal Sand Plain, Coastal Sand Stone Plain, Alluvial Plain, Undulating to Rolling planted Plain, Hill & Valley and Ridge & Valley. Study of each of these land forms resulted in the recognition of 21 soil series. Out of these 21 soil series, only 10 series of soils have been found important for rubber cultivation, the remaining soils being prevalent under other crops such as rice, coconut etc. A short description of the 10 important series found in the *Undulating to Rolling Mantled Plain and Hill and Valley* land forms is given below.

Soil of Undulating to Rolling Mantled Plain Cabook Series

These are well drained very shallow gravelly soils having dark brown to brown loamy and gravelly surface horizons over dusky red to yellowish brown and yellowish red, hardened laterite layer having a thickness more than 15 cm occurring at a depth of 30 cm or less over yellowish clayey horizons with strong reddish mottles; derived from colluvium and residuum from Vijayan gnesis.

These are truncated and occur usually on crests of undulating to rolling landform. These have been found in other slope positions even in hilly landform. The thickness of the hardened laterite layer varies greatly from 15 cm to 1 m or more. The layer below the laterite is clayey in nature with large prominent red and yellow mottles.

Boralu Series

These are well drained to moderately well drained moderately deep to deep soils with yellowish brown to dark brown sandy to loamy surface horizons with lateritic gravel and hard ironstone gravel over very high percentage of brownish red to red lateritic gravel and hard ironstone gravel over hardend laterite (cabook) of colours varying from dusky red to yellowish red and yellowish brown underlain by yellowish, clayey sub-soil with strong reddish mottles over gleyed palled zone with reddish and yellowish mottles; derived from colluvium and residuum from Vijayan gnesis.

These occur on convex slopes of the *upland.* These have been found in similar slope positions even in hilly landform but to a lesser intensity. The concentration of gravel above the laterite layer vary from 20 to 80% and particle size also varies 5 mm to 3 cm in diameter. Thickness of the laterite layer varies greatly from 15 cm to 1 m or more. The soil above the laterite is structureless and loose. Root distribution is rather restricted with the majority of the roots being within the top 30 cm. These are well developed soils with thick cutans in B_2 horizons.

Dadangoda Series

These are well drained, deep soils with dark brown to yellowish brown loamy surface horizons with lateritic gravel over yellowish red to reddish yellow loamy to clayey subsurface horizons with lateritic gravel and increasing amounts of dark red soft plinthite over reddish clays with very high percentage of prominent coarse soft plinthite over a mottled pallid zone with dark red mottles.

These are deeply weathered soils. Closer examination shows well developed textural B with well developed cutans. The structure is generally weak and sometimes structureless but massive. The whole profile is friable. Root distribution is normal with the majority of the roots within the upper 75 cm of the profile. These soils occur on convex and straight slopes of the upland. These have been found in similar slope positions of the hilly terrain too.

Pallama Series

These are moderately well drained to imperfectly drained, deep soils having dark brown to brown coarse loamy surface horizons with some lateritic gravel over strong brown to light yellowish brown loamy sub surface horizons with some soft plinthite; derived from colluvium and residuum from Vijayan gnesis.

The texture varies from sandy loam to sandy clay loam at the surface and sandy clay loam in the sub surface horizons. Lateritic gravel and occasionally hard ironstone gravel are found in the upper part of the profile. The structure is very weak mostly structureless but massive. The B_2 horizons are mottled and gleying starts at a depth of 80cm. The water table is fairly high and fluctuates between 80 and 120 cm.

These soils are located in gently sloping *bottomland* topographically below Boralu and Dodangoda series.

Soil of Hill and Valley

Pallegoda Series

These are well drained, moderately deep to deep, soils having dark brown to dark yellowish brown loamy surface horizons with fine rock fragments and some lateritic gravel over strong brown to yellowish red loamy to clayey subsurface horizons with fine rock fragments over yellowish red clayey horizons underlain by weathered coarse grained gneissic.

The structure is weak. The striking feature in these soils is the uniform appearance of the profile with a fair mount of 1–4 cm size (diameter) rock fragments. The whole profile is porous and permeable. Lateritic gravel and stone size rock fragments are common on surface. 2–10 P. C. boulder size rocks are found in this series. This series occur on convex and straight slopes of the *upland.*

Pannila Series

These are well drained, very deep, gravel free soils having dark brown loamy surface horizons over strong brown to reddish yellow loamy to clayey horizons over yellowish red clayey sub surface horizons underlain by reddish yellow slightly mottled clayey well weathered feldspathic material, often with dark red soft plinthite.

These are deeply weathered, uniform soils with coarse subangular blocky structures. Closer examination shows well developed textural B horizons with quite well developed cutans. The whole profile is friable, porous and permeable. Root distribution is normal with majority of the roots in the upper 75 cm. These soils occur mostly on mid and lower positions of the straight slopes of the *upland.*

Keeranthidiya series

These are imperfectly drained to moderately well drained, moderately deep to deep soils having dark greyish brown sandy surface horizons over borownish yellow to yellow coarse loamy horizons over yellow loamy sub surface horizons with distinct red mottles underlain by yellow, clayey partially weathered feldspathic C horizons, very often with gleyed, coarse rock fragments.

The structure is weak throughout the profile. Surface textures sandy loams or loamy sands while the sub surface horizons are sandy clay loam to sandy clays. These soils occur on gently sloping straight or slightly convex slopes of the *bottomland.* Topographically these lie below soils of Pallegoda series. The water table is fairly high and appear to fluctuate between 70 and 100 cm from the surface.

Manana Series

These are imperfectly to poorly drained, moderately drained soils having very thin bleached (white) quartz sand over dark greyish brown very sandy surface horizons over greyish sandy horizons underlain by highly gleyed (light grey) clays, with prominent yellowish brown mottles.

The most striking features of these solis are the 2–3 cm thick bleached white sands on the surface and the sandy nature of the sub soil. The textures of the surface and the sub surface horizons are sands and loamy sands while the C horizons are clays or silty clays. Structure is single grain. These soils occur as narrow stretches on level to very nearly level valley bottoms if the valleys are narrow while in broad valleys on the slightly higher positions or on the outskirts of the valley bottom. These are alluvial in origin. The water table is very high.

Soil of the Ridge and Valley

Nehinna Series

These are well drained, deep to very deep, uniform somewhat eroded soils having yellowish brown, loamy surface horizons over strong brown to yellowish red clayey sub surface horizons.

The textures in the surface horizons are sandy clay loams and clay loam to clays in the sub surface horizons. The profile has moderate coarse sub angular structures in the B horizons. These have well developed textural B with quite well developed cutans. Rock fragments are fairly common in the profile where boulders of rock are abundant on the surface of the land. Also in this type rocky lands the A horizon is fairly thick and high in organic matter. In land where rocks are absent the A horizon has got eroded off.

These soils occur on the *upland* in areas of Ridge & Valley landform. These ridges are long, narrow and fairly high in relief.

Malaboda Series

These are well drained, deep, gravel free soils having yellowish brown loamy surface horizons over brownish yellow to yellow clayey sub surface horizons.

These have well developed textural B with thich cutans on ped surfaces and in side pore walls. The most striking feature in these soils is the strong, coarse, blocky to prismatic structure. These soils occur on concave mid and upper mid slopes of the upland.

The field work of the North Eastern quadrant was started.

C. G. Silva, [1]*S. E. Jayasooriya, F. P. W. Silva, & T. A. C. S. Wasanthadeva*).

WEED CONTROL

No work was done in this field. But, observations were made from experiments started under covers and cover management on weed competition and succession. Use of herbicides does not appear to be an economic proposition, under the present context of herbicide prices.

(*N. Yogaratnam*)

ANALYTICAL CHEMISTRY

Work of this section involved routine chemical analyses of survey, experimental and advisory, soil, leaf with latex samples of the Department and testing of analytical methods. Requests from other Departments for chemical analyses were also considered.

Routine analyses

Leaf: Foliar survey samples collected for discriminatory fertilizer recommendations and samples collected from experimental sites were analysed for N, P, K, Ca, Mg and Mn. Some analyses were also done for the Botany and Plant Breeding & Genetics Departments. In all 7294 analyses were done.

Soil: Samples collected from experimental sites were analysed. Some analyses were also done for the Botany and Plant Pathology Departments. In all 2864 analyses were done.

Latex: Samples collected from areas affected by Brown Bast were analysed by atomic absorption spectrophotometry. Some analyses were also done for the Rubber Chemistry Department. In all 150 analyses were done.

(*M. A. Perera, H. A. Seemon, B. Arsecularatne, L. J. Wickremasinghe, K. U. C. Perera, D. R. Denawaka, P. S. R. A. Samarakone & S. Ravindran*).

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[1]Land Use Division, Irrigation Department, Colombo.

Analytical methods

Trace element : Attempts were made to determine the trace element concentrations in soils. Analysis of total, molybdenum, zinc, copper, iron and manganese were done after acid extraction with Conc.HCl followed by Conc.HNO_3. Available trace elements were done using ammonium acetate and water soluble fractions after leaching with hot water. The concentrations of the trace elements in the extracts were measured by a Techtron, type A. A. 6, atomic absorption spectrophotometer. (*M. A. Perera, B. Arsecularatne & T. A. C. S. Wasanthadeva*)

Sulphur: Quantitative determination of water soluble sulphate in soils was done successfully by turbidimetry. Mixtures of NaCl/HCl and glycerol/alcohol followed by $BaCl_2$ were used and the turbidity of the solution ($BaSO_4$) was measured by a spectrophotometer. In view of the high cost of the chemicals involved in this method an alternate method was also attempted. This method involved the use of sodium acetate and a 0.25% gum acacia solution. (*L. J. Wickremasinghe*)

Phosphate: It has been agreed to carry out a co-operative study on the possibilities of standardization of laboratory soil testing methods for soils from the humid tropics whith emphasis on soil phosphate. This will be done in collaboration with the Tropical Soils Division of the Department of Agricultural Research, Royal Tropical Institute, Amsterdam and the Institute for Soil Fertility, the Netherlands.

It is to be expected that the results of this co-operative study will be more easily acceptable universally or at least can be used as a standard method for comparison with local methods.

(*N. Yogaratnam with* [1]*Dr. Ir. H. A. Sissingh &* [2]*Ir. A. Muller.*)

OTHER INVESTIGATIONS

Fertilizers to Oil Palm

A foliar survey of the entire 1500 acres of oil palm in Nakiadeniya Estate in the Galle District was carried out. It is hoped to resurvey the same area and any other area that may be planted with oil palm, at six monthly intervals in order to study the changes in nutrient composition of the leaves. This will help us in recommending tentatively, suitable fertilizers for oil palm in Sri Lanka.

(*N. Yogaratnam & F. P. W. Silva*)

Brown Bast

Soil, leaf and latex samples collected from an area at Eladuwa Estate, where the incidence of this disorder was detected, were analysed for N, P, K, Ca & Mg. Soil analysis did not reveal any differences due to the nutrient contents between the affected and healthy areas, but leaf analysis gave indication that trees affected with Brown Bast had high Calcium (0.338%) compared with that of the healthy trees (0.194%). Investigations were continued.

(*N. Yogaratnam & L. J. Wickremasinghe with D. M. Fernando and P. A. J. Yapa*).

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1. Senior Research Officer, Institute of Soil Fertility, Haren, The Netherlands.
2. Head of the Soil Science and Agrochemistry Division, Royal Tropical Institute Amesterdam.

Uses of Natural rubber

Soil stabilisation: Work on stabilisation of sandy soils with NR latex was started. Observation plots demarcated in Dartonfield were sprayed with (1) NR (formaldehyde stabilised) (2) NR+Oil (3) Prevulcanised compounded latex. An unsprayed control was also included. Visual observations made, indicated that all spray treatments were superior to the unsprayed control in soil stabilizing effect. Among the spray treatments NR+oil and pre-vulcanised compounded latex, treatments appeared to be better than NR alone. Investigations were continued.

(*N. Yogaratnam, W. C. Dayaratne with M. Nadarajah*)

Encapsulation of fertilizers: Attempt was made to encapsulate Bio-super with NR formulations in order to prevent the pellet of Biosuper from disintegrating by the bashing action of rain drops, when broadcast on the soil surface. Chemicals were added to the formulation in order to regulate the release of nutrients.

(*N. Yogaratnam with A. Coomarasamy & U. P. de S. Waidyanatha.*)

Nitrogen on Oidium *leaf-fall*

Experiments were started to study the effect of three levels of nitrogen on the incidence of secondary leaf-fall caused by *Oidium*. These experiments were on clone PB 86 and sited in Kiribathgalla Estate, Ratnapura, Hunuwella Estate, Opanaike, Parambe Estate, Undugoda and Ambadeniya Estate, Aranayaka. (*N. Yogaratnam & K. S. A. C. Peiris with A. de S. Liyanage*)

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REVIEW OF THE RUBBER CHEMISTRY DEPARTMENT

M. NADARAJAH

SUMMARY

The results of research and promotional work done by the Rubber Chemistry Department were reported in:

(a) Three papers at the Indian Rubber Manufacturers' Research Association Conference held in Cochin in February 1977.

(b) Four papers at the one day seminar on "Rubber Culture, manufacture and marketing" held in Colombo in May, 1977.

(c) Seven papers at the one day seminar on "Rubber Products" held in Colombo in September, 1977.

(d) Eight papers at the 33rd SLAAS sessions held in Colombo in December, 1977.

A simple method of preparing a light coloured cyclised rubber from field latex, using para-toluene sulphonic acid as the catalyst and the use of this product in paints is being evaluated. The properties of formaldehyde stabilised centrifuged latex have been improved thus enhancing its commercial use in Sri Lanka. The properties of portland cement mortars using LA centrifuged latices and MG latices were investigated and improvements in properties noted as compared to HA centrifuged latices. Work on bound antioxidants to natural rubber latex with Topanol A and Topanol OC was continued.

Twenty five one hour lectures at undergraduate level and seventy seven one hour lectures at post-graduate level were given by our staff at the Katubedda and at the Vidyodaya Campus, respectively.

Production of sole crepe from dry laces and using conventional plantation sole crepe equipment is possible and Sri Lanka should manufacture more sole crepe from dry laces in existing latex crepe and sole crepe factories whenever economic considerations justify it. A simple way of stepping up block rubber production in Sri Lanka is by upgrading and using conventional latex rubbers. Thus SLR 5 can be made from RSS 4 and 5 to the economic advantage of Sri Lanka. Blocked latex crepe can be made to consumer technical specifications and this being an additional outlet for Sri Lanka latex crepe should improve the marketing of this grade of rubber. The SRMC is producing these two grades of block rubber commercially.

Further trials on the use of HCl as a coagulant were carried out in one Group Processing Centre (GPC) and this was extended to four more GPCC towards the end of the year.

A full evaluation of local china clay for the rubber industry was initiated and part of this work has already been reported.

The Rubber Technology Division continued to give assistance to local industrialists in setting up both small and medium scale industries. The work in the Division included analysis of raw materials. testing of compounds and standardisation of products. Training of personnel took a lot of time of the staff of the Rubber Technology Division. A complete evaluation of latex thread, both local and foreign was started in collaboration with the Bureau of Standards to assist in the

formulation of standards for latex thread. Work was done on custom compounding of latex for rubber band manufacture and for improving the clarity of feeding bottle teats. A way of producing satisfactory rubberised fabrics using natural rubber latex and topping with PVC has been devised.

More work was done on the molecular studies of depolymerised natural rubber prepared by using solar energy. It was found that epoxidised depolymerised natural rubber is a good binder for natural and synthetic fibres. Natural graft copolymers containing styrene and acrylonitrile have been found to show thermoplastic behaviour and thin films which are tough could be prepared at 170 – 180 °C and at a pressure of 10 psi. The graft copolymers containing acrylonitrile and acrylamide show mineral oil resistance. Efforts are being made to promote the use of cheap emulsion paints containing 70% of the total binder in the form of prevulcanised formaldehyde stabilised latex.

Powdered rubber has been prepared by the starch xanthate method, using a cellulose derivative, and its properties have been evaluated. The powdered rubber prepared by using a cellulosic derivative can be redispersed into latex using an alkali and this latex has good adhesive properties.

Practical applications of room temperature and sunlight curing for natural rubber was investigated for the manufacture of vulcanised sole crepe, rubberised cart wheels, rubberising concrete boats, lining of water channels, sealing of leaks in concrete roofs and in carpet backing compounds.

Investigations were continued on the use of papain in RSS, in DPNR, in skim rubber and in low nitrogen latex manufacture. 6736 samples of block rubber were tested for specifications.

DETAILED REVIEW

Messrs M. Nadarajah, S. W. Karunaratne, Dr. A. Coomarasamy and Dr. M. R. N. Fernando visited India from 9th to 19th February on the Indo-Sri Lanka Science and Technology Programme, to present papers at the IRMA seminar, to have joint discussions with the IRMRA India, and to visit block rubber, centrifuging and rubber product manufacturing factories.

Dr. W. S. E. Fernando resumed duties as Assistant Rubber Chemist on 7th July 1977 after completing his overseas studies leading to the Ph D. Mr. K. P. N. de Silva went to follow the Processing Course conducted by the RRIM and returned after obtaining a distinction in the Diploma examination.

The following officers were promoted: Dr. M. R. N. Fernando, Dr. A. M. A. Amarapathy and Mr. L. M. K. Tillekeratne to Rubber Chemists, Mr. D. S. Muthukuda to Development Officer, Mr. P. V. G. Perera, B.Sc. (Cey.) to Experimental Officer, Messrs A. S. Dekumpitiya and D. D. Medagama to Senior Technical Assistants and Miss S. Wickremanayake to Technical Assistant.

The following officers joined the Rubber Chemistry Department : Mr. M. C. S. Perera, B.Sc. as Research Assistant, Mr. N. R. Munamalpe, B.Sc., and Miss S. Lokuge B.Sc. as Experimental Officers, Messrs V. K. Jayasiri, P. M. Jayaweera, Jayantha de Silva, S. A. V. K. Kobawaka, D. Dharmadasa, M. P. N. S. Pieris and B. P. H. R. Mendis, as Technical Assistants, Miss D. Peiris, Mr. G. Dodangoda and Mr. G. Wanigatunge as Specifications Assistants and Messrs W. Somasiri, P. J. Perera and P. V. Sunil Weerasiri as Laboratory labourers.

Miss C. L. Punchihewa and Messrs T. Kandasamy, W. D. P. R. Abraham, P. M. Jayaweera, K. A. Piyadasa, N. A. A. Silva and S. Kurera, resigned from the services of the RRI.

Mr. B. A. Perera, Lab. Attendant retired from service and Mr. R. Wickremaratne was transferred from the Soils Chemistry Department as a Lab. Attendant.

Conferences :

The following papers were presented at the Indian Rubber Manufacturers' Research Association Conference held in Cochin from February 10th to 12th 1977.

1. "Recent developments in new uses of natural rubber in Sri Lanka" by M. Nadarajah.
2. "Preparation of powdered rubber" by S. W. Karunaratne.
3. "Some new antioxidants for natural rubber" by A. Coomarasamy.

A one day seminar on "Rubber culture, manufacture and marketing " was organised by Mr. R. Tharmalingam on 1977.05.30 and the following papers were presented:

1. "An assessment of the potentialities of latex crepe manufacture in Sri Lanka" by M. Nadarajah.
2. "Crepe Rubber Development Unit" by R. Tharmalingam.
3. "Quality control of plantation sole crepe" by E. G. Mendis.
4. "Some problems of block rubber manufacture in Sri Lanka" by L. M. K. Tillekeratne.

A one day seminar on "Rubber Products" was organised on 1977.09.19 by Dr. A. M. A. Amarapathy and the following papers were presented :

1. "Possibilities of rubber products manufacture in Sri Lanka"by M. Nadarajah.
2. "Strategy needed for the orderly development of the rubber goods manufacturing industry in Sri Lanka" by S. W. Karunaratne.
3. "Usage of rubber derivatives and rubber seed oil in paints" by A. Coomarasamy.
4. "Possibilities of expansion of latex based products in Sri Lanka" by A. M. A. Amarapathy.
5. "Mathematical model of a single screw extruder" by R. Tharmalingam.
6. "Some practical applications of natural rubber formulations vulcanising at room temperature" by M. R. N. Fernando.
7. "The scope of standardising rubber products in Sri Lanka" by L. M. K. Tillekeratne.

The following papers were presented at the 33rd Annual Sessions of the Sri Lanka Association for the Advancement of Science:

1. "Vulcanising systems for low temperature and sunlight curing of natural rubber compounds" by M. R. N. Fernando and M. Nadarajah.

2. "Future development of natural rubber portland cement mixes for engineering applications" by Upali G. Fernando, M. Nadarajah and W. A. Roger Perera.

3. "Commercial manufacture and uses of cyclised rubber" by A. Coomarasamy and M. Nadarajah.

4. "Epoxidation of depolymerised natural rubber and industrial uses of its product" by L. M. K. Tillekeratne, W. S. E. Fernando and A. J. S. K. de Silva.

5. "The use of natural rubber latex for coating fabrics" by A. M. A. Amarapathy, M. Nadarajah and M. G. Manel.

6. "Evaluation of locally produced clay in the rubber industry" by S. W. Karunaratne and M. Patel.

7. "Production of phytoalexins in Hevea pods in response to infection" by *Phytophthora* spp. - N. I. S. Liyanage, P. A. J. Yapa, O. S. Peries and A. de S. Liyanage.

8. "Some biochemical studies on characterisation of *Hevea* clones" by P. A. J. Yapa, G. A. J. P. R. Goonesekera and S. Kasinathan.

Mr. S. W. Karunaratne participated and delivered the following talks at two seminars organised by the IDB on :

a) Rubber products for the textile industry :

b) Insulating materials for the electrical industry.

Lectures in Polymer Chemistry and Rubber Technology :

The following officers delivered one hour lectures for the M.Sc. course at the Vidyodaya Campus: Dr. M. R. N. Fernando (10), Mr. S. W. Karunaratne (4), Dr. A. Coomarasamy (9), Dr. A. M. A. Amarapathy (18), Mr. L. M. K. Tillekeratne (15), Mr. M. Nadarajah (4), Dr. P. A. J. Yapa (3), and Mr. R. Tharmalingam (14), Mr. M. Nadarajah delivered ten, one hour lectures for the LPRI course, Mr. L. M. K. Tillekeratne delivered eight, one hour lectures for the NDT course and Mr. R. Tharmalingam delivered seven, one hour lectures to the B.Sc. Applied Science course at the Katubedda Campus.

Serving on Boards

Mr. M. Nadarajah served as a Member of the Board of Directors of the State Rubber Manufacturing Corporation (SRMC) and on Ceyesta.

Serving on panels

Mr. S. W. Karunaratne was nominated to serve in two drafting committees by the Bureau of (Ceylon) Standards and was elected Chairman of the drafting committee on latex thread.

Patents:

Applications were made for the following patents:

1) A Sri Lanka Provisional Patent No. 7679 on "Uses of formaldehyde stabilised latices to manufacture rubberised fabrics" in the names of M. Nadarajah and A. M. A. Amarapathy.

2) A Sri Lanka complete patent No. 7625 on "The manufacture of vulcanisable sole crepe" in the names of M. Nadarajah and M. R. N. Fernando.

3) A Sri Lanka complete patent No. 7656 on "Stabilised natural rubber latex as an adhesive for cellulosic materials" in the name of M. Nadarajah.

4) A Sri Lanka provisional patent No. 7670 on "Epoxidised depolymerised natural rubber as a binder for glass fibre and other fibres" in the names of L. M. K. Tillekeratne, W. S. E. Fernando, A. J. S. K. de Silva and T. A. S. Siriwardene.

Rubber Chemistry

Cyclised Rubber:

The necessary assistance was given to Elston Estate, Puwakpitiya, for the commercial production of cyclised rubber using the process developed by this Department for the preparation of cyclised rubber from papain coagulated rubber. A spare 26"x14" two roll smooth mill available at the Estate factory is being used for the production of cyclised rubber and the daily output is 80 kg. The cyclised rubber produced at Elston is sold either as pure resin or as a masterbatch by a firm to rubber product manufacturers for use as a reinforcing filler for rubber. The present estimated demand for cyclised rubber in this application is about 70 tons/annum and arrangements are being made to produce this material in three other crepe factories where spare mill capacity is available.

A grade of cyclised rubber prepared from papain coagulated rubber, using field latex stabilised with 0.02% NH_3 and 0.2% boric acid after treating with 0.07% Nonidet T, 0.05% hydroxylamine hydrochloride, 0.7% RPA 3 and 0.25% papain was found to be suitable for solution applications. At the request of the Road Research Laboratory, Department of Highways, large samples of road marking paints have been prepared and supplied. The machinery required for pilot plant scale production of paint such as a high speed shear mill and a 25 gal capacity ball mill have been fabricated locally. Satisfactory formulations for floor paints have been fabricated locally. Satisfactory formulations for floor paints have also been developed based on cyclised rubber.

Available methods such as Iodine Value determination, estimation of activity and solution viscosity are being used to standardise the cyclised rubber produced. Work is also being carried out to improve the quality of cyclised rubber produced by the method developed by us.

(A. Coomarasamy, M. Nadarajah, L. B. K. Silva, S. Kurera, R. Surendrakumar & S. Lokuge).

Modification of NR by graft-copolymerisation with vinyl monomers;

Monomers such as styrene, acrylonitrile, acrylamide, methyl-methacrylate and maleic acid derivatives have been used individually and as binary mixtures for graft polymerization. In most of the experiments, stabilised field latex was used and it has been that the high ammonia content in latex retards graft copolymerisation, under the conditions tested and deammoniation prior to the reaction has been found to be necessary. Redox intitiators such as CHP/TEP, CHP/Fe^{2+}/ glucose, $K_2S_2O_8/Fe^{2+}$ have been tried out and the system consisting of CHP/TEP was found to be most effective. Ammonium oleate prepared *in situ* is found to be a good emulsifier for these polymerisation reactions.

The vulcanisates prepared from acrylonitrile grafted NR have been found to show satisfactory mineral oil resistance. The NR graftcopolymers containing styrene and acrylonitrile showed good flow properties at 170–180 °C and at a pressure of 10 psi. Thin films could be pressed from these graft copolymers using a laboratory hand operated press. Introduction of thermoplastic characteristics to NR is advantageous and as such extensive studies are being planned for future work.
(*A. Coomarasamy, W. S. E. Fernando, R. Surendrakumar & S. A. V. K. Kobowaka*)

Natural Rubber latex as a binder/encapsulating agent for fertilizer mixtures

This project was started during the latter part of the year. Preliminary experiments, carried out in collaboration with Officers from the Botany and the Soils Chemistry Departments, have shown very encouraging results and experiments are being planned for comprehensive study. (*A. Coomarasamy*)

Preparation and uses of formaldehyde stabilised latices ;

The method of preservation used is NaOH and HCHO at concentrations of 0.15% and 0.4%, respectively, of field latex on the first day and NaOH, HCHO, and TMTD at concentrations of 0.1%, 0.2% and 0.05% of the field latex or of the centrifuged latex on the second day. The MST of the latex is 255 seconds which is below the specifications of 550 seconds for centrifuged latices. The addition of TMTD at a concentration of 0.05%to the field latex on the first day, and TMTD at 0.025 to the field latex or centrifuged latex on the second day raised the MST of the centrifuged latex to 635 seconds. This is therefore a superior method of preservation for FS latices and this change is recommended for commercial implementation. The MST is further increased by the addition of the soaps of the potassium or sodium salts of coconut oil fatty acid and Dispersol LR, or the bases Morpholine and Triethanolamine.

The amount of HCHO added to the field latex on the first day is at 0.4 % on the latex and, when centrifuged, a major portion goes into the skim latex and is not only wasted but causes an effluent problem. It was found that the amount of HCHO could be reduced to 0.2%.

The viscosity of formaldehyde stabilised latices can be increased by the addition of a filler such as Kaolin in the following manner for: (a) *field latex*: to 100 g of FS field latex add 15 g of kaolin in small amounts at a time while stirring vigorously. To this suspension added 40g of a slurry of kaolin prepared by mixing a solution of 3 g of dispersing agent (*e.g.* Dispersol SLR or Dupanol OS) in 37 g of water and then mixing with 60g of Kaolin. The viscosity of the formaldehyde stabilised field latex is also improved by blending with FS centrifuged latex before adding the

necessary amount of Kaolin slurry. (b) *FS centrifuged latex;* the above 60% Kaolin slurry can also be added to FS centrifuged latex to improve its viscosity and some of its properties.

The FS field latex which has its viscosity modified by addition of Kaolin is a good paper to paper adhesive. The FS centrifuged latex with Kaolin slurry at 5% to 10% on the latex (W/W) is a good paper to polythene adhesive. The FS centrifuged latex is not destabilised by the addition of 60% Kaolin slurry.
(*M. Nadarajah & R. Surendrakumar*).

Liquid rubber analysis and chemical modifications;

Some useful data for this project were provided by R. Sebastian who is working on this project at the University of London. Data on the molecular weight range, types of end groups present and the functional group distribution are now available. Having studied the functional groups the next step is to get better end uses.
(*L. M. K. Tillekeratne, P. V. A. G. Perera, Mrs. S. Weeraman, Miss T. Nirmala & R. Sebastian*).

Epoxidised NR

Depolymerised NR, obtained by the use of solar energy was epoxidised and a product which is a good binder for natural and synthetic fibres, such as fibre glass, was made. A patent was taken on this work and a paper on the subject was presented at the last SLAAS sessions. A paper has also been submitted on this work to the Russian Polymer Conference, to be held in October 1978.
(*L. K. M. Tillekeratne, W. S. E. Fernando, A. J. S. K. de Silva & T. Siriwardene*).

Use of Epoxidised Natural Oils as binder and adhesives;

Castor oil epoxidised in the same way as depolymerised NR has been found to give a two component adhesive similar to 'Areldite' which hardens instantaneously. Other natural oils available freely in this country have also been subjected to this type of modification.
(*L. M. K. Tillekeratne, W. S. E. Fernando & M. C. S. Perera*)

Preparation and properties of white factice from rubber seed oil;

It has been found that white factice could be prepared by treating rubber seed oil with industrial grade sulphur monochloride (10 parts per 100 parts of oil) in the presence of a petroleum hydrocarbon solvent. The reaction is found to be highly exothermic and the reaction mixture has to be cooled below 5° C to obtain a light coloured product. The stability of the product at a vulcanisation temperature of 140°C is not satisfactory and methods of improving its stability are being studied.
(*A. Coomarasamy & L. B. K. Silva*).

NR latex in emulsion paints;

Several batches of emulsion paints, containing blends of formaldehyde stabilised prevulcanised latex/polyvinyl acetate latex as binder, have been prepared and their properties such as washability, brushability, rub-fastness and light fastness

were qualitatively evaluated. For satisfactory performance 30% of the binders used must be of synthetic polyvinyl acetate latex and the balance 70% could be of NR latex. The use of a fungicide in the formulation is also found to be necessary. These paints could be sold fairly cheap and therefore the production of these paints should be encouraged. A feasibility report has been prepared for the commercial scale production of this paint on a small scale industrial level.
(*A. Coomarasamy, M. Nadarajah, L. B. K. Silva & R. Surendrakumar*).

Preparation of chlorinated rubber from latex :

Various modifications were tested, including low nitrogen latex, double centrifuged latex, latex with peptizers etc. The chlorinated rubber obtained, in the form of a powder was found to be insoluble in the common solvents.
(*A. M. A. Amarapathy, W. S. E. Fernando & W. Kobawake*).

Bound antioxidants:

The possibilities of grafting Topanol A and Topanol O.C. to low ammonia centrifuged latex and field latex was examined.

It has been found that the grafting reaction could be carried out even with the centrifuged latex but the efficiency of grafting is not as good as with the diluted centrifuged latex. To overcome this problem it has been decided to incorporate about 0.25% of Nonox WSP into the grafted centrifuged latex which could straightaway be used for the manufacture of latex thread and dipped products.
(*A. M. A. Amarapathy & N. R. Munamalpe*).

Rubber Technology

Powdered natural rubber - Starch Xanthate Method:

A batch of 4 kg. of powdered rubber was prepared by the above method, to study its use in extrusion processes. Its raw Mooney Viscosity is around 160 compared to approximately 60 for raw natural rubber.

The powdered rubber prepared by this method has good free flowing properties. The powder was blended with ACS I mix compounding ingredients with 10% processing oil in it and extruded. Due to its high viscosity and tendency to crumb formation, difficulties were experienced in using this material in the extrusion process. Its flow properties at high temperature (140°C) is also very low on moulding. This property may be due to partial vulcanisation of the rubber within each particle due to the presence of Xanthate. No further work to develop a pilot plant will be carried out until the uses of the material and its advantages over conventional forms of rubber are evaluated. This evaluation will be carried out from samples of powdered rubber obtained on a laboratory scale.
(*R. Tharmalingam, S. W. Karundratne & K. P. N. de Silva*).

Powdered natural rubber - using a Cellulose derivative :

When NR latex is mixed with a cellulose derivative and coagulated, the coagulum can be easily broken up into crumb form. These crumbs when dried have free flowing characteristics. Compared to the powdered rubber obtained by the

Xanthate process, this rubber has better flow properties on moulding. In addition, when this rubber was vulcanised using an ACS I mix, the cellulotic material present in the rubber gives a better reinforcement. This was revealed on testing the tensile strength and modulus of the vulcanisate. The equipment required for the process flowline for this rubber will be :

1) A high speed stirrer,
2) A filter press;
3) A deep bed drier.

Drawbacks here are :

1) The high cost of the cellulose derivative, even though it is added at 10% of drc, the cost of this material is about the same as that of the rubber, *i.e.* the material cost alone is double that of the conventional forms of rubber;
2) The particle size (average) are slightly larger than the Xanthate based powdered rubber;
3) The solubility is affected by the cellulotic material.

(*W. S. E. Fernando, R. Tharmalingam & M. C. S. Perera*).

Redispersible Crumbs:

The crumbs obtained by using a cellulose derivative in the preparation of the powdered rubber can be redispersed into latex using an alkali. These crumbs when redispersed have very good adhesive properties. The solid content of the crumb is very low (about 55%), but if the water content is further reduced the redispersible characteristics are reduced. Using a surfactant to retain this property will be investigated. The objective will be to reduce the water content of the crumb to at least 10% while maintaining the redispersible characteristics.

Possibilities of using the redispersed latex in dipped/goods manufacture and other fields where concentrated latex is used as the raw material will be investigated.
(*R. Tharmalingam, W. S. E. Fernando & K. P. N. de Silva*).

Design of Rubber Extruders:

Work has been initiated with local engineering firms and with the National Engineering Research and Development Centre on designing rubber extruders. Design work is already in progress with a local engineering firm on a 1½" extruder for the Rubber Technology Division of the Katubedda Campus. This extruder will be fabricated soon. The UNDP will finance this project. This project is being done in collaboration with the UNDP adviser Mr. M. Patel (Katubedda Campus).
(*R. Tharmalingam & K. P. N. de Silva*).

Custom Compounding of natural rubber for rubber band manufacture:

Preliminary work has been carried out in the preparation of latex masterbatches for rubber band manufacture. As the compounding is carried out in the latex phase, less mixing equipment is necessary. This would amount to a saving of approximately Rs. 4 million in foreign exchange. Further, our objective is to integrate

raw rubber and rubber products manufacture in one factory to minimise costs as well as to improve the quality of the products. Different accelerator systems were incorporated into latex in addition to other conventional vulcanising ingredients. The coagulum was milled, dried, vulcanised and the technological properties studied. (*A. M. A. Amarapathy, W. S. E. Fernando & V. K. Jayasiri*).

The use of natural rubber latex for coating fabrics ;

The work on this project was continued and very successful results were obtained. It was found that the compounded latex could be used for fabric coating but the tensile strength of a film prepared from the compounded latex was not as good as of a film prepared by a mixture of 50:50 prevulcanised latex and compounded latex.

The best formulation obtained for prevulcanisation of formaldehyde stabilised latex at 60°C was:

Sulphur	—	0.75
Zinc oxide	—	0.5
TMTD	—	0.25
ZDC	—	0.25
Dispersol LR	—	0.1 for hundred of rubber.

Further it was found that two base coatings of a mixture of 50% prevulcanised and 50% compounded latex followed by a third coating of MG 20 latex as the tie coat for proper adhesion of the fourth and the final PVC coating, was satisfactory. (*A. M. A. Amarapathy, M. Nadarajah & M. G. Manel*).

Practical applications of room temperature and sunlight curing for natural rubber;

(a) *Manufacture of vulcanised sole crepe;*

A suitable method to manufacture vulcanised sole crepe was developed where a formulation of chemicals capable of vulcanising rubber at room temperature is added to natural rubber latex prior to coagulation. The formulation consists of 1.25 parts of zinc diethyl-dithiocarbamate, 1.25 parts of mercapto benzthiazolyl disulphide, 0.33 parts of zinc oxide and 1.0 parts of sulphur per hundred parts of rubber. In the case of producing bright coloured sole crepe the chemical formulation, in dispersed form, is mixed into latex to which RPA 3 is added, fractioned and the usual dose of coagulant is added. Then a second dose of coagulant is added.

In cases where a bright colour is not a requirement, the chemicals are added to fresh unfractioned field latex and then coagulated with the normal dose of acid.

After coagulation the rubber is converted to sole crepe following the usual factory procedures, within the shortest possible period of time.

Vulcanised sole crepe thus produced in this manner is considered as a finished product which does not become tacky when compared with ordinary sole crepe. Extensive trials were done at two estates, *viz.* Elston and Frocester and the process has reached industrial standards. (*M. R. N. Fernando, M. Nadarajah, & K. A. R. M. Perera*).

(b) *Rubberised cart wheels;*

A method was developed to rubberise wheels of hand carts and bullock carts. The method of fabrication is by using strips of rubber containing carbon black and a sunlight curing system. The only equipment required for this process is a 2-roll mixing mill. Trials are being carried out and road tests undertaken.
(*M. R. N. Fernando, K. A. R. M. Perera & D. Dharmadasa*).

(c) *Rubberising concrete boats;*

A room temperature curing compound in the form of a $\frac{1}{2}$" thick sheet is fixed to the outer surface of concrete barges built by the State Engineering Corporation. The ultimate aim of this project is to increase the impact resistance of these barges. The initial trials have proved to be very promising and the Ceylon Tyre Corporation has agreed to supply the large quantity of rubber compound, required, when a complete boat will be rubberised in the near future.
(*M. R. N. Fernando, M. Nadarajah, K. A. R. M. Perera & D. Dharmadasa*).

(d) *Lining of water channels;*

To prevent erosion of side walls and seepage of large quantities of water in open water channels, a thin layer of vulcanised rubber is applied on to the channels by using natural rubber latex containing a room temperature vulcanising formulation. Small scale trials have been completed. Large scale trials will be carried out in the near future with the collaboration of Lankem Ltd., where a bitumen emulsion will also be incorporated into the latex.
(*M. R. N. Fernando, M. Naddrajah, K. A. R. M. Perera & D. Dharmadasa*)

(e) *Sealing of leaks in concrete roofs;*

Room temperature vulcanising natural rubber latex and shellkote type 3 emulsion are mixed in the ratio of 1:2. This mixture is then applied on to concrete surfaces with a brush. On exposure to sunlight the rubber in the mixture undergoes vulcanisation and along with the bitumen a good sealant is obtained.
(*M. R. N. Fernando, M. Nadarajah, K. A. R. M. Perera & D. Dharmadasa.*)

(f) *Carpet backing compound;*

A room temperature curing natural rubber latex formulation containing 10 parts of Kaolin and 10 parts of titanium dioxide as fillers was used in binding the tufts on the underside of bathroom carpets. Very promising results were obtained.
(*M. R. N. Fernando, & M. Nadarajah*).

Portland cement - natural latex mixes ;

This work was done in collaboration with Dr. Upali G. Fernando and Mr. W. A. Roger Perera of the State Engineering Corporation and a paper on this work was presented at the SLAAS Annual Sessions, 1977. The mixing of natural rubber latex with portland cement reduced its strength properties especially compressive and bending strength. These defects were somewhat rectified by using low ammonia (TMTD/Zn0) once centrifuged latex or by using methyl-methacrylate grafted latex (MG 20); produced from once centrifuged latex; and by reducing the water content in the mortar, depending on the amount of rubber used.
(*M. Nadarajah*).

The use of rubber latex to control soil erosion :

This work was done in collaboration with Dr. N. Yogaratnam and Mr. W. C. Dayaratne of the Soils Chemistry Department. The latex used was formaldehyde stabilised field latex as it would have good bonding to the soil colloids. The latex was sprayed at 10% drc at the rate of 1500 cc. per square metre. The trials done were :

a) 10% drc,
b) 10% drc+4 % mineral oil+0.45% non ionic soap (Nonidet T).
c) 10% drc+room temperature vulcanising chemicals.
d) control.

On visual examination(d) gave the worst results and the best results were given by (b) and (c). It appears that in (b) and in (c) the rubber coated soil particles are stable to dispersive action of rain drops preventing their breakdown into finer particles to cause blockade of soil pores. This increases water infiltration through the soil surface and curtails surface run off, thus reducing soil erosion. (*M. Nadarajah*)

Bitumen emulsion - natural rubber latex mixes :

Cationic bitumen emulsions containing 3% fillers such as (Shellkote Type 3 containing 80/100 bitumen) give stable mixes with formaldehyde stabilised latex even on storing for a period of six months. This appears to be a convenient method of mixing bitumen emulsion and NR latex by the producer rather than by the consumer. Lankem Ltd. is satisfied with this process and is marketing this mix with 3% rubber in the bitumen for use in road construction and 10% rubber in the bitumen for water proofing roofs and is also paying the RRISL a royalty for every gallon of field latex used in the process. (*M. Nadarajah*)

Technological Advisory Services :

A revised project report on establishing a latex based rubber goods industry was submitted to Mr. D. C. L. Amarasinghe.

Assistance is being given to Messrs Jafferjee Bros., to set up an industry to make rubber bands.

Evaluation of compounds and quality control of products was done by testing several compounds for the IDB and other industrial organisations.
(*S. W. Karunaratne*)

Evaluation of local raw materials used in the rubber industry:

Two types of clay available locally, namely ball clay and industrial clay, were evalued in typical rubber compounds to test their processing and reinforcing characteristics. The main conclusions of this study were :

(i) Indigenous clays are quite suitable for compounding rubbers.
(ii) Indigenous clays need improvements on;
    (a) Reduction in dirt content
    (b) Adequate drying to reduce volatiles.

(iii) Ball clays are less suitable than industrial clays for use in the Rubber industry.

(*S. W. Karunaratne, P. P. Jayasinghe & D. D. Medagama*).

Clarity of feeding teats:

The manufacturers of bottle teats out of dry rubber had a problem of transparency of the teats they manufacture. We found that a mixture of petroleum gelly and paraffin oil reduces the crystalisation of dithiocarbomate resulting in a fairly transparent film. It was also found that boiling the film or the teats, after vulcanising, in 20% sodium hydroxide also improves their clarity.
(*A. M. A. Amarapathy, N. R. Munamalpe & V. K. Jayasiri*)

Technological advice on latex based rubber products:

Training of personnel:

Training and advice on setting up of industries were given to about 40 industrialists to manufacture:

(a) Dipped rubber products;
(b) Rubberised coir cushions and mattresses;
(c) Latex castings;
(d) Foam rubber;
(e) Rubberising of gloves (fabric)
(f) Creaming of latex;
(g) Rubberising of coir belts.

Most of the people who have had this training seem to be managing their industries with increased efficiency.

In addition to this training programmes, a few other classes on the manufacture of rubber products have also been conducted.

About 350 gallons of compounded latex and centrifuged latex were supplied to small scale rubber industrialists.
(*A. M. A. Amarapathy, V. K. Jayasiri & W. D. Dharmasena*)

BIOCHEMISTRY

Use of papain in RSS manufacture:

The preliminary investigations on this study, were completed during the year. The main drawbacks, *viz.* loss of dry weight and prolonged drying time, were satisfactorily solved. All the trials were carried out at the Group Processing Centre at Kalupahana. Typical properties of RSS manufactured by papain coagulation are given in Table 1. The use of papain as a part coagulant was found to be the most satisfactory method. The resulting rubber was mould resistant as previously reported, (Annual Review, 1975). However, the degree of resistance to mould growth appeared to be slightly affected by using papain as a part coagulant. The use of raw papaw milk in RSS manufacture was also studied. Chemical preservatives such as sodium metabisulphite used with raw papaw milk had an adverse effect on the final dry weight. (*P. A. J. Yapa, W. A. Lionel & M. D. C. Seneviratne*).

TABLE 1—RAW RUBBER PROPERTIES OF RSS

	Acid	*Papain*	*Acid/Papain*
Ash %	0.152	0.220	0.160
N %	0.322	0.140	0.182
Dirt	0.010	0.007	0.006
P_0	51	50	52
PRI	85	85	34
VM	0.85	0.52	0.73

Production of high quality rubber from skim latex :

The use of papain as a coagulant for skim latex results in a rubber with improved technological properties (Annual Review, 1976). However the coagulation step showed a marked variation mainly depending on the age of skim latex and its ammonia content.

A new method was developed to produce high quality rubber from skim latex. The reproducibility of properties of rubber produced by this method was highly satisfactory. The final coagulation step which involves papain is uniform and the coagulum can be milled into crepe form. Typical properties of a batch of rubber prepared by this method are given in Table 2.

TABLE 2—RAW RUBBER PROPERTIES OF SKIM RUBBER PRODUCED BY THE NEW METHOD

Ash %	0.460
Nitrogen %	0.154
P_0	52
PRI	62
Colour (Lovibond)	2

The nitrogen content is reduced by this method, almost to DPNR level. Cure characteristics were also found to be satisfactory. (*P. A. J. Yapa, M. Nadarajah & W. A. Lionel*).

Studies on DPNR:

These investigations were continued during the year under review. Samples prepared by various treatments were sent to Dunlops India Ltd. and the Rubber Research Institute of Malaysia for testing for heat build-up properties. Several new methods were tried out to produce DPNR from field latex. A method based on the removal of a sludge gave satisfactory results occasionally as far as the nitrogen content is concerned, but the increased ash content was an additional problem. Papain was successfully used to produce DPNR from centrifuged latex with nitrogen and ash contents at 0.08% and 0.09%, respectively. However, the Plasticity Retention Index was low.

It was gathered during the year that the specifications laid down for DPNR have been revised by the RRIM. The nitrogen content has been increased to 0.15% in the new specifications. Nitrogen values close to this can be obtained by papain

coagulation alone, without any additional treatments of field latex. With the introduction of the new specifications it has become important to test the papain treated rubbers, for dynamic properties in order to see if the improvement in heat build up properties by papain treatment would be sufficient to meet the consumer requirements. (*P. A. J. Yapa, M. Nadarajah, A. Coomarasamy & W. A. Lionel*)

Low Nitrogen Latex (LNL) ;

A method was developed to produce LNL from field latex by using proteolytic enzymes. Papain, Trypsin and Superase were all found to be satisfactory. A nitrogen content of 0.08% was obtained after a period of 72 h, from field latex. This can be reduced to 48 h by starting with centrifuged latex. Possible applications of this latex, are now being investigated. (*P. A. J. Yapa & W. S. E. Fernando.*)

Non rubber constituents ;

Thiol content of the F-serum showed a marked clonal variation. Of the clones examined RRIM 600 had the highest thiol content followed by RRIM 501, RRIC 45 Tjir 1, PB 86 and RRIC 36, respectively. High yielding clones generally showed a higher thiol content. Clone, RRIC 101, was an exception. The age of the tree may also have to be considered in future work. Intra-clonial variation in yield of clone PB 86, mature and young, RRIC 100 RRIC 101, was studied. The use of thiol content in assessing the yield potential of clones was also studied.

Neutral lipids and phospholipids associated with the rubber phase were studied. Both the neutral and phospholipid contents in the rubber of low yielding trees were found to increase rapidly during latex flow, whereas those of high yielding trees show a gradual increase over the period of flow. (*P. A. J. Yapa, & S. Kasinathan*).

NR latex as an adjuvant for water soluble fungicides ;

This project is being done in collaboration with A. de S. Liyanage and D. M. Dantanarayana of the Plant Pathology Department. Low ammonia (LA) centrifuged latex, with phenyl mercuric acetate (PMA) as secondary preservatives was prepared by centrifuging field latex containing 0.35% W/W ammonia, adding Nonidet T at 2% W/W on the latex as 10% solution, allowing it to stand for two hours, and adding PMA at 0.1% W/W as a 10% antimucin solution. Antimucin contains 16.5% PMA. This LA latex is being tested in the field for Bark Rot control in the following manner:

(a) neat (drc 60%);

(d) diluted six times with water and the PMA content brought up to 0.1% (drc 10%);

(c) diluted twelve times with water and the PMA content brought up to 0.1% (drc 5%).

Increasing the PMA content over 0.1% did not give improved results.

(*M. Nadarajah*)

Studies on Brown Bast:

The anti-hormonal effect of certain chemicals was studied with a view to controlling latex flow. This study was done in collaboration with the Plant Breeding and the Soils Chemistry Departments. These preliminary trials were carried out on twin seedlings. The role of cations, particularly that of Ca and Mg, was studied. Results will be reviewed in the Soils Chemistry Department report. (*P. A. J. Yapa*).

Biochemical studies on disease resistance :

These studies were continued during the year, in collaboration with the Plant Pathology Department and the progress will be reviewed in Plant Pathology Department report. (*P. A. J. Yapa*).

Factory Effluents:

A survey was initiated towards the end of the year to study the nature of rubber factory effluents and how they are discharged by various rubber factories in the Island. The information received from estates is being analysed and the proposed study on utilization of effluents will be based on the results of this investigation. (*P. A. J. Yapa*)

ADVISORY SERVICES TO PRODUCERS

Routine Advisory Work:

The following advisory visits were done by D. S. Muthukuda, Development Officer.

	RSS manufacture	Pale Crepe manufacture	Sole Crepe manufacture	Latex Weighing & preservation	Others	Total
1st Quarter	6	15	4	5	4	34
2nd Quarter	11	13	1	4	2	31
3rd Quarter	10	15	2	7	2	36
4th Quarter	21	8	2	8	2	41
Total	48	51	9	24	10	142

Preservation of smallholders' latex for RSS manufacture :

A satisfactory preservative system (expressed as a percentage of field latex) for RSS manufacture is

(a) for 12 h preservation, 0.03% ammonia and 0.05% hydroxylamine

and (b) for 24 h preservation, 0.05% ammonia and 0.05% hydroxylamine. Grade 1 RSS was obtained and very little extra acid is needed for coagulation. This preservative system will be of great value in stepping up production in Group Processing Centres.

(*D. S. Muthukuda & M. Nadarajah*).

Preservation of Smallholders' latex for latex crepe manufacture :

Trials carried out show that ammonia and boric acid used at concentrations of 0.02 and 0.3%, respectively, of the latex is an excellent combination for the preservation of field latex for a period of 18 to 20 h. Grade 1 crepe can be produced from latex preserved in this manner. This preservative system will be of great value in stepping up operations in existing crepe factories, which normally work only one shift, but by using this preservative system can step up their factory operation to work a second shift.

However, since the process of fractionation with the above dosages was difficult, lower dosages of ammonia (0.02%) and boric acid (0.2%) are being tested, where it is necessary to take a fraction, but the preservation time will be reduced to about 8h. (*D. S. Muthukuda & M. Nadarajah*)

Block rubber from latex crepe laces;

Block Rubber can be easily produced from latex crepe from estates, and the grades obtained will be as follows, according to the procedure adapted:–

(a) If no fraction is taken and no bleaching done — SLR5L

(b) If no fraction is taken and bleaching is done and oxalic acid — is used as coagulant — SLREQ

(c) If a fraction is taken and bleaching is also done, the product can be sold on colour, dirt and mod specification of 7.0.

(d) In a fraction is taken — bleaching is done and oxalic acid is used as the coagulant — SLREQ

It is suggested that to maintain uniform quality, the laces from different estates be not mixed but a lot production be confined to only laces of one estate. Since there is very keen interest in this type of rubber overseas and since Malaysian promotion of SMR EQ is being discontinued, it is opportune that Sri Lanka steps into supply this grade of block rubber, by supplying a uniform quality light coloured rubber and also catering to consumers' specifications and requirements. (*M. Nadarajah & R. Tharmalingam*)

Implementation of programmes on raw rubber manufacture:

A concerted effort should be made to implement suggested programmes and advice on raw rubber manufacture as this will continue to be for a long time to come, the main rubber industry in Sri Lanka. These are :

1. Increase production of sole crepe in existing factories,
2. Production of remilled sole crepe from crepe laces using conventional sole crepe equipment,
3. Production of block rubber (SLR 5 L and SLR EQ) from latex crepe laces,
4. Production of block rubber from RSS 4 and 5,
5. Production of centrifuged latex for export,
6. Establishment of a trade centre in Europe to promote the marketing of Sri Lanka rubber.

Regarding proposal No. 2, it is recommended that a planned effort be made to increase sole crepe production from dry rubber in Sri Lanka, beginning with 1500 tons annually, and this should be made from IX latex crepe laces. The input to produce 2 tons of sole crepe is 3 tons of latex crepe and the factory should work three shifts at one ton input per 8 hour shift. The wet milling of crepe laces would not result in the oxidation of the rubber resulting in tackiness, breakdown of molecular weight and discolouration, all of which occur during the dry milling in industrial sole crepe manufacture. (*M. Nadarajah & R. Tharmalingam*)

Coagulation with HCl:

Work carried out at Yatalamatta GPC showed that as much as $\frac{3}{4}$ of the quantity of formic acid used can be replaced by HCl which is locally available and much cheaper without adversely affecting any of the properties of the final product. Trials have been extended to four more GPCC, namely, Pore, Pannala, Telikade and Malawala. (*S. W. Karunaratne & R. P. M. de Zoysa*).

Crepe Rubber Drying :

Using fin type heaters for crepe drying was investigated at Dartonfield factory. The Baduraliya crepe factory has adopted a similar system and it is working satisfactorily. There were more queries regarding this system from other factories as well. It is anticipated that more factories will adopt this system in the near future.

An electrically heated boiler was fabricated and tested in the Dartonfield factory. This trial was discontinued as the material used for the boiler vessel is not satisfactory. Further work will continue once a satisfactory vessel is fabricated.
(*R. Tharmalingam*)

Industrial sole crepe:

Following a trial carried out at the Frocester factory a process flowline was evaluated to produce sole crepe from dried laces in an industrial level, using a wet milling process. A feasibility report was submitted to Messrs C. W. Mackie & Co. Ltd., to set up a factory for industrial/remilled sole crepe. This factory will be set up soon. The follow up work to set up this factory is in progress.
(*R. Tharmalingam & E. G. Mendis*)

Block Rubber Manufacture;

Continued to advise the block rubber factory at Mawanella to increase and improve production. Two reports were submitted during this year. A feasibility report for manufacturing block rubber has been prepared and submitted to the Janawasama.

Improved Presentation of crepe rubber;

An improved presentation method for Sri Lanka latex crepe was suggested at the seminar on Rubber Culture, Manufacture and Marketing, held in the Ceylon Chamber of Commerce. This seminar was organised by the RRI. This scheme was again explained in detail to Rubber Brokers and Rubber Shippers and it was accepted in principle. This scheme was outlined in a newspaper article "Improving crepe rubber sales."

A hand book outlining the scheme is being printed for distribution among the crepe rubber consumers. The book briefly outlines the method of manufacture, its end uses and the colour coding scheme. This book will be ready by mid - February 1978. (*R. Tharmalingam*)

Routine Advisory & Subsidy visits;

Advisory visits and subsidy visits to crepe factories were made and recommendations submitted to the Rubber Control Department for subsidy payments.

(*E. G. Mendis & R. Tharmalingam*)

SPECIFICATIONS

Technical Specifications:

During this year 5,530 samples have been tested from the Mawanella Block Rubber Factory. The number of samples tested from the Cenat Factory was 1,206. In addition to this, 826 miscellaneous samples including research rubber samples, acid samples, latex samples and samples of chemicals have also been tested. Rubber products such as rubber compounds and latex thread were tested as usual.

Dr. S. Nair, Head of Specifications, RRIM, was in Sri Lanka on a survey during this year. The Specifications Officer, as the Liaison Officer from Ceylon, visited the Manufacturers, Brokers and Shippers of NR in Sri Lanka with Dr. Nair, and had discussions, studied the problems faced by them and agreed on the solutions for such problems. (*L. M. K. Tillekeratne*).

Study of the seasonal variations of PRI of NR;

Preliminary work on PRI variation after defoliation has already been done. Some study would be carried out during the natural wintering period in February and the latices will be subjected to microanalysis for the micro components, present in them.
(*L. M. K. Tillekeratne, A. de S. Liyanage, U. P. de S. Waidyanatha, A. S. Dekumpitiya & S. Weeraman*).

Variation of PRI of NR when different types of soils are present as impurities :

The work carried out on this project during the last year has shown that certain types of soils have a more deleterious effect than others on PRI of rubber, under normal weathering conditions. Work is in progress on this project.
(*L. M. K. Tillekeratne, A. S. Dekumpitiya & A. G. R. S. Perera*).

REVIEW OF THE STATISTICAL SECTION

G. A. J. P. R. GOONASEKERA

A Technical Assistant was recruited towards the latter part of the year. Two research papers were completed. Routine work expected from the Section was carried out.

DETAILED REVIEW

Staff

The writer continued to serve as Assistant Statistician. Mr. L. T. Peiris, Technical Assistant, was on duty throughout the year. Mr. R. A. P. Abeypala was recruited as a Technical Assistant with effect from September 19th. The total cadre of the Section was 5 with two minor staff members.

Conferences

The paper entitled "A general regression equation for leaf area estimation" was presented at the 33rd Annual Session of the SLAAS.

Visits

Visits were made to the computer centres at the Engineering Corporation and Peradeniya Campus for lengthy calculations and graphical work, Central Bank and Colombo Campus for consultations, Department of Census and Statistics for references and the Meteorological Department and some rubber estates regarding meteorological work and research investigations.

RESEARCH INVESTIGATIONS

Height increments of young plants

During a selected dry weather period, data was collected on the height increments of young rubber plants and an analysis was presented in the paper "Regression analysis of height increments in young RRIM 603 *Hevea* plants".

Characterization of Hevea *clones*

Assistance was given to the Biochemist in field work and analysis of a project on the characterization of *Hevea* clones. The results were presented at the SLAAS session as "Some Biochemical studies on characterization of *Hevea* clones".

Inter-clonal yield variability

Arrangements were made for a causative study on 'between tree yield variations' in some *Hevea* clones with the purpose of recommending economic measures of yield increase.

ROUTINE WORK

Statistical analysis

Analysis of experimental data for the preparation of the Annual Reviews of the Research Departments were carried out. Statistical analysis of data in the preparation of research papers for conferences and publications were also attended to.

Meteorology

Recording weather data at the Dartonfield meteorological station was continued uninterrupted. A summary of the data is given in Table 1. Requirements of the stations maintained in outside estates were also attended to. Collected data were tabulated to fulfil requests for them.

TABLE 1 — METEOROLOGICAL OBSERVATIONS DARTONFIELD, AGALAWATTA

Longitude:- 80° 09'
Latitude :- 6 32'
Height above the sea Level :- 6550 cms

MONTH	Rainfall			Evaporation			Shade Temperatures						Ground Temperatures										Mean grass minimum Temperature	Atmospheric Pressure		Total hours of Sunshine	Mean wind speed (m. p. h.)
					Temp. of water						Mean current dry Temperature		8.30 a.m.					3.30 p.m.									
	Monthly Total (mm)	Greatest daily fall & date	No. of rainy days	Evaporation	8.30 a.m.	3.30 p.m.	Mean daily maximum	Highest Max. & date	Mean daily minimum	Lowest Min. & date	8.30 a.m.	3.30 p.m.	122 cm	30 cm	20 cm	10 cm	05 cm	122 cm	30 cm	20 cm	10 cm	05 cm		Mean at 8.30 a.m.	Mean at 3.30 p.m.		
January	29.2	11.3 (7)	4	3.17	24.1	34.5	31.6	34.6 (22)	18.6	14.8 (28)	25.2	29.2	28.1	27.5	27.4	26.7	—	28.2	29.1	29.2	30.9	—	18.4	757.75	—	244.8	1.31
February	271.6	64.1 (28)	15	3.03	24.3	32.9	32.7	34.5 (23)	19.0	16.2 (14)	25.5	29.3	28.2	27.6	27.5	26.9	—	28.3	29.2	29.4	30.7	—	20.2	759.39	757.03	156.2	1.18
March	378.9	60.1 (1)	23	3.57	25.0	33.8	32.8	34.0 (7)	19.3	18.0 (6,20)	25.9	29.2	28.5	27.8	27.7	27.3	—	28.5	29.4	29.6	31.0	—	21.0	758.11	756.48	185.4	1.09
April	317.7	49.6 (27)	21	3.24	26.4	33.4	32.9	35.0 (4)	20.2	19.0 (28)	27.8	28.9	28.7	28.8	28.6	28.1	—	28.8	30.1	30.3	31.2	—	21.7	758.35	—	148.7	1.11
May	961.9	142.9 (7)	29	3.42	25.5	31.4	30.8	33.7 (6)	21.4	19.5 (9,14,15, 16,19)	27.2	28.7	26.9	26.9	27.0	26.8	—	27.8	27.9	27.1	28.9	—	21.7	757.21	754.9	89.6	1.19
June	466.4	66.8 (14)	25	4.32	25.7	32.2	30.8	32.5 (24)	22.6	21.7 (5,11,20) 21,22	27.0	28.7	28.0	27.2	27.3	27.1	—	27.8	28.3	28.5	29.4	—	22.1	756.65	—	121.8	1.31
July	71.1	11.2 (1)	11	4.13	25.7	32.0	30.4	32.5 (31)	22.8	21.1 (26)	26.5	28.8	28.2	27.9	28.3	27.2	—	28.3	28.9	28.9	29.6	—	22.4	756.65	—	102.0	1.70
August	222.5	45.3 (19)	19	3.08	25.4	32.5	30.8	32.5 (12)	22.6	21.4 (30)	27.1	29.2	28.2	27.7	27.6	27.0	—	28.2	28.9	28.7	29.5	—	21.7	757.0	—	167.0	1.49
Sept.	288.8	51.8 (30)	22	3.43	25.7	33.5	31.5	33.0 (19)	22.1	21.4 (5)	27.1	29.6	28.2	27.7	27.6	26.9	—	28.3	28.4	28.8	29.5	—	21.8	758.59	756.61	111.5	1.54
October	688.9	127.3 (19)	30	1.89	25.5	32.0	31.1	32.6 (27)	22.8	21.1 (11)	26.7	27.2	27.5	26.5	25.5	27.0	26.6	27.9	27.1	27.3	28.1	31.2	20.8	758.85	756.36	104.5	1.02
Nov.	277.0	52.3 (3)	27	2.71	25.2	32.7	32.5	33.8 (30)	21.9	20.2 (24)	27.4	28.2	27.5	27.0	27.1	26.8	27.4	27.5	28.6	28.8	30.2	30.5	21.6	758.21	755.87	130.6	1.07
December	283.8	46.6 (22)	23	2.87	25.4	34.0	32.8	34.2 (15)	21.3	20.0 (14)	26.5	29.5	27.9	27.1	27.2	26.8	26.7	27.8	28.8	29.9	30.2	30.9	21.0	759.11	756.66	141.2	1.07

REVIEW OF THE ADVISORY SERVICES DEPARTMENT AND THE ECONOMIC RESEARCH UNIT

A. B. DISSANAYAKE

GENERAL

The annual report comprises of:–

A. Advisory Services to Smallholders,
B. Advice to Estates,
C. Economic Research

STAFF

The Head, Advisory Services Department and Economic Research Unit, the Deputy Head, two Assistant Advisory Officers, the Agricultural Economist and the Assistant Agricultural Economist were on duty throughout the year. Mr. A. Dahanayake, Assistant Advisory Officer, Southern Division was transferred to Kegalle and Mr. J. D. S. Wickremaratne, Divisional Advisory Officer was promoted as Assistant Advisory Officer, Ratnapura.

Nine trainee Rubber Extension Officers were appointed in September 1977 and are undergoing training under the Senior Rubber Extension Officers. Annual transfers of the field staff were worked out and 38 officers will take over new ranges on 1st January 1978.

I wish to take this opportunity to place on record the service rendered by Mr. D. B. Weligodapola, Mr. D. R. Wijesuriya and Mr. L. A. Wijesinghe which was of value to the Rubber Research Institute and the Rubber Industry.

OTHER ADMINISTRATIVE MATTERS

Correspondence			
Inward	..	7884	
Outward	..	12130	
With Rubber Controller			
Inward	..	4197	(applications for new planting, unregistered rubber lands and new planting permits)
Outward	..	4981	(preliminary reports, final inspection reports and special reports)
From Rubber Extension Officers to Smallholders	..	2712	

ADVISORY SERVICES TO SMALLHOLDERS

New Planting

Visits
The following visits were carried out:

First visits	..	409

Subsequent visits ..	328	
Preliminary reports ..	3151	
Final inspection and special reports..	113	

Lining	*No. of permits*	*Acreage*
This years permit areas :		
Soil conservation ..	308	402
Planting holes ..	336	482
Last year's permit areas:		
Soil conservation ..	87	126
Planting holes ..	94	128

Replanting

Visits		
Permits issued ..	2840	3743
Visits to this year's permit areas ..	5117	
Visits to previous year's permit areas	14735	
Special reports ..	443	

Lining	*No. of permits*	*Acreage*	
This year's permit areas :			
Soil conservation ..	1315	1626	
Planting holes ..	1430	1810	
Last year's permit areas :			
Soil conservation	616	956	
Planting holes ..	610	923	
Marking trees for tapping	231	6475	trees

Special Inspections for Rubber Control Department

Visits for preliminary reports ..	3151
Visits for final inspection reports and special reports (new planting) ..	131
Visits for special inspection reports (replanting)	614
Visits for recommendation of subsidy payments by Divisional Advisory Officers and Senior Rubber Instructors ..	493
Visits to Commodity Purchase Depots ..	614
Visits to planting material checks at the Commodity Purchase Depots ..	71
Plants inspected ..	8881
Plant nursery reports ..	16

Smallholders' Rubber Conferences

During the year under review 14 smallholder conferences were held at range level. Problems relating to the smallholders were discussed at these seminars.

Meetings and Conferences

All staff officers attended the staff meetings presided by the Directors.

A successful 'Field Day' for all field officers of the Department was conducted at the Mawanella Block Rubber Factory.

The Head attended the Seminar and Workshop on the Development of Smallholders at Cochin India in November to read the 4 papers submitted by the Department for that conference.

Improvement of Smallholders' sheet rubber

Progress on the construction of group processing centres is as follows :

1.	Group processing centres in operation ..	93
2.	Group processing centres (work completed) ..	7
3.	Group processing centres (under construction)	2
4.	Group processing centres (surveys completed)	10
5.	Group processing centres (surveys going on)	2

During the year 940 Coagulating pans were sold to group processing centres at a subsidised rate.

Other Visits

A total of 4105 visits to group processing centres and 1082 visits to demonstration and ordinary smoke houses were made.

Training classes

A total of 38 training classes for smallholders consisting of 1154 smallholders were organised and tests for 29 classes were held. A total of 377 trainees were successful and will be issued with certificates.

Fertilizer demonstrations plots

During the year the fertilizer demonstration plots which commenced in 1972 were maintained.

Demonstrations

The following demonstrations were given by the field staff:

Sheet making	..	731
Tapping	..	558
Disease control	..	280
Miscellaneous	..	872

Sale at subsidised price

A total of 368¾ sq. of monel metal mesh were sold to smallholders at the subsidised rate.

Assistance to Commodity Purchase Department

All Rubber Extension Officers assisted the Department of Commodity purchase, in the issue of new Registration cards for the sale of smallholder rubber to the Commodity Purchase Depots, by recommending the applications made by smallholders.

Exhibition

An open week *cum* exhibition was held at the Colombo Office and Laboratories from the 3rd to 8th October both days inclusive. The Department participated very actively, by helping in the organization of the exhibition as well as by organising stalls. It was a great success as over 25000 visitors viewed the exhibits during the 6-day period. Cine/films on rubber and other topics of Agricultural interest were also screened for the benefit of the visitors.

Publications

Advisory leaflets on "Manufacture of Smoked Sheets", "Tapping", Soil Conservation", "Bark Rot", "White Root disease" and Sulphur Dusting Controls Oidium" were published for distribution to smallholders and small estates.

ADVICE TO ESTATES

Visits

A total of 111 visits were made to medium and large estates by the officers of the Department for the year.

Other Visits

In addition a total of 167 visits have been made to Institutions, Committee meetings, discussion groups and interviews etc.

Seminars

The Head attended a week's seminar and a one day workshop organised by the International Trade Centre, Geneva and the Export Promotion Secretariat Sri Lanka on Export Marketing and obtained the "Diploma in Export Market"

Mr. H. D. B. H. Gunasekera, Assistant Agricultural Economist attended a course in "Network Analysis" organised by the Ministry of Plan Implementation.

All senior officers attended a one day seminar on "Rubber Culture, Manufacture and Marketing" at the Ceylon Chamber of Commerce.

All senior officers attended a one day seminar on "Rubber Goods Manufacture" at the Agrarian Research and Training Institute.

All officers attended the Annual Sessions of the Sri Lanka Association for the Advancement of Science.

Visitors

Visiting delegations of scientists from Nigeria and Malaysia were shown round the rubber growing areas by officers of the Department.

State Rubber Manufacturing Corporation

The Deputy Head attended 7 Meetings of the Board of Directors of the State Rubber Manufacturing Corporation during the year.

ECONOMIC RESEARCH

Survey of the economics of production of rubber

The survey was started with the idea of finding out the present economics of production of rubber as a result of price inflation. However with the changing of the exchange rate of the rupee after the budget of 1977 a fresh wave of price increases have appeared. This survey will have to be continued in 1978 also to assess their effects.

Economics of Resource Use

Data collected on the above will be analysed as soon as a "systems analyst" is recruited to the Katubedda Campus, which will enable us to use their computer.

Group Processing Centres

A fair number of group processing centres are reluctant to send their monthly reports to us. Efforts are being made to obtain these reports through the Rubber Extension Officers. From the data available a separate report on the "Progress of the group processing centre scheme" will be submitted to the Director, the Ministry of Plantation Industries and the Ministry of Plan Implementation. From the data so far analysed, 73 group processing centres have processed a total of 2,477,047 lbs. of rubber during 1977. The grades of RSS obtained are as follows :

	Quantity	% of total
RSS – Grade 1	1,133,955	62.7
RSS – „ 2	495,737	21.4
RSS – „ 3	105,336	5.8
Others	73,213	4.1
	808,241	100.0

A study of the economics of the scale of operation of group processing centres has been initiated from data available, the seasonal distribution of production in group processing centres have been worked out and it is attempted to work out the correlation between production and cost of manufacture.

Farm Record Keeping Survey

The long term Farm Record Keeping Survey in smallholdings had to be stopped temporarily due to lack of a favourable response from smallholders. Once the grant from the National Science Council is received it is hoped to re-start the survey after appointing one or more temporary village level field supervisors.

Replanting

The data collected will be analysed once the services of the Katubedda Campus computer becomes available to us.

Talks

At the Seminar on Rubber Culture Manufacture and Processing

"An Aggregate Production Potential for rubber lands in Sri Lanka" by G. R. Chandrasiri.
"Some Comments on the Systems of Accounting in rubber plantations" by A. B. Dissanayake.

To the final Year B.Sc. Agricultural Students, University of Sri Lanka.

"Research Programmes of the Economic Research Unit, RRI" by G. R. Chandrasiri.
"Scale Economics in Group Processing Centres" by H. D. B. H. Gunasekera.
"The programme of Group Procssing Centres for Smallholders" by R. P. M. de Zoysa.

"The world position of the Natural Rubber Industry" by A. B. Dissanayake.
"Extension methods adopted for rubber plantations" by A.B. Dissanayake.

Papers

The following papers were written for publication:
"An aggregate Technical Production Potential for the rubber industry of Sri Lanka" by G. R. Chandrasiri, Vaz de Gunawardena, H. D. B. H. Gunasekera and S. L. Weerasinghe.
"The Socio Economic aspects of Group Processing of Smallholder latex in Sri Lanka" by G. R. Chandrasiri, H. D. B. H. Gunasekera and S. L. Weerasinghe.
"An economic evaluation of the State aided Fertilizer Subsidy Scheme for rubber lands" by G. R. Chandrasiri, H.D. B. H. Gunasekera and S. L. Weerasinghe.

For the ANRPC Seminar and Workshop on the Development of Smallholdings at Cochin, India.

"Group Production - Its possibilities in rubber smallholdings" by H. D. B. H. Gunasekera.
"A discussion of the Group Processing Centre Scheme its progress and problems" by R. P. M. de Zoysa.
"Country Report for Sri Lanka" by A. B. Dissanayake.
"Accelerating the adoption and diffusion of innovations in Smallholdings" by A. B. Dissanayake.

REVIEW OF THE ESTATE DEPARTMENT

M. M. A. NAINA-MARIKAR

SUMMARY

The Institute's Group of Estates known as Dartonfield Group, comprises Dartonfield Division in Agalawatta, Nivitigalakele Division in Matugama and Hedigalla Division in Lathpandura. Including the 2.02 hectares handed over by the Land Reform Commission to Nivitigalakele Division direct, the Estate has an extent of 626.06 ha (1553 acres, 01 rood and 16 perches) which includes 152 hectares of jungle. The planted area is 364.61 ha of which 240.39 ha were tapped during the year. The area of immature plantings and nurseries were 115.86 and 8.36 ha respectively.

The weather conditions during the year were not favourable for harvesting of crop. The crop harvested was 141,807 kg representing an average yield of 576 kg per hectare. The crop secured fell short of the estimate by 32,543 kg which is 18.67% of the seasons' estimate. The harvest on a divisional basis indicates that Hedigalla had harvested 75.0% while Dartonfield had harvested 92.49% and Nivitigalakele 89.41%. Better supervision of tapping and weeding are necessary on the areas with low yields.

No symptoms of *Oidium heveae* were noticeable, since wintering was early this year, but late winterers suffered minor leaf-fall.

Budwood of clones of the RRIC series and PB 86 continued to be much in demand and issues were made accordingly.

All agricultural operations were carried out in both mature and immature areas of the Group, including weeding.

Dartonfield factory continued the Manufacture of latex and scrap from Mukalana, Horagoda and Gallawatte Estates during the year. In addition, complete manufacture of latex was undertaken in February for the State Rubber Manufacturing Corporation, Badureliya Branch, and Kuruwita Sub-station scrap was manufactured in September.

DETAILED REVIEW

The Estate Superintendent, Mr. W. A. Fonseka and the Assistant Estate Superintendent, Mr. S. G. Fernando, were transferred to Frocester Group, Govinna of the Rubber Research Board Plantations Division and Kuruwita Sub-station of the Rubber Research Institute of Sri Lanka, with effect from 01.11.1977 and 11.10.1977, respectively.

The writer assumed duties as Superintendent, Dartonfield Group, Rubber Research Board Plantations Division, with effect from 01.11.1977 and Mr. Y. A. Warusavitarane of Eladuwa Estate, Matugama of the Rubber Research Board Plantations Division as Superintendent, Hedigalla Estate, Lathpandura, of the Plantations Division, with effect from 01.11.1977.

Mr. O. de Alwis, Factory Assistant retired with effect from 02.02.1977, after completing thirty four years of service. The Assistant Rubber Maker is acting in the post at present and this vacancy is to be filled shortly.

The Field Officers post on Dartonfield and Nivitigalakele Divisions continued to be vacant, but, Mr. L. H. Samaranayake, who is designated as Acting Field Assistant, and Mr. N. L. D. Piyadasa, K. P., continued to perform the duties of Field Assistant on Nivitigalakele and Dartonfield, respectively.

Mr. J. S. de Zoysa, K. P., Hedigalla Division, was transferred temporarily to Kuruwita Sub-Station, to act for an Officer who was interdicted. He was reverted to Hedigalla at the beginning of May.

Mr. K. Peter Silva, Assistant K. P., No. 2, attached to Hedigalla Division was under interdiction.

Mr. P. M. Tissera, Nursery K. P., Hedigalla, expired in 1977.

Mr. B. H. Rodrigo, Chief Clerk was transferred to the Rubber Research Board Plantations Division, Colombo Office with effect from 01.10.1977, consequent to the overall reorganisation of the estates of the Rubber Research Institute of Sri Lanka and the Rubber Research Board Plantations Division, which was carried out during the period under review.

Mr. G. A. Kannangara, Correspondence Clerk and Mr. G. S. Doolwela, Junior Clerk, Hedigalla Division, were transferred to the Accounts Department of the Institute from the Estate Department, with effect from 15.11.1977.

Mr. G. J. A. Silva, Estate Medical Assistant, Hedigalla has sent in his resignation from the post of Hedigalla Estate Medical Assistant and this has been accepted.

The Dartonfield Group cadre stood at 19 at the end of the year, made up as follows :-

Senior Staff	2
Intermediate Staff	—
Assistant Staff	10
Minor Staff	7
	19

Correspondence

In ward	458
Out ward	789
	1247

Hectarage Summary

(Hectares)	*Dartonfield*	*Nivitigalakele*	*Hedigalla*	*Total*
Mature	37.37	41.61	162.41	240.39
Immature	10.38	11.58	93.90	115.86
Nurseries	2.22	4.13	2.01	8.36
Total	48.97	57.32	258.32	364.61
Abandoned	3.95	5.58	59.21	68.74
Buildings sites *etc.*	16.23	6.09	3.25	25.57
Pinewood plantation	—	—	.51	.51
Roads	2.67	.32	3.67	6.66
Swamp areas	—	.21	.20	.41
Streams & Reservations	.03	—	5.24	5.27
Jungle *etc.*	—	.71	151.56	152.27
	71.85	70.23	481.96	624.04
Land handed over by The Land Reform Commission	—	2.02	—	2.02
Grand Total hectarage	71.85	72.25	481.96	626.06

The actual extent in tapping differs from the estimated extent, due to the fact that tapping had commenced in the Hedigalla 1971 replant and 1972 replants, during the year under review.

The abandoned extent stands at 59.21 ha mainly due to Hedigalla 1952 replant 28.81 ha which is expected to be uprooted this year for replanting in 1978.

In the 1955 replant, Hedigalla, only 30.22 ha out of the total extent of 31.43 ha is in tapping, as the balance 1.21 ha which was treated as abandoned, adjoining the 1976 replant, was uprooted as part of 1976 replant.

The land demarcated for acquisition as school premises covers an extent of 2.02 ha of Hedigalla included in the above area statement.

A difference of 2.02 ha in extent was detected by the Surveyor, in respect of the 1977 replant.

Visiting Agent

The Visiting Agent, Mr. M. R. C. Peiris paid a visit to Dartonfield Group on 27th and 28th May, 1977 and his report on the Group was submitted to the Rubber Research Board for their perusal and information.

Weather (Estate Gauge)

Comparative rainfall figures (in millimeters) for 1977 and 1976 years are given below:-

	Dartonfield		*Nivitigalakele*		*Hedigalla*	
	1977	1976	1977	1976	1977	1976
January	29.2	83.0	8.9	36.8	63.5	80.0
February	271.6	26.1	135.1	18.8	312.2	58.4
March	378.9	141.4	283.2	245.1	337.7	392.7
April	317.7	634.2	230.1	575.1	310.3	574.3
May	968.4	227.7	1035.1	236.7	920.0	459.0
June	466.4	207.8	460.8	176.0	549.0	283.7
July	71.8	209.2	79.7	233.4	116.0	360.9
August	232.5	307.7	218.5	291.4	354.0	437.1
September	288.8	88.7	235.6	93.7	225.0	135.6
October	688.9	527.8	669.4	499.1	759.0	672.6
November	277.0	620.5	385.0	578.9	531.0	671.8
December	283.8	452.9	179.5	484.1	491.3	567.6
Total	4275.0	3527.0	3920.9	3469.1	4969.0	4693.7
Average (five year period)	3901.0 mm		3695.0 mm		4831.3 mm	
Total number of wet days	235	222	195	198	196	212

The season had begun with a dry January but February was wetter than usual. March was unusually wet while April was dry. May and October proved to be the wettest months. The average rainfall for the group for the year stands at 4388.3 mm.

Hedigalla Division as usual recorded the highest rainfall. However, the highest rainfall for a month was recorded at Nivitigalakele and Dartonfield in May.

Crop

This year's harvest is estimated at 114,350 kg from 240.39 ha. The major portion of the crop is derived from Hedigalla, but the harvested percentage of that Division which stands at 75.09% was not satisfactory, when compared with the other Division. The intake per tapper averages were, Dartonfield 6.14 kg, Nivitigalakele 5.30 kg, and Hedigalla 4.60 kg.

The unfavourable weather which prevailed also resulted in a heavy shortfall in crop.

	1977	1976
Estimated	174,350 kg	226,796 kg
Harvested	141,807 kg	170,274 kg
Deficit	32,543 kg	56,522 kg

The crop harvested for the year 1977 was 81.33% of the season's estimate, as against 75.08% in 1976.

As far as Hedigalla Division was concerned, since the immediate management of the Division had changed, it is hoped that the tapping intakes will improve in the future, within the limitations that exist as a result of old fields being planted with experimental clones, the yields of which are low compared to commercial clones such as PB 86.

The crop secured for the year is 141,807 kg. On this basis, the yield per hectare stands, as follows, in respect of an extent of 255.30 ha in tapping now.

Dartonfield Division	— 725.5 kg
Nivitigalakele Division	— 887.1 kg
Hedigalla Division	— 446.2 kg

Therefore, the yield per hectare, average is 555.5 kg.

Comparative Yield Records of Individual Fields

	Hectarage in tapping	*Total Yield in Kilos*		*Yield in Kilos per Hectare*	
		1977	1976	1977	1976
Dartonfield					
1952 Rep. Area	10.88	7576	8931	696.3	820.9
1953 ,, ,,	3.23	1956	2277	605.5	704.9
1954 ,, ,,	1.01	614	692	608.0	685.2
1955 ,, ,,	2.02	1152	1421	570.0	703.4
1955/56 ,, ,,	1.91	1039	1382	543.9	723.5
1960/61 ,, ,,	12.69	9295	10811	732.4	815.9
1965 ,, ,,	4.63	4826	4814	1042.3	1039.7
	36.37	26458	30328	727.5	833.9

Nivitigalakele

1953 clearing		4.03	2929	3009	726.8	746.6
1954 clearing		4.03	3163	3644	784.8	904.2
1962 Rep. Area		6.75	7747	8145	1147.7	1206.6
1963 „ „		5.64	6813	6803	1207.9	1206.2
1964 „ „		3.22	3878	4200	1204.3	1304.3
1965 „ „		4.03	4625	4533	1147.6	1124.8
1966 „ „		2.32	2595	2352	1118.5	1013.8
1967 „ „		3.53	3028	3251	857.7	920.9
1968 „ „		1.01	776	449	768.3	444.5
1970 „ „	(Tapping commenced recently)	7.05	1360	—	192.9	—
		41.61	36914	36386	887.1	1052.8

Hedigalla

1952, 1953 clearings		—	—	28465	—	—
1954 clearing		68.91	26234	33275	291.2	506.5
1955 „		31.43	13716	13244	451.2	482.8
1956 „		24.18	12958	13680	622.9	421.4
1957 „		6.95	3550	3264	509.1	565.8
1965 Rep. Area		0.81	1312	1028	1374.3	510.8
1967 „ „		4.03	2804	3007	403.7	1269.1
1968 „ „		3.73	4005	2496	1010.0	746.1
1967 „ „	(Thinned out area)	2.82	1963	3543	282.5	885.1
1969 „ „		8.97	6216	1560	796.0	395.0
1970 „ „	(Tapping commenced recently)	10.58	4350	—	399.3	147.4
1971 „ „	(-do-)	6.85	1290	—	184.0	—
1972 „ „	(-do-)	8.06	37	—	4.0	—
		177.32	78435	103562	446.2	473.7
Total for the Group		255.30	141805	170276	555.4	588.1
Outside sources		—	255140	180488		
Grand Total		—	396955	350764		

Tapping

Tapping continued throughout the year including the wintering period. Recovery tapping was done at Dartonfield Division on 27 days, Nivitigalakele Division 6 days and at Hedigalla Division 25 days.

All tapping panels in experimental areas were treated with Antimucin. On the recommendations of the Scientific Departments, tapping cuts were marked with appropriate guide lines for bark consumption.

Apart from the fields estimated as tappable fields, 8.06 hectares of 1972 replant at Hedigalla was brought under tapping in December this year.

The intake tapper averages were, Dartonfield 6.14 kg, Nivitigalakele Division 5.30 kg and Hedigalla Division 4.60 kg. The intake per tapper at Hedigalla was low.

ANALYSIS OF TAPPING ROUNDS ON DARTONFIELD GROUP FOR 1977
(1976 *figures in brackets*)

	Early tapping	*Double tapping*	*Late tapping*	*Winter rest*	*Rain*	*Holidays*
Dartonfield						
1st Qtr.	62 (82)	4 (3)	19 (2)	– (–)	2 (1)	3 (3)
2nd Qtr.	29 (49)	3 (–)	21 (20)	– (–)	35 (18)	3 (4)
3rd Qtr.	47 (58)	12 (10)	20 (10)	– (–)	12 (14)	1 (–)
4th Qtr.	37 (45)	8 (5)	25 (22)	– (–)	22 (22)	– (–)
	175 (234)	27 (18)	85 (54)	– (–)	71 (53)	7 (7)
Nivitigalakele						
1st Qtr.	69 (83)	– (–)	17 (7)	– (–)	4 (1)	– (–)
2nd Qtr.	37 (38)	1 (–)	17 (25)	– (–)	31 (24)	5 (4)
3rd Qtr.	59 (48)	3 (4)	17 (26)	– (–)	12 (14)	1 (–)
4th Qtr.	44 (42)	2 (–)	34 (25)	– (–)	12 (25)	– (–)
	209 (211)	6 (4)	85 (83)	– (–)	59 (64)	6 (4)
Hedigalla						
1st Qtr.	56 (68)	8 (6)	9 (3)	– (–)	16 (7)	1 (7)
2nd Qtr.	24 (40)	– (–)	15 (19)	– (–)	48 (27)	4 (5)
3rd Qtr.	40 (42)	17 (7)	15 (21)	– (–)	16 (22)	2 (–)
4th Qtr.	38 (34)	– (–)	28 (27)	– (–)	28 (31)	– (–)
	158 (184)	25 (13)	67 (70)	– (–)	108(87)	7 (12)

Manufacture

A summary of the manufacture records during the year 1977, is as follows:–

Latex Grades	*Total Kilos*	*Percentage*
Latex Crepe No. 1	114,746	92.00
2	2,997	2.50
3	7,633	5.00
	125,376	100.00
Scrap Grades		
Scrap Crepe No. 1	7,400	63.00
2	5,300	28.0
3	3,731	9.0
	16,431	100.0

Total	141,807 kg.
Outside sources	255,148 kg.
Grand Total	396,955

Dartonfield factory continued the manufacture of latex and scrap for Mukalana, Horagoda and Gallawatte Estates, during the year, in addition to Dartonfield Group. Further, complete manufacture of latex was done in February for the State Rubber Manufacturing Corporation, Badureliya Branch, and scrap of Kuruwita Sub-station of the Rubber Research Institute of Sri Lanka was manufactured in February and September, respectively. The rate levied for manufacture was was -/66.139 cts. per kg.

Due to storage difficulties experienced at Dartonfield factory, it was decided to manufacture all scrap at Mukalana factory, with effect from December onwards, although the right wing of the Dartonfield factory which was earlier used by the Rubber Chemistry Department has now been taken over by the estate and the lack of space experienced earlier has eased considerably.

Factory Machinery

Mill No. 1. – The large helical wheel was found to be defective and had been replaced.

Mill No. 8 *and Mill No.*7 – The end gears had to be replaced. The cost of repairs to these mills was within the current year's estimates.

The other mills in the factory were working satisfactorily. Installing and fitting of the following items to Dartonfield Factory drying tower are under consideration :-

Supplying one expellor Fan.
Installing two heating units and two expellor Fans.

The entire factory was re-electrified with new fluorescent fittings. This work was handled by the Works Department of the Institute and the expenditure incurred on this work is within the 1977 Capital Vote estimate provisions. The work has been very satisfactorily completed.

Weeding

During the first quarter, the expenditure on weeding mature areas has exceeded the proportionate estimate by 9.0% and this attribute mainly due to poor management of labour at Hedigalla Division. Thereafter every endeavour has been made to control expenditure on this item and the expenditure incurred during the year is within the estimate provisions.

Pests & Diseases *Oidium*

There was no significant attack of 'Oidium' on any of the Divisions, except on later winterers, where a mild attack occurred. few rounds of Sulphur dusting was carried out, as a precautionary measure.

Storm Damage

The loss of trees due to storm damage on Dartonfield Group was 186. This was mainly from Hedigalla 1954 and 1955 fields.

Root Diseases

Rigidoporus lignosus was detected mostly in mature areas and remedial measures adopted.

Manuring

First application was done in accordance with the Programme. Thereafter, on the instructions of the Director and Soils Chemist, it was decided to manure only the immature areas and to manure the mature areas only in April next season.

IMMATURE AREAS- Replantings

Dartonfield Division

1973 replanted area	–	6.05 ha
1974 replanted area	–	4.33 ha
		10.38 ha

Nivitigalakele Division

1971 replanted area	–	4.63 ha
1972 replanted area	–	2.42 ha
1974 replanted area	–	4.53 ha
		11.58 ha

Hedigalla Division

1971 replanted area (6.85 ha., in tapping now.)
1972 replanted area (8.06 ha., in tapping now.)

1974 replanted area	–	25.79 ha
1976 replanted area	–	33.05 ha
1977 replanted area	–	20.15 ha
		78.99 ha

1973 *replant Dartonfield Division*
The clones in this area are RRIC 101, PB 86 and other experimental clones.

1974 *replant, Dartonfield Division*
The clone in this area is PB 86.

1971 *replant, Nivitigalakele Division*
The clones are RRIC 50, and Botany Department experimental clones.

1972 *replant, Nivitigalakele*
The clones are RRIC 45, 110, No. 506 and selected experimental seedlings of Plant Pathology Department.

1974 *replant, Nivitigalakele*
This has all experimental clones of Plant Pathology Department.

1974 *replant, Hedigalla*
The clones are RRIC 102, 103 and PB 86. The growth in the RRIC 101 section is good, while the PB 86 block has not grown satisfactory due to its exposed location, and the area being wind blown.

1976 *replant, Hedigalla*
Clone PB 86. Growth is uneven due to staggered planting. Covers are spreading well and regular weeding rounds have been maintained.

1977 *replant, Hedigalla*

The clone is PB 86. A difference in extent of 2,02 ha was detected by the Surveyor in respect of this block.

Ground conditions on all the above areas continued to be satisfactory. All agricultural operations were carried out promptly. The replants are progressing satisfactorily.

The Plant Pathology Department required an extent of 2.02 ha to be planted at Nivitigalakele Division for experimental purposes and the area utilised for this purpose includes part of the land handed over by the Government Agent, Kalutara, to this estate. All preliminary works connected with this replant has been completed. The planting material that will be used in this replant will be PB 86.

NURSERIES

Budwood multiplication Nurseries

2.92 ha at Nivitigalakele, 2.22 ha at Dartonfield and 0.81 ha at Hedigalla.

These nurseries consist of RRIC clones. Routine weeding, manuring and other agricultural operations were carried out on all these nurseries.

Seedling Stock Nurseries

a) All seedlings stock nurseries were satisfactorily maintained.
b) Stocks were budded to meet both experimental and commercial requirements.
c) Two new nurseries were established at Nivitigalakele and Hedigalla for use in 1978.

Budwood Issues

1986 yards were issued during the period under review, for experimental and commercial purposes and for outside estates. Clone PB 86 continued to be much in demand.

Budded Stumps Issues

From the Nursery laid out in 1975 to cater to the requirements of the 1977 replant, 4,000 stumps were issued to the Botany Department.

Field and Technological Experiment

Necessary assistance by way of labour and various other requirements, were rendered to the research departments to carry out their field and technological experiments. In addition, labour required by the Statistical Department and the Works Department too were provided.

Roads

In spite of adverse weather, all roads were maintained in a satisfactory condition. In addition to this, the approach road to Hedigalla was repaired by the Department of Highways in response to a request made by the Institute as the estate road there was far from satisfactory.

Estimates

The estimates for 1977 were finalised and submitted to the Rubber Research Board for approval. Draft estimates due for the succeeding year too were submitted, for recommendations and amendments.

LABOUR AND HEALTH

Labour Force

Although the registered permanent labour force was adequate to cater to the requirements of the estate and Institute, the out-turn of workers was not satisfactory, specially during the paddy harvesting season.

During the period under review, 14 new workers were recruited on the daily paid cadre, while 15 workers left employment due to old age, departure to India for good and on medical grounds. In all, 13 cases were paid with their retiral/ ex-gratia dues in accordance with the retiral gratuity regulations, where they were entitled for same.

In compliance with the Indo-Ceylon Repatriation Act., 34 individuals were repatriated to India for good, so far since 1970.

Application for refund of EPF was made in respect of twenty nine members. In all, 36 cases were settled in full, including the previous year's outstanding claims.

In accordance with the Industrial Disputes Act and the Regulations made therein, two workers were granted with 'Paid Sick Leave Pay', during the year.

Line Rooms

Line room accommodation remained satisfactory, consequent to the Tamil workers departure to India for good. Routine repairs to lines and cottages were attended to, mainly at Dartonfield and Nivitigalakele Divisions. Constructing new water sealed latrines was not carried out, although estimated.

Wages

Wages were paid duirng the year, in accordance with the Rubber Growing and Manufacturing Trade of the latest decisions of the Wages Board. Further, all other statutory wage increases too were granted. Over and above the wages, necessary incentives too were granted to Supervisory Kanganies.

Dartonfield Group

Working Ceylonese	*Resident*	*Non-resident*	*Total*
Men	64	163	227
Women	49	149	198
Children	—	—	—
Working Immigrants			
Men	33	—	33
Women	26	—	26
Children	—	—	—
	172	312	484

Annual Holidays

Annual Holidays with holiday pay wages were granted, in accordance with the Wages Board's latest decisions.

Festival Advances

This was granted on the revised rates, in accordance with the increased labour wages, to be recovered in ten equal instalments.

Maternity Benefits

In all, thirty full and one (1) alternative maternity benefit payments were made.

Workmen 's Compensation

Accidents sustained by workers whilst in employment were duly reported to the Insurance Corporation direct and compensated accordingly, as per the Insurance Regulations.

As from 1977 October, all such matters will be referred to the Insurance Division, Janatha Estates' Development Board, P. O. Box 1753, Colombo, as instructed by the Rubber Research Board.

Feeding Children

All non-working resident children over one year of age and below thirteen years were issued with $\frac{1}{4}$ lb. 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 one year, as recommended by the Estate Medical Assistant.

Health

The health of the members of the Institute's Staff and of the estate labourers workers was generally satisfactory. However, there was an out-break of 'Chicken Pox' and 'Measles' on the Group/Estate and 'Scabies' among resident labourers/ workers and their dependants.

Immunization against Polio and vaccinations of B.C.G. and Triple were carried out at the estate dispensary, with the assistance of the Public Health Inspector of the area.

Sanitary Measures

No DDT spraying was undertaken due to the non-availability of DDT.

Births

Three (3) still births and nine (9) live births were reported.

Deaths

There were two (2) deaths on the estate this year, due to natural causes.

A list of more common diseases treated by the Institute's Estate Medical Assistants, is given below:-

Influenza	647
Ulcers	240
Round worm	167
Diarrhoea and Enterites	588
Eye and ear diseases	146
Other diseases	2114
	3902

The number of cases treated during the year includes non resident patients too. The Rubber Research Board as a social gesture has approved treating of non-residents who are related to the employees of the Institute.

The C.A.R.E. Sri Lanka Branch, continued to provide 'Thriposha'free of charge, under the medically selective programme for infants, ante-natal and lactating mothers.

General

1) As from 01.11.1977, the Estate Department of the Rubber Research Institute of Sri Lanka , will be known as Dartonfield Group, Agalawatta, of the Rubber Research Board, Plantations Division, which consists of Dartonfield, Nivitigalakele and Gallawatte Divisions, but excluded Hedigalla.

2) Workers' Councils active up to 1977 have been discontinued and abolished.

3) A sum of Rs. 12,500/- was paid in 1977 for the Estate Department Staff and Labourers/Workers, as 'Profit Bonus' of 1976, approved by the Rubber Research Board Plantations Division.

4) The former Estate Superintendent, Mr. W. A. Fonseka was in-charge of Kuruwita Sub-station of the Rubber Research Institute of Sri Lanka, for three months, during the period under review, in addition to Dartonfield Group.

REVIEW OF THE LIBRARY AND PUBLICATION SECTION

J. A. AMARAWEERA

Staff

Mr. J. A. Amaraweera, Librarian and Publications Officer, Miss L. I. T. Ramanaden, Library Assistant and Assistant Publications Officer, attached to the Colombo Office Library, Mr. D. C. Thambawita, Library Clerk and Mrs. D. T. Danthanarayana, Clerk/Typist, at Head Office Library were on duty throughout the year.

Meetings and Seminars

The Librarian and Publications Officer attended the workshop on S and T Information Management, organised by the National Science Council (NSC) on 20 – 21st May 1977 at the SLAAS auditorium, Colombo.

The writer represented the Director, RRISL, at the Seminar of the Chief Executives and Scientists of the Technical and Research Institutions in Sri Lanka" on the preparation of S and T Union Catalogue of Sri Lanka publications" arranged by the NSC of Sri Lanka on 27th June, 1977 at the NSC Head Quarters, Colombo. He also attended a Conference of Libraries of the S and T Libraries, Sri Lanka, regarding the compilation of the S and T Union Catalogue, on 28th June 1977, organised by the NSC, Colombo.

The writer was nominated by the Director of Agriculture on the recommendation of Mr. K. P. Broadbent, Senior Advisor to AIBA/SEARCA to represent Sri Lanka at the Workshop and seminar on information systems and AGRIS Methodology, 1 - 21st June 1977 at the SEARCA Headquarters, University of the Philippines at Los Banos, College, Laguna, The Philippines. He left the Island on 30th May to attend the above workshop/seminar and returned to the Island on 24th June 1977. A country report "Progress and some proposals to improve AGRIS Information Systems in Sri Lanka" was presented at the final session of the seminar. He had the opportunity of meeting most of the leading information specialists, scientists. Librarians from the South East Asian Countries and in getting a first hand knowledge of ways and means of the management of agricultural information in various Asian countries. Also it was a good opportunity to witness the computerized information retrieval and disseminating systems, some sophisticated and advanced mechanisms of information handling at the various Research Libraries like the International Rice Research Institute (IRRI) Library, National Centre of UP Los Banos, National Library and other places.

The Publications Officer and the Library Assistant and Assistant Publications Officer attended the seminar on Rubber Products organised by the RRISL on 19th September 1977 at ARTI auditorium, Colombo.

The RRISL library participates in the Union Catalogue of Scientific and Technical Publications (UNICAST) project managed by the National Science Council of Sri Lanka and during the year about 40 Catalogue cards have been sent to the Union Catalogue as RRI contributions. Now, we are in a position to contribute to two world famous Agricultural Indexes *viz.* AGRINDEX and AGRIASIA as a result of the writer's participation in the AGRIS project of FAO. The Institute Library and the writer have applied for the Institutional and Individual memberships, respectively, for the Agricultural Information Society for Asia and Pacific (AISA) and liaised the local activities of AISA in Sri Lanka

The writer attended the course on Management Development Programmes (MDP 108) on Librarianship organised by the Sri Lanka Institute for the studies of State Corporations (SLISSCO) from 2nd February to 9th July and was successful in securing a certificate.

International Liaison

During the year under review 9 more Institutions and Libraries were added to the existing exchange mailing list viz.

Agricultural Information Bank for Asia (AIBA).
SEARCA
IRRI Library
Mindanao Institute of Technology – MIT
University of the Philippines, Mindanao
Bangladesh Documentation Centre – BANSDOC
AVRDC – Taiwan
National Documentation Centre – Thailand
University of Pertinian Library – Malaysia

Library Acquisitions

Our library has received 195 books and 12 journals worth Rs. 35,000/– (approx.) under the Netherlands Literature Programme during December 1977. We wish to thank the officials of the Netherlands Embassy and the Director, External Resources Department and the Secretary, Ministry of Plantations Industries, who helped us in obtaining this assistance. Apart from this donation, library acquisitions amounted to 51 books, purchased locally and abroad, and 18 gifts and donations.

Two hundred and fifty seven titles of periodicals were received at both the Headquarters and Colombo Office Library of the RRI and the break up was as follows :

	Local	*Overseas*
On subscription	10	105
On exchange/gratis	32	110

12 Directories were added to the collection. 48 reprints from various Scientists and Institutions and 12 photocopies of the articles from BLLD, Library, U. K. were received during the year.

There were 96 journals and 16 old books leather bound and added to the existing library collection of bound volumes.

Inter library loans

We loaned 20 periodicals and 8 books to outside libraries on inter library loan scheme and obtained 25 periodicals and 10 books from various research libraries in respect of our requests made for the Research Staff during the year under review.

Our Scientists appreciate the invaluable service rendered during the year by the American Centre, Colombo, through her service of supplying photocopies of current content pages and research articles of topical interest. We thank Mrs. Margeret Gooneratne, Chief Librarian, American Centre, and her staff for this service.

REVIEW OF THE KURUWITA SUB-STATION

R. C. PERIES

ACREAGE STATEMENT:

Mature Rubber

1961	Replanting	33.59	Hectares
1962	,,	15.68	,,
1963	,,	9.11	,,
1964	,,	7.28	,,
1965	,,	7.89	,,
1966	,,	4.05	,,
1967	,,	4.05	,,
1968	,,	4.05	,,
1969	,,	4.05	,,
Extent in tapping		89.74	,,
Nurseries		.86	,,
Paddy		2.23	,,
Roads, Buildings etc.		7.01	,,
Total Extent		99.84	,,

WEATHER :

Year	*Rainfall*	*Wet Days*
1977	171.77"	194
1976	146.38"	272

The year under review commenced with the seasonal drought and after this, rain commenced in March and from March a prolonged period of wet weather continued and interfered with tapping.

CROP:

	1977	1976
Estimated Crop	95,147 Kg.	95,493 Kg.
Crop secured	82,021 ,,	72,217 ,,
Decrease	13,126 ,,	23,276 ,,

Due to unfavourable weather conditions, the crop secured fell short of the estimate by 13,126 kg., but recorded a substantial increase of 9,804 kg. over last year (1976). Recovery tapping was undertaken during the latter part of the year.

MANUFACTURE :

The coagulum was sent to Elston Estate for manufacture into pale crepe. This was discontinued from June, 1977, and latex sold to SRMC factory from 1st July 1977. In addition, a part of the 1977 scrap rubber was sent to Dartonfield factory for manufacture.

STAFF :

Mr. G. D. I. Weerasooriya who had been suspended from service pending a disciplinary inquiry, was reinstated on 22nd April 1977. Mr. F. S. de Zoysa who was acting for him was sent back to Hedigalla Sub-station.

BUILDINGS:

Necessary repairs to one of the Scientific Department bungalows ACB No. 1 was carried out under the supervision of the Institute Work Section.

LABOUR:

Two estate workers were retired on their having reachecd the retirement age.

GENERAL:

Mr. Sali M. Dias relinquished his services at the end of July 1977. Mr. W. A. Fonseka assumed duties as Acting Visiting Superintendent in August, 1977 and relinquished his services in mid-October, 1977.

In addition Mr. S. G. Fernando, Assistant Estate Superintendent, who was transferred from Hedigalla Sub-station, assumed duties at Kuruwita Sub-station in the same capacity from mid October, 1977.

Mr. R. C. Peries assumed duties as Visiting Superintendent from November, 1977.