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The Rubber Research Institute of Sri Lanka

Annual Review 1982

THE RUBBER RESEARCH INSTITUTE OF SRI LANKA

ANNUAL REVIEW 1982

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RUBBER RESEARCH INSTITUTE OF SRI LANKA

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(As at 31st December, 1982)

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

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Secretary to the Board

Mr B. S. Ratnayake

Lawyers

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

Auditors

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

Bankers

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

Registered Office, Laboratories

Dartonfield, Agalawatta.

Colombo Office

Consisting of:

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

THE RUBBER RESEARCH INSTITUTE OF SRI LANKA

STAFF

(As at 31st December 1982)

Director	—	O. S. Peries, BAgSci. (Melb.) PhD (Bristol), M.I.Biol.
Deputy Director	—	A. de S. Liyanage, BAgSci. (Cey.), Ph.D (Lond.)
Assistant Director	—	D. M. Fernando, BSc (Cey.), MSc (McGill)

RESEARCH DEPARTMENTS

Plant Science

Head of Department	—	Mrs A. C. I. Samaranayake, BSc (Cey.), PhD (Lond.)
Assistant Botanists		R. C. W. M. R. A. Nugawela, BSc (Cey.) MSc (Lond)
		A. G. A. de Soyza, BSc (Lond.), MSc (Lond.)
Experimental Officer	—	A. H. R. Jayaratne, BSc (Cey.)
Senior Technical Officer	—	L. S. S. Pathiratne, M.I.Biol.
Technical Officers	—	Miss C. W. Ranasinghe, BA (Cey.)
		Miss G. A. S. Wijesekera
		L. S. Kariyawasam
		K. A. G. B. Amaratunga
		R. P. Karunasena
Senior Experimental Assistants	—	M. C. Perera
		R. B. Gunaratne
Experimental Assistant	—	S. Wilbert
Clerk/Typist	—	Mrs V. Jayasundera

Intercropping

Head of Department	—	L. B. Chandrasekera, BSc (Cey.), Dip Ag. Sci (Cantab.)
Experimental Assistants	—	U. K. D. Lewis
		W. A. T. Silva
		N. L. D. Ruban

Genetics & Plant Breeding

Head of Department	—	D. M. Fernando, BSc (Cey.) , MSc (McGill)
Geneticist & Plant Breeder	—	N. E. M. Jayasekera, BAgSci (Cey.), PhD (Birm.)
Senior Experimental Assistant	—	B. M. S. G. Peiris
Technical Officers	—	K. B. A. Karunasekera
		K. W. Rupatunga
		I. D. M. J. Sarath Kumara
Experimental Assistants	—	D. S. Gamage
		A. K. M. S. Senaratne

Plant Pathology

Head of Department	—	A. de S. Liyanage, BAgSci (Cey.), PhD (Lond.)
Assistant Plant Pathologists	—	*C. K. Jayasinghe, BSc (Cey.), MSc (Cey.)
		Mrs N. I. S. Liyanage, BAgSci (Cey.), MSc (Cey.)
Senior Technical Officer	—	Z. E. Irugalbandara
Technical Officers	—	Mrs P. C. Wettasinghe
		L. W. Amaratunga
		A. Dharmaratne
		W. A. D. D. S. Wettasinghe
		E. B. Fernando
		S. S. Warnapura
		E. A. T. Senadeera
Clerk/Typist	—	Mrs W. S. P. Amarasekera

Soils & Plant Nutrition

Head of Department	—	***N. Yogaratnam, BAgSci (Alhabad), PhD (Lond.)
Acting Head of Department	—	M. K. S. A. Samaraweera, BSc (Cey.) , MSc (Bristol), PhD (Bristol)
Assistant Soils Chemist	—	Mrs M. L. A. Samarappuli, BAgSci (Cey.)
Experimental Officers	—	Miss K. A. D. E. S. Gunasekara, BSc (Cey.)
		W. C. Dayaratne
		A. M. A. Perera
Technical Officers	—	Miss D. I. R. Denawaka
		Miss S. D. C. K. Maheepala
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		Miss H. V. Kumudinie

Technical Officers (Cont.)	—	T. A. C. S. Wasanthadeva J. G. de Mel S. N. Silva P. Karunadasa
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Rubber Chemistry, Technology Biochemistry & Electronic Instruments Repair Unit

Head of Department	—	****S. W. Karunaratne, BSc (Cey.), MSc (Aston.) ARIC, ANCRT, FPRI, FIC.
Acting Head of Department & Biochemist	—	P. A. J. Yapa, BSc (Cey.) PhD (Lond.)
Rubber Chemists	—	A. Coomarasamy, BSc (Cey.), PhD (Aston) W. S. E. Fernando, BSc (Cey.), MSc (Aston), PhD (Aston.)
Rubber Chemist/Specifications Officer	—	L. M. K. Tillekeratne, BSc (Cey.), MSc (Aston), PhD (Aston)
Assistant Rubber Chemists	—	Miss N. M. V. Kalyani BSc (Cey.) *M. C. S. Perera, BSc (Cey.), MSc (Cey.) M. D. R. J. Gunatilleke, BSc (Cey.) E. D. I. H. Perera, BSc (Cey.)
Research Assistant	—	L. B. K. Silva, BSc (Cey.), LPRI
Assistant Rubber Chemist/ Specifications Officer	—	P. A. D. T. Vimalasiri, BSc (Cey.)
Experimental Officers	—	Miss C. P. Wickremasinghe, BSc (Cey.) K. C. Croose, BSc (Cey.) **P. P. Jayasinghe, LPRI K. A. R. M. Perera, BSc (Cey.) S. Kasinathan, M.I.Biol., A.I.Chem.
Senior Technical Officers	—	A. S. Dekumpitiya D. D. Medagama I. H. S. L. Weerasinghe

Technical Officers	—	Mrs N. A. Baduge, BA (Cey.)
		Mrs H. S. Weeraman
		Mrs D. Nirmala
		Mrs M. G. M. M. Nilaweera
		Mrs L. Wanigatunga
		Mrs W. C. M. Kuruppu
		Mrs M. K. Wickremapala
		Miss S. P. S. I. Senanayake
		W. D. Dharmasena
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		G. R. S. S. Gamlath
		L. G. Piyasena
Specification Assistants	—	T. M. Ahamadeen
(*Special Grade*)		W. A. S. Wijesekera
Specification Assistants	—	K. B. Abeysundera
		G. Wanigatunga
		T. A. S. Siriwardene
		R. Wickremaratne
		P. D. J. Rodrigo
		K. K. Austin
		B. Gunasiri
		W. W. Nandasena
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Clerk/Typists	—	Mrs S. A. Paranawithana
		Miss M. D. I. Premawathie
		Miss K. A. J. Malkanthie

Statistical Section

Assistant Statistician	—	*W. N. Wickremasinghe, BSc (Cey.)
Senior Technical Officer	—	L. T. Peiris
Technical Officers	—	Miss J. D. Nandanie
		R. A. P. Abayapala

ADMINISTRATION DEPARTMENT

Chief Administrative Officer &		
Secretary to the Borard	—	B. S. Ratnayake, BA (Cey.)
Office Assistant	—	T. H. Wijesena

Asst. Medical Practitioner	—	M. C. Peiris
Chief Clerk	—	W. D. Jayawansa
Clerks (Special Grade)	—	J. D. Gunaratne
		Mrs D. F. Thambawita
Confidencial Clerk/Stenographer	—	P. H. Seneviratne
Translator/Clerk	—	D. U. Kannangara
Clerk/Typists	—	R. G. D. Sakaraja
		Mrs R. S. Amarasekera
		Mrs W. Paul

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Internal Audit Assistant	—	N. C. de Silva

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Library Asst. & Asst Publications Officer	—	Miss L. I. T. Ramanaden, ALA (Cey.)
Library Clerk	—	D C. Thambawita
Clerk/Typist	—	Mrs D. T. Dantanarayana

Works Section

Works Engineer	—	A. M. S. Kulasekera
Mechanical Foreman	—	M. M. Anderson
Transport Assistant	—	**B. D. Ponnamperuma
Clerk (Special Grade)	—	D. D. D. Adikaram
Clerk/Typists	—	N. Jayasekera
		Miss M. Gunawathie Silva
Mechanical Supervisor (Workshop)	—	W. D. Dharmawardena
Building Supervisor	—	K. K. A. S. Kannangara
Electrical Supervisor	—	W. D. Ratnasinghe
Mechanical Supervisor	—	S. D. Gunawardena

Accounts Department

Accountant	—	D. P. Ashley Perera
Assistant Accountant	—	A. K. D. Amaradasa

Accounting Assistant	—	K. G. A. K. Dharmawardena
Accounts Clerk	—	A. L. Ratnayake
Store Keeper	—	P. D. Somadasa
Clerks	—	D. A. Rajapaksa
		**G. A. Kannangara
		G. S. Doolwela
Graduate Assistants	—	Mrs. G. K. Somasiri, BA (Cey.)
		Mrs K. K. Jagoda, BA (Cey.)
Clerk/Typists	—	W. Kularatne
		Mrs C. C. Silva
		Miss S. Irene
		Miss M. Mullevidane
		Miss M. Rajapakse
Cashier	—	D. C. A. D. B. de Silva
Asst. Store-Keepers	—	P. L. R. A. W. Cooray
		D. C. P. Pothmitiyage

ESTATE DEPARTMENT

Estate Superintendent	—	R. G. Siriwardene
Actg. Chief Clerk	—	A. A. Ariyaratne
Junior Assistant Clerks	—	K. K. P. Gunawardena
		K. D. Sumanasena
		C. N. Wickremasinghe
Field Officers	—	N. L. D. Piyadasa
		A. K. D. Hemapala
		S. K. S. de Silva
Factory Officer	—	D. C. C. Jayasekera
Assistant Field Officers	—	A. K. D. M. Wickremasinghe
		A. J. A. Wimalasena
Assistant Factory Officer	—	D. S. K. Ranaweera
Field Supervisor	—	S. R. Vadivel

Kuruwita Sub-station

Visiting Superintendent	—	R. C. Peries

* On study leave overseas
**On no pay leave overseas
*** On no pay & sabbatical leave overseas
**** On sabbatical leave overseas

RUBBER RESEARCH INSTITUTE OF SRI LANKA

DIRECTOR'S REVIEW

By

O. S. PERIES

Rubber price

Rubber prices have been in the doldrums or steadily declining over the last 3 years, essentially because of the recession of the economies of all countries the world over. This has had a crippling effect on the demand for natural rubber, as for all other commodities. The most important factors contributing to the lack of demand for rubber is the drop in sales of new cars, the massive and unexpected conservation of fuel, and the consequent restricted movement of vehicles, in most of the developed countries, leading to a dramatic reduction in the sale of replacement tyres. The lack of demand for natural rubber has brought untold hardships to the small rubber producers, of whom there are over six million in the less developed countries.

The prospects for rapid recovery are not attractive either, as the total rubber consumption, both natural and synthetic, declined by 6 per cent in the first quarter of 1982—the decline in synthetics being 7 per cent and natural 3.7 per cent. The serious situation for synthetics has led to extensive "rationalisation" of production, with many plants closing down permanently, because of recurring losses. The current forecast by The Economist Intelligence Unit Ltd. is that the natural rubber price will continue to remain weak in the short term, but that it will not fall much further from the current price of 50 pence per kg., a price 10 per cent lower than 3 years ago. The same source forecasts a slightly more promising picture for 1983, when consumption is expected to increase by about 2.5 per cent; because of better sales of tyres with increased demand for new cars, particularly in Western Europe and the USA.

The best news for natural rubber during 1982 was that the swing towards NR, which started with the increased demand for radial tyres was continued throughout the year, although at a slower rate. NR accounted for 31 per cent of total consumption in the first quarter of 1982 compared to 30 per cent in the same period of 1981. Unfortunately, one of the important reasons for this was that NR prices were low. It is hoped that, with the recovery of the economies of some countries, NR will reach a price of at least 60 pence per kg, which is a fair price for it on technical and economic grounds.

The International Natural Rubber Agreement, which was started to stabilize the price of natural rubber, has not been able to stem the tide of world events to ensure a fair price for the commodity. It now seems that stockpiling natural rubber may not be the quick answer to declining prices, as at first surmised. It appears that, as long as there is a stockpile of rubber somewhere in the world, the commodity demand for it will be sluggish. The oil producing countries are also learning a lesson of a different kind and some major producers like Mexico are inundated with debts. Therefore, a major shift in world thinking and planning is necessary to ensure that all countries and people survive the impact of recession.

Market promotion

Irrespective of world prices for natural rubber, Sri Lanka being a very small producer (now sixth in order of production, behind Malaysia, Indonesia, Thailand, India and China) must pay more attention to market promotion. We produce the purest and whitest form of NR in crepe rubber, which must be sold as a specialized rubber. We can produce other forms of specialized rubber too. These must be sold aggressively in the world market, with adequate market intelligence and proper after sales service. However, at present this is a completely neglected field, although the Rubber Research Insitute has stressed the importance of aggressive marketing for over 1½ decades now. It is sad but true to say that Sri Lanka, the world's largest producer of crepe rubber from the inception of the industry, does not have the bare statistics on what this rubber is used for by the consumer. Again we lost the whole crepe rubber market in the UK and USA over the last decade; but no query was ever made and no attempt to find out why these countries switched from crepe to other forms of rubber. It is quite possible that, if this market intelligence was available to us, we would easily have made slight modifications in the quality and price of the rubber, the method of packing or whatever was lacking in our rubber to hold these markets. This is important, but it has to be noted that this paragraph is practically a repetition from our Annual Reviews of the 1970s, which failed to carry the message to the higher echelons of Government. We trust that, with new faces and new ideas, this message will be taken in its correct perspective.

Rubber based industries

Several new rubber based industries have been started in the Free Trade Zone; but footwear and toys appear to be the trades of choice. It is pleasing to note that the Sri Lanka Tyre Corporation has entered the world tyre market with expert collaboration with a tyre manufacturer in the USA; similarly another Sri Lankan firm has been successful in establishing an international market for its solid rubber tyres, manufactured locally with foreign collaboration. It is expected that these pioneers will set the pattern for more rubber based industries to be set up in Sri Lanka.

One of the baffling aspects of this subject is to find that, although it was this Institute that carried out studies and popularised the use of rubber wood for the manufacture of furniture, this industry has not developed as fast as it has in other countries like Malaysia

and Thailand, that entered the field long after us, but are now large scale exporters of rubber wood furniture to Europe, Japan and the USA. It would be useful to set up a central planning authority to plan and organise the uprooting of rubber trees, so that the wood is transported to central factories on a phased programme. This would enable replanters to obtain better prices for their wood so that they can prepare their land better for replanting, thus reducing the incidence of root diseases, which is the most important disease of the rubber tree at present. This would also lead to the more efficient use of the roots and smaller branches for firewood, which is a dwindling commodity worldwide.

Hevea germplasm

It is interesting to note that the total area of rubber planted in South East Asia, now comprising some 7 million ha, is in fact the progeny of a small number of seedlings that survived from the 70,000 seeds collected by Sir Henry Wickham from a small area in Brazil, within a few weeks, in 1876. The International Rubber Research and Development Board (IRRDB) has now organised international teams of scientists to collect rubber seeds from various areas of Brazil, some reported to have higher yielding varieties of *Hevea* than those that came into the Wickham collection. This will widen the genetic base of *Hevea* and, will hopefully enable rubber breeders to produce higher yielding clones. Two expeditions have already visited Brazil one in 1981 and the other in 1982, and collected several thousand rubber seeds, which have passed through careful quarantine procedures in the UK and been planted in Malaysia. All IRRDB Institutes that contributed to the financial costs of the project are entitled to material from these collections. Scientific information on all aspects of the project and the collected material will also be freely available to the IRRDB participants.

This ambitious undertaking has already cost the IRRDB a massive sum of US $ 240,000, and it will cost a further US $ 200, 000 per year to maintain the plants over the next 6 years. The project is being funded entirely by the member countries of the IRRDB, from their meagre funds. Sri Lanka has been able to meet its share of the project costs, each country contributing a share on a proportionate basis on the amount of rubber it produces.

RESEARCH HIGHLIGHTS

Plant Breeding

RRIC 102 and RRIC 103 have both shown satisfactory bark thickness on Panel D and uniformity in yields in Panel C. Reports from International Clone Trials in Thailand, Malayasia, Indonesia, India and Ivory Coast have confirmed immature vigour significantly more than material from other countries for RRIC 100, 102, 103, 110. The oil content of rubber plants was shown to have a relationship to South Amercican Leaf Blight (SALB) susceptibility. A visiting team of IRRDB plant breeders endorsed the suitability of RRIC 100 series for large scale planting in Sri Lanka. The SALB resistant clone RRIC 121

continued to show high yields and increase of girth after tapping. Tapping was commenced on the first set of clones viz. RRIC 36, 52, 100, 101, 102, 103, PB 86, RRIM 600, 623, and IAN 710 in six sites in genotype/environment studies.

Plant Science

Evidence from puncture tapping experiments suggest that the high yields recorded during the first 2 weeks of tapping a band could be maintained by exploiting any one band for only 2 weeks, instead of 1 month as at present. During the drier months of the year puncture tapping has given significantly higher yields than normal S/2 d/2 tappings. Trees may be exploited more economically by using the puncture tapping method during the dry months when yield sitimulants are most effective. Such alteration of tapping methods will allow better use to be made of the bark. Puncture tapping may prove to be most useful in the drier districts. Experiments are now under way to determine the best possible combination for commercial use.

Crown budding experiments have shown that certain crowns can improve both growth as well as yield of the trunk. Buddings grown in polybags are being used by most growers at least in supplying vacant points in replantations. In the drier districts most planters are using them in place of bare root stumps.

The effect of varying the concentration of N, Mg and Ca in the growth medium reveals that, whilst the proportion of dry weight to fresh weight remains almost constant in calli grown for 6 weeks on the medium, growth by weight increases with increase in concentration of the three nutrients investigated so far.

Plant Pathology

Variation in growth characteristics, morphology and sporulation was observed in isolates of *Colletotrichum gloeosporioides*. Differential host reactions were also seen. Leaf leachates of resistant clones suppressed the growth of this fungus and promoted the formation of appressoria. Waxes and other substances associated with it inhibited the growth of the pathogen.

Peroxidase activity was higher in clones susceptible to South American Leaf Blight (SALB). The glycoside content showed an inverse relationship to SALB resistance. Among naturally occurring phenols kaemferol and quercetin were present in large amounts in *Hevea* leaves, there was more of the latter in SALB resistant clones.

Environmental conditions largely determine the pattern of infection. A low and a high incidence and severity were linearly and curvilinearly related, respectively.

Drechslera heveae appeared to be a problem in stock nurseries during the dry season. This fungus was able to grow even at a temperature of 45°C without any adverse effect.

Of several criteria evaluated to separate physiologic races of *Phytophthora palmivora* from cocao, growth and sporulation were best.

A new fungicide formulation developed, incorporating Difolatan, gave promising results, in preliminary trials for the control of bark rot.

Long term rainfall records were used to predict the probability of occurrence of rain in six estates located in Ratnapura and Kalutara Districts. This will help to predict incidence of diseases and help in timing other cultural operations.

Two new diseases affecting pineapple (*Thielaviopsis* state of *Ceratocystis paradoxa*) and cardamom (*Phytophthora nicotianae* var. *nicotianae*) were recorded.

Soils and Plant Nutrition

Young rubber trees showed good growth in response to fertilizer application and mature fields produced high yields when they were continuously fertilized. Based on several years of research we were able to recommend urea as the only source of N to all the rubber plantations. At present the fertilizer consumption in the rubber sector is 22,000 mt per year and the savings made by the growers by using urea based mixtures are Rs. 28.9 million. During the year, 12,000 ha of mature rubber fields were surveyed to find out the nutritional status of the trees and to recommend fertilizers on a discriminatory manner. The growers who follow our advice will be able to save another Rs. 5.0 million during 1983. Because of the subsidy on fertilizer the savings to the nation are much higher than this.

We have noticed an exceptionally high incidence of nutrient imbalance in 2 - 3 year old clearings in several districts and chemical analyses of leaves from affected trees have shown that the plants suffer from deficiency of several nutrients especially that of magnesium.

Computer aided research has shown a relationship between the latex yield and the nutritional status of the tree.

Attempts were also made to study the effect of different ground covers on increasing the soil fertility and conserving the mositure in the soil.

Using sand culture methods we were able to confirm the deficiency symptoms of N, P, K, Ca, Mg and to produce hunger signs for S.

Rubber Chemistry

An alternate bleaching agent to the scarce xylyl mercaptan (RPA 3), namely tolyl mercaptan (RRI-7) was found suitable for use in the manufacture of high quality crepe rubber. RRI-7 marketed as Nexobleach was found to be even superior to RPA 3.

Mixtures of formaldehyde stabilised natural rubber field latex containing room temperature vulcanising systems and bitumen emulsion were found to be a very effective water

proofing material. The use of these mixture was tested in sealing cracks in cement/concrete surfaces and for constructing cheap irrigation tanks and channels. This becomes more important due to the Accelerated Mahaweli Scheme and other projects which include the Wind Energy Programme of the Water Resources Board. A Sri Lanka Patent has been applied for the above process and a leading engineering organisation in the country has commenced the manufacture of these materials on a commercial scale.

A new system of using solar energy for the drying of crepe rubber was tested to find out the area of solar collection required to obtain the necessary heat, and store it for a prolonged period; especially to keep the drying tower warm at night when the temperature is low. A storage system consisting of a packed bed of clay bricks could be adopted.

Technical assistance was given to a leading company to manufacture road marking and floor paints from cyclised rubber. A sample of road marking paint made with cyclised rubber was supplied to the Department of Highways for field trials.

The Department of Commodity Purchase handed us the task of making suitable inks for bale marking RSS/exported to China. Trials were carried out using a rubber paint prepared by incorporating the pigment into the rubber and dissolving the pigmented rubber in waste terpentine. Colour fastness and rubbing qualities of the paint during transit was found to be satisfactory. In the field of raw rubber processing, RRIC 103 was found to be the most suitable of the RRIC 100 series clones for crepe rubber manufacture, whereas RRIC 102 was found to be unsuitable, due to discolouration.

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

A useful non-rubber resource is rubber seed oil. Of the triglycerides available in Sri Lanka, rubber seed oil is the only one which has useful drying properties. Rubber seed oil has been used in this country in the paint industry, thus by utilising the oil of rubber seeds, a new industry has been started and a local raw material which otherwise would have been wasted has been utilized.

Advisory Services

This Department was taken out of the Rubber Research Institute and set up as a separate institution, which will function under the Rubber Research Board, but under its own Director and an expanded staff. This was found necessary to implement the World Bank assisted smallholder rubber replanting project.

STAFF

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

Dr O. S. Peries, Director was out of the Island for 4 weeks each in February-March and September-October, as FAO Consultant to the Rubber Research Centre, Hat Yai, Thailand.

Mr D. M. Fernando, Assistant Director and Head of Genetics and Plant Breeding Department was on no-pay leave from 30.12.81 to 14.04.82 having accepted an assignment as Advisor to the National Institute for Agricultural Research, Mexico.

Dr A. de S. Liyanage, Head of Plant Pathology Department participated in the 4th meeting of the ANRPC Technical Committee on South American Leaf Blight (SALB) Chiengmai, Thailand from 12-26 January.

Mr S. W. Karunaratne, Head of Rubber Chemistry Department attended a Technical Review meeting on Radiation Processing in Kuala Lumpur, Malaysia from 15 - 19 February. Mr Karunaratne also participated in the first UNDP Industrial Technology Transfer Workshop, Jakarta, Indonesia, from 1 - 3 November. He is on his sabbatical leave of 6 months from 10 November to 9 April 1983 following a course of training in Radiation Vulcanisation in Japan.

Dr L. M. K. Tillekaratne, Rubber Chemist/Specification Offiicer, attended ISO/TC 45 meetings on Rubber and Rubber Products in New Delhi, India, 11 - 21 December.

Dr N. Yogaratnam, Head of Soils and Plant Nutrition Department, attended the 12th International Congress on Soil Science in New Delhi from 8 - 16 February. He also participated in the Nitrogen Seminar in Kuala Lumpur, Malaysia, 29 March - 1 April. He was on sabbatical leave from 18 May, working as the Chief Agronomist at the Tree Crop Research Station of the Ministry of Agriculture and Water Development in Zambia.

Mr R. C. W. N. R. A. Nugawela, Assistant Botanist, Plant Science Department followed a training course for 13½ months in Applied Plant Science at Wye College, United Kingdom from 24 August in 1981.

Mr C. K. Jayasinghe, Assistant Plant Pathologist, is following a course of training in nitrogen fixation in Australia for 1 year commencing 18 September.

Mr W. N. Wickremasinghe, Assistant Statistician, is continuing his studies in Biometrics leading to the Master's Degree at the Iowa State University, USA.

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

Mr M. D. R. J. Goonetilleka, Assistant Rubber Chemist, is continuing his postgraduate stuides in Chemical Engineering at the University of Aston in Birmingham, United Kingdom.

Mr A. S. Dekumpitiya, Senior Technical Officer, Rubber Chemistry Department followed a training course leading to the Diploma in Natural Rubber Processing in Malaysia from 5 March - 16 December.

Mr P. P. Jayasinghe, Experimental Officer, Rubber Chemistry Department is on 1 year's no-pay leave from 29 November, having accepted a contracted assignment as Guest Researcher and also as a participant in an electronics course.

Mr K. A. R. M. Perera, Technical Officer, Rubber Chemistry Department, followed a 6 months practical training course commencing 12 October 1981 in Rubber Technology at the International Technical Centre for Rubber and Plastics in the United Kingdom.

Mr R. Jayarante, Experimental Officer, Plant Science Department participated in a training course on Mycorrhizae Research Techniques from 3-15 May, in Serdang, Selangor, Malaysia.

Mr B. D. Ponnamperuma, Transport Assistant, is on 2 years no-pay leave commencing 16 August, having accepted a contracted assignment in Saudi Arabia as Collection Route Supervisor.

Mr G. A. Kannangara, Clerk, Accounts Department is on 1 year's no-pay leave commencing 12 March having accepted a contracted assignment in Saudi Arabia as Purchasing Officer.

Mr K. D. J. Siriwardene, Driver, is on 2 year's no-pay leave commencing 10 September having accepted a contracted assignment in Saudi Arabia as Driver.

The salaried staff of the Institute at the end of the year (1982) was as follows:

Officers in Grades	..	I - VI	— 42
Officers in Grades	..	VII - XV	— 293
Officers in Grades	..	XVI - XIX	— 142
Total	..		477

This includes Rubber Research Institute Staff, Colombo Office and Advisory Services Department (including SRRP).

Director's publications

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

Dantanarayana, D. M., Peries, O. S. and Liyanage, A. de S. Taxonomy of *Phytophthora* Species isolated from Rubber in Sri Lanka. *Trans. Bri. mycol. Soc.* (In press).

Liyanage, N. I. S., Yapa, P. A. J., Liyanage, A. de S. and Peries, O. S. (1981). Production antifungal compound in *Hevea* pods in response to infection by *Phytophthora meadii*. *J. Rubb. Res. Inst. Sri Lanka* **58**, 37 - 45.

Director's duties

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

General President, Sri Lanka Association for the Advancement of Science

President of the Institute of Biology, Sri Lanka

Member of the National Science Council

Member of the Rubber Research Board

Member of the Board of Governors, Ceylon Institute of Scientific and Industrial Research

Member of the Coconut Research Board

Member of the Board of Management of the Post Graduate Institute of Agriculture

Member of the Board of the National Institute of Plantation Management

Member of the Rubber Replanting Advisory Board

Member of the Steering Committee of the Smallholder Rubber Replanting Project

Editor, Journal of the Rubber Research Institute of Sri Lanka

Editor, Journal of the National Institute of Plantation Management

VISITORS

Visitors to the Institute included

Mr Rene Moreno Jr. World Bank, Washington DC, USA

Mr John A. Hayward, World Bank, Washington, DC, USA

Mr Louis E. Dela Grave, VWR Scientific Int'l - HK - Ltd. Hong Kong

Mr Morin et Raveau, Paris, France

Mr James Roger, Reading University, UK

Mr A. M. Choudhury, Chairman, Bangladesh Forest Industries, Dev. Corpn., Dacca

Dr M. Mohinder Singh, RRI, Malaysia

Dr R. Prumal, Department of Biochemistry, University of Malaysia, Malaysia

Mr Chan Woon Peng, Department of Chemistry, Damrich, Malaysia

Elizabath Khan, Medical Department, Sarawak, Malaysia

Kinat Singh, Department of Chemistry, Penang, Malaysia

Soekarmando H. Agency of Agr. Extension, Training and Education, Ministry of Agriculture, Indonesia

Ruyat Wiratmasa, Ministry of Agriculture, Jakarta, Indonesia

Azril Aazhari - do -

Prof. A. I. McMullen, Chemistry Department, University of Southampton

Mr. G. M. Roberts do -

Dan F. Boyd, USA

Dr John Daries, Sunn Street, London, UK

Dr D. A. Nethsinghe, IAEA, Vienna

Dr K. G. Dharmawardena, Chairman AEA, Colombo

Prof R. B. Sopper, CIDA - Univeristy of Manitoba, Canada

REVIEW OF THE PLANT SCIENCE DEPARTMENT

By

CHANDRA SAMARANAYAKE

SUMMARY

Some of the recently introduced high yielding clones have responded well to tapping at higher intensities during the first year of high intensity tapping on virgin bark. The long-term effects on growth , yield and brown bast incidence has to be followed especially in clone RRIC 100 which has responded with very high yields. Early results from a large scale experiment on puncture tapping show that girth increase is not significantly different from conventionally tapped trees of the same clone.

The advantage of using polybag grown plants over bare root plants, especially in unfavourable weather conditions, is evident from experiments carried out during the year. In the first year of tapping stock-scion and crown budding experiments, significant effects on yield have been shown by rootstocks and crowns.

DETAILED REVIEW

Staff

Dr (Mrs) A. C. I. Samaranayake was appointed Head of Department in July and was on duty throughout the year. Mr A. G. A. de Soyza, Assistant Botanist, was on duty through out the year. Mr A. Nugawela, Assistant Botanist, who was in England on study leave, returned in October after successfully completing his post-graduate training and obtaining an MSc at Wye College, University of London.

Experimental Officer, Mr A. H. R. Jayaratne, Senior Teehnical Officer, Mr L. S. S. Pathiratne and Technical Officers, Messrs L. S. Kariyawasam, K. A. G. B. Ameratunge, R. P. Karunasena, Miss C. W. Ranasinghe, Miss G. A. S. Wijesekera, Senior Experimental Assistants, Messrs M. C. Perera, R. B. Gunaratne and Experimental Assistant, Mr S. Wilbert were on duty throughout the year. Technical Officers, Mr D. K. Angammana and Miss N. D. K. Wickremasinghe resigned their posts during the year. Mr L. B. Perera, Laboratory Attendant, retired after long years of service in the Department. Mrs V. Jayasundera was transferred to this Department as Clerk/Typist, in May.

Visits

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

Mr L. S. S. Pathiratne, Mr R. B. Gunaratne and Mr A. P. L. D. Michael inspected budwood multiplication and rootstock nurseries in estates managed by the Janatha Estate Development Board (JEDB) and Sri Lanka State Plantation Corporation (SLSPC) as well as private nurseries that supply plants to the Small-holder Rubber Rehabilitation Project.

Meetings

Chandra Samaranayake addressed the following meetings:

JEDB Planter's Seminar, Kegalle Region - on "The use of polybag plants and green budding technique."

SLSPC Planter's Seminar, Balangoda Region - on "Tapping and physiology of the tree".

Institute of Biology Sri Lanka - on "Exploitation of *Hevea*."

Training courses were conducted by Chandra Samaranayake, Mr A. G. A. de Soyza and Mr L. S. S. Pathiratne to Rubber Extension Assistants and Rubber Extension Officers of the Advisory Services Department and Agricultural Instructors of the Agriculture Development Authority on "Propagation methods, nursery management and exploitation of *Hevea*".

Messrs R. B. Gunaratne, M. C. Perera and R. P. Karunasena conducted field demonstrations for these training courses.

Publications

Samaranayake Chandra (1981). Use of plants grown in polythene bags. *Rubb. Res. Inst Sri Lanka Bull.* **16**, 1 - 3.

Laboratory Investigations

Tissue culture

Determination of nutrient requirements

Experiments were carried out to determine the optimum concentrations of chemical elements in the growth media for growth. Growth was measured in terms of fresh and dry weight.

Nitrogen: The Mureshige & Skoog (Modified) medium MS(M) at full strength gave best fresh weight increase although ¾ MS(M) concentration yielded the best dry weight increase.

Magnesium, Calcium: Full MS(M) concentration gave best fresh and dry weight increase.

Zinc: Half MS(M) concentration gave best fresh and dry weight increase. Experiments on other constituents are in progress whilst the above are to be repeated and modified to confirm results. (A. G. A. de Soyza and G. A. S. Wijesekera)

Anatomical studies (CC/77/1)

Studies on the anatomy of the bark of the 10 clones indicate that the latex vessel size and the number of latex vessel rings are significantly different in different clones. (Chandra Samaranayake and K. A. G. B. Ameratunge)

Field Experiments

Tapping

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

This experiment was laid down to investigate the tappability of PB 86 at relative intensities higher than 100%, using half spiral cuts, and the effect of recovery tapping. Yield data for 1982 are summarized in Table 1.

Table 1. *Yield (kg/ha/yr) for 1982 (T/75/3)*

Tapping system	Yield (kg/ha/yr)	Brown bast (%)
S/2 d/2, 100%	1355.5	10
S/2 d/1, 200%	2016.0	26.6
S/2 2d/3, 133%	1871.2	16.6
S/2 d/2, 100% + Recovery tapping*	2324.7	6.6
S/2 d/2, 100% + Recovery tapping**	1620.3	13.3
LSD (5%)	414.1	
LSD (1%)	570.5	

* Recovery of lost tapping days by daily tapping

** Recovery tappings spaced out so that there are not more than six additional tappings per month

Highest yields were obtained from the treatment S/2 d/2, 100% + Recovery tapping, which were significantly greater than all other treatments except S/2 d/1, 200% which, however, showed the highest incidence of brown bast. (A. G. A. de Soyza and S. Wilbert)

Eight clones, 1970 replantation, Nivitigalakele (T/77/2)

In this experiment, puncture and short cut tapping with stimulation is compared with conventional tapping systems on 8 clones. Yield data for 1982 are summarized in Table 2.

Table 2. *Yield (kg/ha/yr) and girth increment (cm) (T/77/2)*

Tapping system	Clone							
	RRIC 101	RRIC 100	RRIC 13	RRIC 45	PR 252	AV 1734	IRCI 2	WR 101
S/2, d/3 67%	688 (1.7)	1114 (2.0)	704 (2.6)	750 (2.2)	529 (0.9)	433 (2.6)	677 (1.3)	478 (2.2)
S/2, d/2 100%	1122 (1.5)	1769 (1.8)	968 (2.6)	920 (2.1)	703 (1.2)	728 (1.7)	1051 1.9	640 (1.4)
S/4, d/2 50% E*	710 (1.2)	1372 (1.9)	822 (3.3)	704 (1.7)	627 (1.5)	602 (1.8)	880 (1.6)	564 (1.5)
PT 1m d/3 + E*	367 (2 9)	454 (3.5)	318 (4.8)	260 (3.5)	412 (2.3)	331 (2.0)	527 (3.5)	338 (3.0)
PT 1.5m d/3 + E*	529 (3.6)	608 (3.7)	467 (5.0)	359 (3.3)	622 (2.4)	443 (2.8)	683 (3.8)	460 (1.8)

Yield LSD (5%)=67 LSD (1%) = 90 LSD (0.1%) = 119

E*=5% Ethrel applied every 4-5 weeks on puncture bands (1g/metre) and every 2 months on S/4 cuts (1g/cut) girth increments are in parentheses.

Significant differences occur between clones, between tapping systems and between clones and tapping systems. Highest yields were obtained from the clone RRIC 100 which was significantly better than all other clones especially when tapped on the S/2 d/2, 100% system. This clone also responded well to short cut tapping with stimulation (Ethrel). Clone IRCI 2 showed the best response to puncture tapping. (A.G.A. de Soyza and S. Wilbert)

RRIC 101, 1969 replantation, Eladuwa (T/78/1)

This experiment is being carried out to ascertain the best tapping systems for the clone RRIC 101 which is high yielding and low plugging; hence sensitive to brown bast (see Ann Rev. 1979 for experimental details). Yield data for 1982 are summarized in Table 3.

Table 3. *Yield (kg/ha/yr) for various tapping systems (T/78/1)*

Tapping system	Yield		Total
	L	*H*	
S/2 d/3, 67%	1725		1725
S/2 d/2, 100%	2734		2734
S/2 d/2 (2 x Y/2), 100% — 53 cm L ↑	2672		2672
— do — 105 cm L ↑	2493		2493
S/2 d/2 (2 x 2d/4), 100% — 53 cm H ↑	2054	2753	2404
— do — — 53 cm H ↓	1980	2709	2344
— do — — 106 cm H ↑	2110	2954	2532
— do — — 106 cm H ↓	2081	2846	2464
PT 1m d/3 — E			2651
	LSD (5%)		379
	LSD (1%)		510
	LSD (0.1)		674

L Lower cut 53, 106 cm distance between L and H cuts
H Higher cut ↑ upward tapped ↓ downward tapped

S/2 d/2 tapping continued to give the best yields whilst double cut systems do not appear to have any particular advantage. Puncture tapping gave yields comparable to the S/2 d/2, 100% system. (A. G. A. de Soyza and M. C. Perera)

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

Conventional tapping at high relative intensities with and without change of panels at each tapping is being tested on clone RRIC 100. Intensification was carried out from 1982. 04. 01. Yield data for the period from intensification are summarized in Table 4.

Table 4. *Yield (kg/ha/yr) for different tapping systems (T/78/2)*

Tapping system	Yield		Total
	L	*H*	
S/2 d/2, 100%	3359		3359
S/2 d/1, 200%	5973		5973
S/2 d/2 (2 x 2d/2), 200% 53 cm H ↓	6595	3887	5241
— do — — 106 cm H ↓	6882	4262	5572
	LSD (5%)	1617	

H - Higher cut L — Lower cut
↓ - Tapped downward
53, 106 cm distance between the two panels mean yields per cut

Highest yields were obtained from the S/2 d/1, 200% treatment although this did not differ significantly from yields of the two cut systems. Yields from lower cuts were significantly greater than yields from higher cuts in both double cut systems. (A. G. A. de Soyza and M. C. Perera)

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

Conventional tapping systems, puncture tapping, short cut tapping with stimulation and change over systems are being tested on clone RRIC 103. The effect of high relative intensities of continuous excision tapping is being tested on this clone. Intensified tapping was done from 1982.04.01. Yield data for the period from intensification are summarized in Table 5.

Table 5. *Yield (kg/ha/yr) for various tapping systems (T/78/3)*

Tapping system	Yield		Total
	L	*H*	
S/2 d/2, 100 %	2539		2539
S/2 d/1, 200 %	3845		3845
S/2 d/1, 200 %	4403		4403
S/2 2d/2, 200 % — 53 cm H ↓	4328	3133	3731
S/2 2d/2, 200 % — 106 cm H ↓	4907	3283	4095
PT 2m d/3 — E			2691
S/4 d/1, 100%	2137		2137
	LSD (5%)	912	
	LSD (1%)	1228	
	LSD (0·1%)	1628	

H — Higher cut L — Lower cut
↓ — Tapped downward
E — 5% Ethrel applied every 4 - 6 weeks
E — 5% Ethrel applied on a band of scraped bark below cut

Highest yields were obtained from the S/2 d/1, 200% treatment which, as did all higher intensity treatments, gave significantly higher yields than lower intensity tapping treatments S/2 d/2, 19 100%, PT 2m d/3 — E and S/4 d/1, 100%. Lower cuts of double cut systems significantly out yielded the higher cuts. (A. G. A. de Soyza and M. C. Perera)

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

This experiment was done to investigate the use of puncture tapping on a large scale and compare it with the conventional tapping method. Twelve tapping tasks were each divided into two approximately equal halves and puncture tapping carried out in one half whilst conventional tapping was carried out in the other half of the task.

There was no significant difference in girth increase between the two tapping treatments although puncture tapped trees have generally shown a greater girth increment. (A. G. A. de Soyza, Chandra Samaranayake, M. C. Perera and S. Wilbert)

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

This experiment was laid down to investigate the effect of three levels of Ethrel and three numbers of punctures per band of 1 metre length. S/2 d/4 and S/2 d/2 tapping systems served as controls. Yield data for 1982 are summarized in Table 6.

Table 6. *Yield (g/t/t) for 1982 (T/78/4)*

Treatment	Yield (g/t/t)
Puncture tapping	
0.5 g/tree Ethrel (E_1)	20.8
1.0 g/tree Ethrel (E_2)	22.2
2.0 g/tree Ethrel (E_3)	25.1
5 punctures/m band/tree (P_1)	22.9
10 punctures/m band/tree (P_2)	22.5
15 punctures/m band/tree (P_3)	22.3
LSD (5%)	2.2
LSD (1%)	2.9
LSD (0.1%)	3.8
Conventional tapping	
S/2 d/2, 100%	27.3
S/2 d/4, 50%	26.9

g/t/t — grammes/tree / tapping

Application of higher quantities of Ethrel increased yields significantly. 2 g/tree Ethrel continued to give the best yields. A greater number of punctures per tapping of a one metre band did not result in higher yields. (A. G. A. de Soyza and A. H. R. Jayaratne)

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

The purpose of this experiment is to ascertain the most effective tapping systems for different clones. Fifteen clones were included in the experiment. There is provision for introducing five tapping treatments and tapping will commence in early 1983.

Girth data recorded at 5½ years from planting showed that many of the RRIC clones had girth measurements better than clones PB 86 and RRIM 600. (Chandra Samaranayake and L. S. S. Pathiratne)

Yield stimulation

Yield stimulants on renewed bark, Gallewatte (Eth/81/3)

Two concentrations of Ethrel viz. 2.5% and 5%, two frequencies and two methods of application were tested in this experiment started in November 1981. Yield data recorded for the year indicated no significant differences in yield response either to different concentrations of Ethrel or to different methods of application. Overall increse in yield was 15%. (A. H. R. Jayaratne and S. Wilbert)

Rainguards

Evaluation of rainguards, Urumiwella (RG/82/1)

This experiment was laid out to evaluate a rainguard developed by the Ceylon Institute of Scientific and Industrial Research. The rainguard developed by the Rubber Research Institute of Sri Lanka is also included as a treatment. Rainguards were fixed in March 1982 and records kept from April. Only 3 extra tapping days have been recorded from April to November. (Chandra Samaranayake and R. P. Karunasena)

Propagation

Stock-scion relationships

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

The trees in this experiment were tapped towards the end of 1981, yield data recorded for the year have indicated that there was a significant rootstock effect on yield of the scion. Girth of scions at 7½ years indicated that there were no rootstock effects on growth of the scion. (Chandra Samaranayake and R. B. Gunaratne)

Stock-scion experiment, Eladuwa (St. sc/78/5)

Clones PB 86, RRIC 13, 48, 52, 94 and RRIC 100 have been budded on to seedling rootstocks of PB 86, RRIC 52, 94 and RRIC 100. Girth data recorded 4½ years after planting do not show any significant rootstock effect on growth of the scion. (Chandra Samaranayake and K. A. G. B. Ameratunga)

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

Seedling rootstocks of the clones RRIC 100,101,103, PB 86 and GT 1 have been budded in all possible combinations with scions of the same clones. Growth in height of plants measured at 1 year from planting does not show any significant rootstock effect. (Chandra Samaranayake, R. B. Gunaratne and L. S. Kariyawasam)

Crown budding

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

The trees in this experiment were tapped in late 1981. Yield data recorded for the year indicated that certain crowns were capable of significantly influencing the yield of the trunk. Growth of the trunk was also affected by the crown in certain crown/trunk combinations. (Chandra Samaranayake and R. B. Gunaratne)

Improvements in planting techniques

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

Growth of plants raised in polybags upto the 5-6 whorl stage were compared with bare root budded stumps, after trasplanting in the field. There was a highly significant difference in growth between the two types at the end of 4 years. (Chandra Samaranayake, S. L. Kariyawasam)

Use of stumped buddings, Eladuwa (RI/78/2)

Growth of budded stumps and stumped buddings were compared in this experiment. A few plots in this experiment have been damaged by stray cattle. In the rest of the plots, stumped buddings continued to maintain a significant difference in growth over the budded stumps. (Chandra Samaranayake and K. A. G. B. Ameratunge)

Stumped buddings large scale, Neuchatel RI/81/3)

Green budded stumps which will serve as controls were planted in the field in May 1982. Buddings are being grown in a nursery, to be prepared and planted as stumped buddings in 1983 South West planting season. (Chandra Samaranayake, R. B. Gunaratne and K. A. G. B. Ameratunge)

Comparison of planting techniques, Pallegama (GB/79/2)

Several methods of establishing rubber in the field were compared in this experiment. Growth of plants 2 years after planting in the field indicated that budded stumps raised in polybags; seedlings raised, budded and grown in polybags and plants budded at stake in the field are superior to bare root planted, green and brown budded stumps. (Chandra Samaranayake and K. A. G. B. Ameratunge)

Comparison of planting techniques, Peenkande (GB/79/2)

This experiment is similar to that at Pallegama (GB/79/2). Growth of seedlings raised, budded and grown in polybags and then transplanted in the field and plants budded at stake in the field were very much superior to bare root planted, green and brown budded stumps. (Chandra Samaranayake and L. S. Kariyawasam)

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

Green budded stumps of clone RRIC 102, prepared with 5 – months old rootstocks, were planted in the field in June 1981. Green buddings grown in polybags since June 1981 were planted in the field in September 1981. These two treatments were planted in the field in a randomized block design with 17 replicates. Establishment success of 99% was achieved with polybag grown buddings as compared to 89% with bare root stumps. Budded stumps planted bare root have shown significantly better growth than polybag grown plants after transplanting in the field. (Chandra Samaranayake , R. B. Gunaratne and L. S. Kariyawasam)

Brown budding in polybags, Galewatte (PB/81/4)

Performence of brown buddings grown in polybags upto two whorl stage is compared with bare root brown budded stumps after transplanting in the field during North East 1981. In polybagged buddings, only 3.7% of the plants did not become established in the field. In bare root stumps 46% of the buds did not sprout whilst out of those that sprouted 27% died during a dry spell in February 1982. Growth of plants measured 1 year after planting show that polybag grown plants were significantly superior in girth to bare root plants. (Chandra Samaranayake and S. Wilbert)

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

Performance of bare root green and brown budded stumps and green and brown budded plants raised in polybags were compared after transplanting in the field. Bare root plants were transplanted in June 1981. Budded stumps planted in polybags in June 1981 were transplanted in the field in May 1982. Girths, recorded in November 1982 indicated that bare root plants have a significantly better growth than those transplanted 11 months later as polybagged plants. (Chandra Samaranayake and K. A. G. B. Ameratunge)

Use of growth inducing agents. Gallewatta (PT/81/4)

Two proprietary formulations containing indole butyric acid (IBA) and indole butyric acid + nephthalene acetic acid (NAA), marketed as root-inducing agents for *Hevea*, were used in different concentrations in two field experiments. IBA alone has promoted early sprouting of the bud patch. IBA + NAA at certain concentrations delayed sprouting and at lower concentrations had no effect. Treatment with either of these formulations had no significant effect on the growth of plants in height or in girth. (Chandra Samaranayake and S. Wilbert)

Clone characters

Field observations, Eladuwa (CC/77/1)

The purpose of this study was to investigate a number of clones in order to identify criteria, if any, that could be used in the early selection of clones. The trees in this experiment will be tapped in 1983 when individual tree yields will be recorded.

Correlations between the various criteria studied and tree yields will then be investigated. (Chandra Samaranayake, L. S. Kariyawasam and C. W. Ranasinghe)

Tree spacing and density

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

Clones RRIC 101, 103 and PB 86 were established at six spacings and densities on a 3 x 6 factorial experiment with three replicates. Each plot accommodated 64 - 156 plants depending on the density. Two outer rows in each plot were considered as guard rows. Girth of effective trees at the age of 5 2/1 years indicated that there was a significant decrease in girth with increasing density. (Chandra Samaranayake and L. S. S. Pathiratne)

REVIEW OF THE INTERCROPPING DEPARTMENT

By

L. B. CHANDRASEKERA

SUMMARY

Passion fruit, banana and pineapple continue to be promising intercrops during the immature phase of rubber in Sri Lanka. Of the three, passion fruit has given the highest profits. From the very limited data that is available from smallholdings, the maximum income from banana appears to come in the second and third years from planting. There is a decline in productivity in the fourth year due to competetion from the rubber. Coffee has proved to be unsuitable for intercropping during the early years. Another promising intercrop has been pepper when trained on to live supports.

DETAILED REVIEW

Staff

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

Visits

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

Meetings

The Head of the Department attended the following meetings: Kegalle Planters' Association - a talk on intercropping among rubber.

RRISL Scientific Committee meeting, colombo.

Publications

Chandrasekera, L. B. (1982). Potential for intercropping rubber lands in Sri Lanka, *Rubber Puwath.* (in press)

Reports

Chandrasekera, L. B. (1981). Review of the Intercropping Department.

Intercropping with banana, passion fruit and coffee (IC/80/1, IC/80/2 and IC/80/3)

Three field trials were set down in 1980 in order to study the three crops for their suitability as intercrops among rubber. They are located in three climatically different rubber growing districts, namely Kalutara, Ratnapura and Kegalle.

The design of each trial is a randomised layout with the four treatments banana, passion fruit, coffee and a control replicated six times. A single row of banana, passion fruit and coffee were planted centrally between each pair of number rows at spacings of 3.6 m, 6.0 m and 2.4 m along the row. The rubber is spaced 2.4 m x 9 m.

The banana clumps were thinned out periodically to leave only three to four suckers of varying ages so as to maintain continuity of production. The passion fruit creepers were trained along horizontal wires stretched across wooden posts at approximately 2 m above ground level. Temporary shade was provided for the young coffee seedlings by planting three sticks of *Gliricidia maculata* approximately 1 m in length round each coffee seedling. The fertilizer schedules adopted for the intercrops are given on pages 36 - 38 in the Annual Review for 1980.

Passion fruit and banana began to bear at the end of 1 year in 1981. The yields recorded in the first year are given on pages 27 and 28 of the Annual Review for 1981. The yields recorded and the estimated value of the crops in the second year are given in Tables 1 and 2.

Table 1. *Yield of passion fruit (IC/80/1, IC/80/2, IC 80/3)*
Total

Districts	Estate	Field exp. number	Number of plants	Yield (kg)	Estimated value (*Rs*)	Mean yield (kg/plant)
Kegalle	Pallegama	IC/80/3	136	336	1344.00	2.5
Ratnapura	Kiribatgalla	IC/80/2	109	1316	5149.00	12.0
Kalutara	Eladuwa	IC/80/1	89	1294	4710.00	14.5

Table 2. *Yield of banana (IC/80/1, IC/80/2, IC/80/3)*

Districts	Estate	Field exp. number	No. of trees	No. of bunches	Estimated value (*Rs*)	Mean value per bunch (*Rs*)
Kegalle	Pallegama	IC/80/3	240	46	274.00	5.95
Ratnapura	Kiribatgalla	IC/80/2	180	251	6019.50	23.98
Kalutara	Eladuwa	IC/80/1	180	110	1975.35	17.95

The procedure adopted in estimating crop yields in the experimental plots is outlined on page 28 of the Annual Review for 1981. As in the first year, the lowest yields of passion fruit and banana during the second year were recorded for the Kegalle District. Of the two crops, banana and passion fruit, the latter has continued to be the most profitable in spite of the depressed prices that prevailed during the year.

The establishment of coffee in all three trials was very poor. Hence no yields were recorded for any of the trials in the second year as well. (L. B. Chandrasekera, N. L. D. Ruban and W. T. Silva)

Experiment on banana/coffee combined (IC/80/5)

In this experiment, banana was planted in order to provide temporary shade during the early establishment of coffee. The treatments are as follows:

1. Control
2. Banana spaced 3.0 m along the row
3. Banana spaced 3.6 m along the row
4. Banana spaced 3.6 m along the row with a single plant of coffee planted between each pair of banana plants.

A single row of banana was planted centrally between each pair of rubber rows, the rubber being spaced at 3.6 x 6.0 m. The treatments were replicated five times.

In this trial too, no yields were recorded for coffee in the second year in 1981 as the establishment of coffee was very poor. The yields recorded for banana during the second year of growth in 1981 are given in Table 3.

Table 3. *Yield of banana (IC/80/5)*

Number of trees	Number of bunches	Estimated value (*Rs*)	Mean value per bunch (*Rs*)
720	251	3351.50	13.35

It appears from this trial as well as others that coffee would be unsuitable as an intercrop during the immature phase of rubber. (L. B. Chandrasekera and W. T. Silva)

Experiments with passion fruit (IC/82/1)

In order to evaluate the optimum densities of passion fruit vines that could be planted without affecting the growth and yield of rubber a density trial was set down in 1981. The treatments are as follows:

1. Control - no passion fruit
2. One row of passion fruit spaced 4.5 m along the row
3. One row of passion fruit spaced 6.0 m along the row

4. Two rows of passion fruit spaced 4.5 m along the row and 2.4 m between rows

5. Two rows of passion fruit spaced 6.0 m along the row and 2.4 m between rows.

The five treatments are replicated four times. The rubber is spaced at 5.7 m x 6.0 m. This experiment provides for a maximum density of approximately 720 passion fruit vines per hectare. (L. B. Chandrasekera and W. T. Silva)

Experiments with papaw (IC/80/4, IC/81/4)

These two experiments were set down in order to evaluate methods that would be suitable for large scale growing of papaw as an intercrop. The design of the experiments and the treatments applied are given on pages 29 and 30 of the Annual Review for 1981. In experiment No. IC/80/4 sited at Udapolla Group, Deraniyagala, papaw trees did not come into bearing in the first year. In the second year, 35% of the trees were in bearing. In the third year in 1982 approximately 60% of the trees were in bearing. This cannot therefore be considered a satisfactory performance for papaw as an intercrop during the immature phase of rubber. The second experiment (Field exp. No. IC/81/4) sited in a smallholding in the Kalutara District was a failure due to the long spells of dry weather that prevailed during the years 1981 and 1982. (L. B. Chandrasekera, U. K. D. Lewis and W. T. Silva)

Experiment with pepper (IC/81/2)

There is one experiment involving the interplanting of pepper between immature rubber. *Hevea* clone PB 86 was planted in june 1981 at spacings of 2.4 m x 9 m. Pepper was planted in the inter-row area and trained on to live *Gliricidia* posts approximately 2.5 m in height.

The various treatments are as follows:

1. No pepper (control)
2. One row of pepper planted centrally between each pair of rubber rows spaced 2.4 m along the row
3. Two rows of pepper planted between each pair of rubber rows spaced 2.4 m along the row and 2.4 m between rows

The experimental design is a randomised layout with three treatments replicated eight times. Unfortunately, there was a prolonged drought in 1981 that continued into 1982 immediately following the planting of this trial. As a result 75 percent of the pepper had

to be re-supplied in 1982. The plants that survived came into bearing 1 year after planting in 1982. and 56 vines yielded an average of 72.7 grammes dry pepper per vine. (L. B. Chandrasekera and N. L. D. Ruban)

Experiments with pineapple (IC/81/3)

After preliminary small scale observation plots, a large scale trial was set down at Sorana Estate, Horana, in the wet zone in 1981. *Hevea* clone PB 86 was planted in June 1981 at spacings of 3.7 m x 6.0 m. The various treatments, the experimental design and maintenance of this experiment are described on pages 31 and 32 of the Annual Review for 1981. The experiment is located on comparatively flat land and the pineapple plots are kept clean weeded all the time.

During dry weather that prevailed in the months of February and March 1982, patches of pineapple plants were subject to dry rot caused by the fungus *Ceratocystis paradoxa*. However, with the onset of wet weather in May and June in 1982 the infections ceased to spread and even some of the affected plants showed symptoms of recovery. Fruit set in pineapple commenced in September 1982 approximately 15 months after planting. (L. B. Chandrasekera and N. L. D. Ruban)

Experiments with cacao (IC/81/1)

The experimental layout and the various treatments of this first large scale trial in the wet zone are described on page 32 of the Annual Review for 1981. Cacao seedlings were planted under the shade provided by the bananas in September 1982. (L. B. Chandrasekera and N. L. D. Ruban)

Experiments with winged bean

Multiplication nurseries were set down for providing planting material for comprehensive trials in 1983. (L. B. Chandrasekera and W. T. Sllva)

In all the intercropping experiments described above, the growth of *Hevea* budgrafts is still insufficient to evaluate any possible growth interactions with the intercrop.

Smallholder trials

More emphasis was placed in 1982 on setting down smallholder demonstration plots of the recommended intercrops in order to popularise intercropping among the rubber smallholders. These are small scale plots located in various parts of the country. In all instances the rubber is planted at inter-row spacings of not less than 6 metres. A single row of either banana or passion fruit is planted between each pair of rubber rows spaced 9 cm and 6 cm along the row, respectively. A list of smallholder demonstration plots that are maintained at present are given in Table 4.

Table 4. *Smallholder demonstration plots intercropped with banana and passion fruit*

District	Village	Year Planted	Crop	Extent (ha)
Galle	Pitigala	1979	Banana	0.5
Kalutara	Welipenna	1979	Banana	0.5
Kalutara	Bulathsinhala	1979	Passion fruit	0.4
kegalla	Nelundeniya	1979	Banana	0.5
Kalutara	Gamagoda	1980	Banana	0.8
Kalutara	Palatota	1981	Banana	0.8
Kalutara	Palatota	1981	Passion fruit	1.0
Kalutara	Bellana	1982	Banana	0.25
Kalutara	Bellana	1982	Passion fruit	0.5
Kalutara	Pantiya	1982	Passion fruit	0.25
Galle	Batapola	1982	Passion fruit	0.5
Kalutara	Wadduwa	1982	Pineapple	0.25
Kalutara	Wadduwa	1982	Passion fruit	0.5
Ratnapura	Ketandola	1982	Banana	0.5
Kalutara	Welipenna	1982	Vegetables	0.25

The income derived by smallholders from some of their intercropped plots is summarised in Table 5.

Table 5. *Income derived from intercropped smallholdings*

District	Crop	Year planted	Extent (ha)	Expenditure in 1982 (*Rs*)	Income in 1982 (*Rs*)
Kalutara	Passion fruit	1979	0.4	1085.00	5309.00
Kalutara	Passion fruit	1982	1.0	2277.00	3649.00
Kalutara	Banana	1979	0.5	552.00	962.00*
Kalutara	Banana	1980	0.8	1329.00	1882.00
Kalutara	Vegetables**	1982	0.25	215.00	640.00

* up to May 1982

* Brinjal, Chillie, Ladies finger and Bitter gourd

In spite of the depressed prices in 1982, intercropping with passion-fruit has given the highest retruns to the smallholders.

REVIEW OF THE GENETICS AND PLANT BREEDING DEPARTMENT

By

D. M. FERNANDO

SUMMARY

RRIC 100, 103, 121 moved appreciably into planting. All Institute budwood of these clones were released to growers: commercial nurseryman also increased supply of these clones. Reports from International clone trials in Thailand, Malaysia, India, and Ivory Coast indicated optimum vigour for RRIC 100, 102, 103 and 110. At a meeting of plant breeders within the International Rubber Research and Development Board (IRRDB) in Colombo, a recommendation of these clones for large scale planting was endorsed. RRIC 121 was released on request to Thailand and the Ivory Coast. The first Genotype/Environment trials came into tapping, clarifying superior immature vigour in RRIC 100 series and early yields comparable to PB 86.

DETAILED REVIEW

Staff

Mr D. M. Fernando, Assistant Director and Head of the Department was attached to the National Research Institute of Mexico for 3 months, from 1 January to 31 March as consultant on rubber research and cultivation. Dr N. E. M. Jayasekera, Geneticist and Plant Breeder was on duty throughout the year. Mr Sarath Kumara was appointed Technical Officer from 1 November 1982. Mr B. M. S. G. Peiris, Senior Experimental Assistant, Messrs K. B. Karunasekera and K. W. Rupatunge, Technical Officers and Messrs D. S. Gamage and A. K. M. S. Senaratne, Experimental Assistants were on duty throughout the year.

Visits

Research staff made regular visits to all the experimental areas to collect data and for observations.

Mr D. S. Gamage attended to some of the clone identifications requested by estates in addition to his normal duties.

Meetings

The Head of the Department addressed a Planters' Meeting at Kegalle on the newer clones. In November as part of the programme of Visiting International Clone Trials,

IRRDB plant breeders from Malaysia, Thailand, India and Ivory Coast visited Dartonfield and Kuruwita and inspected the RRIC 100 series clone trials and International Trials. An exchange of clones was planned for 1984. The very satisfactory yields and formation of renewed bark of RRIC 100, 102, 103, 121 was noted.

Publications

Fernando, D. M., Wickremasinghe, W. N. and Peiris, B. M. S. G. (1982). The performance of some RRIC 100 series Rubber clones in differing Agroclimatic Zones in Sri Lanka. *Jl. Nat. Inst. of Pl. Management* **2**, (1), 21 - 30.

Jayasekera, N. E. M. and Fernando, D. M. (1981). New RRIC 100 clones recommended for planting. *Bull Rubb. Res. Inst. Sri Lanka* **16**, 23 - 25.

Liyanage, A de S. and Fernando, D. M. (1982). Recent development in studies on South American leaf blight resistance in Sri Lanka. Paper presented at the fourth Technical committee on SALB, Chiengmai, Thailand.

Abstracts

Wijetilaka, L. C., Fernando, D. M. , Liyanage, A. de S. and Yapa, P. A. J. (1982). The Relationship between *Colletotrichum* Leaf Disease and South American Leaf Blight of Rubber (*Hevea brasiliensis*). *Proceedings of the thirty-eighth Annual Sessions of the SLAAS*. December 1982, Part I, 25.

Reports

Jayasekera, N. E. M. (1981). Annual Review of the Genetics and Plant Breeding Department.

Fernando, D. M. (1982). Report on Consultancy in Mexico on Rubber Research, January to March 1982 INIA, Mexico City.

Clone registration

RRIC 117, RRIC 121, RRIC 130 were registered with the International Registrar for *Hevea* Cultivars. Type seeds of the clones were despatched to the same Authority located at the Rubber Research Institute of Malaysia (RRIM). Budwood of RRIC 7 and RRIC 121 was despatched to the Rubber Research Centre (RRC) at Thailand. RRIC 121 and RRIC 130 were released to the Institut Researches Caoutchouc Afrique, Ivory Coast.

Planting material

The budwood nurseries at Kuruwita released 533 yards of budwood of the newer clones during the year. The largest issues were of RRIC 121 followed by RRIC 103 and RRIC 100. 2903 budded stumps of RRIC 100, 103 and 121 were supplied to the Smallholder Rubber Rehabilitation Project (SRRP) for a multiplication nursery at Kuruwita: 474 Polybagged plants of RRIC 103 and RRIC 121 were supplied for the same purpose. (D. M. Fernando and B. M. S. G. Peiris)

General

In International Clone Trials based in Malaysia and Thailand RRIC 100, RRIC 102 and RRIC 110 showed outstanding immature vigour. Growth of RRIC 103 in Malaysia was set back owing to *Corynospora* infection: this has not so far been reported from trials elsewhere. RRIC 103 showed a potential yield above 3000 kg/ha in Bibile and Sabaragamuwa. An yield of over 1000 kg/ha was reported from an estate for the first year of tapping from RRIC 102. Genotype/Environment experiments established superior vigour for the new RRIC clones now recommended for large scale planting.

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

Diameter measurements were recorded from four small scale trials established in 1980 to evaluate 52 clones selected from 1974 HP seedling population (see 1980 Annual Report).

At Moralioya Estate, where all 52 clones are included, 19 test clones exceeded the diameter of the best control clone RRIC, 103. The clone number, the parentage and the mean diameter of these 19 clones are given in Table 1 along with the mean girth of the control clones.

Table 1. *Mean girth of 19 test clones and control clones (HPS/74-75/1)*

Clone no.	Parentage	Mean girth (cm)
74 – 9	RRIC 103 x 8501	6.2
74 – 25	RRIC 103 x 8501	6.5
74 – 34	RRIC 103 x 8501	6.0
74 – 45	RRIC 103 x 8501	6.0
74 – 58	RRIC 103 x RRIC 101	6.2
74 – 93	RRIC 103 x 2427	6.8
74 – 103	RRIC 103 x 2427	6.2
74 – 116	RRIC 103 x 2427	6.0
74 – 120	RRIC 103 x 2427	6.2
74 – 130	RRIC 103 x 2418	6.0
74 – 141	RRIC 103 x 2417	6.6
74 – 144	RRIC 103 x 2417	6.1
74 – 147	RRIC 103 x 5-90	6.3
74 – 151	RRIC 103 x 5-90	6.2
74 – 157	RRIC 103 x 6-704	6.6
74 – 159	RRIC 103 x 6-704	6.2
74 – 160	RRIC 103 x 6-704	6.2
74 – 166	RRIC 100 x 8501	6.1
74 – 173	RRIC 100 x 101	6.4
RRIC 100	Control clone	5.6
RRIC 103	Best control	5.8
RRIC 121	Control clone	5.2
RRIM 600	Control clone	5.2

Sixteen selections were tested in the small scale clone trial planted at Perth State Plantation and only three of them had mean diameters above RRIC 103 which was again the best control as seen in Table 2. Table 2 gives the selections which had higher mean diameters than RRIC 103.

Table 2. *The clone number, parentage and mean diameter of three selections which exceeded the mean diameter of RRIC 103 (HPS/74-75/1)*

Clone No.	Parentage	Mean diameter (cm)
74 – 120	RRIC 103 x 2427	5.5
74 – 141	RRIC 103 x 2417	5.6
74 – 147	RRIC 103 x 5-90	5.6
RRIC 100	Control clone	4.8
RRIC 103	Best control clone	5.3
RRIC 121	Control clone	5.2
RRIM 600	Control clone	4.5

At Yatadola State Plantation where 18 selections were tested seven had larger diameters than the best control clone as shown in Table 3.

Table 3. *Clone number, parentage and mean diameters of the seven selections which had better mean diameters than the best control clone (HPS/74-75/1)*

Clone No.	Parentage	Mean diameter (cm)
74 – 166	RRIC 100 x 8501	6.4
74 – 173	RRIC 100 x 101	6.4
74 – 174	RRIC 100 x 101	6.2
74 – 175	RRIC 100 x 101	6.4
74 – 181	RRIC 100 x 101	6.4
74 – 200	RRIC 100 x 101	6.1
74 – 202	RRIC 100 x 101	6.2
RRIC 100	Control clone	5.6
RRIC 103	Best control clone	6.0
RRIC 121	Control clone	5.8
RRIM600	Control clone	5.1

Eighteen clones were tested at Arapolakande State Plantation. In this experiment RRIC 121 had the best diameter among the four control clones, and six selections exceeded the mean diameter of RRIC 121 (Table 4).

Table 4. *Clone number, parentage and mean diameter of six promising selections (HPS/74-75/1)*

Clone No.	Parentage	Mean diameter (cm)
74 – 1	RRIC 103 x 8501	4.8
74 – 4	RRIC 103 x 8501	4.9
74 – 9	RRIC 103 x 8501	4.5
74 – 34	RRIC 103 x 8501	4.9
74 – 42	RRIC 103 x 8501	4.5
74 – 43	RRIC 103 x 8501	4.9
RRIC 100	Control clone	4.2
RRIC 103	Control clone	3.6
RRIC 121	Best control clone	4.4
RRIM 600	Control clone	3.6

Seventeen selections from 1974 hand pollination (HP) seedlings were not included, in these trials established in 1980. They were included in a small scale trial planted at Kuruwita Sub-station during 1982 South-West (SW) planting season.

Twenty six (26) out of 41 selections made from 1975 HP seedlings were planted in two small - scale trials at Sorana and Padukka State Plantations. Excess plants after establishing these trials were utilized in another small scale trial at Clyde State Plantation. The balance 15 selections were not included in these trials due to lack of suffiicient amount of budwood. These 15 selections will be tested in a separate trial. (N. E. M. Jayasekera, K. B. A. Karunasekera and K. W. Rupatunge)

Selections from 1976 HP seedlings (HPS/76/2)

A multiplication nursery was established in 1982, to multiply the 52 selections derived from 1976 HP seedling population. (N. E. M. Jayasekera and K. W. Rupatunge)

1979 HP seedlings (HPS/79/2)

This seedling population belonging to nine families was scored for the diameter. The mean diameter and growth rate during 1981 SW to 1982 SW are given in Table 5. (N. E. M. Jayasekera, K. B. A. Karunasekera and K. W. Rupatunge)

Table 5. *Mean diameter and growth rates of 1979 HP families (HPS/79/2)*

Family	Mean diameter (cm)		Growth rate (cm)
	1981	1982	
RRIC 101 x RRIM 600	2.2	5.2	3.0
RRIC 101 x RRIM 623	1.9	4.6	2.7
RRIC 100 x RRIM 600	2.4	5.5	3.1
RRIC 100 x RRIC 101	2.4	5.5	3.1
RRIC 102 x RRIM 600	1.9	4.6	2.7
RRIC 102 x RRIM 623	1.8	4.2	2.4
RRIC 103 x RRIM 600	2.1	4.7	2.6
RRIC 103 x RRIM 623	2.2	5.3	3.1
RRIC 103 x RRIC 101	2.3	5.6	3.3

1981 HP seedlings (HPS/81/1)

These seedlings were germinated in polybags and transplanted in the field at Eladuwa State Plantation. A fully randomized single tree plot design was used in the field. (N. E. M. Jayasekera, K. B. A. Karunasekera and K. W. Rupatunge)

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

A girth measurement was recorded in this experiment. The mean girth of each clone in each site, the means over sites all the sites and clones are given in Table 6. It was observed that RRIC 100 series clones generally have bigger girth than RRIM 600, PB 86 and GT 1. Another important feature was that within the RRIC 100 series clones, clones RRIC 104 and RRIC 107 had the best growth . (N. E. M. Jayasekera, K. B. A. Karunasekera and k. W. Rupatunge)

Table 6. *Mean girth (cm) of clones (CET/79/1)*

Clone	Estate				
	Eladuwa	Elston	Peenkande	Hathbawe	Clone meen
RRIC 100	25.0	27.4	24.6	22.9	24.9
RRIC 101	28.0	28.5	24.3	24.2	26.2
RRIC 102	26.8	29.6	24.6	25.2	26.5
RRIC 103	26.0	28.8	26.0	25.6	26.6
RRIC 104	29.1	30.1	27.5	25.4	28.0
RRIC 105	25.4	26.3	24.0	22.5	24.5
RRIC 107	28.9	29.3	28.4	26.3	28.2
RRIC 118	24.3	26.0	23.4	23.1	24.2
RRIM 600	23.1	25.1	22.2	22.0	23.1
PB 86	23.0	23.6	21.1	20.8	22.1
GT 1	25.1	27.3	21.3	21.3	23.8
Site mean	25.8	27.4	24.2	23.6	25.2 (*Grand mean*)

Hand pollination programme for 1982 (HPS/82/1)

The HP programme for 1982 was carried out at Miriswatte and Clyde State Plantations. The number of crosses made, number of pollinations done in each cross and the seedlings derived are given in Table 7. (N. E. M. Jayasekera and A. K. M. S. Senaratne)

Table 7. *The crosses, number of pollinations and seedlings derived in each cross (HPS/82/1)*

a) Kanana Division (Miriswatte State Plantation)

Cross	No. of pollinations	No. of seedlings
PB 86 x PB 28/59	1485	—
PB 86 x IAN 45/710	705	—
PB 86 x RRIC 102	912	3
PB 86 x RRIC 36	850	3
IAN 45/710 x PB 86	141	—
IAN 45/710 x PB 28/54	954	18
IAN 45/710 x RRIC 102	675	—
IAN 45/710 x RRIC 36	720	17
RRIC 102 x PB 86	82	—
RRIC 102 x IAN 45/710	22	—
RRIC 102 x PB 28/59	339	—
RRIC 102 x RRIC 36	366	—
RRIC 36 x PB 86	189	7
RRIC 36 x IAN 45/710	191	12
RRIC 36 x RRIC 102	664	8
RRIC 36 x PB 28/54	801	11
Total	9096	79

b) Clyde State Plantation

Cross	No. of pollinations	No. of seedlings
PB 28/59 x PB 86	427	18
PB 28/59 x IAN 45/710	438	30
PB 28/59 x RRIC 102	455	18
PB 28/59 x RRIC 130	570	19
Total	1890	85
Grand total	10986	164

Genotype - environment interaction studies (GE/75/1)

Though it was envisaged to record at least one test tapping per month from each site, the actual number of test tapping done in each site was less than expected. This was mainly due to rainy weather experienced during the 2nd, 3rd and 4th quarters of the year. In Kanana Golinda and Bibile, the number of test tapping was further reduced as these areas were brought into tapping later than the other areas. The number of test tappings done in each site is given in Table 8.

Table 8. *The number of test tapping done during 1982 (GE/75/1)*

Estate	District	No. of test tapping
Bentota State Plantation	Galle	9
Miriswatte State Plantation	Kalutara	6
Hunuwella State Plantation	Ratnapura	6
Bibile Estate	Bibile	4
Monrovia Estate	Galle	8
Golinda Estate	Kegalle	4
Densworth Estate	Kelani Valley (KV)	5

Means of the first two test tappings are given in Table 9. It has observed that RRIC 101 had the best initial yield when averaged over all experimental sites.

Table 9. *Mean yields (based on first two test tappings) of clones planted in (GE/75/I)*
(S/2, d/2, 67%)

Clone	Mean yield							
	Densworth	Miriswatte	Hunuwella	Golinda	Bentota	Monrovia	Bibile	Clone mean
RRIC 36	27.5	22.9	27.9	20.8	26.2	36.4	28.9	27.2
RRIC 52	11.6	16.2	11.6	6.3	6.1	12.0	9.3	10.4
RRIC 100	19.9	18.6	29.1	13.0	23.4	29.2	20.2	20.4
RRIC 101	42.7	42.4	40.0	36.8	52.3	63.1	43.5	45.8
RRIC 102	26.0	26.7	28.8	19.8	26.9	34.7	17.3	25.7
RRIC 103	20.6	23.5	19.2	12.2	20.0	25.5	22.9	20.5
RRIM 600	17.7	22.6	24.6	17.3	30.2	34.7	19.4	23.7
RRIM 623	14.2	14.3	18.6	8.6	4.5	31.9	17.8	15.7
PB 86	17.4	22.8	22.2	21.9	19.0	33.2	15.5	21.7
IAN 45/710	18.9	25.5	14.0	19.5	14.8	18.5	16.2	18.2

A girth measurement was recorded towards, the end of 1982. The mean girth of each clone in each site is given in Table 10.

Table 10. *Mean girth(cm) of clones in genotype-environmental experiment (GE/75/I)*

Clone	Estate							
	Densworth	Miriswatte	Hunuwella	Golinda	Bentota	Monrovia	Bibile	Clone Mean
RRIC 36	53.0	51.0	48.0	48.3	57.0	55.7	47.7	51.5
RRIC 52	66.0	68.9	64.0	53.4	71.5	66.6	57.9	64.0
RRIC 100	54.4	55.4	51.6	50.0	56.9	54.6	46.7	53.0
RRIC 101	60.3	58.2	55.4	52.6	58.5	58.6	52.1	56.5
RRIC 102	58.5	58.0	58.9	47.1	59.7	57.3	47.2	55.2
RRIC 103	56.8	62.9	61.3	53.2	64.0	62.4	53.6	59.1
RRIM 600	55.7	54.9	53.0	52.5	58.6	54.1	44.6	53.4
RRIM 623	58.1	57.6	56.2	51.3	60.7	58.6	45.7	55.4
PB 86	52.2	53.1	51.9	50.0	54.0	53.1	42.0	50.9
IAN 45/710	54.6	59.6	56.5	53.9	57.9	54.4	49.4	55.1
Site mean	56.9	57.9	55.7	51.2	59.8	57.5	48.8	

It is evident from Table 10 that RRIC 52 had the best absolute growth followed by RRIC 103. (N. E. M. Jayasekera, K. N. A. Karunasekera and K. W. Rupatunge)

Diallel progeny (GEN/78/1)

The trees in the above progeny were marked for test tapping at the height of 45.7 cm irrespective of their girth. The tapping was commenced in September and it is expected to evaluate the yield potential of these trees by two test tapping techniques viz. Morris-Mann technique and fiilter paper technique (micro tapping technique suggested by Waidyanatha and Fernando). A girth measurement was also recorded in this progeny. (N. E. M. Jayasekera, K. B. A. Karunasekera and K. W. Rupatunge)

Clone trials

In general the bark thickness, yields and rate of girthing of RRIC 100, 102, 103 were very satisfactory.

Clone evaluation in Matale (VC/65/10)

RRIC 103 continued to show satisfactory yields and growth. The yields of the other clones also indicated over 1000 kg/ha for RRIC 118 and IAN 710, (Table 11) which would re-establish *Hevea* as a feasible proposition especially in the prevention of erosion hazards in the Matale District. (D. M. Fernando and D. S. Gamage)

Table 11. *Mean girth and yield of clones (VC/65/10)*
(Tapped S/2, d/2, 100%)

Clone	Trees tapped	Mean girth (cm)		Mean yield (g/t/t)		
		1981	*1982*	*1980*	*1981*	*1982*
RRIC 103	10	71.1	73.4	33.5	36.1	33.9
RRIC 118	76	56.6	57.8	22.3	31.6	26.0
IAN 710	67	61.4	63.1	21.3	26.1	22.1
RRIC 116	53	67.2	69.1	20.2	21.5	18.3
1108	34	63.3	65.0	15.7	22.2	17.5

Clone evaluation in Kumarawatte State Plantation, Moneragla (V/65/9)

The condition of the renewed bark of RRIC 100 series was better than the control clone RRIM 623. There were no significant differences in girth or yield between RRIC 102 and RRIC 103 though both were significantly higher at 5% level than the control clones RRIC 45 and RRIM 623 with reference to yield (Table 12). (D. M. Fernando and D. S. Gamage)

Table 12. *Mean girth and yield of clones (V/65/9)*
(Tapped S/2, d/2, 100%)

Clone	Trees tapped	Mean girth (cm)		Mean yield (g/t/t)	
		1981	*1982*	*1981*	*1982*
RRIC 103	18	69.4	71.2	23.6	24.9
RRIC 102	16	63.2	64.6	24.5	23.1
RRIC 112	21	64.2	65.6	15.1	17.7
RRIM 623	29	64.3	65.9	15.4	13.8
RRIC 101	23	60.5	62.2	17.7	18.7
IAN 710	27	60.9	62.7	13.8	12.9
RRIC 104	19	67.4	69.4	18.3	17.3
RRIC 45	24	63.7	65.5	12.8	15.1

Clone evaluation at Bibile (V/67/20, V/73/37)

Twenty five trees in each replicate were test tapped and measured for girth. There were no significant differences in yield (Table 13). RRIC 103 showed significantly (5% level) better girth than RRIC 100. In this experiment polybag supplying ensured an adequate stand per ha which is essential for higher production in these drier areas.

In the 1973 clone trial on this estate with three or more replicates of each clone, more trees were brought into tapping resulting in reduced figures for girth which were not significant for clones (Table 14). There were no significant difference in yield between RRIC 103 and RRIC 104. RRIC 110 yields were second only to RRIC 112; the clone RRIC 112 has been found to be susceptible to branch breakage in other trials. Both RRIC 103 and RRIC 110 indicate over 1000 kg/ha in the second year of tapping.
(D. M. Fernando and B. M. S. G. Peiris)

Table 13. *Mean yield of clones (V/67/20)*
(Tapped S/2, d/2, 67%)

Clone	Trees tapped	Mean girth (cm)	Mean yield (g/t/t)	
		1982	*1981*	*1982*
RRIC 103	270	74.6	67.7	63.6
RRIC 100	428	67.4	58.5	42.8
RRIC 101	389	68.8	50.3	47.1
RRIC 112	375	70.1	45.7	53.7
IAN 710	386	77.4	44.0	54.8
RRIC 45	441	71.1	38.6	44.1

Table 14. *Mean yield and girth, Bibile* (F/73/37)
(Tapped S/2, d/2 100%)

Clone	Trees tapped	Mean girth (cm)	Mean yield (g/t/t)	
		1982	*1981*	*1982*
RRIC 103	175	57.2	37.1	26.1
RRIC 112	326	56.5	37.0	42.1
RRIC 110	122	55.0	29.8	38.0
RRIC 102	148	55.2	24.1	24.7
RRIC 117	42	52.5	22.6	26.2
RRIC 105	108	56.4	18.8	12.3
RRIC 104	148	59.4	16.3	21.6

Clone evaluation - Nivitigalakele (VC/67/14)

RRIC 111 showed the best girth but yields were not very satisfactory. RRIC 102 showed a potential of 1900 kg/ha with panel B coming close to the union. (D. M. Fernando and D. . S. Gamage)

Table 15. *Clone evaluation in RRI (Substation), Nivitigalakele (VC/67/14)*
(Tapped S/2, d/2, 100%)

Clone	Trees tapped	Mean girth (cm)		Mean yield (g/t/t)		Dry trees No.
		1981	*1982*	*1981*	*1982*	
RRIC 102	300	71.7	72.7	43.5	30.8	18
RRIC 101	308	70.0	71.6	43.0	39.8	32
RRIC 111	392	76.7	78.6	37.4	24.8	17
RRIM 623	143	71.7	73.2	30.0	22.2	12

Clone evaluation in RRI Sub-station, Kuruwita (VSM/67/5,/VSM/68/21/VSM/69/28)

A cyclonic storm ran through these 3 trials during the year uprooting over 400 trees. Two replications of RRIC 121 were lost from the 1968 clearing. Differences in girth were more significant than differences in yield in all 3 trials.

In the 1967 trial RRIC 121 was significantly better than all the other clones in that experiment in both yield and girth. A 400 tree plot of this clone is expected to come into tapping in Kegalle District in 1983: this would reveal constraints to yield more effectively than the small scale trial (Table 16).

Table 16. *Mean girth and yield of clones (VSM/67/5)*
(Tapped S/2, d/2, 100%)

Clone	Trees tapped	Mean girth (cm)	Mean yield (g/t/t)	
		1982	*1981*	*1982*
RRIC 121	18	94.1	76.1	96.7
RRIM 623	26	71.3	56.2	63.1
10570	11	52.3	52.3	47.6
10727	15	76.3	48.4	53.1
7281	15	76.8	48.1	54.7
8794	8	79.8	46.9	52.5
5682	13	79.0	46.6	44.9
8501	8	91.1	30.2	34.7
8798	15	103.7	19.0	23.1

In the 1968 trial RRIC 121, 130, 102 and 104 were significantly better in girth than the control clone RRIC 45. Significantly better yields were shown only by RRIC 121 and RRIC 130 over the control clone RRIC 45 (Table 17).

Table 17. *Mean girth and yield (VSM 68/21)*
(Tapped S/2, d/2 100%)

Clone	Trees tapped	Mean girth (cm)	Mean yield (g/t/t)	
		1982	*1981*	*1982*
RRIC 121	7	100.3	92.5	95.2
RRIC 131	11	85.2	80.2	75.2
RRIC 102	17	84.4	78.8	56.2
RRIC 110	17	77.1	76.3	64.9
RRIC 130	13	74.2	74.6	79.3
5 – 90	7	98.5	73.0	75.9
RRIC 104	12	95.5	72.8	46.3
RRIC 123	9	82.4	70.2	61.3
RRIC 112	16	78.6	67.1	47.6
RRIC 45	16	69.2	66.6	46.7
7263	11	78.9	57.0	43.1
RRIC 113	9	78.7	52.6	36.5
6 – 541	13	83.6	51.3	59.2
RRIC 120	16	70.5	44.1	38.0

In the 1969 trial no statistically significant differences were discerned in either yield or growth (Table 18). Many trees were lost during the cyclonic storm.

Table 18. *1969 clone trial – Kuruwita (VSM/69/28)*
(Tapped S/2 d/2 100%)

Clone	Trees tapped	Mean girth (cm)	Mean girth (g/t/t)	
		1981	*1981*	*1982*
RRIC 128	17	82.9	78.8	79.8
RRIC 126	14	69.5	60.6	65.1
7 – 1413	19	75.0	55.8	59.5
6 – 746	13	74.7	61.6	51.7
7 – 1189	14	80.8	51.2	50.4
7 – 1415	14	71.8	59.9	50.3
RRIC 127	8	67.2	58.5	49.2
RRIC 125	14	61.8	57.1	48.7
RRIC 124	16	69.5	71.4	45.9
RRIC 45	7	73.7	57.3	44.9
7 – 1176	20	76.4	50.8	44.1
RRIC 129	10	75.0	67.9	42.5
7 – 1077	7	80.0	58.7	37.8
7 – 1218	21	76.3	39.0	30.6

Clone evaluation - Sirikandura (VG/69/26)

The yields of RRIC 101 dropped to the same level as the control clone RRIC 45. RRIC 102 and RRIC 103 (Table 19) both showed an increase in yield significant at 5% level over the control clone. With reference to girth both RRIC 102 and RRIC 103 were better at 1% level.

Table 19. *Yield and girth – Sirikandura (VC/69/26)*
(Tapped S/2, d/2, 100%)

Clone	Mean girth (cm)	Mean yield (g/t/t)	
	1982	*1981*	*1982*
RRIC 101	59.8	22.5	21.7
RRIC 102	68.8	25.7	30.1
RRIC 103	69.2	26.3	28.8
RRIC 45	59.4	17.2	21.7

Clone evaluation Hedigalla VSM/69/30

In this trial with 31 replications of each clone the girth of RRIC 102 and RRIC 103 was better than control RRIC 45 at 0.1% level and RRIC 100 was better at 5% level. With reference to yield RRIC 103 was better at 0.1% level, and RRIC 102 at 1% level than the control RRIC 45; RRIC 103 was better than RRIC at 5% level (Table 20).

Table 20. *Yield and girth – Hedigalla (VSM/69/30)*

Clone	Mean girth (cm)	Mean yield (g/t/t)
	1982	*1982*
RRIC 100	66.9	30.2
RRIC 101	68.3	25.6
RRIC 102	67.8	34.3
RRIC 103	75.7	47.3
1173	57.3	14.5
1458	66.3	28.9

Clone evaluation at Eladuwa Estate (VSM/69/29)

In this experiment where each clone is replicated 31 times RRIC 103 showed a significantly better yield than the other clones including RRIC 100 (Table 21).

Table 21. *Mean yields – Eladuwa (VSM/69/29)*

Clone	Yield (g/t/t)
	1982
RRIC 100	27.4
1458	19.3
RRIC 112	20.0
82	33.5
RRIC 103	40.4
RRIC 101	24.9

International clone trial Neboda (ICT/78/1), Belmont (ICT/78/2, ICT/79/3)

The mean girths of clones in this experiment are given in Table 22. During the year the experimental area was divided into 3 blocks and sold. RRIC 103 and RRIM 703 showed the best growth (significantly better than the control, RRIM 600).

Table 22. *Mean girth, international clone trial – Neboda (ICT/78/1)*

Clone	Mean girth (*cm*) *1982*
RRIC 103	36.9
RRIM 703	37.7
RRIC 100	35.0
RRIC 101	35.7
RRIC 110	36.6
RRIM 600	30.8
RRIM 722	33.0
PR 306	33.5
RRIC 105	28.5

The mean girth for the 1978 clearing in Belmont Estate are given in Table 23. RRIC 103 showed the best growth.

Table 23. *Mean girths, international clone trial – Belmont (ICT/78/2)*

Clone	*Mean* girth (*cm*) *1982*	DMRT
RRIC 103	20.20	a
RRIC 100	18.73	ab
RRIC 110	18.60	ab
PR 306	18.38	ab
RRIM 703	18.15	ab
RRIM 600	18.10	ab
RRIC 105	17.53	ab
RRIM 725	15.50	b
RRIC 113	12.23	b

DMRT – Duncan's Multiple Range test

The mean girths for the 1979 clearing at Belmont are given in Table 24. RRIC 101, 100, BPM 22 and RRIC 107 were better at 5% level than the control clone RRIM 600.

Table 24. *Mean girth, international clone trial – Belmont (ICT/79/3)*

Clone	Mean girth (*cm*)
	1982
RRIC 101	13.60
RRIC 100	13.35
BPM 22	13.23
RRIC 107	12.90
BPM 3	11.38
BPM 24	11.36
RRIM 717	11.35
RRIM 712	11.05
RRIC 118	10.73
RRIM 600	10.63
RRIC 121	10.63
RRIC 117	10.50

Small scale clone trial – Menikwatte (VSM/79/53)

In this trial (Table 25) seven clones are in 25 randomized replicated single tree plots. RRIC 100 and Tjikadoe selections S4 and S5 were significantly better than the control clone RRIM 600.

Table 25. *Mean girth – Menikwatte (VSM/79/53)*

Clone	No.trees measured	Mean girth (cm)
		1982
RRIC 100	23	19.4
RRIM 600	23	17.1
S – 1	23	19.3
S – 3	23	17.6
S – 4	25	19.4
S – 5	23	20.1
BPM 24	24	18.5

Yields from estates

A few estates reported yields from RRIC 100 series (Table 26). An estate in the Sabaragamuwa District reported an intake of 7 kg per task from 12 ha of RRIC 100 (1975 planting) in the second year of tapping on S/2, d/3; 5 kg intake per task was also reported from a mixed area (97 ha) 1974, 1975 planting) of RRIC 100 101, 102, 103, 104, 105, 109, 110 also in the second year of tapping. There were four changes of management in the last 6 years on this estate. Increase of girth was substantial on a 67% tapping intensity on these clones.

Table 26. *Commercial yields reported from estates*

Clone	District	Extent (ha)	Yield (kg/ha) Year of tapping			
			1	*2*	*3*	*4*
PB 86	Kalutara	12	620	1224	1265	1362
PB 86	Experimental		915	942	1196	1381
RRIM 600	Experimental	8	705	1040	1380	
RRIC 100	Kegalle	2			1320	1847
RRIC 100	Experimental		764	996	1558	2066
RRIC 102	Galle	2	1529	2064	2002	
RR C 102	Experimental		799	1249	1596	
RRIC 100	Galle	75	600	1610		

Smaller commercial plots planted in 1970 and 1971 gave very satisfactory average yields (Table 27). RRIC 121 showed the best yield and girth. RRIC 103 indicates over 3000 kg/ha in the 6th year of tapping.

Table 27. *Yield (g/t/t)*
(S/2, d/2, 100%)

Clone	District	No. of trees	Year of tapping					
			1	*2*	*3*	*4*	*5*	*6*
RRIC 100	Sabaragamuwa	405	—	—	—	—	55.6	55.5
RRIC 103	Sabaragamuwa	413	—	—	—	—	63.3	66.1
RRIC 100	Sabaragamuwa	56	—	—	—	—	45	
RRIC 103	Sabaragamuwa	52	—	—	—	—	66.4	
RRIC 121	Sabaragamuwa	36	—	—	—	—	70.2	

Comparison of RRIM 600 and RRIC 103

An experimental area consisting of several 100 tree replications of RRIM 600, RRIC 103, RRIC 111 and other clones, which was abandoned earlier owing to division of the area and neglect, was taken into experimental tapping in 1981. Twenty five trees in each plot were sampled. An yield of 23 g/t/t was obtained from both RRIM 600 and RRIC 103 (approximately 1400 kg/ha) in the 6th year of tapping. A mean girth of 58.4 cm for RRIC 103 and 53.6 cm for RRIM 600 was significantly different at 5% level. (D. M. Fernando, I. A. U. N. Gunatilake and S. S. Senaratne)

REVIEW OF THE PLANT PATHOLOGY DEPARTMENT

By

A. de S. LIYANAGE

SUMMARY

Oidium leaf fall caused by *Oidium heveae* was heavy in most areas of Kalutara and Ratnapura Districts. The incidence of Phytophthora leaf fall and bark rot cuased by *Phytophthora meadii* was high in the Kegalle and Kelani Valley Districts. The damage caused by secondary leaf fall and shoot die - back (*Colletotrichum gloeosporioides*) especially in 1–2 year old plants was extensive during the wet months. Bird's eye spot disease caused by *Drechslera heveae* was a problem in seedling nurseries during the dry period.

Variation in growth characteristics, morphology and sporulation was observed in isolates of *C. gloeosporioides*. They also exhibited differential reactions to several clones. Leaf leachates of resistant clones suppressed the growth of this fungus and promoted the formation of appressoria. Waxes and other substances associated with it inhibited the growth of the pathogen.

Peroxidase activity was higher in clones susceptible to South American Leaf Blight (SALB). The glycoside content showed an inverse relationship to SALB resistance. Among the naturally occurring phenols, kaemferol and quercetin were present in large amounts in *Hevea* leaves, the latter was more in leaves of SALB resistant clones.

Environmental conditions largely determine the pattern of infection caused by *C. gloeosporioides*. A low incidence and severity of the disease showed a linear relationship, while a curvilinear relationship was observed when the incidence and severity of colletotrichum leaf disease were high.

In preliminary trials new fungicide formulations developed incorporating Difolatan and Aliette gave promising results.

Growth and sporulation characteristics helped to separate physiologic races of *Phytophthora palmivora* from cacao.

Long term rainfall records were used to predict the probability of occurrence of rain, in six estates located in Ratnapura and Kalutara Districts thereby helping to forecast infection periods of diseases affecting rubber and times suitable for other cultural operations.

Three new diseases were identified on pineapple (*Thielaviopsis* state of *Ceratocystis paradoxa,*) cardamom (*Phytophthora nicotianae* var. *nicotianae*) and clove (*Cylindrocladium quinqueseptatum*).

DETAILED REVIEW

Staff

The Head of the Department, Dr A. de S. Liyanage was promoted as Deputy Director (Research) on the 16 December and was on duty throughout the year. He still continues to be in - charge of the Plant Pathology Department. Mr C. K. Jayasinghe, Assistant Plant Pathologist left for post-graduate studies to the University of Western Australia, Perth on the 19 October. Mrs N. I. S. Liyanage, Experimental Officer, was promoted as Assistant Plant Pathologist on the 12 July and was on duty throughout the year.

Mr D. M. Dantanarayana, Senior Technical Officer, was promoted as Experimental Officer on the 1 September but resigned his post on the 6 December. Senior Technical Officer, Mr Z. E. Irugalbandara and Technical Officers, Messrs W. Amaratunga, A. Dharmaratna, S. Wettasingha, B. Fernando, S. S. Warnapura, E. A. T. Senadheera and Mrs J. L. P. Wettasinghe were on duty throughout the year. Mrs Priyani Amarasekera, Clerk/ Typist was transferred to the Department from the Head Office on the 5 May.

Research students

Messrs P. K. Samaradeewa and L. C. Wijetilaka were awarded the MSc degree from the Sri Jayawardenapura Univerisity for their thesis entitled "Disease resistance in *Hevea brasiliensis* to *Colletotrichum gloeosporioides*" and "The relationship between resistance to Gloeosporium leaf disease (*Colletotrichum gloeosporioides*) and South American Leaf Blight (*Microcyclus ulei*) in *Hevea,*" respectively.

Mr V. Perera has completed the research work and is in the process of writing up the thesis.

Misses Sunethra Threemanna and Ramani Kaluarachchi, from the Ruhunu University College, Mapalana worked for 6 months under A. de S. Liyanage's supervision for their final year research projects entitled "Studies on the variability of *Phytophthora palmivora* from cacao in Sri Lanka" and "Studies on the biology of *Drechslera heveae*", respectively.

Visits

The following visits were undertaken by the department staff.

Experimental	371
Advisory	44
Miscellaneous	83
Total	498

Meetings

A. de S. Liyanage attended the fourth meeting of the Association of Natural Rubber Producing Countries (ANRPC) Technical Committee on South American Leaf Blight held at Cheingmai, Thailand from 14 – 16 January. He also visited the Rubber Research Centre at Hat-Yai and several regional reserach stations.

The Head of the Depratment served in the following bodies:

Chairman of the Drafting Committee on Pesticides.

Member of the section B of the Sri Lanka Association for Advancement of Science (SLAAS).

Member of the committee on Plant Imports and Quarantine.

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

Member of the Agriculture Group of the Atomic Energy Authority (AEA).

Sub-committee on packaging of pesticides.

Member of the steering committee of the Smallholder Rubber Replanting Project (1 meeting).

Scientific Committee of the Rubber Research Institute (RRI).

Estate committee of the RRI.

He attended a seminar on "Agriculture planning at district level" at the Agrarian Research and Training Institute. He spoke at the inaugural meeting of the Institute of Biology of Sri Lanka and at a symposium organised by the Section D of the SLAAS on "Some important diseases of *Hevea* and their control" and "Rubber crop and the environment," respectively. He also gave some lectures to the final Botany special students at the University of Colombo on epidemiology, with special reference to diseases of rubber.

The Head of the Department and the Assistant Plant Pathologists, Mr C. K. Jayasinghe and Mrs N. I. S. Liyanage were involved in training Rubber Extension Officers, Rubber Extension Assistants of the RRI and Agriculture Instructors of the Agricultural Development Authority on identification and control of diseases of rubber.

Publications

Liyanage, N. I. S., Yapa, P. A. J., Liyanage, A. de S. and Peries, O. S. (1981). Production of antifungal compounds in *Hevea* pods in response to infection by *Phytophthora meadii*. *J. Rubb. Res. Inst. Sri Lanka* **58**, 37 - 45.

Liyanage, A. de S. (1982). Observations with the scanning electron microscope on the conidial, pycnospore morphology and infection of rubber leaves by conidia of

Microcyclus ulei. Paper presented at the fourth ANRPC Technical Committee on SALB, Chiengmai, Thailand.

Liyanage, A. de S. and Fernando, D. M. (1982). Recent developments in studies on South American Leaf Blight resistance in Sri Lanka. Paper presented at the fourth Technical Committee on SALB, Cheingmai, Thailand.

Liyanage, A. de S. (1981). Long distance transport and deposition of spores of *Microcyclus ulei* in tropical America - A possibility. *Rubb. Res. Inst. Bull.* **16**, 3 – 9.

Liyanage, A. de S. (1982). Disease problems in rubber and their control. *J. Nat. Inst. of Pl. Man.* **2** (2), 188 – 192.

Abstracts

Liyanage, A. de S. and Samaradeewa, P. K. (1982). Preliminary studies on the microflora on leaves of rubber (*Hevea brasiliensis*). *Proceedings of the thirty-eighth annual session of the SLAAS,* December 1982, Part 1.

Samaradeewa, P. K. and Liyanage, A. de S. (1982). Pre and post-penetration behaviour of *Colletotrichum gloeosporioides* in rubber (*Hevea brasiliensis*) leaves. *Proceedings of the thirty-eighth annual session of the SLAAS,* December 1982, Part 1.

Wijetilaka, L. C., Fernando, D. M., Liyanage, A. de S. and Yapa, P. A. J. (1982). The relationship between resistance to *Colletotrichum* leaf disease and South American Leaf Blight of rubber (*Hevea brasiliensis*). *Proceedings of the thirty-eighth annual session of the SLAAS,* December, Part 1.

Reports

Liyanage, A. de S. (1981). Annual Review of the Plant Pathology Department.

Liyanage, A. de S. (1982). Country Report. Fourth Meeting of the ANRPC Technical Committee on SALB, Cheingmai, Thailand, 14 – 16 January.

General

Wintering commenced early in the Kegalle and Kelani Valley Districts, as a result the incidence of *Oidium* leaf fall caused by *Oidium heveae* was negligible. However, in most areas of Kalutara and Ratnapura Districts the incidence of *Oidium* was high as conditions favourable for the development and spread of this disease were present at the time of refoliation. *Phytophthora* infection was severe in Kegalle District and also in some parts of Kelani Valley District, but mild in the Kalutara and Ratnapura Districts. The secondary leaf fall and die-back caused by *Colletotrichum gloeosporioides* were high due to the prolonged rain experienced during the year. Bird's eye spot caused by *Drechslera heveae* was found

to be a widespread problem in seedling nurseries especially during the dry period. The damage caused by white root disease (*Rigidoporus lignosus*) is still the major disease problem in rubber plantations, especially in the wet zone. Black root disease caused by *Xylaria thwaitesii* is present only in dry rubber growing districts.

Thielaviopsis state of *Ceratocystis paradoxa* was established as the causal organism of dry root rot of pineapple. *Phytophthora nicotianae* var. *nicotianae* was reported for the first time as the organism causing pod, rhizome and root rot in cardamom.

Laboratory Investigations

Diseased specimens

The following specimens were sent to the Institute, for identification:

	Identity of the disease	Number of specimens
Fungi	*Oidium heveae*	2
	Glomerella cingulata	1
	Phytophthora nicotiane var. nicotianae (Cardamom)	1
	Pythium vexans (Cardamom)	1
	Ceratocystis paradoxa (Pineapple)	1
Pests	Mealy bugs	1
Others	Brown bast	1

Biology

Oidium heveae

Susceptibility of cultivars (*0/76/1*)

Copper-brown leaves of clones RRIC 103 and PB 86 were inoculated with conidia of *O. heveae*. Sellotape strippings were made at different intervals after inoculation, to study the germination and germ tube growth. Spore germination and germ tube growth were significantly less in RRIC 103 than in PB 86. (A. de S. Liyanage and A. Dharamaratna)

Phytophthora meadii

Nomenclature (*P/76/1*)

Several *Phytophthora* isolates were collected from Kegalle, Kelani Valley and Kalutara Districts during the South-West monsoon period. These were identified as *P. meadii* thus confirming that it is the principal pathogen of rubber in Sri Lanka. (O. S. Peries, D. M. Dantanarayana and A. de S. Liyanage)

Colletotrichum gloeosporioides

Susceptibility of cultivars (G/76/2)

It was observed that some isolates germinated equally well on both resistant and susceptible clones and others showed a significant reduction in germination on resistant clones (Table 1).

Table 1. *Spore germination (%) of six isolates (I) of* C. gloeosporioides *on the leaf surface of four* Hevea *clones, 3 h after inoculation (G/76/2)*

Clone	Isolate no.					
	I_1	I_2	I_3	I_4	I_5	I_6
RRIC 52	72.7	46.5	58.3	14.7	42.5	15.7
RRIC 100	68.2	37.5	59.7	19.0	32.7	15.5
RRIC 103	70.5	43.7	59.7	19.7	39.0	18.0
PB 86	58.0	50.7	66.5	17.2	46.5	17.0

	SE (±)	*LSD* (5%)
Isolate differences	0.66	3.3
Clones	0.54	2.75
Isolate x clone interaction	1.32	6.5

Generally, the germ tube length of all the isolates increased with time, and I_6 showed the highest increase. Germ tube growth was favoured on leaf surfaces of clones RRIC 103 and PB 86 than on RRIC 52 and RRIC 100 and significantly interacted with the clones.

Most of the isolates initiated appressoria formation 3-4 h after inoculation, while in I_6 they were formed after 6h. The number of appressoria increased with time. More appressoria were formed by the I_1 and I_3 and they attained maturity very fast. Also, most of the appressoria formed by these two isolates were sessile. These germ tubes branched out readily, usually immediately after the formation of appressoria. In resistant clones, I_1, I_2, I_3, I_4 and I_5 formed appressoria abundantly. These differences were significant except in I_3 and I_6; at the early hours after inoculation. (P. K. Samaradeewa and A. de S. Liyanage)

Resistance to South American leaf blight (G/76/2)

The germ tube length of *C. gloeosporioides* conidia in South American leaf blight (SALB) susceptible and resistant *Hevea* leaves was similar when observed after 3h; but their rate of growth was significantly higher in all clones tested, between 6-9 h after inoculation. Further, the rate of germ tube elongation in susceptible clones (H. P. 6005, RRIC 114 and RRIC 45) was higher, though in resistant clones it was slightly lower after 9h.

The number of appressoria was higher in leaves of resistant clones than in susceptible clones. In SALB resistant clones a similar increase in the number of appressoria formed was observed, but in H. P. 7263 which was less resistant to SALB than RRIC 121, a significantly higher number of appressoria was seen at 12 h after inoculation in leaves of copper-brown and apple-green stages of development. There was an inverse relationship between the number of appressoria and the mean germ tube length of *C. gloeosporioides* on leaves of different *Hevea* clones after 12 h, except H.P. 7263. (L. C. Wijetilaka, A. de S. Liyanage and D. M. Fernando)

Growth characteristics of isolates (G/76/2)

The I_6 isolate obtained from Peenkande Estate showed exceedingly high rate of growth on potato dextrose agar (PDA) when compared with the other isolates. Morphologically, it differed greatly from other isolates showing a superficial growth with loosely aggregated raised strands of mycelium giving a loose and fluffy appearance where as the remaining isolates showed compact mycelium. I_2, I_4 and I_5 collected from Muwankanda, Nakiadeniya and Padukka Estates, respectively, formed alternatively dark grey and light grey concentric growth rings when they grew older.

A marked variation was seen in different isolates with regard to their ability to produce conidia (Table 2). The number of spores produced per unit area of the colony in 6-day-old cultures, grown on PDA indicated an abundance of spores in I_1 and I_5; a significanlty lower number was produced by I_2.

Table 2. *Colony area and production of spores of six isolates (I) of* C. gloeosporioides *on PDA at 28 ± 2° C, 6 days after inoculation (G/76/2)*

Isolate	Colony area (cm^2)	Spores per cm^2 ($\times 10^4$)
I_1	21.3	159.2
I_2	26.8	27.2
I_3	26.6	47.2
I_4	20.8	76.8
I_5	23.4	206.0
I_6	56.4	78.0
SE (±)	—	0.92
LSD (5%)	—	2.68

However, microscopic examination revealed that they were exceptionally large in size but retained the normal oblong shape. Most of the spores produced by I_4 were oval in shape. I_5 had two forms of conidia which were oval and oblong in shape. Spores formed by I_2 were relatively long and slender.

The spore germination on glass slides also showed differences amongst the six isolates at 3 h after incubation. The germinability of spores was very low in I_6 while the spores of I_1 and I_3 germinated readily. However , by 6 h after incubation germination was complete in all the isolates. There were differences in germ tube growth among the different isolates. Initially, in I_6 the germ tube growth was slow but on prolonged incubation it showed the highest germ tube growth. (P. K. Samaradeewa and A. de S. Liyanage)

Effect of leaf exudates (*G/76/2*)

Leachates collected from different clones exhibited a differential inhibitory effect on spore germination. Both spore germination and germ tube growth were markedly depressed by the leachates left on the leaves for a longer period. This effect was more evident on leachates of resistant clones. Germ tube growth was slightly stimulated by the leachates of susceptible clones PB 86 and Tjir 1, collected after 12 h. Leachates of *Hevea* leaves substantially favoured the formation of appressoria when compared to the water controls where only few were formed. Similarly, water placed for a longer period on the leaf surface of resistant clones significantly increased the appressorium formation compared to the leachates of susceptible clones. (P. K. Samaradeewa and A. de S. Liyanage)

Nutritive composition of leaf exudates (*G/76/2*)

Two types of sugars viz. sucrose and glucose were detected, from leaf exudates, but several other sugars were also present in trace amounts. It was observed that relatively more sugars leached out from mature leaf tissues while little or no detectable amounts of sugars were found in the leachate of copper-brown leaves.

Striking differences were observed in the amino acid content in the leachate of leaves of different maturity. Immature copper-brown leaves were capable of leaching more amino acids than apple-green leaves which also had leachable amino acids in moderate quantity. Mature leaves had trace amounts of amino acids in the leachate. Four major ninhydrin positive compounds; alanine, aspartic acid, glutamic acid and proline were present. Phenylalanine was also present in trace amounts. Three other ninhydrin positive compounds were detected but they could not be identified. No differences were seen amongst the amino acids in the leachate of different clones. (P. K. Samaradeewa, L. C. Wijetilaka, A. de S. Liyanage, D. M. Fernando and P. A. J. Yapa)

Effect of sugars and amino acids (*G/76/2*)

The spore germination was favoured by both sucrose and glucose as well as by an amino acid, alanine. However, they exhibited an inhibitory effect at high concentrations. Glutamic acid, aspartic acid and proline showed no stimulatory effect on spore germination but slightly depressed their germination, at very high concentrations. Glucose, sucrose, alanine and glutamic acid stimulated germ tube growth. At high concentration of sugars, the germ tube elongation was reduced when compared to the water controls. However, the

germ tubes in these sugar solutions were thick whereas in water controls they were long and slender. Aspartic acid and proline had no effect on the growth of germ tubes. High concentrations of glutamic acid favoured the development of two germ tubes from the germinating spores.

The development of appressoria was also studied with respect to each nutritive substance at various levels. Only sucrose slightly favoured the development of appressoria while glutamic acid significantly depressed their development. Other substances did not show any affect on the appressoria formation when compared with the water control. (P. K. Samaradeewa, L. C. Wijetilaka, A. de S. Liyanage and D. M. Fernando)

Phenols in leaf exudates (*G/76/2*)

When highly concentrated samples of leaf wash were analysed, two para nitroaniline (PNA) positive spots giving an orange colour with R_f values 0.22 and 0.82 were detected. Two other fluorescent spots (R_f 0.25 and 0.90) which did not answer the PNA test were also detected under UV light. The substance separated at R_f of 0.22 only showed inhibitory activity on the germinating spores of *C. gloeosporioides*. (P. K. Samaradeewa, A. de S. Liyanage and P. A. J. Yapa)

Rhizobia spp

Isolation of bacterial strains (*N/81/1*)

Several isolates of *Rhizobia* spp., were collected from *Pueraria* grown in different environments, to examine their variation. (C. K. Jayasinghe)

Host-parasite relationships

Colletotrichum gloeosporioides

Histopathology (*G/76/2*)

Electron microscope studies on the histopathology of *Colletotrichum* leaf disease were started using the facilities at the Medical Faculty of the University of Colombo. These studies are in progress. Appressoria formation, ramification of fungal hyphae in the epidermal cells, palisade and spongy parenchyma were observed. (A. de S. Liyanage, N. I. S. Liyanage and Z. E. Irugalbandara)

Histology of brown bast (BB/*81/1*)

Sections of healthy and brown bast affected tissues were examined. A thick corky layer was observed in the bark of trees affected with brown bast compared to that of healthy bark.

Bark samples collected from trees affected with brown bast were sent to Dr P. Jones at Rothamsted Experimental Station in England for transmission electron microscopy.

There was no evidence that this condition is due to a virus or mycoplasma. However, some abnormalities were observed in the pholem cells of affected tissues. (A. de S. Liyanage, O. S. Peries, N. I. S. Liyanage, Z. E. Irugalbandara and J. L. P. Wettasingha)

Resistance

Colletotrichum gloeosporioides

Leaf surface waxes (G/76/2)

The leaf surface waxes isolated from different clones of *Hevea* at varying stages of leaf maturity are given in Table 3.

Table 3. *Relative amount of chloroform extractable waxy materials (mg/cm²) in* Hevea *leaves of four clones at varying stages of maturity (G/76/2)*

Clone	Stage of leaf maturity		
	4-day-old	7-day-old	10-day-old
RRIC 52	25.6	37.3	42.0
RRIC 105	24.3	34.6	42.6
PB 86	26.3	33.3	43.3
Tjir 1	19.3	30.6	40.7
		SE (±)	*LSD* (5%)
Between clones		0.77	2.26
		SE (±)	*LSD* (5%)
Stages of maturity		0.67	1.96
Interaction			NS

NS— Not significant

There is a significant variation in the amount of waxes, depending on the stage of the leaf development. The amount of wax in 4-day-old leaves was significantly less than in the older leaves. The wax content of the leaf increases with leaf maturity. Although no differences were seen among the clones RRIC 52, RRIC 105 and PB 86, a significantly lower amount was recorded for Tjir 1, especially in 4-day-old leaves. (P. K. Samaradeewa and A. de S. Liyanage)

Effect of crude chloroform extract (G/76/2)

The leaf waxes significantly affected spore germination 4 h after incubation (Table 4).

Table 4. *Effect of different amounts of crude chloroform wax extract of four* Hevea *clones on germination of* C. gloeosporioides *spores, at different periods (G/76/2)*

Incubation period (h)	Clone	Amount of the extract (g)			
		$(3X10^2)$	$(3X10^1)$	(3X1)	$(3X10^{-1})$
4	RRIC 52	0	11.2	80.1	89.5
	RRIC 105	0	7.2	78.5	84.2
	PB 86	2.7	10.4	82.4	87.3
	Tjir 1	2.5	12.3	81.5	87.0
6	RRIC 52	37.5	67.3	88.5	97.2
	RRIC 105	30.1	64.5	89.4	98.5
	PB 86	45.0	69.2	91.0	94.3
	Tjir 1	48.7	78.5	90.8	96.2
SE (+)	1.27				
LSD (5%)	4.52				

There is a significant variation in the amount of waxes depending on the stage of the leaf development. The amount of wax in 4-day-old leaves was significantly less than in the older leaves. The wax content of the leaf increases with leaf maturity. Although no differences were seen among the clones RRIC 52, RRIC 105 and PB 86, a significantly lower amount was recorded for Tjir 1, especially in 4-day-old leaves. Higher amounts inhibited spore germination, while lower amounts did not affect the germination. Although a high deposit of wax showed an inhibitory effect when the incubation period was increased up to 6 h, some of the spores germinated.

Waxes and other substances isolated with chloroform were deposited on glass slides to give the amounts 5, 10, 15, 20, 25 and 30 µg and the effect on spore germination and appressoria formation was studied. Inhibition of spore germination was detected at higher levels of the substance irrespective of the clone from which it was obtained. The extract from RRIC 105 which showed field resistance, inhibited the spore germination at a considerably lower level of the waxy material. Wax and other substances isolated from the cuticle of susceptible leaves also appeared to be inhibitory when higher amounts were deposited on glass slides.

All the extracts prevented the development of appressoria at higher levels. Lower contents of the substance stimulated appressoria formation. In most instances, no significant difference in appressoria formation was observed within the same concentration of wax of different clones. The extracts obtained from both susceptible and resistant clones favoured their initiation at very low levels. Appressoria formed on the wax deposit did not reach maturity even on prolonged incubation. (P. K. Samaradeewa and A. de S. Liyanage)

Leaf waxes and susceptibility to SALB (G/76/2)

Of the nine clones tested, leaves of H. P. 8798 (susceptible) showed the highest leaf wax content, whilst RRIC 121 (resistant) showed the lowest amount. RRIC 45 (susceptible) RRIC 115 and RRIC 119 (resistant) contained about 2 x 10 mg^{-2}/cm^2. No correlation was observed between leaf waxes and susceptibility to SALB.

The germ tube length of conidia of *C. gloeosporioides* in leaf waxes of clones of differential susceptibility to SALB is shown in Table 5.

Table 5. *Mean germ tube length of conidia of* C. gloeosporioides *in leaf waxes extracted from* Hevea *cultivars (G/76/2)*

Clone	SALB rating*	Mean germ tube length (μm)
RRIC 45	NA	31.0
RRIC 114	5	36.9
RRIC 115	3	23.6
RRIC 119	2	27.5
RRIC 121	1	18.1
RRIC 130	1	27.8
$CHcl_3$ (Control)	—	34.7
SE (±)		1.33
LSD (5%)		4.02

*According to Liyanage and Chee, 1981
NA — Not available

The mean germ tube length in wax extracts of clones tested, except in clone RRIC 114 (susceptible) was lower than that of the control. Further, germ tube length in extracts of susceptible clones viz. RRIC 45 and RRIC 114 was higher compared to other clones tested. The shortest germ tube length was observed in extracts of RRIC 121 and extracts of RRIC 115 and RRIC 119 occupied an intermediate position. These results indicate an inverse relationship between germ tube length and disease resistance to SALB ($r = 0.81$; LSD 5%)

Qualitatively, no difference in compounds associated with the leaf material of different *Hevea* leaves was observed, although there were quantitative differences amongst the compounds of different clones, when compared to the germ tube length of *C. gloeosporioides* conidia in the compounds of the same R_f value. Four iodine and para nitroaniline positve spots were detected in all nine clones tested.

Effect of five elutes on germination and germ tube length of conidia of *C. gloeosporioides* was tested. The germ tube length of fungus was significantly lower in elutes 1 to 4 of the resistant clones RRIC 130 than on the corresponding elutes of susceptible clone

RRIC 114. However, there was no significant difference between the germination in corresponding elutes of susceptible and resistant clones. (L. C. Wijetilaka, A. de S. Liyanage and D. M. Fernando)

Phenols in healthy leaf tissue (G/76/2)

The level of total phenol and orthodihydroxyphenol (ODP) content showed a considerable variation in different *Hevea* clones tested. The total phenol content was slightly higher than the polyphenol content. The results indicated that there is no relationship between either phenol or ODP level and field resistance of clones. The phenol level of some susceptible clones viz. PB 86 and RRIC 103 was higher than in RRIC 100 which is a resistant clone. (P. K. Samaradeewa and A. de S. Liyanage)

Infection and phenol level (G/76/2)

The variation of total phenol content in inoculated and healthy leaves is shown in Table 6. In resistant clones of RRIC 105 and RRIC 52, the total phenol level showed a slight decrease 96 h after inoculation when compared to the healthy control, while susceptible clones had no significant decrease.

Table 6. *Variation of the total phenol level in healthy and infected leaves of four* Hevea *clones at different intervals (G/76/2)*

	Phenol content (mg)				Catechol equivalents/g fresh weight			
Incubation	RRIC 52 (R)		RRIC 105 (R)		PB 86 (S)		Tjir 1 (S)	
period (h)	H	I	H	I	H	I	H	I
	10.6	—	11.8	—	13.2	—	11.3	—
	10.4	10.6	11.7	13.7	13.0	13.0	11.8	11.2
	10.8	8.5	12.0	8.8	13.0	13.0	12.9	10.4
SE (±)	0.31		0.41					
LSD (5%)	1.71		2.29		NS		NS	

R — Resistant S — Susceptible NS — Not signiiificant

H —Healthy I — Infected

There is a considerable variation of the ODP content when compared to the healthy control. Resistant leaf tissues are characterised by an early increase in phenol level. This increase was marked in RRIC 52 and RRIC 105 by 24 and 48 h after inoculation, respectively. Thereafter, the phenol level decreased considerably, the maximum decrease was shown 96 h after inoculation. ODP content in leaf tissues of susceptible clones (PB 86 and Tjir 1) was not significantly depressed until 96 h after inoculation when only a slight decrease was shown by both clones. (P. K. Samaradeewa and A. de S. Liyanage)

Estimation and identification of phenols (G/76/2)

When paper chromatograms were developed and treated with PNA, different phenolic compounds were seen. Although the pattern of phenolic separation was same in RRIC 52, RRIC 105, PB 86 and Tjir 1, the colour intensities of individual spots were dissimilar. Phenols occur in high concentrations in the extracts obtained from PB 86 and Tjir 1 while the compounds located at R_f values 0.41 and 0.49 yielded more intense colour reaction with PNA reagent and were observed at high concentrations in resistant clones, RRIC 52 and RRIC 105.

Leaf extracts were also prepared from healthy and inoculated RRIC 105 leaves to determine the qualitative changes in the phenols with disease development. The phenols giving the R_f values 0.49 and 0.73 appeared to give a more intense colour reaction with PNA reagent indicating an increase in some phenols compared to healthy controls. However, the phenols appearing at the R_f values 0.49 , 0.64 and 0.74 decreased in colour intensity at 72 h while they showed an intense colour reaction at 48h after inoculation.

Other than free phenols, those which occur in bound form and thought to be implicated in disease resistance were extracted with ethyl acetate after acid hydrolysis and the chromatograms of these were examined under ultra-violet. By comparing with authentic samples of phenol the compounds appearing as a yellow spot giving the R_f value of 0.40 was identified as quercetin. Other compounds which gave a brown colour under UV with the R_f value of 0.57 was thought to be kaemferol. (P. K. Samaradeewa, A. de S. Liyanage and P. A. J. Yapa)

Toxicity of the leaf extract (G/76/2)

Boiled leaf extracts obtained from healthy leaves were tested against spores of *C. gloeosporioides* for their toxicity. Leaf extracts were found to be toxic when the number of disks used for the extraction was increased from 10-25. When 25 leaf disks were extracted with 5 ml of boiled water and used for bioassays, some clones which are resistant showed an inhibitory effect on spore germination.

It was observed that the boiled extracts obtained from inoculated leaves showed a marked inhibition on spore germination when compared with healthy leaf extracts and water control on glass slides. The extracts obtained from the inoculated leaves after prolonged incubation were more inhibitory than those extracted in early hours of incubation. It was also observed that the extracts from infected leaves of RRIC 105 suppressed the spore germination in 24 h and this effect was more marked with increase in time. Boiled leaf extracts obtained from infected Tjir 1 leaves were also relatively toxic to spore germination 72 h after inoculation. (P. K. Samaradeewa and A. de S. Liyanage)

Phenol content and susceptibility (G/76/2)

There was no relationship between ortho-dihydroxy phenol content and quercetin with susceptibility to *M. ulei.* When phenolic extracts were diluted (1 : 2) no germination of conidia of *C. gloeosporioides* was observed. However, when diluted 5 and 10 times there was a marked increase in the conidial germination in both RRIC 114 and RRIC 130 leaf phenol extracts. At higher dilutions (more than 10 times) no significant inhibition of conidial germination was observed in the phenolic extract of the resistant clone when compared to the susceptible clone.

An increase in the germination was found with the decrease in molarity of the compounds tested between the range of 5×10^{-4} M – 5×10^{-9} M : germination of conidia in quercetin at 5×10^{-4} M was significantly lower than that of the chlorogenic acid and the water control.

Phenols extracted with methanol and water were separated by paper chromatography. Qualitatively (*i. e.* in the number of compounds) no difference between the compounds of susceptible and resistant *Hevea* clones was observed. However, there were quantitative differences, between different clones. The R_f values of the compounds as well as the colour that developed after spraying with p–nitroaniline reagent were similar in all clones tested. When colour intensities of compounds of similar R_f values in different clones were compared, no visual changes among the clones were observed.

Eight phenolic compounds were detected with p–nitroaniline in methanolic extracts but two compounds were not detected in water extracts. Of the 8 compounds present in the resistant clone RRIC 130, some exhibited an inhibitory effect on germ tube elongation of *C. gloeosporioides.* One compound was found to stimulate germ tube elongation compared to the control. Inhibitory effects of these compounds could also be observed reducing the germination of conidia of *C. gloeosporioides.* The compounds extracted with water from RRIC 114 (susceptible) and RRIC 130 (resistant) showed a similar pattern of inhibitory effects when compared to the control. (L. C. Wijetilaka, A. de S. Liyanage. D. M. Fernando and P. A. J. Yapa)

Peroxidase activity (G/76/2)

The relative activity of peroxidase of different clones showed that the clone RRIC 114 (susceptible) showed the highest peroxidase activity. RRIC 130 (resistant) showed the lowest and RRIC 115 and RRIC 119 gave an intermediate reaction, the former showing a greater activity than the latter. (L. C. Wijetilaka, A. de S. Liyanage, D. M. Fernando and P. A. J. Yapa)

Peroxidase activity of leaves at different development stages (G/76/2)

Of the three stages of development, the mature leaves of *Hevea* possessed a higher peroxidase activity than the other two development stages. Further, an increase in the

peroxidase activity during maturity of the leaves of all clones tested was observed. Leaves of susceptible clones viz. RRIC 114 and RRIC 45 at the copper-brown stage of development had higher peroxidase activity than the leaves of same stage of development of resistant clones RRIC 121 and RRIC 130.

Changes in the peroxidase activity of leaves of 7-day-old copper-brown leaves indicated that SALB susceptible clones RRIC 45, RRIC 114, H. P. 6005, showed a higher peroxidase activity than those of the resistant clones (RRIC 115, RRIC 119, RRIC 121 and RRIC 130). Generally, an increase of peroxidase activity was observed with susceptibility to SALB. (L. C. Wijetilaka, A. de S. Liyanage D. M. Fernando and P. A. J. Yapa)

Glycoside content of healthy leaves (G/76/2)

There was a linear relationship between the amount of glycosides present in *Hevea* leaves and their susceptibility to SALB ($r = 0.91$; LSD 5%). The clone RRIC 114 which is susceptible to SALB contained the highest amount of glycoside while SALB resistant clones RRIC 121 and RRIC 130 showed the lowest glycoside content. (L. C. Wijetilaka A. de S. Liyanage, D. M. Fernando and P. A. J. Yapa)

Ortho-dihydroxy phenol content of leaves (G/76/2)

In resistant clones viz. RRIC 121 and RRIC 130 a significant increase in the ortho-dihydroxy phenol content was observed compared to the healthy controls after 24 h of incubation. However, 48, 72 and 96 h after incubation, the variation of phenol levels in clone RRIC 121 in relation to healthy controls (uninfected) was different from that of clone RRIC 130. The ortho-dihydroxy phenol content in infected leaves was higher than that of healthy leaves in clone RRIC 130 (resistant) at 96 h after inoculation, whilst in clone RRIC 121 (resistant) the phenolic content of diseased leaves was lower than that in healthy leaves.

There was a slight increase of phenols in both susceptible clones than in the control, after 48 h of incubation. A decrease in the phenol content was observed after 72 and 96 h of incubation in susceptible and resistant *Hevea* clones. (L. C. Wijetilaka, A. de S. Liyanage, D. M. Fernando and P. A. J. Yapa)

Flavanol content during infection (G/76/2)

In resistant clones of RRIC 121 and RRIC 130, a marked increase in the flavanol content was observed 24 h after inoculation. It reached a peak at 48 h in H. P. 8798 and on further incubation flavanol content declined. RRIC 114 showed an incrase in flavanol content at 96 h, but in both susceptible clones the reduction of flavanol content after 96 h, compared to the healthy control was highly significant. The change in the flavanol level in each clone in respect to its healthy controls was similar to that shown by ortho-dihydroxy phenols. (L. S. Wijetilaka, A. de S. Liyanage, D. M. Fernando and P. A. J. Yapa)

Drechslera heaveae

Medium for growth and sporulation

Seven media; Potato Dextrose agar (PDA), Czapek Dox agar (CDA), Malt agar (MA), Water agar (WA), Lima Bean agar (LBA), Dextrose peptone agar (DPA) and Corn Meal agar (CMA) were used. On the growth pattern the media could be categorised into three groups viz. those favouring fast, intermediate and slow growth of the fungus. CDA and WA supported good growth while MA supported little growth and the rest occupied an intermediate position. There was a sharp decline in fungal growth during the 24-48 h period, in all three categories.

Spore production occurred three days after inoculation on CDA, MA and WA, in CMA it took five days and in PDA, LBA, DPA sporulation was not observed up to six days after inoculation. MA was the best medium for sporulation. (A. de S. Liyanage and Ramani Kaluarachchi)

Fungal morphology

In MA the fungus appeared as a dark brown colony. Growth was cottony and compressed. In CMA the growth of the mycelium was uneven and dark green. Distinct zones consisting of alternate heavily sporulating and non-sporulating areas were present. The fungus appeared green on PDA and its growth tended to be wooly in later stages of growth. On WA the mycelium was thin and slender. (A. de S. Liyanage and Ramani Kaluarachchi)

Spore germination

An integrated analysis of variance of spore germination showed that all three factors viz. temperature, humidity and incubation period influence spore growth. It was observed that germination increases with temperature, reaching a maximum around 35°C and even at 40°C conidia germinated well but at lower temperature germination was low. Maximum spore germination occurred at 100% relative humidity but at 0% humidity, 70% of the spores germinated. At higher humidities the inhibitory effects of high temperature is less on spore germination and also more spores germinated when the incubation period was longer. (A. de S. Liyanage and Ramani Kaluarachchi)

Colony growth

The maximum spore germination occurred at 28°C but good colony growth was recorded between 25-30°C. However, at lower and higher temperature of 15° and 40°C respectively, substantial colony growth was recorded. Growth also increased with increasing humidity reaching a maximum at 100% relative humidity. At higher humidities and increase in incubation period, the inhibitory effect of high temperature was less.(A. de S. Liyanage and Ramani Kaluarachchi)

Phytophthora palmivora

Growth on lima bean agar

Several isolates of *P. palmivora* from cacao were grown on Lima bean agar (LBA). The growth measurements taken daily indicated that there were significant differences in growth between the isolates. These were grouped into three categories, each significantly different from one another, on the basis of Duncan's multiple range test. Isolates which grew fast (> 75 mm), slow growing isolates (< 60 mm) and those showing an intermediate pattern (60-75 mm) were recognised. Most of the isolates fell into the intermediate category and there were several fast growing ones but only one was categorised as a slow growing isolate. Highest growth increment was recorded between 48-72 h period after inoculation. (A. de S. Liyanage and Sunethra Threemanna)

Colony morphology

All the isolates produced stellate and striate colonies usually with a sharply, defined leading edge. The striate, smooth combed appearance was most pronounced in the peripheral area of the colonies. The aerial mycelium of the isolates was mostly confined to the colony centre, but some isolates produced more aerial mycelium over the entire colony and it was particularly dense towards the centre. (A. de S. Liyanage and Sunethra Threemanna)

Sporangial morphology and size

Sporangia formed on solid LBA were mostly ovoid to ellipsoid in shape. The sporangia were often symmetrical, usually have a rounded base but sometimes the base tapers slightly, and they were papillate, occassionally sporangia with two papilla were seen.

The sporangial measurements taken at room temperature ($28 \pm 2^{o}C$) showed highly significant differences between the isolates, in respect of both length and breadth. Isolates did not fall into identical groups, when they were separated on the length and breadth but the increase in breadth was proportional to the increase in length ($r = 0.7337^{***}$) but length and breadth dimensions were not related ($r = 0.1209$). (A. de S. Liyanage and Sunethra Threemanna)

Sporangial concentration

Of three methods tested (see text of publication), method 1 and 2, all the isolates formed sporangia within 16 h, when vigorously growing young mycelium was transferred to water. Isolates incubated in the culture room at temperature on LBA was rather variable. After 4 days, sporangia were found in abundance in some isolates and sparsely in others. Only small quantities of sporangia were produced in method 1 and 2. The results of all three methods when analysed indicated that there were significant differences between the

isolates. The correlation coefficient between method 1 and 2 ($r = 0.9912$) was significant, but methods 1 and 3, 2 and 3 were not correlated. Although three methods were done for assessing sporangial production, a grouping between the isolates was not possible due to overlapping of the groups. (A. de S. Liyanage and Sunethra Threemanna)

Compatibility type

A_2 compatibility type was predominant. The mating behaviour of A_1 x A_2 combinations were variable with some pairings, producing few orgonia and others producing sex organs in abundance. (A. de S. Liyanage and Sunethra Threemanna)

Chlamydospore production

All isolates, formed chlamydospores readily and freely under all conditions tested. On LBA, these were produced within 7-10 days. Chlamydospores were spherical when formed terminally and slightly ellipsoidal when intercallary. (A. de S. Liyanage and Sunethra Threemanna)

Colletotrichum gloeosporioides

Microflora on rubber leaves

Microflora on *Hevea* leaves was examined in different seasons in relation to leaf age and clones. Their antagonism towards *C. gloeosporioides* was also determined. Microbial density increased with leaf age. The number of colonies, mainly of fungi, increased during the rainy months, with the appearance of species not detected during the dry months. The population of microbes did not show any variation between the clones. These isolates were grouped into 3 categories depending on their reaction to *C. gloesporioides*, after pairing. Three species of fungi and a bacterial species showed antagonism against *C. gloeosporioides*. (A. de S. Liyanage and P. K. Samaradeewa)

Field Investigations

Host parasite relationships

Phytophthora meadii

Depth of penetration (P/76/2)

Virgin and renewed panels were inoculated after damaging (a) only the corky layer (b) without injuring the cambium (c) with injury to cambium. There was very little infection when only the corky layer was damaged. There was infection, when the panels were tapped in the normal manner without any injury to the cambium or tapped deep with injury to the cambium, the infection being more in the latter case. The fungus was re-isolated from infected wood upto a depth of 3 mm. (A. de S. Liyanage and B. Fernando)

Epidemiology

Colletotrichum gloeosporioides

Environment - disease incidence and severity (G/76/1)

Disease incidence (I) and severity (S) on different clones during October - November 1979, May - June 1980 and November - December 1980, in several locations were assessed. Analysis of results of the first season showed that there was no interaction between the clones and the locations both in respect of I and S, although both were very high in all locations for this season. During the second season, an interaction between the clones and the location was shown only for disease incidence. It was observed that some clones viz. RRIC 105 and RRIC 118 were consistently resistant and other clones viz. PB 86, GT 1 and RRIC 101 were susceptible. However, clones RRIC 100, RRIC, 104 and RRIC 102 which showed an intermediate reaction varied their respective positions in different locations. The degree of infection in this season was very low in all the locations. The results obtained during the last season showed that in Peenkande the plants were heavily infected while in Elston and Hatbawe Estates they were less infected. Analysis of these results showed that there was an interaction between the clones and the locations for both I and S. Similar to the results of the first season (May - June, 1980) the clones RRIC 105, RRIC 118 and RRIM 600 showed a low degree of incidence while the clones RRIC 101, PB 86 and GT 1 showed relatively high degree of incidence at all locations. RRIC 100 in particular, showed a varying degree of incidence and severity in different locations. (A. de S. Liyanage and P. K. Samaradeewa)

Relationship between incidence and severity (G/76/1)

A linear relationship between incidence and severity of the disease was obtained by using the regression model, $S = a + bI$. Irrespective of locations and seasons, high correlations are shown for resistant clones (RRIC 105 and RRIC 118). Similarly, in high incidence location (Peenkande) high correlations are given in low incidence season (May-June, 1980) than in high incidence season (November - December, 1980). However, in low incidence location (Hatbawe) correlation coefficients do not differ much with respect to the seasons May - June, 1980 and November - December, 1980.

The linear relationship was constructed by using the regression values obtained for a and b and they were compared for resistant and susceptible clones in different seasons in a high incidence location. Consistently higher values were given for severity/incidence (SI) values which are denoted by the regression parameter b for susceptible than for resistant clones. Similarly, this ratio is higher in high incidence season (November - December, 1980) than in low incidence season (May - June, 1980).

When the correlation coefficients shown in these two functions for the two clones were compared with that obtained for the linear model no significant differences were observed

between the degree of fit of these models. However, relatively high correlations (0.9069 and 0.9377) were obtained with the two curvilinear models (*i. e.* Quadratic and Cobb-Douglas) for susceptible clones in high incidence season compared to those obtained with the linear model (0.8805). For the susceptible clone GT 1 in high incidence season it appears that there is a curvilinear trend and the relationship is positively correlated. (A. de S. Liyanage and P. K. Samaradeewa)

Rigidoporus lignosus

Natural spread (*F/76/5*)

The rate of natural spread of the disease in estates located in different agro-climatic regions is given in Table 7.

Table 7. *Natural spread of white root disease in 12 months* (*F/76/5*)

Estate	Cumulative increase infection (%)	dead (%)
Rilhena	13.0	9.8
Elston	22.9	22.5
Udabage	10.1	8.1
Panawatte	21.5	21.5
Pallegama	10.0	10.0
Golinda	6.1	6.1
Pitiyakanda	11.9	10.3
Yatadola	6.6	6.6
Culloden	13.3	13.3
Heatherly	6.8	6.8
Elpitiya	18.2	16.2
Padukka	5.8	5.8

It was observed that the disease spread is greater in the wet districts, where the initial infection was high. (A. de S. Liyanage, O. S. Peries, N. I. S. Liyanage, S. S. Warnapura and E. A. T. Senadheera)

Control

Phytophthora meadii

Efficacy of fungicides (*P/77/3*)

In a preliminary trial, new formulations which were prepared by incorporating Aliette and Difolatan gave promising results. (A. de S. Liyanage, W. S. E. Fernando and B. Fernando)

Rigidoporus lignosus

Clearing and disease incidence (F/75/1)

Growth measurements, assessment of rate of decay and the incidence of white root disease were continued. Results obtained from seven experiments indicated that the incidence was less when the stumps were uprooted and burnt. The spread of the disease was low in dry than in wet districts. (A. de S. Liyanage and W. Amaratunga)

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

Observations were taken at four locations where sulphur was added at recommended dosage with and without proper removal of infected debris. When infected roots were not removed incidence of the disease was high especially when sulphur was not added. The infection in the new stand starts at the border of infected patches, due to the presence of active inoculum. (A. de S. Liyanage, O. S. Peries, N. I. S. Liyanage, S. S. Warnapura and E. A. T. Senadheera)

Application of sulphur and disease incidence (F/76/7)

Amendment of soil with sulphur significantly reduced the incidence of white root disease. Of the six methods of applications of sulphur (See Annual Review 1981) sprinkling or mixing sulphur in the top and bottom layer of soil in the planting hole or sprinkling sulphur on the surface of the soil was superior to the rest. (A. de S. Liyanage, O. S. Peries, N. I. S. Liyanage, S. S. Warnapura and W. A. T. Senadheera)

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

The effect of the recommended dosage and double the dosage of ammonium sulphate and urea with and without sulphur on the effect of soil pH and viability of inoculum was examined. The soil pH in the upper (0 - 10 cm) and lower (30 - 40 cm) layers of soil reached the pre-treatment level within 1½ years. The fungal population on soil amended with ammonium sulphate with and without sulphur was more than in soils receiving urea. (A. de S. Liyanage, S. S. Warnapura and E. A. T. Senadheera)

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

Four planting distances were used in trials conducted in two estates (see Annual Reviev 1981). It was observed (Table 8) that changing the planting distance has helped to reduce the infection in the new stand.

Table 8. *Infection and loss of trees at different planting distances (F/80/1)*

Estate	Planting distance (m)	Infection (%)		Losses (%)	
		1 yr	*2 yr*	*1 yr*	*2 yr*
Peenkande	4.6 x 4.9	2.6	2.7	2.6	2.7
	3.7 x 6.1	1.7	2.2	1.6	2.1
	*3.1 x 7.3	2.5	2.8	2.5	2.8
	2.4 x 9.2	0.3	0.8	0.3	0.8
Mapalagama	4.6 x 4.9	0	2.1	0	1.7
	*3.7 x 6.1	1.5	3.9	1.5	3.5
	3.1 x 7.3	1.1	3.4	1.1	3.1
	2.4 x 9.2	0.7	2.7	0.7	1.8
Panawatta	4.6 x 4.9	1.4	1.4	—	—
	*3.7 x 6.1	5.0	4.5	—	—
	3.1 x 7.3	0.7	0.6	—	—
	2.4 x 9.2	5.2	4.4	—	—

*Spacing of the old stand

However, the spread of the disease was rapid especially when the new planting row coincided with the infected roots in the old stand. In such an event, the spread is rapid when the inter-row spacing in the new stand is small. (A. de S. Liyanage, S. S. Warnapura and E. A. T. Senadheera)

Methyl bromide fumigation (F/81/13)

None of the infected root pieces buried upto 1 m had viable inoculum, 10 days after fumigating the soil with methyl bromide at 1000g/9m^2 and 2000g/9m^2. With a lower concentration of 500g/9m^2 this effect was observed only upto a depth of 0.5m. (C. K. Jayasinghe, A. de S. Liyanage and S. S. Warnapura)

Resistance

Phytophthora meadii

Clonal susceptibility (OGP/75/1)

The 124 clones planted in Dartonfield Estate were inoculated using the disk method to assess their susceptibility to bark rot. The results are still being analysed. (A. de. S. Liyanage, S. Wettasingha and A. Dharmaratne)

Colletotrichum gloeosporioides

Incidence and severity (P/76/4)

The clones RRIC 100-130 planted in 12 locations were assessed for susceptibility to Colletorichum leaf disease. The results are being processed for analysis. (A. de. S. Liyanage, S. Wettasinghe and A. Dharmaratne)

Miscellaneous

Basal rot of oil palm

The pathogenicity of *Thielaviopsis* state of *Ceratocystis paradoxa* was established on a mature oil palm tree at Nakiadeniya Estate. The palm was treated by drenching the soil around it with 5 g of the chemical at the rate of 1.25 g/1. Concentration of 0.3g/1 and 0.6g/1 at the rate of 2 1 per palm tested by the estate were found to be ineffective in controlling the fungus. (A. de S. Liyanage and D. M. Dantanarayana)

Pod, rhizome and root rot of cardamom

Phytophthora nicotianae var. *nicotianae* was established as the causal organism of pod, rhizome and root rot of cardamom. Three fungicides viz. Ridomil, Aliette and Difolatan were used at two concentrations to control this disease in the field. All three fungicides were effective with Difolatan being marginally better. (A. de S. Liyanage, C. K. Jayasinghe and N. I. S. Liyanage)

Leaf spot in clove

Cylindrocladium quinqueseptatum was identified as a pathogen causing leaf spotting in clove. Benlate, Baycor, Bavistin and Dowcil were tested at concentrations of 0.002 and 0.2 (a.i). Benlate and Bavistin proved to be more effective than the rest. (C.K. Jayasinghe and A. de S. Liyanage)

Rainfall and crop data

Rainfall and yield data from Dartonfield, Peenkanda, Frocester, Urumeewela Estates are being analysed in a collaborative project with the University of Reading and the Statistical unit of the University of Colombo. (A. de S. Liyanage)

REVIEW OF THE SOILS AND PLANT NUTRITION DEPARTMENT

By

M. K. S. A. SAMARAWEERA

SUMMARY

The research programme of the Department concerns the following:

Response of rubber trees to fertilizers

Economics of fertilizer application to rubber

Influence of the leaf nutritional status on production of latex

Effects of cultural practises on the availability of nutrients and water to plants

Development of analytical methods for the study of mineral nutrition of rubber and associated cover crops.

The latex yields in our factorial fertilizer experiments showed variable response. This emphasises the value of careful interpretation of the experimental results. Using computer facilities, we were able to find how the latex yield is related to the nutritional status of the plant. This enables us to re-evaluate the critical levels of nutrients in plants.

We have noticed an exceptionally high incidence of nutrient imbalance in 2-3 year old clearings in several districts and chemical analyses of leaves from affected trees have shown that the plants suffer from deficiency of several nutrients especially that of magnesium.

Using sand culture methods we have been able to confirm the deficiency symptoms of N, P, K, Ca and Mg and to produce hunger signs for S.

During the year 12,000 ha of mature rubber fields were surveyed to find out the nutritional status of the trees and to recommend fertilizers on a discriminatory manner. This is the largest area surveyed in any year and is even higher than that achieved by the Rubber Research Institute of Malaysia. The growers who follow our advise will be able to save Rs. 5.0 million during 1983. Because of the subsidy on fertilizer the savings to the nation are much higher than this.

The International Atomic Energy Authority has accepted our proposal for the setting up of an isotope laboratory and agreed to sponsor the programme with a substantial grant.

DETAILED REVIEW

Staff

The Head of the Department, Dr N. Yogaratnam, the Agricultural Chemist, Dr M. K. S. A. Samaraweera and all other staff were on duty throughout the year. Mrs L. Samarappuli (nee Alwis) joined the Department in March as the Assistant Soils Chemist.

Dr N. Yogaratnam left for Zambia on sabbatical leave in May and was attached to the Ministry of Agriculture and Water Development of the Republic of Zambia during his leave. Dr M. K. S. A. Samaraweera was appointed Acting Head of the Department with effect from 1 June.

Mr S. Abayaratne was transferred from the Head Office to the Department as the Clerk/Typist.

Research students

Mr W. M. Jayatilaka Bandara (NSC, student) left the Institute to take up a permanent position as Research Officer in the Department of Agriculture.

Miss Ajantha Pushpakumarie from the Faculty of Agriculture Ruhunu University College, worked on a project that links cover crops and soil fertility.

Visits

N. Yogaratnam, M. K. S. A. Samaraweera, Mrs L. Samarappuli, Experimental Officers/Assistants and Technical Officers paid advisory visits to plantations and routine visits to experimental areas where necessary.

Meetings

N. Yogaratnam presented a paper entitled 'Urea as a nitrogen fertilizer for rubber plantations in Sri Lanka' at a seminar on nitrogen in Malaysian Agriculture, organized by the Malaysian Society of Soil Science and University Pertanian Malaysia, held in Kuala Lumpur in March. He also delivered a lecture on 'Tree Crop Nutrition' at a seminar held at the Mount Makulu Research Station in Zambia.

M. K. S. A. Samaraweera delivered a lecture on 'Nutrition of Hevea' in a seminar organized by the Institute of Biology (Sri Lanka) and also conducted a course of lectures

in Analytical Chemistry for undergraduates and MSc students at the University of Sri Jayawardenapura.

The following staff members conducted lectures and demonstrations in the field for the Rubber Extension Officers of the Smallholder Rubber Rehabilitation Project and for the Instructors of Agriculture Development Authority: Dr N. Yogaratnam, Dr M. K. S. A. Samaraweera, Mrs L. Samarappuli, Miss S. Gunesekera, Mr W. C. Dayaratna, Mr A. M. A. Perera and Mr S. Wasanthadeva.

The research staff also served on the following working groups and committees:

N. Yogaratnam - Head of the Department

Co-ordinating Committee on 'Fertilizer supplies' of the Ministry of Plan Implementation.

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

Technical Committee of the Bureau of Ceylon Standards of the Ministry of Industries and Scientific Affairs.

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

Working Group on 'Studies related to the use of Neutron moisture probe for assessing availability and conservation of soil water in plantation crops in Sri Lanka' co-ordinated by the AEA of Sri Lanka.

Working group on 'Phosphate fertilizer efficiency studies' co-ordinated by the AEA of Sri Lanka.

Sub-committee, for internal co-ordinated programme on the use of ^{15}N in soil/plant studies, co-ordinated by the AEA of Sri Lanka.

Executive Committee of the Soil Science Society of Sri Lanka.

M. K. S. A. Samaraweera-Agricultural Chemist

Committee for Popularisation of Science of the Sri Lanka Association for the Advancement of Science.

Sub-committee for fertilizer analysis, National Fertilizer Secretariat, Ministry of Plan - Implementation.

Committee for Standardisation of Analytical Methods sponsored by the Centre for Analytical Research and Development, Department of Chemistry, University of Colombo.

The Council, Institute of Biology, Sri Lanka.

Stearing Committee of Fertilizer Credit Scheme for Tea and Rubber Smallholders, Ministry of Plantation Industries.

Sub-committee for internal co-ordinated programme on the use of ^{15}N soil/plant studies, co-ordinated by the AEA of Sri Lanka.

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

Technical Committee of the Bureau of Ceylon Standards of the Ministry of Industries and Scientific Affairs-Chairman, Sub-committee on Fertilizers.

The Acting Head served on all the Committees on which the Head of the Department served during the latter's absence from the country.

Mrs L. Samarappuli-Assistant Soils Chemist

Working group on 'Studies related to the use of the Neutron moisture probe for assessing availability and conservation of soil water in plantation crops in Sri Lanka' co-ordinated by the AEA of Sri Lanka.

The Research Staff also particpated in the following:

N. Yogaratnam-Head of the Department

12th International Congress of Soil Science held in New Delhi, India.

He was invited by the Petroleum National of Malaysia (Petronas) for a meeting on the use of urea as a fertilizer and presented a report on the use of urea as nitrogenous fertilizer in the rubber plantations of Sri Lanka.

He also served as the Secretary to the Tree Crops Research Planning Committee of the Ministry of Agriculture and Water Development of the Republic of Zambia.

Publications

Samaraweera, M. K. S. A. (1982). Use of isotope in developing countries for the study of *Hevea* and other tree crops in "the use of nuclear techniques in improving fertilizer and water management practices for tree crops"-Proceedings of a consultants meeting IAEA Vienna p. 83.

Ladonin, V. and Samaraweera M. K.S. A. (1982). Plant physiological isotope aided studies specific to rubber trees in 'the use of nuclear techniques in improving ferti-

lizer and water management practices for tree crops". Proceedings of a consultants meeting, IAEA, Vienna p. 109.

Reports

Samaraweera, M. K. S. A. Annual Review of the Soils and Plant Nutrition Department.

Yogaratnam, N. The present status of tree crops research in Zambia and a programme for further development and improvement. Ministry of Agriculture and Water Development, Republic of Zambia.

Yogaratnam, N. End of contract report to the Ministry of Agriculture and Water Development of the Republic of Zambia, MAWD, Republic of Zambia.

Laboratory Investigations

Analytical Chemistry

Routine analyses

Routine chemical analyses of soil and leaf samples, collected during surveys, experimental and advisory visits of the Department were carried out. Requests from research depratments of the Institute, other Institutions and the National Fertilizer Secretariat were also considered. A breakdown of the number of samples analysed is given in Table 1. (M. K. S. A. Samaraweera, N. Yogaratnam, A. M. A. Perera, I. Denawaka, C. K. Mahipala, D. A. Udaratagedera and H. V. K. Rodrigo)

Table 1. *Details of the analysis of samples*

Department Institution	Sample	NPK Ca and Mg	Micro Nutrients Fe, Cu, Zn, Mn	Mechanical analysis, CEC Organic C and pH
Soils & Plant Nutrition	Leaf	3650	21	—
	Soil	92	28	28
	Fertilizer	8	—	—
Plant Pathology	Soil	96	—	60
Rubber Chemistry	Soil	82	—	—
	Water	2	4	—
	Organic compounds	—	4	—
Plant Science	Fertilizer	88 (Avai. & Tot. P)	—	—
Coconut Research Institute	Leaf	476	—	—
National Fertilizer Secretariat	Fertilizer	25	—	—

Analytical methods

Leaves: Determination of Molybdenum in rubber leaves:

The low levels of molybdenum found in plant tissues did not permit us to employ atomic absorption spectrometry for the quantitative estimation of the element. A green coloured Mo-toluene 3,4 dithiolate complex was prepared, extracted with carbon tetrachloride and the Mo content was assayed by measuring the intensity of the colour. The organic matter in 5.0 g of dried leaves was destroyed by the dry ashing method. A mixture of $KHSO_4$, HNO_3 and H_2SO_4 was used as an ashing aid. Several variable conditions were employed for dry ashing and they were:

1. Ashing temperature (three levels)
2. Ashing time (two levels)
3. Composition of ashing aid (three levels)

While the composition of the ashing aid and the temperature had significant effects on the efficiency of extracting Mo from leaves, ashing time had no significant effect. No significant interactions were also seen.

The optimum procedure is to ash 5.0 g of leaves at 550°C with $KHSO_4$ (1.0 g) and 2.5 ml of the HNO_3 : H_2SO_4 acid mixture.

Bark: Determination of NPK contents in *Hevea* bark:

The destruction of organic matter in powdered bark samples was affected by employing dry ashing procedures and wet digestion procedures, to find conditions for optimum recovery of N, P and K. The N, P and K contents were determined by the automated methods.

(1) Dry ashing : The variables were:

(a) Ashing temperature (four levels)
(b) Ashing time (four levels)
(c) Composition of the ashing aid (four levels)

(2) Wet digestion: Three digestion mixtures were used:

(a) HNO_3 : $HClO_4$
(b) H_2SO_4 : Se : H_2O_2
(c) H_2SO_4 : $HClO_4$ and in each case the variables were:

i. Composition of acid mixture (four levels)
ii. Digestion time (three levels)
iii. Digestion temperature (four levels)

The most suitable digestion procedure was to employ a mixture of H_2SO_4, Se and H_2O_2. The recovery of the elments was influenced by all three factors and at times there were significant interactions too. The optimum procedure (for 1.0 g sample) is to use 10 ml of H_2SO_4. Semixture and 2.0 ml H_2O_2 a 325°C for 6 h. (M. K. S. A. Samaraweera and W. M. Jayatilaka Bandara)

Sand culture

Rubber seeds of the clone PB 86 were germinated in nutrient free sand. Seedlings of uniform height were transplanted in pots containing nutrient free sand. Four seedlings were planted in a pot. The plants were treated with modified Hewitt's solution and there were eight treatments replicated five times. Two sets were given all the nutrients, the source of N for one set was NH^+_4 and for the other it was NO^-_3. The remaining six were given all nutrients except N,P,K, Ca, Mg and S respectively, in each. The source of N to those plants not receiving S was NO_3.

The leaves were collected at different stages. Visual deficiency symptoms were photographed and nutritional compositions (*i.e.* N,P,K, Ca, Mg and S contents in all tissues) determined. Relationships between the chemical composition and visual symptoms were established. The growth of the plants not receiving Mg was exteremely poor. The nutritional composition of latex from nutrient deficient plant is also being studied. (M. K. S. A. Samaraweera, Mangalika de Costa).

Soil fertility

Effect of legume covers

The effect of seven different cover crops viz. naturals, *Pueraria, Calapogonium, Desmodium, Mimosa, Stylosanthus* and *Centrosema* on the growth of immature rubber was tested in an on going experiment at Muwankanda State Plantation (C/77/6). There are four replicates in a randomized block design. Thus the total number of plots is 28. Cation exchange capacity, organic carbon content, pH and content of nutrients such as N, P, K, Ca, Mg, B, Ma, Zn, Cu, Fe were determined in the soil samples that were collected in April 1981. A representative sample was taken by sampling at ten different points in each plot. Nutrient content in tissues such as leaves, stems, petiols, roots of different cover crops was also determined. An attempt was also made to identify the different compounds formed during the decay of the cover crops. (M. K. S. A. Samaraweera, A. M. A. Perera S. N. Silva and Ajantha Pushpakumarie)

Field Experiments

Response to fertilizer

N, P, K, Mg on growth of immature plants (F/76/1, F/76/3, F/76/4, and F/76/5)

Experiment, F/76/1, started at Pembroke Estate, compares the effects of 5 levels of N,P,K and Mg on clone PB 86 growing in Boralu series, in a central composite second order design. This experiment was designed to study the response surface of the nutrients

N,P,K and Mg by fitting the function Y (girth response) $=b \pm b_1N \pm b_2P \pm b_3K \pm b_4N^2 \pm b_5P^2 \pm b_6K^2 \pm b_7NP \pm b_8NK \pm b_9PK$. Analysis of girth measurements made at the end of 1982 continues to indicate a significant linear response to application of potassium and curvilinear response to aplications of nitrogen. Response to applications of phosphate and magnesium has however not been significant. This result therefore confirms our previous observation that application of fertilizers in particular nitrogen and potassium would give beneficial results in Boralu soils. (N. Yogaratnam and W, C. Dayaratne)

In the other two experiments, F/76/3 and F/76/4 the rate of growth of all RRIC clones was significantly greater than that of PB 86 and also there was a significant response to application of nitrogen and phosphorus (Tables 2 and 3). This effect was similar in all the clones tested. (N. Yogaratnam and G. de Mel)

Table 2. *Effect of three levels of phosphorus on growth of PB 86, RRIC 101 and 102 on Agalawatta soils*

Clone	Mean girth (cm)	Levels of nitrogen	Mean girth (cm)	Levels of phosphorus	Mean girth (cm)
PB 86	43.20	n_0	43.59	p_0	44.13
RRIC 101	48.86	n_1	46.77	p_1	47.56
RRIC 102	49.59	n_2	51.36	p_2	50.02

Table 3. *Effect of three levels of nitrogen and potassium on growth of PB 86, RRIC 100, 101 and 102 on Homagama soils*

Clones	Girth	Levels of nitrogen	Mean girth (cm)	Levels fo potassium	Mean girth
PB 86	42.79	n_0	46.22	k_0	43.98
RRIC 100	48.44	n_1	49.19	k_1	50.55
RRIC 101	51.93	n_2	50.57	k_2	51.43
RRIC 102	51.47				

LSD 2.40

Another experiment, F/76/5, laid down on Boralu soils compared the effects of three levels of potassium on clones PB 86, RRIC 100 and 101. Provision was also made in the experimental design to compare the effects of three tapping systems during the mature phase. Analysis of girth measurements made at the end of 1982 showed that the rate of growth of all RRIC clones was significantly greater than the PB 86 and also there was a significant response to application of potassium (Table 4), this effect was similar in all the clones tested.

Table 4. *Effects of three levels of potassium on growth of PB 86, RRIC 100 and 101 on Boralu soils*

Clones	Mean girth (cm)	Levels of Potassium	Mean girth (cm)
PB 86	42.70	k_0	44.33
RRIC 100	49.53	k_1	49.03
RRIC 101	50.75	k_2	49.63

Different levels of NPK and Mg on yield of rubber (F/61/1, F/61/2, F/76/6, F/76/8 to 11)

Six experiments studying the effects of fertilizers on growth and yield of mature rubber were in progress covering Boralu, Agalawatta and Parambe series soils. Yield data obtained from these experiments showed that application of fertilizers at the currently recommended rates is likely to give yield increases ranging from 6 to 30%.

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 and the methods of their application.

Sources and placement of nutrients (F/76/2, F/72/2, F/73/1 and F/76/17)

Experiment, F/76/2, compared the effects of three forms of N viz, sulphate of ammonia, urea and ammonium chloride, three forms of P viz: imported rock phosphate, Eppawela rock phosphate and concentrated super posphate and three forms of Mg viz. commercial Epsom Salt, dolomite and kieserite on nutrient uptake and growth of PB 86 in Boralu soils. Girth measurements made at the end of 1982 did not indicate any significant effect of applied nutrients on growth. Therefore, no comparison can be made between the source of nutrient from this data.

The effects of two sources of phosphate were compared at three levels of P in experiment F/76/17, on the performance of PB 86 in Boralu soils. Girth measurements made at the end of 1982 (Table 5) indicated a significant positive response to application of phosphate fertilizer which ever the source of phosphate was applied. Increasing the concentration of P to level 2, however did not have any beneficial effect on growth. Yield data however did not indicate any treatment effect. (N. Yogaratnam, M. A. Mendis, G. de Mel and M. Abeysinghe)

Table 5. *Effect of imported rock phosphate and Eppawela rock phosphate on the growth of PB 86*

Treatment	Mean girth (cm)
Nil phosphate	52.06
Eppawela rock phosphate level 1:	54.42
level 2:	53.78
Imported rock phosphate level 1:	55.32
level 2:	56.40
LSD	1.59

Covers and cover management

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

Types of covers (C/72/2 and C/77/1 to 5)

Experiment, C/72/2 was started to determine whether legumes are superior to naturals in promoting growth of immature rubber. If so, whether application of extra nitrogen to non-legume covers could improve growth during the immaturity period and the yield during early maturity.

Girth measurements made at the end of 1982 (Table 6) continued to indicate that plants that were associated with legumes are still superior to the ones that were in naturals. Yield data also indicated similar tendencies.

Table 6. *Effects of ground covers on growth and yield of immature rubber*

Treatment	Mean girth (cm)	Yield (kg/ha)
Naturals (control)	56.1	1900
Legumes	61.5	2506
Elimination of non-legumes	58.9	2440
Naturals with extra nitrogen	60.5	2578
Naturals with extra nitrogen based on leaf analysis	57.5	2202
LSD	2.3	559

Studies on the effects of various leguminous covers viz. *Pueraria phaseoloides, Calapogonium muconoides, Desmodium ovalifolium, Mimosa invisa, Centrosema pubescens* and *Stylosanthus guyanensis* (*gracillis*) on growth and production of rubber were in progress at three sites. The control plots in these experiments are in naturals. In general growth of trees in legumes (Tabe 7) was superior to the trees in naturals.

Table 7. *Effects of leguminous covers on growth of immature rubber*

Treatment	Mean girth (cm)	
	C/77/3	C/77/6
Naturals	44.19	39.68
Pueraria	47.01*	48.17*
Calapogonium	44.98	44.86*
Desmodium	45.78	44.93
Mlmosa	42.66	44.71*
Stylosanthus	45.05	42.83
Centrosema	—	44.87
LSD	1.95	3.76

Nutrition of legumes

Phosphate: The influence of phosphate application to covers was studied in an experiment (C/70/2) at Pussella State Plantation in Parakaduwa. The ground cover treatments ceased to exist from 1974 and phosphate application was also discontinued in 1974. Data obatined at the end of 1982 (Table 8) continued to show that application of phosphate to cover is more beneficial than its application direct to the rubber tree.

Table 8. *Influence of phosphate application on growth and yield of rubber*

Treatment	Mean girth (cms)	Mean yield kg/ha
Nil P	64.28	1418
P to rubber	65.98	1565
P to cover	68.33	1753
P to rubber and cover	68.24	1660
LSD	1.65	152

Potassium: The influence of potassium application to the ground covers was investigated in an experiment (C/77/8) on Boralu series soils. Unlike phosphate, potassium application direct to the rubber tree (Table 9) appears to be as efficient as its application to the ground covers, especially on K deficient soils as the Boralu soils. (N. Yogaratnam, W. C. Dayaratne and S. Wasanthadeva)

Table 9. *Influence of potassium application on growth of rubber*

Treatments		Girth (cm)
K for rubber:	nil	39.64
	level 1	43.06**
K for cover:	nil	37.04
	level 1	43.23**
	level 2	43.78**
	LSD	2.70

Soil physics and moisture

Preliminary investigations were started to determine the most appropriate position of access tubes in relation to planting points for studies connected with the use of the Neutron moisture gauge. Four trees were selected at random in a two year old replanting at Clyde State Plantation. Twelve access tubes were installed at different points in relation to a rubber tree. Soil samples were collected at different depths and analysed. The analytical data are presented in Tables 10 and 11. (Mrs L. Samarappuli, S. Wasanthadeva, I. Denawaka and P. Karunadasa in collaboration with S. Dimantha of the Land Use Division)

Table 10. *Details of soil analysis*

Depth	pH	Clay %	Silt %	Coarse sand	Fine sand	Organic %
0 — 14 cm	4.50	31.56	4.80	51.58	12.66	1.75
14 — 26 cm	4.70	34.50	5.88	51.28	11.34	1.45
26 — 40 cm	4.80	36.50	4.85	48.00	8.26	1.91
40 — 110 cm	4.85	45.48	5.05	43.15	6.77	0.62
110 — 140 cm	5.35	50.03	11.20	36.93	4.45	0.38
140 — 180 cm	5.45	47.50	11.30	36.13	3.81	0.28

Table 11. *Bulk density data*

Depth	Bulk density	Depth	Bulk density
0 — 10	1.209	90 — 100	1.385
10 — 20	1.255	100 — 110	1.311
20 — 30	1.392	110 — 120	1.313
30 — 40	1.441	120 — 130	1.262
40 — 50	1.415	130 — 140	1.268
50 — 60	1.446	140 — 150	1.288
60 — 70	1.339	150 — 160	1.303
70 — 80	1.377	160 — 170	1.331
80 — 90	1.367	170 — 180	1.425

Other investigations

Components of yield

The latex yield, for the last 3 years were collected from almost all the plantations managed by the Janatha Estate Development Board and the State Plantations Corporation. Attempts are being made to study how the latex production is related to variables such as age of the tree, clone, size of the clearing and the nutritional status of the tree. (M. K. S. A. Samaraweera, S. Gunasekera in collaboration with S. Jayawardena of Department of Mathematics, University of Colombo)

Economics of fertilizer applications in smallholdings

A new project was initiated to study the economics of fertilizer applications in smallholdings.

Smallholdings will be grouped according to their sizes and then will have discussions with a few selected farmers. A questionnaire will then be made and sent to a few smallholders, (say 5-10% of each group).

The data from this survey and the information obtained by soil and foliar survey of the smallholdings will be computed to get an equation regarding the product of latex. (M. K. S. A. Samaraweera, W. C. Dayaratne in collaboration with N. A. Fernando of Central Bank and P. Samaranayake of Advisory Services Department)

Extension

Soil and foliar survey for discriminatory fertilizer recommendations

The foliar survey programme for 1982 commenced in June and estates covering 12,000 ha were surveyed this year. Fertilizer recommendations to all these estates were sent in January 1983. In general N and K fertilizers were recommended to almost all the plantings and some plantings were deficient in NPK and Mg. Urea was recommended as the only source of nitrogen. (M. K. S. A. Samaraweera, N. Yogaratnam L. Samarappuli, A. M. A. Perera, S. Wasanthadeva and S. N. Silva)

Fertilizer demonstrations

Demonstrations were conducted on the correct use of fertilizers at 25 holdings in Galle and Colombo Districts. ((M. K. S. A. Samaraweera in collaboration with C. G. Silva of National Fertilizer Secretariat, G. Dhanayake and P. Samaranayake of Advisory Services Department)

Nutrient deficiency

We have noticed an exceptionally high incidence of nutrient imbalance this year in new and replantings. The symptoms of this are a golden yellow colouration of the edges and the interveinal area of the leaf blade of young rubber trees. Sometimes veins are seen as a green herring bone. These symptoms have been found in 2-3 year old clearings in several districts. Chemical analyses of the tissues from such trees indicate that the plants suffer deficiency of several nutrients, especially that of magnesium. Remedial measures were recommended. (M. K. S. A. Samaraweera, W. C. Dayaratne, and A. M. A. Perera)

REVIEW OF THE RUBBER CHEMISTRY DEPARTMENT

By

P. A. J. YAPA

SUMMARY

A new area of research was on the use of irradiated latex in various applications. This project was sponsored by IAEA. Work on liquid NR was continued during the year. Samples prepared by using coconut oil fatty acids in place of oleic acid were sent abroad for evaluation.

Nexobleach and Rupepa can be used in making low viscosity CV rubber. One commercial batch of this rubber was prepared. Several complaints with regard to the use of Nexobleach in crepe manufacture were attended to. Promising results were obtained in the work on a water soluble tolyl mercaptan as a bleaching agent for crepe rubber.

Mawanella block rubber factory commenced recovery of skim rubber by using the method developed by us.

Attempts to improve the colour of the cyclized rubber prepared from *Hevea* latex as well as dry rubber were continued. Cyclized rubber prepared by solid rubber method was found to be very much more soluble in hydrocarbon solvents than cyclized rubber prepared by the latex method.

Work on the preparation of encapsulating agents and granular rubber was continued. Free radical polymerization method was used to prepare polymers containing carboxyl groups.

Attempts to prepare positively charged latex having excellent stability were successful. Several practical applications were carried out.

Several projects were undertaken by the Department to prevent water seepage using latex/bitumen and latex/cement formulations.

Allylic halogenation of NR and synthetic cis 1,4 polyisoprene was investigated using tertiary butyl hypochlorite as the chlorinating agent.

Crumbs obtained by mechanical pulverization of micro cellular scrap could be successfully used in profile extrusion. Investigations on antioxidants were continued. Preliminary trials on the use of solar energy in drying of crepe rubber were successful.

The data of an island-wide survey clearly indicated the necessity to imporve the overall facilities of all processing units in order to eliminate/minimise the production of low grades of RSS.

Biochemical studies on brown bast trees showed a decrease in protein content in A-serum. Investigation on ATP-ase activity revealed that Mn and K ions stimulates the enzyme activity. Seed protein content of about 70 *Hevea* clones was determined.

DETAILED REVIEW

The work of the Department is described under five main sections. The Rubber Chemistry Section is mainly concerned with studies oriented towards chemical modification of natural rubber; Rubber Technology section is concerned with technological studies; the Specifications Unit is involved mainly with analysis of raw rubber; the Crepe Rubber Development Unit (CRDU) gives advice on the manufacture of crepe rubber and the Biochemistry Unit at Dartonfield is concerned with biochemical studies.

Staff

Mr S. W. Karunaratne, Head of Department was on duty until November. Dr P. A. J. Yapa, Biochemist, was appointed Acting Head of Department from December. Dr A. Coomarasamy, Rubber Chemist, Dr L. M. K. Tillakeratne, Rubber Chemist/Specifications Officer, Dr W. S. E. Fernando, Rubber Chemist, Mr P. A. D. T. Vimalasiri, Assistant Specifications Officer were on duty throughout the year. Mr K. C. Croose, Miss C. P. Wickramasinghe continued to work as Experimental Officers throughout the year. Mr D. D. Medegama, Senior Technical Officer was on duty throughout the year. Technical Officers Messrs W. D. Dharmasena, K. N. U. Mitrananda, P. H. Sarath Kumara, Mrs D. Nirmala, Mrs Manel Nilaweera, Mrs N. Baduge, Mrs S. Weeraman, Misses W. C. M. Perera, R. L. Perera, M. K. Wickramapala, S. P. S. I. Senanayake were on duty throughout the year. Specifications Assistants Messrs W. A. S. Wijesekara, T. M. Ahamadeen, T. A. S. Siriwardhana, G. Wanigatunge, R. Wickramaratne, K. B. Abeysundara, K. K. Austin, M. D. C. Seneviratne, P. D. J. Rodrigo and Mrs D. K. Goonawardane and the Stores Assistant Mrs L. Rukmani were on duty throughout the year.

Dr N. C. Walpita continued to work as a Visiting Senior Research Officer (Chemical/Mechanical Engineer) throughout the year.

Assistant Rubber Chemists Mr E. D. I. H. Perera and Miss N. M. V. Kalyani joined the Institute in September.

Mr G. R. S. S. Gamlath, Mr L. G. Piyasena and Miss K. C. S. Dissanayake joined the Institute in January as Instrument Technicians in the electronic servicing laboratory.

Mr B. Gunasiri and Mr W. W. Nandasena joined the Institute in April and July respectively, as Specification Assistants.

Mr P. A. D. T. Vimalasiri and Mr R. Gunatillake were promoted as Assistant Rubber Chemists during the year. Mr K. A. R. M. Perera and Mr S. Kasinathan were promoted as Experimental Officers in September. Mr I. S. H. L. Weerasinghe was promoted as Senior Technical Officer in April.

Research students

Miss A. Angammana continued her studies on the effect of metal salts of higher fatty acids on sulfur vulcanizaition of NR and its blends under the supervision of Dr W. S. E. Fernando and Dr A. Coomarasamy on a NSC grant.

Mr Li-Jiu-Long of Shanding Chemical Engineering Institute, Student of Peoples Republic of China commenced his studies in the field of rubber technology towards the end of the year.

Mr P. W. Sedirishamy, Experimental Officer resigned his post in November. Mr D. G. Samaneris, Technical Officer resigned his post in late November. Mrs M. D. K. Gunawardana, Specification Assistant vacated her post in March 1982.

Seminars, meetings and lectures

A Seminar on crepe rubber, problems of mould growth, was conducted by the Department at the Chamber of Commerce on the 27 January 1982 where brokers, shippers and representatives from the JEDB and SPC participated.

S. W. Karunaratne and A. Coomarasamy attended a 3-day seminar conducted by the Ministry of Plan Implementation on Coumputer Techniques held in May.

S. W. Karunaratne represented the RRI at the ESCAP meeting on "Renewable Sources of Energy" held at the BMICH from 2 to 8 March 1982.

S. W. Karunaratne was elected Chairman of drafting committees of the Bureau of Ceylon Standards (BSC) on a) Mechanical contraceptives b) Rubber bands. He attended six drafting committee meetings during the year.

S. W. Karunaratne attended two meetings of the Advisory Council of the Industrial Development Board (IDB) in connection with setting up of the technical service centre and participated in the opening ceremony of the centre.

S. W. Karunaratne attended 11 meetings of the Rubber Advisory Committee of the Export Development Board.

S. W. Karunaratne participated in a workshop on facilities for postgraduate training of chemistry graduates in Sri Lanka, organized by the Institute of Chemistry, Ceylon, on 26 February 1982 at the SLAAS Headquarters.

S. W. Karu naratne and A. Coomarasamy attended the Annual Sessions of the Institute of Chemistry held from 14 to 17 June.

The Departmental staff attended the inaugaral meeting and seminar of the Institute of Biology (Sri Lanka) held on the 14 June. P. A. J. Yapa gave a talk on 'The Yield Stimulation of *Hevea*' at this Seminar.

A. Coomarasamy attended four meetings of the BCS on plastics, two meetings on rubber seed oil.

The Departmental staff participated in a factory officers training programme given to SPC personnel in the Horana/Ratnapura area. This was sponsored by the NIPM and was held at the Tebuwana Planters Club on 30 April.

The Departmental staff participated in a training programme held at Nivitigalakele Training Centre on the 25 June and conducted lectures on processing of rubber to the Agricultural Instructors of the ADA.

The Departmental staff also participated in a training programme held at Nivitigalakele Training Centre and conducted lectures on processing of rubber to three batches of Rubber Extension Officers during the year.

The Departmental staff were involved in the organization and holding of a series of practicals for the MSc students in Polymer Science and Technology from the Sri Jayawardanapura University. L. M. K. Tillakeratne, Specifications Officer, and W. S. E. Fernando, Rubber Chemist, took 10 and 8 lectures respectively for MSc students at Sri Jayawardanapura University.

L. M. K. Tillakeratne delivered 15 lectures to Applied Engineering Students at Moratuwa Univeristy, whilst W. S. E. Fernando delivered 8 lectures to them.

P. A. J. Yapa gave 5 lectures on Biochemistry of latex at University of Colombo for MSc (Biochemistry) students.

P. A. J. Yapa served as a co-opted member of the committee for the Popularization of Science of the SLAAS and attended its monthly meetings during the year. He also served as the Chairman of the Editorial Sub-Committee for Vidya Viyapthi magazine.

P. A. J. Yapa also served as an External Faculty member of the Faculty of Applied Sciences of the Sri Jayawardanapura University and attended its meetings during the year.

P. A. J. Yapa attended two seminars on Environmental pollution organized by NIBM/ ILO during the year.

W. S. E. Fernando served as a member of the drafting committes on contraceptives

K. A. R. M. Perera delivered a talk on "The opportunities at RAPRA" to the staff of the Rubber Chemistry Department after his return from overseas training at RAPRA.

Visits

M. C. S. Perera, Assistant Rubber Chemist proceeded to Australia in February on a Colombo Plan Scholarship for post graduate studies at Australian National University.

A. S. Dekumpitiya, Senior Technical Officer proceeded to Malaysia in March for training in rubber processing at the Rubber Research Institue of Malaysia and returned in December, 1982.

S. W. Karunaratne, Head, Rubber Chemistry Department visited Indonesia to attend a Seminar on Radiation Vulcanization in early November.

S. W. Karunaratne, Head, Rubber Chemistry Department, proceeded to Japan for a 6-month research study on Radiation Vulcanization in November. The visit was sponsored by the International Atomic Energy Authority.

M. D. R. J. Gunatillake, Assistant Rubber Chemist proceeded to United Kingdom for postgraduate studies at the University of Aston, Birmingham, UK.

L. M. K. Tillakeratne, Specifications Officer visited India to represent Sri Lanka at the 30th meeting of the ISO TC 45 conference as the leader of the Sri Lanka delegation.

P. P. Jayasinghe, Experimental Officer proceeded to the Netherlands on no-pay leave for one year in November.

Arrangements were made during the year for postgraduate training of P. A. D. T. Vimalasiri, Assistant Rubber Chemist. He is to proceed to Australia in early 1983.

S. W. Karunaratne participated in a technical review meeting on radiation processing held in Malaysia from 15 to 19 of February , 1982.

Publications

Coomarasamy, A. (1982). Cyclisation of natural rubber. *J. Plastics & Rubb. Inst.* (*Sir Lanka*) – in press.

Coomarasamy, A., Perera, P. P. and Nadarajah, M. (1982). Preparation and uses of cyclised rubber obtained from papain coagulated natural rubber. *J. Rubb. Res. Inst. Sri Lanka,* **58**, 46 – 57.

Coomarasamy, A., de Silva, K. G. K. and Wijesinghe, U. P. (1982). "Preparation of free flowing granular natural rubber". *J. Rubb. Res. Inst. Sri Lanka,* **58**, 58 – 72.

Fernando, W. S. E. (1982). Dual purpose vulcanization activator for NR. *J. Rubb. Res. Inst. of Sri Lanka,* **58**, 11 – 31.

Fernando, W. S. E., Jayasinghe, P. P. (1982). Evaluation of some indegenous fillers for the rubber industry. *J. Rubb. Res. Inst. of Sri Lanka* (in press.)

Tillakeratne, L. M. K., and Coomarasamy, A. (1982). Improvement of smallholder rubber in Sri Lanka. ANRPC 5th Seminar, December 1982, Kuala Lumpur.

Yapa, P. A. J. (1982). Yield stimulation of *Hevea. Bull. Rubb. Res. Inst. Sri Lanka* (in press)

Yapa, P. A. J. and Lionel, W. A. (1982). A study of raw rubber properties of clones of RRIC series. *Bull. Rubb. Res. Inst. Sri Lanka* (in press)

Abstracts

Coomarasamy, A. and Nirmala, D. (1982). Studies on improving the flame resistance of rubberized coir. *Proc. of the Annual Sessions of the SLAAS,* 1982, p. 59.

Tillakeratne, L. M. K. and Vimalasiri, P. A. D. T. (1982). Manufacture of general-purpose CV rubber in Sri Lanka. *Proc. of the Annual Sessions of the SLAAS,* 1982 p. 60.

Tillakeratne, L. M., K., Vimalasiri, P. A. D. T. and Sarath Kumara, P. H. (1982). Effect of humidity on the moisture intake of lace crepe rubber. *Proc. of the Annual Sessions of the SLAAS,* 1982, p. 59.

Wijetillake, L. C., Fernando, D. M., Liyanage, A. de S. and Yapa, P. A. J. (1982). The relationship between *Colletotrichum* leaf disease and South American leaf blight of rubber (*Hevea brasiliensis*). *Proc. of the Annual Sessions of the SLAAS* (1982) p. 25 – 26.

Reports

Tillakeratne, L. M. K. (1982). Cure rate determination in natural rubber – Presented at the ISO TC 45 Conference held in New Delhi, 1982.

Thesis

Prematillake, S. P. (1982). Biochemical characterization of *Hevea* clones with special reference to A-serum protein patterns. Thesis submitted for the MSc. degree at University of Sri Jayawardanapura, Sri Lanka.

Miss I. Jayawardana, Miss M. Angammana and Miss H. D. W. H. Perera, NSC students were writing up their MSc Thesis and they were assisted by their supervisors Dr A. Coomarasamy, Dr W. S. E. Fernando and Dr L. M. K. Tillakeratne, respectively.

Vacation students

Five university students were given vacation assignments in the Department during the year.

Miscellaneous

Departmental staff spent a fair amount of time on the revision of the hand book on rubber culture and processing. In all, 14 Chapters were compiled which included 7 new Chapters.

Research and Technology

Liquid natural rubber

Work on this project was continued during the year and further samples of the emulsion prepared by using coconut oil fatty acids in place of oleic acid were sent to West Germany for evaluation. The non availability of a method to analyse excess nitro benzene left behind in liquid NR remained the biggest draw back. (L. M. K. Tillakeratne, P. A. D. T. Vimalasiri and T. A. S. Siriwardane)

Manufacture of CV rubber using peptizers in addition to viscosity stabilizers

The work carried out on CV rubber showed that Nexobleach and Rupepa can be used in making low viscosity CV rubber at a drying temperature of 100 ± 10^{0}C. Attempts were made during the year to make low viscosity rubbers using these chemicals. Trials were carried out at C. W. Mackies factory at Horana and Dartonfield factory. CV 50 and CV 60 rubber samples prepared by this method from RSS cuttings and scrap in granulated form by mixing with latex treated with hydroxylamine and peptizer was found to be superior in all properties when compared to other methods tried out before, to make CV out of scrap.

A 5 MT consignment of CV rubber prepared at Dartonfield factory was exported to West Germany at a premium price. Further, new orders are expected in the near future. (L. M. K. Tillakaratne and P. A. D. T. Vimalasiri)

Manufacture of skim rubber

The work on this project was continued during the year (see Annual Report 1981). Mawanella Block Rubber Factory has commenced large scale recovery of skim rubber at their factory using the method developed by us and considerable amount of rubber is recovered daily from skim latex. Attempts will be made to develop methods to utilize the sludge formed during centrifuged latex manufacture. (L. M. K. Tillakeratne and P. A. D. T. Vimalasiri)

Cyclised rubber

Technical assistance on the manufacture and uses of Cyclised rubber from papain coagualated rubber was given to the interested parties throughout the year. But due to the ready availability of high styrene resins at a reasonable price, the commercial use of cyclised rubber obtained by the solid rubber method had been quite low. One of the drawbacks of the product obtained by the solid rubber method is its dark colour.

Cyclised rubber obtained by the latex method is light in colour and fresh work was initiated on latex stage cyclisation using concentrated sulphuric acid as the cyclising agent. The aim of these experiments is to determine the most suitable type of latex for cyclisation. In a typical experiment 2000 ml of high ammonia centrifuged latex (60% drc) was stabilized by adding 300 ml of 10% solution of non ionic stabiliser vulcastab LW after deammoniation and allowing the mixture to stand over night. 1650 ml of 98% commercial sulphuric acid was added little at a time with continuous stirring and the temperature was kept at 80°C during the addition. The mixture which turned chocolate brown was maintained at 80°C for a further 2 1/2 hours and coagulated by pouring into boiling water. The precipitated cyclised rubber powder was filtered, washed and dried. This experiment was repeated with 2-years old centrifuged latex, low nitrogen latices prepared by treating the latex with proteolytic enzymes (papain and pineapple juice) and also with positively charged centrifuged latex (55% drc). The nature of the product obtained along with the nitrogen content after 2 1/2 hours reaction time are given in Table 1.

Table 1. *Latex stage cyclisation of concentrated latice*

Type of latex	drc	Nitrogen content	Reaction time	Nature of the product
Ammonia stabilized centrifuged latex (after deammoniation) (New sample)	58	0.12	2 1/2 hrs	white powder
Ammonia stabilized centrifuged latex (after deammoniation) (2 years old sample)	58	0.15	2 1/2 hrs	rubbery but hard
Low nitrogen latex (papain treated)	50	0.056	2 1/2 hrs	rubbery
Low nitrogen latex (pineapple juice treated)	49	0.070	2 1/2 hrs	rubbery
Positively charged centrifuged latex (prepared with citrimide as the stabilizer)	55	—	2 1/2 hrs	rubbery

These results show that the higher degree of cyclisation resulting in the formation of cyclised rubber powder occurred only when ammonia stabilized centrifuged latex was used. The results obtained with other latices cannot be correlated directly as the rubber content in these latices is relatively low. These results suggest that ammonia stabilized centrifuged latex is the most suitable type of raw material of the latices used.

The solubility characteristics of cyclised rubber samples prepared by the latex method, the solid rubbr method and commercially produced solution grade cyclised rubber samples (obtained from abroad) were studied. It was found that the cyslised rubber prepared by the solid rubber method was very much more soluble in hydrocarbon solvents than the other samples and this is due to the mechanical break down of the polymer chain during the milling process prior to cyclisation. This is an advantage, as this grade of cyclised rubber could be readily used for the preparation of quick drying paints such as floor paints and road marking paints. Latex grade cyclised rubber has to be milled to increase the solubility but it has the advantage over the cyclised rubber prepared from the solid rubber method as it is light in colour. NMR spectral analysis revealed that the cyclisity in these samples is around 3.

A paper on "Cyclisation of natural rubber" giving details on the work done on the preparation of cyclised rubber by the solid rubber method, latex method and solution on the uses of cyclised rubber has been submitted to the PRI (Sri Lanka) Journal for publication. (A. Coomarasamy, C. Kuruppu and D. G. Samaneris)

Granular rubber

Earlier work has shown that granular rubber samples prepared by the use of acrylic polymers and alginates as encapsulating agents when compounded and vulcanised, had good physical properties such as increased hardness, tensile strength and modulus. Gum compounds were found to be quite transparent. In order to investigate these properties in detail, work on the preparation of encapsulating agents and granular rubber was continued during this year.

The free radical polymerisation method was used to prepare polymers containing carboxyl groups. Methacrylic acid, acrylic acid, acrylamide were used as monomers of the copolymers and homopolymers. Polymerisation reaction was done at 60°C and potassium persulphate/sodium metabisulphite (0.6/0.3 g hpr) used as the initiater system. Sodium salts of the prepared polymers were used in the preparation of granular rubber. These sodium salts were mixed, in different proportions with deammoniated natural rubber latex. A saturated solution of potassium aluminium sulphate was added to the resultant mixture until the formation of a wet granular coagulum. This was kept overnight and filtered under suction in order to remove serum water and wet granular coagulum was dried in an oven at 70°C. (A. Coomarasamy, N. M. V. Kalyani, E. D. I. H. Perera and P. Sedirishamy)

Kinetics of polymerisation

Dilatometry was used in order to select the optimum concentrations of the initiator and the reducing agent for the polymerisation of the acrylic acid. Potassium persulphate was used as the initiator and sodium metabisulphite was the reducing agent. The reaction was done in a thermostatically controlled water bath at 50°C. 5 cc of the destabilized monomer mixed with 20 cc of distilled water in a volumetric flask, and kept in the thermostatically controlled water bath at 50°C. Potassium persulphate and sodium metabisulphite were dissolved in 1 cc of distilled water and added immediately to the flask and shaken. This solution was poured into the dilatometer bulb and fixed vertically in the water bath at 50°C, with the polymerisation the minimum level decreases and the change in height was noted. (N. M. V. Kalyani).

Positively charged latex

Positively charged latex could be prepared by adding a 10% solution of a cationic surfactant to field latex at 2% immediately after collection. This positively charged latex could be centrifuged to obtain a drc of about 57% using the laboratory centrifuge available at Dartonfield. It was found that it is possible to add concentrated sulphuric acid to three latices without any coagulation problem for use in cyclisation studies. To ensure long term stability ZnO/TMTD mixture was added at 0.13% of each on latex for the positively charged

centrifuged latex. The stability was found to be excellent. Bacterial and fungal count carried out with this latex showed that it was not contaminated with these organisms. Positively charged latex could be easily added to Portland cement without coagulation. problems. This latex is also compatible with cationic bitumen emulsions, and it can also be used to carry out modification reactions such as epoxidation and halogenations.

Samples of positively charged latices were prepared from fresh field latex using cetyl trimethyl ammonium bromide and Duomeen, a commercial product obtained from M/s Lankem Ltd., as stabllizers. Cetyl trimethyl ammonium bromide was found to be superior to Duomeen as a stabilizer. Preparation of positively charged latex from ammonia stabilized latex is also being investigated.

In order to get some information on the effect of added cationic soap-cetyl trimethyl ammonium bromide upon the mechanical stability, viscosity, compounding processes and electrode deposition, a series of experiments was done using natural rubber field latex. Samples of positively charged latex containing different amounts of cationic soap were prepared (2% - 12%). The addition of a cationic soap to natural rubber latex was found always to be accompanied by an increase in mechanical stabllity . It increases with the amount of cationic soap. The mechanical stabilities were determined at 50% TS content instead of 55% TS content because of the difficulty of preparing the latex at 35% TS content. The dilution was done using distilled water instead of 1.6% w/v ammonia solution, required by the standard procedure. Two methods were used to locate the end point of the stability test, and both gave the same results. One method was to drop small quantities of latex on the surface of distilled water and take the end point as the time at which small nucleus of coagulum first became permanently visible on the surface of the water. The other method was to place a small quantity of latex on the edge of the palm of the hand and then slowly smear it to form a thin film on the palm using a clean glass rod. The end point was taken as the time at which small particle first became visible in the film. (A. Coomarasamy, N. M. V. Kalyani, P. Sedirishamy, K. C. Croose, D. Nirmala and C. Kuruppu)

Flame resistant rubberized coir

The work which was initiated last year on this project was continued. Rubberized coir samples prepared with various flame retardant chemicals were tested for flammability using both qualitative and quantitative tests. For the quantitative test, the procedure adopted in American motor vehicle safety standards MVSS 302 was used, except for the fact that a fume cupboard was used instead of the special chamber. Samples treated with (1) antimony trioxide alone at 20% or more (2) antimony trioxide at 10% on rubber with coir treated with borax, (3) calcium pyrophosphate at 10% on latex with coir treated with borax, (4) bromotrichloro methane modified (15% on rubber) with borax at 10% on coir and (5) a polymeric complex compound of boric acid at 10% on rubber, were found to have satisfactory flame resistance. A paper on this subject was presented at the 38th SLAAS Annual Sessions in December, 1982. (A. Coomarasamy, D. Nirmala and W. D. Dharmasena)

Latex/Bitumen and latex cement mixes for water proofing concrete floors and roofs

Several projects were undertaken by the Department to prevent water seepa ge using previously developed formulations. Basically our method involves thorough clean ing of the surface followed by application of two or three coats of rubberized bitumen emulsion followed by rendering the top surface rubberized with cement motar. It is also necessary to carry out periodic inspection and maintenance work for satisfactory performance. (S. W. Karunaratne, A. Coomarasamy, K. A. R. M. Perera and K. C. Croose)

Coagulants for raw natural rubber

This study was initiated during the course of this year. Formic acid, hydrochloric acid, sulphuric acid, phosphoric acid and a proprietory chemical catalyst AC have been used as coagulants in this study. The five following types of crepe rubber smaples were prepared: Fractionated and unfranctionated, bleached and unbleached rubbers and fraction rubber.

The samples prepared with fomic acid and hydrochloric acid as the coagulants were comparable, in colour. There was a slight discolouration in the samples prepared with sulphuric acid as the coagulant and the samples prepared with phosphoric acid were much darker in colour. Although the samples prepared with catalyst AC as the coagulant were not discoloured, the properties of vulcanisates prepared using this as the coagulant were very much inferior to those of control samples prepared with formic acid. The work in this project is being continued. (A. Coomarasamy, P. Sedirishamy, D. G. Samaneris and D. Nirmala)

Due to the formation of bubbles in RSS when catalyst AC is used as the coagulant its use in RSS manufacture is not recommencded. However, in crepe manufacture, there were no adverse effects. The dosage used was 8 to 12 g per kg of dry rubber as a 1% solution. Large scale trials are planned to confirm these findings. (M. D. R. J. Goonatillake, S.Weerasinghe and C. Samaneris)

Slow release fertilizers

Ordinary rubber film is impermeable to water and aqueous solutions of fertilizers. In order to make the rubber film permeable to water, starch and derivatives of starch were incorporated into the compounded latex and thin rubber bags were made by the standard dipping process. The rubber bags were then packed with urea and tested for permeability in a soxhlet extractor, using water as the solvent. The tests showed that the rubber bags prepared with compounded latex containing starch derivatives release the fertilizer in small quantities as aqueous solutions. Future work is being planned. (A. Coomarasamy and D. Nirmala)

Reactions of halogen compounds with NR

Experiments on allylic halogenation of NR and synthetic cis 1,4 polyisoprene were carried out in the solution stage using tertiary butyl hypochlorite as the chlorinating agent. IR and NMR spectral data of the treated rubber samples indicated the presence of allylic chlorine. Quantitative estimation of chlorine content in the polymers was carried out using the oxygen flask method. This project was given as a MSc research project to Mr P. Sedirishamy under the supervision of Dr A. Coomarasamy. (A. Coomarasamay and P. Sedirishamy)

Rubber seed and rubber seed oil

(a) Several hundred kg of fresh rubber seeds and rubber seed kernel were purchased from Piliyandala/Kottawa area for the extraction of oil. The rubber seed sample and kernel samples were heat - treated at 60° C for 2h and at 100°C for 1 h to study the effect of heat treatment on the FFA and colour of the oil and also to see the effect on storage characteristics. These heat treated samples which were stored for 2 weeks were milled by one of the leading millers for the extraction of oil. The yield was found to be quite low compared to the untreated seed. These millers have obtained higher yields by pre-heating the seeds immediately before feeding into the expeller. Discussions were held with one expeller manufacturer and one rubber seed miller regarding the storage and the milling of rubber seed. The discussion revealed that it is possible to obtain good quality oil, provided the seeds are properly stored and dried before milling. The millers advocate collection of seeds in coir bags and storing them in covered sheds for about 2 months before milling. When the seeds are stored in the above manner, the moisture content of the seed comes down to the required minimum level, this takes about 2 months. Long storage results in deterioration of seeds and along with it, the colour of the oil and FFA value increases. (A. Coomarasamy, K. C. Croose and C. Kuruppu)

(b) Purification of the four samples of rubber seed oil supplied by the IDB was carried out using acid and alkali refining processes, followed by treatment with fullers earth for the recovery of the colour. Acid value, iodine value and colour of this refined samples were estimated. (A. Coomarasamy, K. C. Croose, C. Kuruppu and M. Nizar - Vacation trainee)

Evaluation of irradiated latex

Irradiated latex received from the radiation centre in Indonesia was evalauated. Our laboratories have undertaken to participate in a programme of work to evaluate irradiated latex for this project. Sri Lanka is expected to receive financial assistance to set up a fully equipped latex testing laboratory at the RRI. The initial batch of latex was tested for film properties, and physical characteristics of dried film. Compared to prevulcanised latex

film, the irradiated latex film showed better clarity due to absence of sulphur and other additions in appreciable quantities, to reduce the transparency. Very thin films were prepared by dipping once tnto the latex without any coagulant. These films showd good tensile strength properties in all directions. Tensile strength was determined with and without antioxidants (Nonox WSP) after the dry films were heated at 50°, 75°, 100° and 120°C for periods ranging from 15 min to 1 h. Above 75°C the tensile strength dropped to very low values. At 75°C, the optimum tensile strength was obtained when the sample was heated for 45 min.

Cross linking intensities of dry films of irradiated latex, heated in an oven at 100°C for periods of 15, 30 and 45 min were measured to study the effect of heating on cross link formation. Toluene was used as the solvent. They were compared with prevulcanized films using sulphur as the vulcanizing agent. Further investigations are in progress. (S. W. Karunaratne, Manel Nilaweera and D. Nirmala)

Extensive investigations have been carried out using carbon tetra chloride as a sensitiser to reduce the irradiation dose. Its effect is dependent on the level of addition, the rate of addition and how effectively it is imbibed in the rubber phase, prior to irradiation. Emulsification of the sensitiser prior to addition has also been reported to cause enhancement of properties. With carbon tetrachloride, up to 5% of the irradiation dose could be reduced to a level less than or equal to 5mR to give optimum tensile properties in the region of 250 - 300 kg/cm^2. The toxicity of carbon tetrachloride is of major concern at present and this has prompted some work to find suitable non toxic alternatives. Poly functional monomers have been successfully used to initiate cross linking of rubber molecules during irradiation. So far the most successful monomer has been Neopently glycol acrylate. This chemical is about three times more expensive than carbon tetrachloride but non toxic and safer to handle. With a reduced irradiation dose as compared to carbon tetrachloride a high tensile strength upto 350 kg/cm^2 has been achieved along with improved heat ageing properties.

Following are the noteworthy developments in the investigations on radiation vulcanization of NR latex.

(a) Use of neopentyl glycol acrylate as a cross linking agent instead of carbon tetracholoride which is a toxic chemical.
(b) Use of methanol as a radical scavenger to modify the structure of latex particles and improve inter particle bonding and hence the tensile strength.

These two additives bring about the desired tensile properties and heat ageing properties but further improvement in permenent set reduction has to be achieved. The combined effect of these two chemicals has still to be investigated thoroughly.

The most promising fields for rubber products and related applications based on irradiated latex are:

(1) In the manufacture of dipped products eg condoms and surgical gloves
(2) In adhesives and carpet backing
(3) Hospital sheeting and baby cot sheets
(4) We have already initiated some work in the manufacture of SP rubber using irradiated latex and the results appear to be encouraging. (S. W. Karunaratne)

Extrusion studies

Use of micro crumbs in extrusion

It was observed that crumbs obtained by mechanical pulverisation of micro cellular scrap could be successfully used in profile extrusion. These behave in a similar manner to SP rubber, aiding the rubber compound to lower die swell, and retain the profile shape after extrusion. One of the advantages of micro crumbs is that unlike SP rubber, if occassion demands, the former could be tailor made *in situ*. Further studies are in progress to determine the effect of various fillers and reinforcing resins in micro crumbs on the extrusion characteristics of rubber compounds. A paper entitled micro crumbs in profile extrusion has been sent for publication. (W. S. E. Fernando, D. D. Medagama and K. M. U. Mitrananda.)

Use of IPVR/NR blends

A blend of natural and irradiated prevulcanized rubber (50 : 50) was prepared by mixing field NR latex with IPV latex. The latex blend was coagulated with formic acid and processed in the usual manner to crepe rubber.

It was envisaged that this blend could have similar properties to that of SP rubbers, because both are blends of cross linked rubber and raw rubber. The differences lie only in the nature of cross links, and the residual compounding ingredients used in cross link formation. Thus SP rubber consists entirely of sulfur cross linked rubber with residual accelerator and activators dispersed in a matrix of raw rubber whereas IPVR blend is carbon - carbon cross linked rubber dispersed in a raw rubber matrix with no other additives.

The IPVR blends were found to be capable of reducing the die swell and extrudate distortion of rubber compounds. The efficiency of IPVR blend in bringing about these two effects were much higher than for SP rubber.

One major drawback is the increase in scorch time of the compound in the presence of IPVR blend. This led to partial collapse of the extrudate. Further trials are in progress to formulate a suitable accelerator system for compounds containing IPVR blends. The progress of this project will depend entirely on the supply of IPV latex which is air – freighted in limited quantities from Indonesia. (W. S. E. Fernando, S. W. Karunaratne and D. D. Medagama)

Use of carboxylated polymers

Considerable length of tubing were extruded successfully using encapsulated NR obtained by alum coagulation of NR latex containing carboxylated polymer. An interesting feature observed here was the excellent surface finish of the extruded profile. (W. S. E. Fernando, D. D. Medagama, W. D. Dharamasena and K. M. U. Mitrananda)

NR/Poly (Vinyl acetate co Acrylate) blends

These blends were prepared by blending NR field latex with latices obtained by co-polymerising vinyl acetate and acrylic acid. The latexblend was coagulated using formic acid and processed in the usual manner to crepe.

With suitable compounding modifications these blends were successfully extruded with minimum extrudate swell and distortion. An interesting feature of these blends is the excellent surface finish of the extruded profile. (W. S. E. Fernando, W. D. Dharmasena, D. D. Medagama and K. M. U. Mitrananda)

NR/Poly (Vinyl acetate co. Acrylic acid) blend (POLY BLEND)

The blends obtained by the method described previously under extrusion studies were used in the following investigations.

POLY BLEND/Nitrile rubber and Poly blend/Chloroprene blends

Since the polyblend consists of a blend of NR with polymers containing polar groups, trials were conducted to assess the compatibility of the latter with Nitrile and Chloroprene rubbers. This project was initiated to study.

(i) the effect blending, poly blend with oil resistant rubbers on oil resistance of resulting vulcanizaties.

(ii) the effect of blending of poly blend on the physical properties.

Furthermore, if these are within specification for specified applications where oil resistance is of importance, the poly blend could lower the compounding cost. (W. S. E. Fernando and K. A. R. M. Perera)

Poly blend vulcanization

The valcanization characteristics of these blends are similar to those of natural rubber. The ability of these compounds to adhere to different substrates during vulcanization are being investigated. (W. S. E. Fernando and K. A. R. M. Perera)

Tread repair compound

This project was begun towards the end of the year to design a low temperature curable compound, suitable for *in situ* repair of heavy vehicle tyres. The compounds formulated have now been sent for evaluation. (W. S. E. Fernando and K. A. R. M. Perera)

Industrial extension

(I) A report was submitted to The Greater Colombo Economic Commission (GCEC) on a centrifuged latex factory set up by a latex thread manufacturer

(II) Our cooporation was extended in the process design and compound formulation of the following items.

i. Resin soling compounds

ii. NR/EVA blends for microcellular soling materials

iii. Rubber to metal bonded oil seals using nitrile rubber

iv. Extrusion of wiper blades

v. General purpose oil seals from nitrile rubber

vi. Shoe solings of 60 - 65 hardness range

vii. Tyre retreading

viii. Production of microcellular sheets

ix. Production of remilled sole crepe

(W. S. E. Fernando, K. A. R. M. Perera and S. Weerasinghe)

Antioxidants for products based on latex crepe

Two hundred phenol derivatives containing hydrazide (TBHP) and carboxyl functionality (BHPPA) were obtained by methods described in the literature. The former was incorporated into natural rubber as a dispersion and the latter as its sodium salt at the latex stage. These latices were coagulated in the usual manner and processed into latex crepe for testing.

Antioxidant BHPPA

The performance of this antioxidant at 1.5 phr and 1.0 phr, in the formulation given below, was compared with Nonox WSP

NR crepe	100.0
ZnO	4.0
Steraic acid	2.0
$CaCO_3$	20.0
TiO_2	5.0
CBS	1.2
TMTD	0.3
S	1.0
Antioxidant	1.0/1.5

The retention of physical properties of the vulcanization on ageing with experiment antioxidant was found to be comparable to that of Nonox WSP. On repeated extraction with a 10% detergent solution followed by ageing, the test samples containing antioxidant BHPPA was found to be superior.

Antioxidant TBHP

It was envisaged that at least a portion of this antioxidant would adhere to the NR chain by reacting with carbonyl groups. It has been possible to confirm this indirectly by measuring the storage hardening of TBHP containing crepe; green ageing and extraction studies are in progress. (W. S. E. Fernando and E. D. I. H. Perera)

Barium stearate as additives to silica-filled compounds

Barium stearate (as additives) can be added directly during mixing rubber and filler. Mixing was carried out in a laboratory internal mixer. In this case the surface treatment of the filler takes place during compounding rather than by pretreatment. Table 2 gives formulation; Table 3 gives the performance of compounds. According to the Tables a comparative study could be made of the properties of precipitated silica with and without addition of barium stearate.

Table 2. *Silica-filled compound formulations*

Ingredient	Compound I No. 1	Compound II No. 2
RSS	100.0	100.2
ZnO	5.0	5.0
Stearic acid	2.5	
Antioxidant	1.0	1.0
Silica (VN II)	50.0	50.0
Polyethylene glycol	2.5	2.5
Dutrex R	3.0	3.0
MBTS	1.0	1.0
DPG	0.3	0.3
S	2.2	2.2
Barium stearate	—	2.5

Table 3. *Comparison of the physical properties of vulcanizates from Table* 2

Properties	Compound No. 1	Compound No. 2
Mooney viscosity of cpd	97	103
100% Modulus (kg/cm²)	21.115	21.113
300% Modulus (kg/cm²)	51.229	65.81
Tensile strength (kg/cm²)	177.41	224.51
Elongation at break (%)	550	640
Shore hardness IRHD	70	78
Resilience	50	52
Abrasion loss ml	0.10773	0.10205
Cure time at 145°C (mm)	12	12
Aged 72 hours at 100°C		
100% Modulus (kg/cm²)	24.9	29.26
300% Modulus (kg/cm²)	86.0	92.66
Tensile strength (kg/cm²)	151.82	167.54
Elongation at break	500	500

The addition of Barium stearate results in a significant improvement in performance. The substance corrects a number of inherent deficiencies of precipitated hydrated silica filler.

Use of microcrumbs in extrusion of rubber compo u nds

Work carried out in this department clearly shows the possibility of using microcellular crumbs in profile extrusion. The use of micro crumbs could help eliminate the need for factice and/or SP rubber for certain operations. This project was initiated to examine the effect of various compounding ingredients in microcurmbs in the extrusion characteristics of rubber compounds.

Microcellular expanded soling materials for this investigation were prepared by using the formulations given in Table 4. (Li-Jiu-Long and W. S. E. Fernando)

Table 4. *Formulation used for microcellular expanded soling materials*

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8
Smoked sheet	100.0	100.0	100.0	100.0	100.0	—	—	—
High styrene resin	—	—	15.0	15.0	—	—	—	—
Silica	—	45.0	—	45.0	—	45.0	45.0	45.0
Zinc oxide	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Stearic acid	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Tio_2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
MBTS	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
DPG	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
SP	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Wax	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Polyethylene glycol	—	1.0	—	1.0	—	1.0	1.0	1.0
Process oil	3.0	3.0	10.0	3.0	10.0	3.0	3.0	3.0
Sulfur	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Blowing agent (BN 94)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Clay	—	—	100.0	—	100.0	—	—	—
Pale crepe	—	—	—	—	—	90.0	95.0	85.0
PVA	—	—	—	—	—	10.0	5.0	15.0
Cure time at 150°C (Min)	5	6	7	7	7	7	7	7

Raw Rubber Manufacture and Specifications

Solar drying of crepe rubber

Laces of crepe have been successfully dried in the scale model drying tower using solar energy alone. A control experiment was also performed. Where the collector was closed off and ambient temperature air was circulated. Drying time with the collector in operation was about 72 h compared to 80 h with air at ambinet temperature. Solar drying appears to compare favourably even with electrical drying. Further experiments will be performed with different weights of crepe and other variables.

A simple air heater has been designed and constructed. The purpose of this unit is to act as a back up to the solar collector at night and during cloudy weather. The unit consists of a sealed box for fresh air with a through duct for hot air fan. A fan blows air through the sealed box. Air is heated within the unit by burning fire wood. Preliminary tests have given air temperature of 120°-130°F over a period of 3 h with the consumption of 5 kg of firewood.

In another trial, 50 kg of laces were dried, using this unit, in 67 h; the moisture-content being reduced from 15% to 0.13 during this period.

The wood consumption of the air heater will be compared with that of a traditional boiler. Also, a simple thermostatic temperature control will be installed to prevent over heating of the drying tower.

If the wood consumption of the air heater is low, it would then be worthy of further investigation as a replacement for the traditional boiler. Another advantage is that these air heaters are manufactured out of metal sheet and angle iron therby minimising the cost. (N. C. Walpita, M. D. R. J. Goonatilake and S. Weerasinghe)

A trial was also carried out at Cemac Rubber Factory at Horana for drying of lace crepe and other forms of rubber by using a solar collector manufactured in Australia. This can generate steam in a minute in day light for drying laces of crepe rubber. The main objective is to find an alternative for electrical heating systems which are expensive. If this method proves successful , it can be used drying of TSR granules. (L. M. K. Tillakeratne and P. A. D. T. Vimalasiri)

Control of factory effluents

An experiments was carried out at Dartonfield to test the "oxidation ditch" concept. However, very little reduction in BOD and COD occurred over the three day test period.

After preliminary trials it was decided to install a stirrer system as this method is preferred in Malaysia over the compressed air injection method. The experiments will be resumed as soon as the stirrer system is installed. (N. C. Walpita, M. D. R. J. Goonatillake and S. Weerasinghe)

Bleaching agents

Saturation temperature of RRI - 7 (Nexobleach) solutions

Experiments were carried out to evaluate the crystalization behaviour of RRI - 7 solutions. Normally RRI - 7 contains 50% of tolyl mercaptan as an active ingredient. It was found that the recrystalization of tolyl mercaptan occurs when the temperature is

lower than 22°C. This temperature can be reduced further by reducing the strength of the solutions. The following temperature measurements were taken against the various concentrations (Table 5).

Table 5. *Variation of crystalisation temperature with concentration of active ingredient*

Percentage of active ingredient	Crystalization temperature
	°C
50	22
40	15
35	12
30	10
20	5

There is a linear relationship between the concentration and crystalization temperature (CT). CT is an indicator of the strength of the solution. This is a very useful method as the known laboratory methods determine mercaptans are very cumbersome. (M. D. R. J. Goonatillake and C. Samaneris)

Reduced strength of Nexobleach solutions

Recently there had been a lot of complaints regarding the instability of Nexobleach solutions (tolyl mercaptan, 50% solution). These solutions tend to recrystalize and form large lumps at the bottom of the drums when it is stored. These large lumps cannot be redissolved and consequently reduces the strengh of the solutions. This has been a major problem in rubber manufacture, since the actual strength of the solution is not known.

At present Nexobleach is marketed as a 50% tolyl mercaptan solution and this high strength can be attributed to this crystalization. The above data revealed that this type of recrystalization can occur when the temperature is lower than 23°C. In these circumstances, the best strength appears to be the 35% tolyl mercaptan solution and our experiments show that these solutions are not liable to recrystalization under our climatic conditions. We have therefore recommended to Ms Chemanex Limited to reduce the strength to 35% from the next shipment. To identify the strength of this solution they were advised to mark the solutions as "Nexobleach-35%". A few trails have been carried out using 35% tolyl mercaptan solutions and it was found that the following dosages can be used.

10 parts of Nexobleach — 35 + 1 1/4 parts of Nexol
+ 188 3/4 parts of water — 200 parts

These dosages give a very stable emulsion and from this emulsion 2 - 3 litres can be used for 100 kg of dry rubber to effectively bleach the rubber. (M. D. R. J. Goonatillke and S. Weerasinghe)

Mackwoods 30% tolyl mercaptan as a bleaching agent for crepe rubber and Luperintol P. L. as a surfactant

Samples from the above chemicals have been received by us to ascertain the bleaching effect in crepe rubber manufacture. Experiments were carried out in several crepe rubber factories including our Dartonfield factory druring the year. Nexobleach was used as a control. The colour, appearance and keeping qualities were similar to the samples obtained from Nexobleach as a bleaching agent. Raw rubber properties were also evaluated and they are within the accepted limits. The following dosages can be used;

10 parts of 30% tolyl mercaptan solution + 1 part of Luperintol P. L. surfactant + 189 parts of water = 200 parts

From the emulsion, 2 - 3 litres can be used for 100 kg dry rubber.
(M. D. R. J. Goonatillake and S. Weerasinghe)

Rupepa - 31 (35% Tolyl Mercaptan) as a bleaching agent for crepe rubber manufacture

We have evaluated the bleaching effect of the above chemical by experimental trials and found that this chemical is comparable with Nexobleach. The following dosages can be recommended.

10 parts of Rupepa — 31 + 1 part of the Surfactant + 189 parts of water= 200 parts

From this, 2 - 3 litres can be used for 100 kg of drc.
(M. D. R. J. Goonatillake and S. Weerasinghe)

Metal contents of the bleaching agents

As a general guidance, the maximum limits given in Table 6 can be laid for the metal contents of the bleaching agents.

Table 6. *Maximum limit of metallic contamination in bleaching agents*

Metal	Maximum limit ppm
Fe	5 g/ml
Zn	2 g/ml
Cu	0.5 g/ml

Raw rubber properties of crepe rubber prepared by using 3 types of bleaching agents

We are now recommending three commercial grades of bleaching agent viz. Nexobleach, Rupepa - 31 and Mackwoods 30% tolyl mercaptan solution. Trials were carried out using these three bleaching agents and the results are given in Table 7.

Table 7. *Properties of rubber using different bleaching agents*

	Nexobleach (30% *tolyl* mercaptan)	Rupepa - 31 (35% tolyl mercaptan)	Mackwoods (30% tolyl mercaptan solution)
P_0	44	44	44
P.R.I.	54	60	58
Raw mooney viscosity	74	74	74
Saturation temperature	23°C	15°C	13°C

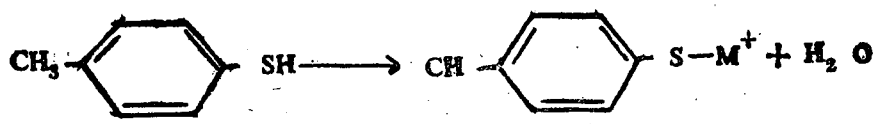
The same amount of active ingredient was used in all the trials (M. D. R. J. Goonatillake and C. Samaneris)

Use of chemically modified tolyl mercaptan as a bleaching agent for crepe rubber

Tolyl mercaptan which is available under the trade names Nexobleach and Rupepa as a 30% solution in a petroleum oil was successfully modified to make it water soluble but with the same bleaching and peptising action for the following advantages:

1. Being water soluble no need of a petroleum solvent
2. Being water soluble no need of an emulsifier for mixing with latex
3. Being an ionic compound it is non volatile and therefore non smelling and there fore does not cause air pollution
4. Easy to transport as a white powder
5. Method of conversion is simple and very cheap

Trials carried out with the above product gave successful results in bleaching experiments as well as in peptising experiments. Permission has been granted by the RRI board to patent this compound in Sri Lanka as well as abroad.



water insoluble

water soluble
M^+ — Metal iron

(L. M. K. Tillakeratne and P. A. D. T. Vimalasiri)

Advisory services to the rubber producers

RSS manufacture

The following estates were visited and we advised them either to improve their quality or to renovate their smoke houses:

Usk - valley
Paraduwa
Hathmatta

Crepe rubber manufacture

The following estates were visited for advice on crepe rubber improvement:

Ehaliyagoda Estate, Ehaliyagoda,
Indurana Estate, Wahakula,
Peenkande Estate, Uda - Karawita,
Poranuwa Estate, Pelmadulla,
Ambadeniya Estate, Ambadeniya,
Culloden Estate, Matugama,
Padukka Estate, Padukka,
Sorana Estate, Horana.

(M. D. R. J. Goonatillake, S. Weerasinghe and E. D. I. H. Perera)

Factory Development Subsidy Scheme

The following 20 factories were visited for inspections under the above Scheme and reports were sent to the Rubber Controller.

Udabage, Chesterford, Sunnycroft, Siriniwasa, Ingiriya Block Rubber factory, Millawa, Elgiriya, Peenkande, Ambatenna, Uskvalley, Divitura, Elipitiya, Neuchatel, Sapumalkande, Farnham, Padukka, Woodend, Mahaoya and Dewalakande.
(A. Coomarasamy W. S. E. Fernando, S. Weerasinghe and M. D. R. J. Goonatillake)

Testing of technically specified rubber (TSR) samples

Altogether 16,463 TSR samples were tested during the year 1982. Details of the number of samples tested from various TSR producers are as follows:

Code	producer	No of Samples
AA	State Rubber Manufacturing Corporation	1893
AB	Cenat Block Rubber Factory, Payagala	799
AD	Statcon Block Rubber Factory, Getahetta	2155
AE	(I) Sherman Sons Ltd, Colombo	729
	(II) Shermans TS Rubber Ltd, Ingiriya	5379
AF	(I) Ceymac Rubber Co Ltd, Colombo	1166
	(II) Ceymac Rubber Co Ltd, Horana	1628
AG	Orient Rubber Products Ltd, Homagama	239
AH	Lanka Star Rubber Works Ltd, Parakaduwa	2475

In addition to the above, 206 miscellaneous rubber samples, 12 latex samples, 13 chemicals and water samples were also tested.

Analysis of masterbatch samples

1113 samples from Bergongnan Lanka Ltd.
16 from Atco Rubber Products Ltd,
123 from Associated Motorways Ltd,
3 from Associated Trades Ltd, Colombo,
16 from Cenat Block Rubber Factory and
1 from Orient Rubber Products Ltd, were analysed.

In this connection, visits were made to the above factories and analysis reports were sent to Sri Lanka Customs in respect of consignments, stating whether the masterbatchest are confirming to BTN 40.05 classification.

Inspection visits

Arrangements have been made to visit all block rubber factories every month for routine inspection. Hence all the factories which are in block rubber production were visited at least twice in the last quarter; but factories which areclosed for mainteance due to scarecity of raw materials were not visited.

Mould growth on natural rubber

The moisture intake experiment was extended from lace crepe rubber to other conventional grades such as RSS during the last quarter of this year. It was seen in the study carried out for lace crepe rubber that when the rubber is stored in a place where the humidity is above 90%, there is a 15 fold increase in the VM level in the yellow fraction in 2 weeks. But in 15% fractioned latex crepe the increase is only six fold. There is a linear variation in the VM levels of crepe subjected to different levels of faractionation with the variation of the relative humidity of the storage place. (L. M. K. Tillakeratne, P. A. D. T Vimalasiri and P. H. Sarath Kumara)

Mould growth in RSS

Two fungicides Mergal K 7 and Mergal K 8 obtained from Hoechst (Ceylon) Company Limited were tested against mould growth on RSS. MK 7 is a combination of high activity heterocyclic compounds and MK 8 is a formaldehyde release agent mixed with a heterocyclic compound.

Tests were carried out in two depots of the Commodity Purchase Department at Elpitiya and Ittapana. Concentrations up to 0.5% were used and the preliminary trials have indicated that MK 8 is a more effective fungicide than MK 7 and could withstand fungal contamination up to 21 days at a concntration of 0.5%. (S. W. Karunaratne and S. Weerasinghe)

Survey of smallholders processing facilities and methods

The above survey was carried out by the Rubber Chemistry Department Research Officers with the assistance of Technical Officers and Field Officers attached to the Advisory Services Department.

The data obtained in this island-wide survey clearly indicated the necessity to improve the overall facilities of all the processing units in order to eleminate/minimise the production of low grades of RSS.

Our estimated total cost for improvement to the units covered in the survey is about Rs. 25 million. A break down of this expenditure in percentage for various items is as follows:

Collection and bulking facilities	5.26%
Strainers	0.56%
Pans for coagulation	15.23%
New rollers and repairs to rollers already in use	35.95%
Smoke house repairs/new smoke houses	36.85%
Water	6.13%

A comprehensive report on this survey was submitted to the Chairman, RRB.

A paper entitled "Studies on the quality improvement of Smallholders Rubber in Sri Lanka' by L. M. K Tillakeratne and A. Coomarasamy was submitted to the 5th ANRPC Seminar held in December 1982 in Kuala Lumpur. (S. W. Karunaratne, A. Coomarasamy L. M. K. Tillakeratne, W. S. E. Fernando, R. G. Goonatillake and T. Vimalasiri)

Central Electronic Servicing Laboratory

The UN consultant Mr H. G. Grau completed his assignment and left the island in September 1982. Three Instrument Technicians and one Laboratory Attendent were recruited in January. Building of the servicing laboratory was completed and the laboratory was fully equipped during the course of the year. All test and measuring instruments, tool and components ordered under the project have been received. A reference library with about 100 technical books and a number of data books has been set up.

Training of staff attached to the laboratory started in April. A week's training course for technicians was conducted at the TRI in July. However the planned training programme could not be completed before the expert left the island. Two meetings were held in January to review the progress of the project.

Repairs to some equipment were carried out during the year. Orders have been placed for electronic components and more testing and measuring instruments.

Biochemistry

Latex proteins and brown bast

Serum protein patterns of healthy and brown bast affected *Hevea* trees of six clones viz RRIC 7, RRIC 45, RRIC 100, RRIC 107,RRIM 600 and PB 86 were investigated. Total protein content in A-serum decreased considerably in all six clones when affected by brown bast, the highest reduction being 50% in PB 86. Gel electrophoretic separation of serum proteins complimented these findings, with the disappearance of a number of bands and reduced intensity of the remaining bands. Protein contents at different heights showed a high degree of reduction extending upward from the tapping panel in clone RRIC 101 whilst in RRIM 600 it extended downward from the tapping panel. Protein levels are indicative of the spread of brown bast to neighbouring tissues at varying degrees although they may not result in a noticeable change in external appearance or in latex yields. (S. P. Prematillake and P. A. J. Yapa)

Enzyme deproteinization of NR latex

The studies on this project were continued during the year. The effect of proteolytic enzymes on ash content of rubber was investigated. This work confined to RSS initially, will be extended to other grades of rubber too. The results will be compared with conventional acid coagulants.

The investigation on storage hardening of DPNR was continued during the year and it is expected to be completed in 1983. (P. A. J. Yapa, S. I. Senanayake and M. D. C Seneviratne)

Seed proteins

Seed protein content of about 70 *Hevea* clones was determined. Protein content of some of the popular clones are given in Table 8. Attempts to separate water soluble protein by gel electrophoresis were unsuccessful. (P. A. J Yapa and S. I. Senanayake)

Table 8. *Protein content of rubber seeds of some of the popular clones*

Clone	Protein content %
RRIC 100	1.58
RRIC 45	0.99
RRIM 607	1.31
RRIC 101	1.06
RRIM 600	1.05
RRIC 52	1.05
PB 86	0.78
RRIC 102	0.75
RRIC 103	0.70
GT 1	1.18

Effect of genotype - environment interaction on raw rubber properties

A new investigation was initiated to study the effect of genotype environment interaction on raw rubber properties. Experimental blocks laid down by the Genetics and Plant Breeding Department in seven areas namely Galle (2), Ratnapura, Kelani Valley, Kalutara, Kegalle and Bibile were used in this study. This will be continued till end of 1983. (P. A. J Yapa, S. I. Senanayake, M. D. C. Seneviratne, in collaboration with the Genetics an Plant Breeding Department)

Phospholipids

Phospholipids D was partially purified as described by Davidson and Long (1958). The acetone precipitated enzyme from C-serum and F-serum was assayed for enzyme activity. The choline content was estimated by the ammonium reineckate method. The protein content of the enzyme in C-serum was determined and it was found to be 4.2 mg/ml. The kinetics of the enzyme at various substrate concentrations were studied. The optimum activity was observed at 25°C.

Phospholipids in rubber were separated by thin layer chromatography and indentification of them was confirmed by specific reagents and IR. It was observed that 1 % NaF inhibited latex had more of phospholipids. The bottom fraction also contained a considerable amount phospholipids.

The physical and technological properties of rubber incorporated with phospholipids and degraded lipids were studied. The amines in the lipids seem to accelerate the curing characters. Phospholipids in general were found to improve the technological properties. (S. Kasinathan and P. A. J. Yapa)

Enzymological studies

The adenosine triphosphatase (ATP-ase) activity in *Hevea* latex was studied with special reference to brown bast. The F-serum obtained from the latex of PB 86 was used as the source of enzyme. The partial purification of the enzyme was done by gel filtration and dialysis. Partially purified enzyme was investigated for its activity patterns when subjected to the variation of physical factors that affect the activity of the enzyme. These factors comprised of enzyme concentration, substrate concentration, temperature pH and the time. The curves drawn from the results obtained from the above experiments were quite similar to the typical curves of the enzymes.

The effect of various cations on enzyme activity was also investigated. The ions tried were Ca, Mg, Na/k and Mn. The chlorides of the cations were used. Of all cations used Mn and K ions were found to give the highest activation.

The bark tissue of healthy and brown bast diseased trees were analysed for the presence N,P,K, Ca, Mg and Mn. The results are being analysed.

The ATP-ase activity of the bark extracts obtained from both healthy and brown bast trees was also investigated. A greater enzymic activity was observed in diseased bark extracts than that of healthy trees. (C. P. Wickramasinghe and P. A. J. Yapa)

REVIEW OF THE STATISTICS SECTION

By

V. ABEYWARDENA

SUMMARY

Statistical assistance was provided, as usual, to Research Departments of the Institute throughout the year, as it was the main concern of the section. Altogether, data from about 70 experiments were analysed during the current year. In addition to this, meteorological work was also carried out uninterrupted.

DETAILED REVIEW

Staff

The Assistant Statistician Mr W. N. Wickremasinghe was on study leave throughout the year, at the Iowa State University in the USA to read for the Degree of Master of Science.

The consultant Biometrician Mr V. Abeywardene paid regular visits to the section to advise the officers of the section as well as the Research Officers of the Institute.

Technical Officers Mr L. T. Peiris and Mr R. A. P. Abayapala and Miss J. D. Nandanie were on duty throughout the year. Mr L. T. Peiris was promoted to the post of Senior Technical Officer with effect from 21 April 1982. Mr R. A. P. Abayapala was promoted to the higher grade with effect from 1 January. Miss J. D. Nandanie passed the General Science Qualifying Examination in the subject of Statistics.

Statistical work

The main function of the section is to assist the research departments in design of experiments and the analysis of data. Most of the time was spent on routine statistical work.

The section also analysed the experimental data of six research students attached to Plant Pathology and Soils and Plant Nutritions Departments. This work included studies on white root disease, *Phytophthora palmivora* and leaf nutrient extraction.

The Plant Science Department was assisted by finding the relationship between total yield and sub - totals of all possible consecutive tappings of Ethrel stimulated yields of 71 tapping days.

The work of the Plant Pathology Department involved a study on the correlation between rainfall and *Colletotrichum* leaf disease (CLD). A high correlation was established between rainfall and CLD.

The data of the genotype environmental interaction experiment of the Genetics and Plant Breeding Department were analysed.

Meteorology

The routine meteorological data collections and regular supplies of these summaries to various departments outside the Institute, were carried out uninterrupted. These included the records from Dartonfield Meteorology Station and also from Nakiyadeniya Estate.

The graph of rainfall, temperature and sunshine duration at Dartonfield is shown in Fig. 1.

Miscellaneous

Mr L. T. Peiris received an acknowledgement for the statistical analysis carried out in connection with the paper on "Taxonomy of *Phytophthora* species isolated from Rubber in Sri Lanka" which has been accepted for publication in the Transactions of the British Mycological Society.

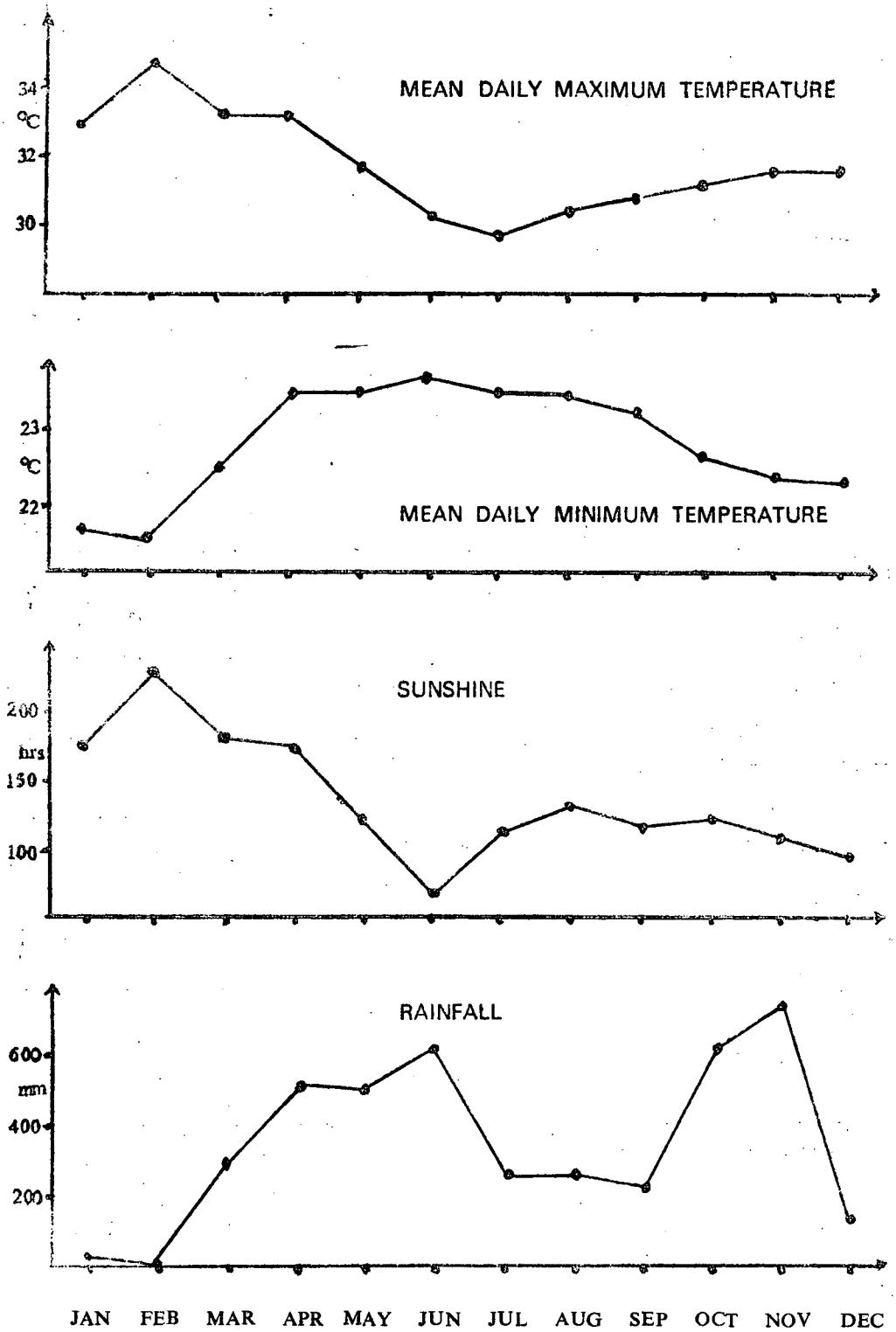


Fig. 1. *Rainfall, duration of sunshine and temperature at D'field*

REVIEW OF THE ESTATE DEPARTMENT

By

R. G. SIRIWARDANE

SUMMARY

The Institute's estate, Dartonfield Group, comprises of Dartonfield & Gallewatta Divisions in Agalawatta and Nivitigalakele Division in Matugama consisting of 336.22 ha. The planted area is 284.88 ha of which 209.10 ha were in bearing during the year.

The rainfall recorded in 1982 was higher than that in 1981. Weather conditions that prevailed during the year were unfavourable for harvesting of crop. Specially the South-West and North-East monsoons merged resulting in an unusual weather pattern.

Wintering was early this year. No symptoms of *Oidium* leaf disease was noticeable. The incidence of *Phytophthora* leaf disease was negligible; trees affected with white root disease were treated with "Collar Protectant" fungicide.

Budwood of clones of the RRIC 100 series and PB 86 continued to be in demand and issues to all estates and smallholders were made accordingly.

All agricultural operations were carried out in mature and immature areas and nurseries of the Group.

DETAILED REVIEW

Staff

The Estate Superintendent, Mr R. G. Siriwardane was on duty throughout the year.

The post of Chief Clerk was filled by promoting Mr A. A. Ariyaratne the Senior Assistant Clerk.

The post of Junior Assistant Clerk was filled on 6 October, by recruiting Mr C. N. Wickramasinghe.

Messrs K. K. P. Gunawardane and K. D. Sumanasena, Junior Assistant Clerks, Messsrs N. L. D. Piyadasa and A. K. D. Hemapala, Field Officers, Mr D. D. C. Jayasekara, Factory

Officer, Mr. D. S. K. Ranaweera, Assistant Factory Officer, Messrs A. K. D. Wickramasinghe and J. A. Wimalasena, Asssistant Field Officers, Messrs S. R. Vadivel, T. Somaratne and W. D. D. Senanayake, Field Supervisors, Mr. W. D. Sugathadasa, Tractor Driver and Miss M. Thambathy, Creche Attendant were on duty throughout the year.

Mr S. K. S. de Silva the Field Officer of Nivitigalakele Division was suspended for six weeks with effect from 3 August, on disciplinary grounds. Mr N. L. D. Piyadasa, Field Officer of Dartonfield Division was temporarily transferred to Nivitigalakele Division during this period.

Mr T. Somaratne, Field Supervisor, Gallewatta Division was transferred to Dartonfield Division with effect from 5 August.

Mr. V. K. Suppiah resigned from the post of Lorry Driver on 31 October.

The services of the School Teacher, Miss M. Kalyani was terminated on 17 November, as the Estate School was taken over by the Education Department.

Meetings

The writer represented the Rubber Research Institute at a "National Seminar on Productive Employment Promotion in the Plantation Sector of Sri Lanka" organised by the Asian Regional Team for Employment Promotion of the ILO and Sri Lanka Foundation Institute in December 1982.

Agricultural Adviser

The Agricultural Adviser, Mr R. C. Peries of Elston Estate, Puwakpitiya, paid two visits to the property during the year under review. Reports on these visits were submitted to the Rubber Research Board.

Hectarage

A summary of the hectarage is given in Table 1.

Table 1. *Land distribution in Dartonfield Group*

	Dartonfield	Gallewatta	Nivitigalakele	Total
Mature area	27.70	137.98	43.42	209.10
Immature	16.88	42.67	6.88	66.43
Nurseries	3.42	1.80	4.13	9.35
	48.00	182.45	45.43	284.88
Paddy fields	—	1.25	—	1.25
Abandoned area	5.85	—	8.78	14.63
Swamps	—	—	1.21	1.21
Buildings	16.23	6.00	7.79	30.02
Roads	2.67	.50	.32	3.49
Streams/reservations	.03	—	—	.03
Jungle	—	—	.71	.71
Grand total	72.78	190.20	73.24	336.22

Weather

Rainfall figures (mm) for 1982 and 1981 are given in Table 2.

Table 2. *Rainfall distribution for 1981 and 1982 in Dartonfield Group*

	Dartonfield		Gallewatte		Nivitigalakele	
	1982	1981	1982	1981	1982	1981
January	21.4	128.8	18.8	232.9	86.9	133.5
February	10.7	64.0	16.8	79.8	—	48.5
March	286.1	253.9	287.2	311.4	302.7	67.0
April	520.5	646.6	446.5	481.3	340.5	376.8
May	508.5	904.9	479.8	827.8	472.3	958.4
June	615.2	422.7	608.1	503.2	646.4	376.0
July	264.2	206.7	261.6	201.9	295.0	213.2
August	271.3	191.2	123.2	172.7	314.6	157.4
September	235.8	444.1	236.5	388.6	258.5	324.5
October	614.2	419.6	590.0	450.3	628.1	579.2
November	764.0	240.2	789.7	312.7	951.3	285.4
December	154.9	230.5	180.8	191.5	331.7	262.0
	4266.8	4153.2	4039.0	4154.1	4628.0	3781.9
Total wet days	228	215	207	196	146	133

Crop

The harvested crop of 169130 kg this year fell short of the sesson's estimate by 46299 kg and stood at 79% of the estimated crop. The adverse weather conditions that prevailed during the year caused a heavy short fall in crop. The yield data for the last 5 years are given in Table 3.

Table 3. *Yield records from 1978 - 1982 (kg/ha)*

	Year				
	1982	1981	1980	1979	1978
Dartonfield	772	818	858	1058	766
Gallewatta	875	1233	1129	901	869
Nivitigalakele	864	953	944	803	915
Total	858	1105	967	836	860
Estimated	1124	1064	983	970	887
Tapping (ha)	209	187	207	216	261

Tapping

Sixty (60) days tapping was lost due to unfavourable weather conditions and recovery tapping was done on thirty (30) days during the year. Tapping was carried out throughout the wintering period.

Manufacture

A summary of manufacture records during the year is given in Table 4.

Table 4. *Types of rubber manufactured in Dartonfield Group*

Latex Grade	Total crop (kg)	(%)
Sole Crepe No. 1	1166	100
Sole Crepe No. 2	—	—
Sole Crepe No. 3	—	—
	1166	100
Pale Crepe No. 1	163399	88
Pale Crepe No. 2	2350	2
Pale Crepe No. 3	19287	10
	184946	100
Scrap Crepe No. 1	4974	38
Scrap Crepe No. 2	6153	48
Scrap Crepe No. 3	1832	14
	12959	100
Smoke Sheet No. 1	8850	94
Smoke Sheet No. 2	421	4
Smoke Sheet No. 3	129	2
	9400	100
Total crop manufactured (inclusive of 39341 kg of bought latex)	208471	

REVIEW OF THE LIBRARY AND PUBLICATIONS SECTION

By

VIJITHA JAYARATNE

SUMMARY

Number of books purchased was reduced because the expenditure incurred to acquire periodicals amounted to Rs. 300,000.

The Advisory and Research Publications of the Institute were published more frequently, and necessary action was also taken to revise the Institute's Handbook of Rubber Culture and Processing.

Agricultural Information Network (AGRINET) and the National Information System for Agricultural Science (AGRIS) were of a great help to the Institute in obtaining current information on scientific research done throughout the world.

DETAILED REVIEW

Staff

Mrs V. S. Jayaratne, Library Assistant and Assistant Publications Officer, Mr D. C. Thambawita, Library Clerk and Mrs D. T. Dantanarayana, Clerk/Typist at Head Office, Library and Miss L. T. Ramanaden, Library Assistant and Assistant Publications Officer attached to the Colombo Office Library were on duty throughout the year.

Mrs V. S. Jayaratne the Library Assistant and Assistant Publications Officer was appointed as the Librarian and Publications Officer with effect from 1? July 1982.

Mrs D. T. Dantanarayana successfully completed the Intermediate Examination for Library Science.

Acquisitions

Book purchases and subscription to journals were reduced during this year too. Due to the escalating prices of books and lack of foreign exchange available the purchase of books had to be limited (33 books for the whole year) to the requests made by Research Officers. The number of books purchased was reduced because the expenditure incurred

to acquire periodicals amounted to Rs. 300,000. It is not possible to reduce the number of journals acquired for subscription as it is the only medium available for the Research Officers to obtain information on the current research done throughout the world.

Two hundred and twenty four titles of current periodicals, including 15 abstracting and indexing periodicals were obtained.

	Local	overseas
On subscription	—	97
On exchange/gratis	32	115

Abont 300 periodicals from both Head Office and Colombo Office Libraries were sent for binding , to complete the series of bound copies in the library.

Inter library loans

Inter library loan scheme has been of an immense help to us in the wake of increasing subscription rates of periodicals. It has been possible to obtain scientific papers from journals which are not available in our library through this scheme. Most of the libraries were co-operative and has been sending us the required information without delay. Similar requests sent to our library were readily attended to by sending photocopies with minimum cost and delay.

Information service

Publications

The Institute continued to publish its regular Advisory and Research Publications more effectively than before as there are requests for information on the research work done by our Officers. The Annual Review, two volumes each of the journal and the Bulletin were published without much delay, in a revised format and in a more attractive way. Though the total printing cost of the publications amounted to Rs. 1,59,610; the Director of the Institute wishes to publish more volumes of our publications more frequently by next year to enable all sectors of the industry throughout the world to obtain the valuable information on the research done by our Officers.

All necessary action has been taken to revise the Institute's Handbook of Rubber Culture and Processing.

Dissemination of information

Our publications and Advisory Circulars have been the main source of dissemination of information to the others. The Research Staff were continuously kept informed of the

current research done throughout the world by circulating and indexing of research articles from relevant books and periodicals.

Liaison with other libraries

Agricultural Information Network

The work of the Network of Agricultural Libraries implemented with the initiative of the Natural Resources Energy and Science Authority of Sri Lanka, carried out its programme successfully during this year too. Their main objective of content page service was successfully implemented during this year. As a member of the Agricultural Information Network (AGRINET) it was possible to get some of the most useful articles from journals that are not available in our library, through this service. Copies of content pages of journals requested by other Libraries were sent out. This service has been of great help to us as the cost of periodicals has risen very high and it is not possible to subscribe for all the periodicals requested by the Staff. This Network has also organized a service of user seminars for the benefit of the Scientists in the various Agricultural Research Institutes. Three of these seminars were held at the Coconut Research Institute (CRI), Tea Research Institute (TRI) and Central Agricultural Research Institute (CARI) Gannoruwa and the next meeting will be held in 1983 at our Institute.

All these years binding of periodicals had been a big problem to us becuase of the very high cost. This problem was discussed at one of the AGRINET meetings and through a place suggested by one of the Librarians, our periodicals were bound for a reasonable price, and the binding too was of a very high standard.

National AGRIS Project

National Information Systems for Agricultural Science (AGRIS) Project executed by the Central Library, Peradeniya, does manual and computer assisted SDI (Selective Dissemination of Information) and retrospective searches and this has assisted us in our requests too. With their SDI service we have been able to receive every month a bibliography of articles published on every aspect of Rubber throughout the world. Some of our Scientists received retrospective searches done on various subjects of their interest.

The Sri Lanka AGRIS Project hopes to produce, annually a Sri Lanka National Agricultural Bibliography from 1983, for which all the published and unpublished material of our Institute were sent. These will also be included as the reference input to AGRIS by the Sri Lanka AGRIS Project.

Other activities

A new charging system was implemented during this year to control the number of books lent to the Staff.

REVIEW OF THE KURUWITA SUB-STATION

By

R. C. PERIES

DETAILED REVIEW

Staff

Mr S. G. Fernando, Assistant Superintendent of this Sub-Station relinquished his post on the 16 August to accept a job in the Middle East.

Mr G. D. A. Weerasooriya and Mr T. D. Kularatne continues as KP and Assistant KP respectively, on the property.

Hectarage statement

The distribution of the mature rubber hectarage is given in Table 1.

Table 1. *Hactarage statement*

1961 Replanting	32 1/2
1962 ,,	15 3/4
1963 ,,	9
1964 ,,	7 1/2
1965 ,,	7 3/4
1966 ,,	4
1967 ,,	4
1968 ,,	4
1969 ,,	4
Extent in tapping	88 1/2
1982 New planting	2
Nurseries	1 1/2
Paddy fields	2 1/4
Roads, buildings etc	5 1/2
Total	99 3/4

Weather

Rainfall distribution for 1982 is given in Table 2.

Table 2. *Rainfall and wet days for 1982*

Year	Rainfall (mm)	Wet days
1982	5100.23	201
1981	4596.07	191

The rainfall and number of wet days were more for the season under review compared to the previous season.

Crop

The estimated and harvested crop are given in Table 3.

Table 3. *Details of crop figures*

	kgs
Estimated crop for 1982	90,000
Crop harvested in 1982	77,738
	12,262

General

A budwood nursery was established under Smallholder Rubber Rehabilitation Project (SRRP) and 1,000 stumps have been planted in September 1982. A further 1910 budded stumps were added to this nursery in November 1982.

A new stock nursery containing 17,000 seedlings was also established in September 1982.