THE RUBBER RESEARCH INSTITUTE OF SRI LANKA

ANNUAL REVIEW FOR 1980

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*On study leave overseas.

DIRECTOR'S REVIEW

By

O. S. Peries

The Institute was 70 years old in 1980. Therefore, it is a good reference point from which to review the progress of the Institute and suggest how it should develop in the next few years. In the past 70 years, natural rubber (NR) more than any other crop, has had its ups and downs, reaching its nadir, perhaps, in the early 1970's ; then with the support of vigorous research and abetted by the energy crisis, it has risen from the ashes like the mythical phoenix—stronger than ever, we are sure.

The rubber prices have now reached peak levels in real terms, just as predicted in these reviews from 1973 - 1979. Any further increase in price will be inflationary adjustments, and any depressions merely temporary fluctuations of the market. Therefore, it is now time for the Government and the industry to plan the strategy for the future development of the crop in Sri Lanka. The NR tree is ideally suited for growth in our country, we are sure of its price trends, know a great deal about how the tree grows, what it requires for maximum output, what diseases it is susceptible to and how to control them, the area over which it can be planted, how to produce the world's best raw rubber and, when necessary, how to modify this product to suit certain specific requirements. So the message is loud and clear — " every prospect pleases, and only man is vile " ; therefore, the policy makers, the top management on estates, the Advisory Services to Smallholders and the Research Staff of this Institute has a duty by this country to develop NR to be the top money earner for Sri Lanka. This can be done, it only needs clear thinking, bold planning and the will, at the top, to ensure that the plans are implemented. At present, however, the organisation to plan for the industry is too diffuse, with a great deal of the burden being placed on the Ministry. This is just not feasible, as the Ministry has many calls on its time, it has no experts on rubber and does not need to have, so the operation is static. The need is for a single person to be made responsible for the development of the industry. He can be the Head of the Rubber Industry Development Authority (RIDA), as suggested by both the World Bank and the Rubber Master Plan team. Such a person must be hand-picked on ability alone and made absolutely responsible for the development of the industry in all its aspects in the country. This system has worked to perfection in Malaysia, the world's biggest producer of NR, and there is no reason why it should not work in Sri Lanka, as long as the right man is selected for the job.

This management structure is essential as there are three very important aspects of the industry that must be vigorously developed for the optimum earning capacity of the crop to be achieved. These three limbs of the industry : Market Promotion, Smallholder Development and Replanting have been neglected, although highlighted in these reviews over the years from 1969.

Market promotion : Sri Lanka produces the world's best crepe rubber, the highest grade of NR there is ; but we do not have any market intelligence on this product. We have little or no information on who buys this grade of rubber, what it is used for and why it is used—yes, we have some information, but not sufficient for competitive selling. This is why Sri Lanka was non-plussed, when the price of crepe rubber fell below that of smoked sheet (RSS) in 1980. We did not know why the Russians pulled out of the market or why China, which bought 10,000 tons (25% of our production) in 1979, did not buy any in 1980. The USA and UK bought practically all our crepe rubber in the 1960's ; they have dropped out of the market now. Why ? We just do not know. You cannot sell peanuts leave alone rubber without that kind of market information. We must remedy the situation immediately. Malaysia has 18 Natural Rubber Bureaux situated in cities like Washington, Boston, London, Hamburg and Bombay. We do not have to do likewise, but we certainly must do some competitive selling.

Smallholders development : The smallholders own about 70% of the rubber growing land in this country. Therefore, it is essential to ensure that they produce the maximum amount of rubber from their land, this can be achieved only if they get a worthwhile return from their rubber. The importance of replanting and the correct management methods, which entail adequate fertilization, disease and weed control, soil conservation, correct tapping methods and, most important, the production of the highest quality of dry rubber, must be taken into consideration here. The Smallholder must be educated and supported by a dedicated extension service. This will require heavy investment, but in the long term, such expenditure will bring excellent results. Therefore, the smallholder sector must be given its due place in the development of the industry.

Replanting : There is only a limited area of land on which rubber can be grown in this country, and practically all such land has already been planted with the crop. Therefore, increase in production of NR in Sri Lanka can be achieved primarily by replanting. To illustrate this, consider that we produced only 93,000 tons of rubber in 1953 and 155,000 tons in 1975 — during the same period the area under rubber dropped from 660,000 acres to 560,000 acres. The increase in production was therefore almost entirely due to replanting with higher yielding clones. This shows the importance of replanting and it is a sad reflection on ourselves that the acreage replanted fell to about 7,000 acres in 1977 from the peak years of 1955/56 when we replanted over 25,000 acres per year. The Institute has bred several new, high yielding, disease resistant clones and it is important to ensure that the industry replants an adequate acreage every year to exploit the potential of these clones.

RUBBER NEWS

Malaysia : The Government of Malaysia has decided to plant rubber on about 120,000 acres of new land in the next few years, compared with the present 40 - 50,000 acres annually. This is on the basis of the strengthening of the rubber market following the implementation of the International Natural Rubber Agreement for price stabilisation of NR. This agreement serves to assure producers of rubber, remunerative and equitable prices in both the short and long term.

China : Malaysia's Minister of Primary Industries led a 25-member Malaysian Economic and Technical Mission for a month long tour of the People's Republic of China, the Republic of Korea and Japan in April 1980. This is the second economic mission from Malaysia to China. This year's visit was aimed at furthering contracts, strengthening ties of friendship and expanding trade, economic and technical cooperation between the two countries, especially in the field of primary commodities on the basis of mutual benefit. During the visit, discussions were held with the Chinese National Chemical Import and Export Corporation and representatives from the Ministry of State Farms and Land Reclamation and the Ministry of Chemical Industries. The main subject of discussion, of course, was Standard Malaysian Rubber (SMR), its merits and advantages in use and answers to queries on problems related to SMR usage. Sri Lanka has a lesson to learn from this — the importance of technical personnel in Trade Delegations, to explain the merits of our produce.

China imports 120,000 tonnes of NR from Malaysia, approx. 7·5% of the latter's total production — yet the simple expedient of providing one pair of rubber shoes to each of China's billion pairs of feet would increase her rubber consumption by 150,000 tonnes. This is the reason why China, which has the world's fourth largest acreage under cultivation with 308,000 ha, but the sixth largest production, with about 100,000 tonnes, is interested in increasing its own production of NR. Consumption of rubber is approx. 320,000 tonnes, and due to the modernisation process in the country, use of rubber (NR & SR) is increasing by 8 - 10%per year, almost double the world's increase. China grows NR essentially for purposes of self reliance. At present, her average yields are about 600 kg per ha. The industry is beset by problems of poor soils, wind damage due to typhoons, cold weather and drought. In spite of this, Estate management is very good and she has achieved yields of 3,000 kg per ha, which compares favourably with Malaysia and Sri Lanka.

One of the most impressive features of China's rubber industry is its research. Their most prominent success to date has been in tissue culture, where she has produced the plantlets and put them out in the field two years ago — ahead of Malaysia and Sri Lanka. Four Chinese seientists spent a month in Sri Lanka, at our Institute, studying our research methods, and no doubt this link will enable us to advance rapidly in the field of tissue culture.

Sri Lanka : The Sri Lanka Tyre Corporation has entered the world tyre market. It has signed major contracts with Pakistan, Burma, Bangaladesh and Kuwait. The biggest order is for 75,000 car tyres from Kuwait. This export breakthrough started with a small order from Pakistan last year. Our tyres soon became popular there and larger orders followed with the other South East Asian countries also becoming interested. Sri Lanka tyres are cheaper than Japanese or Korean makes and the chances are good for us to capture new markets in this area. The closing down of the Bridgestone tyre factory at Singapore has been advantageous to us, as the former had up to now supplied tyres to many of the Asian countries.

RESEARCH HIGHLIGHTS

Breeding : The yield potential of the RRIC 100 series clones has now been clearly established and RRIC 100, 102, 103, 104 and 105 can be planted in large blocks. Estates are now anxious to plant these clones and budwood nurseries of RRIC 103, 117, 121 and 130 were increased substantially during the year to assist the Smallholders too in getting material from these new clones for the World Bank assisted replanting programme. RRIC 117, 121 and 130 are the high yielding South American Leaf Blight (SALB) resistant clones, which can now be planted in 5-acre plots of large estates.

Plant Science : Experiments carried out over a 5-year period have shown that there is no advantage in changing over the panels daily or annually. Therefore, it would be best to tap right down one side of the tree and then start at the top of the opposite panel. This is both convenient and economical.

Response to puncture tapping on RRIC 100 series clones has been poor compared to conventional tapping ; but puncture tapped trees when tapped on conventional cuts have given higher yields than normal cuts. The exploitation of this finding will depend on establishing the economics of early puncture tapping followed by the tapping of conventional cuts. In contrast to puncture-tapping, recognised higher yielding clones have given good yields on microtapping for the third year in succession.

The problem of Brown Bast is being studied by a multi-disciplinary team because of its ramifications into many disciplines. There are interesting indications that this may at least partly be caused by a nutritional imbalance similar to internal cork of apples. This line of investigation is being followed, as well as those on the possibilities of this disorder being caused by a virus or other sap-transmissible disease, or that it is a purely physiological disorder, caused entirely by the over-extraction of latex, the classical theory. Whatever the cause of the disorder, we have found that tapping Brown Bast affected trees, gives yields high enough to warrant the exploitation of such trees.

Crown budding experiments have shown that the growth of the trunk is significantly affected by the type of crown used. Therefore, it is necessary to use not only disease resistant, but vigorous crowns for optimum growth and yield of the mid-section. Budding experiments have also shown, that high stumped buddings can grow and reach maturity faster than bare-root budded stumps. This can be exploited for bringing replanted areas into bearing in a much shorter time. However, the economics of the preparation and use of budded stumps have not been fully analysed up to now.

One of the more interesting aspects of our research is that on the use of local sources of fertilizer. We have tried over the years to use the local Eppawela Apatite, a rather insoluble phosphate rock, as a source of phosphate for rubber. We now find that uptake of phosphate from this source can be enhanced by mixing it with sulphur. Studies are continuing, and when the system is fully developed this will provide a substantial saving on the fertilizer bill to the Government, as Eppawela Apatite will then be suitable not only for rubber but for other crops.

Intercropping : The four crops : bananas, passion fruit, pineapple and coffee are promising intercrops for rubber in the early years of the growth of the main crop. The income from these intercrops is so attractive that many estates and smallholders are planting large areas of some of them, particularly bananas. Passion fruit gives a very good return in the first year of growth. However, the Institute forsees a marketing problem when these crops are grown on a large scale and it is important for the local authorities in each area to ensure that a proper marketing system is developed for these products.

Plant Pathology : The control of White Root (*Rigidoporus*) disease, at the lowest cost is the most important commitment of this Department. The planting public has still not recognised the importance of this disease in the economics of rubber production and the ravages it can cause in their plantations. Our studies have shown that the vacant patches caused by this disease can account for 8 - 15% of the total area of certain estates, and the increase in infection can be as high as 0·4 - 1·2% annually. When this is converted to hard cash, on the basis of production losses, the figures become astronomical. Therefore, obviously this is a problem that has to be tackled with military precision. Consequently, we have arranged to train " Root Disease Teams " for all estates, and seeing the importance of the problem the Head of the Department himself is conducting these training classes.

The critical factor in the control of White Root disease in the removal of the food base, as we have clearly shown that new centres of infection in replanted areas always originate from infected debris left from the previous stand. Therefore effective control should start at the time of uprooting for replanting, when all infected material should be removed ensuring a disease free " seed bed " as far as practicable.

We have pioneered the studies on the biological control of *Rigidoporus* and have shown that soil amendment with sulphur significantly reduces the incidence of the disease. We have now found that soil amendment with urea too gives good results. We are perfecting a method for the biological control of this disease, and, in this respect, our observation that the roots of clone LCB 1320 are consistently resistant to *Rigidoporus* is significant. We are confidnet that, with meticulous land clearing, suitable soil amendment, and a resistant root stock we can control this disease and maintain an optimum stand of rubber throughout its economic life span.

The other threat to rubber in South East Asia is South American Leaf Blight (SALB), a devastating leaf disease, which has not yet been recorded in this hemisphere. However, we are breeding material resistant to this disease, and 26 clones bred by us were tested for resistance to it, in Trinidad. Eight of the clones were found to be resistant, so that we now have high yielding disease resistant varieties, which will be planted out on a small scale in all the rubber growing areas of Sri Lanka. We are happy to record that we have bred the highest yielding SALB-resistant clones in the world to date.

Soils & Plant Nutrition : This Department has taken a special interest in the use of indigenous or locally manufactured fertilizers for rubber. We have now found from experiments, which have gone on for 8 years, that urea is as effective as sulpate of ammonia as a nitrogen source in Boralu soils, that Eppawela Apatite is as efficient as imported rock phosphate for immature rubber, and that Dolomite, although sparingly soluble can be effectively used for replantings. All three are local or locally manufactured materials, and based on these findings our fertilizer recommendations for rubber have been revised, to utilize the cheapest sources of fertilizer in our schedules.

Our most recent studies have shown that certain clones require higher amounts of some fertilizer elements e.g. potassium (PB 86), than the levels recommended earlier for Boralu soils. The nitrogen and potassium requirements of the RRIC 100 series clones appear to be higher than those of PB 86. There are also indications in general of higher yields with higher dosages of N,P,K in other clones. Yield increases of 5 - 27% over no fertilizer plots have been recorded overall, and, in view of the high cost of fertilizers, it has been decided to study the long term economics of fertilizer usage.

We have now found that the rubber soils of Sri Lanka can be placed in three distinct groups of weathering stages : Oxic, Demi-oxic and Inceptic, based on the mineralogy of the sand fractions. The details of the scheme are given in the Departmental report and the currently recognized soil series placed in the relevant groups.

Rubber Chemistry : The price of crepe rubbers fell to uneconomic levels early in the year and crepes sold at a discount to RSS up to the end of the year. This position has reversed only now. The problems of crepe rubber marketing in 1980, clearly showed the importance of market promotion for rubber and the necessity of the State Plantation Corporations to have some flexibility in the manufacture of dry rubber ; so as to follow market trends. Other natural rubber (NR) producing countries have vigorous market promotion systems for their rubber, we have none and are completely at sea as to the reasons for market changes, when they do occur. Therefore, adequate sales promotion, backed by sound market intelligence is essential for our country to ensure the maximum income from this crop.

The high cost of fuels for drying rubber and other produce has made it imperative for us to look for other energy sources. A new system for using solar energy for drying crepe rubber was tested and we now have data on the area of the solar collector required and how to store solar energy for night heating. This is a significant break-through in energy conservation and we are carrying out further tests on estate factories, to perfect the method.

The new bleaching agent for crepe, RRI 7, developed by the Institute and commercially marketed as Nexobleach, has proved completely effective for the manufacture of the highest quality crepe. We have found that the initial problems with this material were due to contamination from their storage cans, and these have now been solved on the basis of our recommendations to the manufacturers.

A major area of research was on the structural modification of and the applications of NR in diverse uses. Two of the members of our staff worked on a UNIDO sponsored project in the UK in this connection, to develop thermoplastic NR. Significant advances have been made in this field, by our staff, showing the importance of and the long term advantages of the reorientation of the work of the Institute, undertaken by the Rubber Research Board in the early 1970s. The current developments achieved by us, would have been impossible without such a reorientation of research interests.

The use of latex-bitumen and latex-cement mixes as sealants for concrete roofs and for the construction of cheap irrigation channels and tanks has been successful. One large commercial firm is manufacturing large quantities of roof sealant according to our formula and has found it an extremely profitable commercial venture.

A large quantity of road-marking paint based on cyclised rubber was supplied to the Highways Department Research Unit for further testing. The competition for enamel paints based on alkyd resins made from rubber seed oil became more pronounced during the year. A research student worked full-time to improve the drying characteristics and clarity of rubber seed oil alkyd resins.

Our studies on the manufacture and uses of deproteinised natural rubber (DPNR) has created international interest. We have found that rubber prepared from pineapple juice assisted biological coagulation will cyclise readily and completely with p-toluene sulphonic acid.

Advisory Services and Agricultural Economics : This Department will be expanded with World Bank Assistance, to provide a much more personalized service to smallholders. Steps were taken to recruit the staff and train them at the Institute, while a new training school and dormitory are under construction at Nivitigalakele Division. In addition to its present function, this Department will arrange to supply fertilizers to smallholders and have several mobile publicity units to carry the message on correct cultivation and manufacturing methods to the remote villages.

The research work on Agricultural Economics was restricted due to lack of staff.

RESEARCH STUDENTS

There are 11 research students working at the Institute during the year, in addition to four Experimental Officers who have registered to read for higher degrees at the various Universities. One of our Experimental Officers, Mrs. N. I. S. Liyanage, Plant Pathology Department, successfully completed her studies and was awarded the degree of M.Sc. from the University of Sri Jayawardenapura, her external examiner being Dr. B. E. J. Wheeler, the Director of the course leading to the degree of M.Sc. at Imperial College, University of London. It is a pleasure to record that Dr. Wheeler, in recommending the award of the M.Sc. to Mrs. Liyanage had commented that the scope of her studies, the planning of her experiments, the facilities provided her and the presentation of her thesis were all of high quality. This clearly shows the high standards maintained by the RRISL in research work.

STAFF

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

Mr. D. M. Fernando, Head of Genetics & Plant Breeding Department and Assistant Director, attended the Silver Jubilee and the International Rubber Conference of the Rubber Research Institute of India held in Kottayam, from 24 November to 28 November.

Mr. S. W. Karunaratne, Head of Rubber Chemistry Department, attended a Seminar on the use of Radiation Techniques in NR Latex applications, held in Japan from 30 June to 19 July.

Mr. S. W. Karunaratne also attended a Final Work Plan Meeting of the UNDP Radiation Processing Project as a Technical Adviser, Representative and a Consultant at the Pasar Jumat Atomic Energy Research Centre, Jakarta, Indonesia, from 6 November, to 8 November.

Dr. P. A. J. Yapa, Biochemist attended the Silver Jubilee and the International Rubber Conference of the Rubber Research Institute of India, held in Kottayam, South India, from 24 November to 28 November.

Dr. A. de S. Liyanage, Head of Plant Pathology Department, returned to the Institute on 10 November after completing a course of studies in South American Leaf Blight disease at Trinidad, West Indies and the United States of America.

Dr. U. P. de S. Waidyanatha, Botanist, was on Sabbatical leave from 1 May 1980 to the end of the year.

Dr. A. Coomarasamy, Rubber Chemist, returned to the Island on 10 July, after carrying out Research and Development work into Thermoplastic Natural Rubber, in connection with a special UNIDO Financial Project at the MRPRA, Brickendonbury, Hertford, United Kingdom.

Dr. M. R. N. Fernando, Rubber Chemist, represented Sri Lanka at the International Rubber Conference on Rubber Technology held in India from 28 December to 31 December.

Dr. L. M. K. Tillekeratne, Rubber Chemist/Specification Officer won the 1980/81 Nuffield Foundation Fellowship and is carrying out Post Doctoral studies at the University of Aston in Birmingham for 1 year.

Dr. W. S. E. Fernando, Rubber Chemist, is carrying out Research and Development work into Thermoplastic Natural Rubber in connection with a special UNIDO Financed Project at the MRPRA, Brickendonbury, Hertford, United Kingdom, from July.

Dr. M. K. S. A. Samaraweera, Agricultural Chemist attended the 26th Meeting of the International Rubber Study Group held in Malaysia from 29 September to 04 October, after which he visited the RRIM and other Rubber Research Stations in Malaysia, to study the available new rubber clones and their potential for use in Sri Lanka.

Mr. H. B. D. H. Gunasekera, Assistant Agricultural Economist, tendered his resignation, effective 1 October as soon as he completed his Master's Degree in Australia. This is the second Officer of the Institute to resign soon after completing their post graduate studies. The cool, calculated manner in which these officers carefully plan to let down their country has to be deplored by all right thinking people.

Mr. Z. E. Irugalbandara, Senior Technical Officer, Plant Pathology Department, completed his training course at East Malling Research Station, United Kingdom, and returned to Sri Lanka at the end of March.

Mr. D. M. Dantanarayana, Senior Technical Officer, Plant Pathology Department, returned to the Island on 26 May after following a course of training in Fungal Identification at the Commonwealth Mycological Institute, United Kingdom.

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

Officers in Grades	I — VI	..	34
Officers in Grades	VII — XV	..	258
Officers in Grades	XVI — XIX	..	136
	Total	..	428

Director's Publications

Peries O. S. (1980). Concern for the rubber smallholder. *Economic Rev.* 6, 24-25.

Peries, O. S. (1980). The management of root diseases on rubber estates *Jl. Nat. Inst. Pl. Man.* 1, 15-25.

Peries, O. S. and Liyanage, N. I. S. (1980). The use of sulphur for the control of White Root Disease caused by *Rigidoporus lignosus*. Silver Jubilee Conference of the Rubber Researsh Institute of India, 1980.

Peries, O. S. and Liyanage, N. I. S. (1980). Observations on the biology and spore inoculation of *Hevea* by *Rigidoporus lignosus*. Sri Lanka Association for the Advancement of Science, 1980.

Visitors

Visitors to the Institute included :—

Dr. L. R. Wallace, Director Agricultural Research Division, Ministry of Agriculture & Fisheries, New Zealand.

Mr. Chan Weng Hoong, Head, Agricultural Research, Highlands Research Unit, P. O. Box 2009, Klang, Malaysia.

Mr. & Mrs. D. G. Alexander, England.

Mr. & Mrs. D. Gargin, Norwich, England.
Mr. U. Tin Maung, Agricultural Corporation Rubber, Tavoy, Burma.
Mr. U. Shwe Sein, Agricultural Corporation Rubber, Kewthamang, Burma.
Mr. L. G, North, Institute of Biology, London, England.
Mr. C. Gene Haugh, Virginia Polytechnic Institute, Blacksburg, VA, U.S.A.
Mr. Ejner Kristensen, Borom Byvej 16 ; Borom, DK 8471, Sabro, Denmark.
Mr. B. Abraham, Sundley Alle, Denmark.
Mr. Carol Brian, Bollimore, Leeds, England.
Mr. S. McCarthy, Desterre Roegue, Colombia.
A Chinese delegation including 4 Scientists, who spent 3 weeks at the Institute, familiarising themselves with our studies.

FUTURE DEVELOPMENT

One of the major weaknesses in research in Sri Lanka is the lack of high quality research officers. The " Brain Drain " has had a telling effect here : trained research personnel are attracted by higher salaries, and plentiful supply of sophisticated equipment in developed countries. Therefore, they leave us just about the time their services are most required. There is no easy remedy for this, the solution is to recruit and train at least twice the number of research officers we require and regard the " Brain Drain " as another of our essential exports. The Rubber Research Board has accepted this policy and has decided to amend the service bonds adequately to ensure that trained persons who leave the Institute's services pay sufficient compensation to enable us to train other officers to replace them.

The policy of the Board to have at least three highly trained officers in each Department, except Rubber Chemistry which requires more, has proved successful. This has now to be backed up by suitable recruitments to ensure a permanent cadre of three top level officers, to compensate for any that may leave us. There is no necessity to increase the research cadre of any of the Biological Research Departments, as we have always been, and should continue to be, a small but elite research station. At present, our achievements in all aspects of rubber research compare very favourably with institutions ten times our size. This is the assessment of outsiders who are qualified to speak on the subject.

INSTITUTE PUBLICATIONS

Papers

AMARATUNGE, L. WIMAL. White root disease caused by *Rigidoporus lignosus*. *Rubber Purath* **8** (2) 1980 (in press).

ATAPATTU, N. K., DISSANAYAKE, A. B. & THARMALINGAM, R. The economics of control processing of smallholder rubber. *Paper read at the* ANRPC *Seminar Colombo* 1980.

Centrifuged latex — supply and price by the sub-committee consisting RRI, JEDB, SPC and SMRC. *Paper submitted to the Central Bank.*

COOMARASWAMY, A. *et al.* NR analogous of styrene diene thermoplastic Rubbers. *Paper read at the* SLAAS *sessions December* 1980.

DISSANAYAKE, A. B. Determination of the maximum production capacity of NR in Sri Lanka and the constrainists in achieving a dynamic production policy for NR. *Paper read at the* ANRPC *Seminar Colombo* 1980.

DISSANAYAKE, A. B. Country Report for Sri Lanka. *Paper read at the* ANRPC *Seminar Colombo* 1980.

DISSANAYAKE, A. B. An assessment of the training classes on rubber cultivation for smallholders. *Paper read at the* ANRPC *Seminar Colombo* 1980.

FERNANDO, D. M. Review of the Genetics and Plant Breeding Department for 1979.

FERNANDO, D. M. Report on the breeding and selection of *Hevea* in Brazil. IICA/KMBRAPA, Brasilia, 1980.

FERNANDO, D. M. Some considerations of newer rubber clones for the smallholders in Sri Lanka. *4th Seminar and Workshop.* ANRPC *Colombo July,* 1980.

FERNANDO, D. M. An evaluation of recent *Hevea* selections. *Jubilee Conference,* RRI *of India, Kottayam, Nov.,* 1980.

FERNANDO, M. R. N., PERERA, K. A. R. M., CROOSE, K. C. AND PERERA, W. C. M. Network structures and technological properties of room temperature vulcanisation. *Paper read at the* SLAAS *Sessions December,* 1980.

JAYASINGHE, C. K. Diseases of rubber plants (in Sinhala). *Rubber Puwath* **8** (2) 1980 (in press).

JAYASINGHE, C. K. White root disease (in Sinhala). Advisory Leaflet.

JAYATILAKE, K. C. K., COOMARASWAMY, A. AND FERNANDO, W. S. E. Use of acrylic polymers for the preparation of granular NR. *Paper read at the* SLAAS *Sessions Dec.,* 1980.

KARUNARATNE, S. W. Prospects for Sri Lanka Pale Crepe. *Rubber Reporter* (India) April 1980.

KARUNARATNE, S. W. Radiation vulcanisation of Natural Rubber latex. *Paper read at the* SLAAS *Sessions December* 1980.

LIONEL, W. A. (1980). Deproteinized natural rubber (in Sinhala). *Rubber Puwath* **8** 19 — 21.

LIYANAGE, A. de S. & CHEE, K. H. The occurrence of a virulent strain of *Mycrocyclus ulei* on *Hevea* in Trinidad. *Paper presented to the Int. Rubb. Conf. in Brazil, July* 1980.

PERIES, O. S. Annual Review of the Plant Pathology Department 1980.

PERIES, O. S. The rubber replanting scheme in Thailand — key to success (in Sinhala). *Rubber Puwath,* **8** (2), 1980 (in press).

PERIES, O. S. & LIYANAGE, N. I. S. The use of sulphur for the control of white root disease caused by *Rigidoporus lignosus. Int. Conf. India, Nov.* 1980.

PREMATILLAKE, S. P. (Replanting and rubber production in Sri Lanka (in Sinhala). *Rubber Puwath* (in press).

SAMARANAYAKE, CHANDRA. Preparation and planting of stumped buddings. RRISL *Bulletin,* **14,** 1979.

SAMARANAYAKE, CHANDRA. High stumped buddings (in Sinhala). *Rubber Puwath,* **8** (2) 1980 (in press).

SAMARANAYAKE, C., ABEYWARDENA, V., GUNARATNE, R. B. & BANDARA, K. A. G. Effect of the rootstock and scion on bud emergence of *Hevea* bud grafts. *RRISL Jl.* **57,** 1980 (in press).

SAMARANAYAKE, P., RUPATUNGE, K. W., FERNANDO, D. M., & JAYASEKERA, N. E. M. (1979). In vitro germination of pollen and pollen tube growth of *Hevea brasiliensis* in the presence of calcium and boron. *J. Rubb. Res. Inst. Sri Lanka.* **56,** 29 — 33.

THARMALINGAM, R. A solar powered crepe drying tower. *Karmantha*, 8 (9) 1980.

THARMALINGAM, R. & DISSANAYAKE, A. B. Implications of the use of the metrolac in weighing smallholder latex. *Paper submitted to the* ANRPC *Seminar* 1980.

TILAKARATNE, L. M. K., VIMALASIRI, T. & DE SILVA, A. Production of CV 50 using high viscosity rubber latices from smallholders latex. *Paper presented at the* SLAAS *Sessions Dec.* 1980.

WAIDYANATHA, U. P. DE S., WIDANAPATHIRANA, A. S. & DE ZOYSA, R. P. M. Some observations on Sri Lankan rubber smallholder practices with special reference to tapping. *Paper read at the* ANRPC *Seminar Colombo* 1980.

WICKREMASINGHE, W. N. & ABEYPALA, R. A. P. Error reduction in field experiments on *Hevea* using covariance techniques and effective blocking. *RRISL Jl.* 57, 1980. (in press).

WIDANAPATHIRANA, A. S. Socio-economic factors that affect the development of smallholders *Paper read at the* ANRPC *Seminar, Colombo*, 1980.

YAPA, P. A. J., FERNANDO, D. M. & PEIRIS, B. M. S. G. (1980). Heritability of raw rubber properties in *Hevea* population. *Sessions Sri Lanka Assoc. Adv. Sci.* 1980, *Dec.*

YAPA, P. A. J. & LIONEL, W. A. Some studies on cyclisation of bromelain treated rubber. *J. Rubb. Res. Inst. Sri Lanka* 1980 (in press).

YAPA, P. A. J., PREMATILLAKE, S. P. & LIONEL, W. A. (1980). Proteolytic action of bromelain an *Hevea* latex. *Paper presented at the Int. Rubb. Conf*, 1980. *Kottayam, India.*

YAPA, P. A. J. (1980). Technological properties of new RRIC clones (in Sinhala). *Rubber Puwath*, 8 (2) 1980 (in press).

Circulations

COOMARASAMY, A. A report on the UNIDO Project to increase the competitiveness of NR.

KARUNARATNE, S. W. Regional co-operation agreement (RCA) sub-project for Asia and the Pacific on industrial applications of radiation technology.

Patents

YAPA, P. A. J. AND LIONEL, W. A. Use of Pine Apple Juice (PAJ) as a coagulant for NR latex and the use of PAJ treated rubber in cyclised rubber manufacture.

Sri Lanka provisional patent application No. 7713. An application for a Sri Lanka Patent on the use of natural rubber in leak proofing applications was made in the names of M. R. N. Fernando, M. Nadarajah & K. A. R. M. Peiera.

REVIEW OF THE PLANT SCIENCE DEPARTMENT FOR THE YEAR 1980

By

CHANDRA SAMARANAYAKE

SUMMARY

Tapping experiments conducted over a period of 5 years indicate that there is no advantage in changing over of panels at each tapping of a tree both for daily and alternate daily tapping systems. When there are two tapping cuts one higher and one lower, but on opposite panels the higher panel has always yielded less than the lower panel. Accepted high yielding clones have given high yields on microtapping for the third year in succession. Response to puncture tapping in the RRIC clones tested have been relatively lower than for conventional tapping. The trees which have been puncture tapped for 2 years when tapped later with conventional tapping cuts, on previously punctured panels, have given higher yields than the normal panels. Tapping of trees affected with Brown Bast has given yields high enough to warrant exploitation of such trees on unaffected bark.

When rubber is intercropped with forage grasses, generally, the more productive grasses have been more competitive to the rubber. The grass-legume mixed pasture systems have been less competitive than the grass alone.

Crown budding experiments indicate that the growth of the trunk is significantly affected by the nature of the crown. Stumped buddings are maintaining about an years growth advantage over bare-root budded stumps.

Callus initiation and growth has been faster from stem explants of a vigorous growing clone, when compared with that from a relatively slow growing clone.

Mixing of rock phosphate and apatite with sulphur has improved the response of young rubber trees to these phosphates.

DETAILED REVIEW

The Botany Department was renamed the Plant Science Department with effect from 11 March, 1980. The Director was in over-all charge of the Department till 1 September 1980 when Dr (Mrs.) A. C. I. Samaranayake, Botanist, was appointed the Acting Head of the Department.

Staff

Mr. L. B. Chandrasekera, Head of Botany Department was on duty till 11 March when he assumed duties as the Head of Intercropping Department.

Dr. (Mrs.) A. C. I. Samaranayake, Botanist, was on duty throughout the year.

Dr. U. P. de S. Waidyanatha, Botanist went on Sabbatical leave from 1 May 1980. He will be away for one year doing Research on Zero-tillage farming with the International Institute for Tropical Agriculture, Sri Lanka Project.

Dr. R. Satchuthananthavale, Botanist, resigned from the services of the Institute on 31 August.

Mr. N. Ruwanpathirana assumed duties as Research Assistant, on 25 June 1980, but resigned on 1 September.

Mr. A. Nugawela joined the Department as Research Assistant on 1 September.

Miss G. A. S. Wijesekera joined the Department as Technical Officer on 11 February.

The Experimetal Officer Miss E. M. A. I. Ekanayake, Senior Technical Officers Mr. W. G. V. Fernando and Mr. L. S. S. Pathiratne, Technical Officers Messrs. I. R. M. Amarakoon, D. K. Angammana, W. A. Ariyaratne, K. A. G. B. Amaratunge, L. S. Kariyawasam, R. P. Karunasena, Miss C. W. Ranasinghe, Senior Experimental Assistants Mr. M. C. Perera, Mr. R. B. Gunaratne and Experimental Assistants S. Wilbert were on duty throughout the year.

Mr. S. Kodikara, Experimental Assistant, and Mr. U. S. Weerakoon, Field Attendant, were appointed processing Assistant and Extension Assistant, respectively, in the Advisory Services Department.

Research Students

Mr. S. N. Dissanayake reported back for duty on 1 October at the Vidyodaya University, after completion of his field experiments on forage grasses and legumes.

Messrs. M. H. Mendis and A. H. R. Jayaratne continued their studies for higher degrees, in the Department.

Visits

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

Meetings

The Research staff held a series of lectures and demonstrations to two batches of Planter trainees from the Ministry of Plantation Industries on subjects relevant to their specialities.

The Research staff also participated in the following meetings and conferences :

R. Satchuthananthavale — Botanist

Planters meetings at Avissawella, Kegalle & Galle on " Ethrel stimulation ".
These meetings were organised by Harrisons & Crossfield Ltd., Colombo.

A. C. I. Samaranayake — Botanist

S.L.S.P.C. Planters' seminar Ratnapura and Kalutara Regions.

S.L.S.P.C. Planters' seminar — Galle Region — On the use of plants grown in polythene containers.

Training Programmes

REO's of the Advisory Services Department were given a training in the method of fixing rainguards to tapping panels at Eladuwa Estate, Paiyagala.

Fifty nine budders of the S. L. S. P. C. were trained on budgrafting methods at St. George State Plantation, Matugama.

Publications

Samaranayake, Chandra ; Preparation and planting of stumped buddings. *RRISL Bulletin.*

TAPPING

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

The treatments given in Table 1 commenced in July 1975.

Table 1. *Yield, girth increment and brown bast data for 1980*

Tapping system	*Yield kg/ha/yr*	*Girth increment (cm)*	*Brown bast %*
S/2 d/2 100%	2490·5	3·3	5·9
S/2 d/1 200%	4266·4	2·2	19·1
S/2 d/2 (2 × 2d/4) 100%	1855·1	1·5	5·9
S/2 d/1 (2 × 2d/1) 200%	2970·3	0·5	18·6
2S/2 d/2 200%	2405·2	2·0	19·1

This year's yield data are consistent with those of the previous year in that there is no advantage in alternating panels at each tapping of a tree both for daily and alternate daily tapping systems. Again the very high yields for the S/2 d/1 tapping system is hard to explain.

Incidence of Brown Bast continues to be high for the 200% tapping intensity. (U. P. de S. Waidyanatha & S. Wilbert)

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

The treatments given in Table 2 were first applied in August 1979.

Table 2. *Yield, girth increment and brown bast data for 1980*

Tapping system	*Yield kg/ha/yr*	*girth increment (cm)*	*Brown bast %*
S/2 d/2 100% (Normal)	1457·3	1·6	12·5
S/2 d/2 100%+ recovery tapping*	1679·9	1·8	10·0
S/2 d/2 100%+ recovery tapping**	1471·7	1·5	5·0
S/2 2d/3 133%	1887·6	2·3	12·5
S/d2 /1 200%	1998·4	1·4	22·5
LSD (5%)	391·5	N.S.	

* Recovery of lost tapping days by daily tapping

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

Significantly higher yields were obtained when tapping half spirals at 2d/3 and d/1 frequencies than at the normal d/2 frequency. There was no difference between d/1 and 2d/3 frequencies meaning that the 2d/3 system is therefore more economical. There has been no significant yield advantage this year from recovery tappings as compared to normal tapping. Incidence of brown bast is high at the 200% intensity tapping. (U. P. de S. Waidyanatha & S. Wilbert)

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

The treatments and experimental design were described in the Annual Report for 1979. Table 3 gives the yield data for 1979.

There was no advantage in tapping two panels, shifting from one to the other at each tapping or on an annual basis. Yields were not significantly different between treatments with the change over tapping systems, but tapping the same panel (d/2 frequency) gave higher yields than any of the change over tapping systems at the same tapping frequency and intensity. S/2 d/2 tapping also gave significantly higher yields than S/2 d/3. There was no advantage in spacing out the panels to 106 cm compared to 53 cm. (U. P. de S. Waidyanatha & M. C. Perera.)

Table 3. *Yield (kg/ha/yr) for 1980, various tapping systems*

Treatment	*Yield*		*Total*
	L	*H*	
S/2 d/3 67%	1036	—	1036
S/2 d/2 100%	1906	—	1906
S/2 d/2 (2 × Y/2) 100% — 53 cm H ↑	1566	—	1566
— do — — 106 cm H ↑	1722	—	1722
S/2 d/2 (2 × 2d/4) 100% — 53 cm H ↑	1836	1415	1626
— do — — 53 cm H ↓	1942	1361	1657
— do — — 106 cm H ↑	1754	1322	1538
— do — — 106 cm H ↓	1787	1322	1555
PT 1 m d/3 + E			1891
		LSD (5%)	271

H = Higher cut L = Lower cut

53, 106 = Distance between L & H cuts

↑ Upward tapped ; ↓ Downward tapped

PT 1 on d/3 = Puncture tapping of 1 m band 3rd daily.

Tapping experiment: RRIC 133, 1969 Replantation, Eladuwa (T/78/3/F)

S/2 d/2 tapping has very significantly out-yielded S/2 d/3 tapping. S/2 2d/3 tapping of a single panel has yield of more than tapping two panels alternatively (S/2 2 × 4d/6) at the same intensity. The yield of S/2 2d/3 also but not the S/2 2 × 4d/6 was higher than the S/2 d/2 yield. As with RRIC 100 and 101, in this clone too, the higher panels yielded very significantly less than the lower, and there was no advantage in separating out the two panels wider apart from 53 to 106 cm. The puncture tapping and S/4 d/2 tapping with stimulation yields are not significantly different from S/2 d/2. (U. P. de S. Waidyanatha & M. C. Perera).

Table 4. *Yield (kg/ha/yr) for 1979*

Tapping system	*Lower cut*	*Upper cut*	*Total*
S/2 d/3 67%	945	—	945
S/2 d/2 100%	1444	—	1444
S/2 2d/3 133%	1956	—	1956
S/2 2d/3 (2 × 4d/6) 133% — 53 cm ↓	556	606	1462
S/2 2d/3 (2 × 4 d/6) 133% — 106 cm ↓	977	647	1624
PT 2m d/3 + E*	1300	—	1300
S/4 d/2 50% + E	1388	—	1388
LSD (1%) for lower and		LSD (5%)	215
upper cuts within treatments 157		LSD (1%)	290

↓ Tapped downwards ; 106, 53 cm = distance between upper and lower cuts.
E* = 5% Ethrel applied every 4 — 6 weeks on puncture tapped trees (2g/tree)
E = 5% Ethrel applied every 8 — 9 weeks on a 4 cm band below cut (2g/cut)

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

In this experiment (Table 5) also S/2 d/2 tapping has out yielded S/2 d/3. Tapping of two panels alternately again gave lower yields than tapping the same panel on the d/2 frequency. There was also, as with other clones, no advantage in separating the panels wider apart from 53 to 106 cm. (U. P. de S. Waidyanatha, M. C. Perera)

Table 5. *Yield (kga/g/yr) for 1980*

Tapping system	*Lower cut*	*Upper cut*	*Total*
S/2 d/3 67%	1806	—	1806
S/2 d/2 100%	2503	—	2503
S/2 d/2 (2 × 2 d/4) 100% — 53 cm ↓	1267	858	2125
— do — — 106 cm ↓	1295	849	2144
		LSD (5%)	386

↓ Tapped downwards
53 to 106 cm — distance between the 2 panels

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

Of the several tapping systems (Table 6), S/2 d/2 has given the highest yield for all clones except PB 252 in which the yield for puncture tapping of a 1·5 m band is not significantly different from S/2 d/2. S/2 d/2 has also outyielded S/2 d/3 in all clones except WR 101. This yield difference is greatest in the highest yielding clones, RRIC 100 and 101. S/4 d/2 tapping with stimulation yielded significantly more than S/2 d/3 only for RRIC 101. The response to puncture tapping in the RRIC clones has been relatively lower than for conventional tappings at the same tapping frequency, (d/3), especially when the puncture tapping band is 1 m. Yields therefore improved with the longer puncture band of 1·5 m but yet remained lower than for S/2 d/3. By contrast the relative response of PB 252 to puncture tapping has been better than in the other clones. Generally, the disparity between yields for puncture as compared to conventional tapping is less for the foreign than for the local clones. This is perhaps a reflection of the relatively poor yields of these foreign clones and hence their greater magnitute of response to Ethrel-stimulated tappings. (U. P. de S. Waidyanatha & S. Wilbert)

Table 6. *Yield (kg/ha/yr) for 1980*

Tapping system	RRIC 101	RRIC 100	RRIC 13	RRIC 45	PB 252	AV 1734	IRCI 2	WR 101
S/2 d/3 67%	985	990	738	639	500	449	709	515
S/2 d/2 100%	1702	1765	1046	935	762	650	998	699
S/4 d/2 50% + E	1410	1144	779	629	555	442	713	604
PT (1m) d/3 + E	559	508	350	309	529	396	559	386
PT (1·5m) d/3 + E	875	836	530	450	796	625	829	589

	LSD (5%)	LSD (1%)
Between treatments, within clones	189	248
Between clones, within treatments	235	313

E — 5% Ethrel applied every 4 - 5 weeks on puncture bands (1g/metre) and every 2 months on S/4 cuts (1 g/cut)

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

Increasing the quantity of Ethrel but not the number of punctures increased yields, Yield per tapping was also higher at the d/4 frequency than at the d/2 (Table 7a). There were significant interactions in yield between levels of Ethrel (E) and number of punctures (P) (Table 7 b) and also between levels of Ethrel (E) and frequency of puncture tapping (F) (Table 7c). There is no significant yield difference between the S/2 d/2 and S/2 d/4 conventional tappings in terms of yield per tapping but in terms of yield per year the difference is great. (U. P. de S. Waidyanatha, D. K. Angammana)

Table 7a · *Yield data for 1980*

Treatments		*g/tree/tapping*	*kg/ha*
Puncture tapping			
0·5 g/tree 5% Ethrel (E_1)		16·7	
1·0 g/tree 5% Ethrel (E_2)		18·5	
2·0 g/tree 5% Ethrel (E_3)		21·5	
LSD (5%)		1·6	
LSD (1%)		2·1	
5 Punctures/m band/tree (P_1)		18·5	
10 Punctures/m band/tree (P_2)		18·7	
15 Punctures/m band/tree (P_3)		NS	
Tapping frequency	d/2 (F_1)	18·0	
	d/4 (F_2)	19·8	
	LSD (1%)	1·7	
Conventional tapping			
S/2 d/2 100%		15·7	774
S/2 d/4 50%		17·9	441
		N.S.	
S/2 tapping mean		16·8	829
Puncture tapping mean		18·9	931
		N.S.	

Table 7b *Ex. P interactions*

	P_1	P_2	P_3
E_1	18·5	15·6	15·9
E_2	17·2	19·0	19·4
E_3	20·6	21·8	22·0

LSD (5%) 2·7

Table 7c *Ex. F. interactions*

	F_1	F_2
E_1	16·9	16·5
E_2	17·1	20·0
E_3	19·9	23·0
	LSD (5%)	2·2

Tapping immature trees PB 86, 1973 Replantation, Dartonfield (T/8/73/F)

This experiment was described fully in the Annual Review for 1979. The following amendments were made at the end of December 1979 :—

(a) The S/8 d/6 + 1 gm of 5% Ethrel treatment was changed to S/8 d/3 + 0·5 g of 5% ethrel.

(b) Half the number of trees in each treatment, puncture tapped on a 0·5 m band (PT 0·5 m d/3 or d/6) was changed to conventional tapping on d/3 on the previously puncture tapped panel. The balance 50% of trees of each of the two treatments was tapped on the untapped panel.

(c) The d/6 puncture tapping of a 1 m band was changed to d/2.

(d) The S/2 d/6 conventional tapping was changed to Micro-X tapping on d/3, here the trees were tapped 5 consecutive rounds on the normal tapping cut with needle punctures, after Ethrel stimulation of the cut, followed by an equal number of rounds conventionally with the Michie-Golledge knife.

The most interesting result is that the puncture tapped trees, when later tapped conventionally on the previously punctured panels, gave higher yields than comparable trees which were tapped conventionally on bark previously not punctured. This is perhaps a result of some residual effect of the Ethrel that was applied on puncture tapped panels. Also of interest is that trees on which tapping (S/2 d/3) commenced at 28·9 cm of girth in August 1977 have given yields comparable with those tapped initially in Dec. 1979 at a girth of 45 cm or above.

Puncture tapping on 1 m continues to give yields comparable to or approaching conventionally tapped yields. Short cut and Micro-X tapping yields were lower than conventional or puncture tapped yields. On average S/3 cuts have given yields/tree/ tapping approaching S/2 cuts ; per hectare yields were hence higher for the S/3 cuts. (U. P. de S. Waidyanatha & D. K. Angammana)

Table 8. *Yield data for 1980*

Previous tapping system	*Present*	*g/tree/tapping*	*kg/ha/yr*
S/2 d/3 67%	same	22·0	720
S/2 d/6 33%	S/2 d/3 — Micro-X	13·7	503
S/8 d/3 + E	same	14·2	475
S/8 d/6 + E ..	S/8 d/3 0/5 E	13·8	459
PT 0·5 m d/3	S/3 d/2 tapped panel	21·1	1029
	S/3 d/2 untapped panel	17·1	858
PT 0·5 m d/6 + E	S/3 d/2 tapped panel	19·5	979
	S/3 d/2 untapped panel	16·7	838
PT 1 m d/3 + E	Same	18·5	909
PT 1 m d/6 + E	PT 1 m d/2 + E	18·3	859
Untapped (immature) S/2 d/3 67%		23·3	757
(Tapped at a girth of 45 cm)	LSD (5%)	4·6	
	LSD (1%)	5·5	

E = 1 gm of 5% Ethrel ; 0·5 E = 0·5 g of 5% Ethrel
PT = puncture tapping ; 1 m = 1 metre, 0·5 m = ½ metre ;

Tapped panel = previously stimulated and puncture tapped panel, now tapped S/3 d/2 ; Untapped panel = untapped (unstimulated) bark of previously puncture tapped trees now tapped S/3 d/2.

BROWN BAST STUDIES

Tapping Brown Bast trees: RRIC 101, 1969 Replantation, Eladuwa (BB/78/1/F)

This trial was described in detail in the Annual Review for 1979.

Table 9. *Yield (g/tree/tapping) of Brown Bast affected trees*

Treatment	*Yield*
Resting of affected trees	—
Removal of affected bark, application of Kankerdood and resting	—
Same as (2) but tapping on S/2 d/3 downwards starting at 100″ above union	12·8
Isolation of affected bark with grooves and tapping as in (3)	12·0
Tapping downwards as in (3) but without any treatment on affected bark	13·8
Continuation of tapping of affected bark	6·9

The yields that decreased remarkably in 1979 continued to do so in 1980 too in all treatments. This is because several trees of each treatment are now partially dry, supporting the belief that a tree once afflicted by the disorder although it may yield normally for a period when tapped on unaffected bark, will eventually run dry again totally or partially. The indication however confirms that tapping unaffected bark gives higher yields than continued tapping of affected bark.

Isolation grooves have not improved yields nor curtailed spread of the disorder to unaffected bark in this trial as shown by some cuts of this treatment being partially dry. (U. P. de S. Waidyanatha & M. C. Perera)

Tapping Brown Bast trees: RRIC 89 and PB 28/59: 1961 Replantation, Dartonfield.

The treatments in Table 10 ie. (1), tapping upwards on V cuts and (3), removal of affected bark, panel dressing with Kankerdood and tapping unaffected bark continued to give yields comparable with that of normal trees in this trial. Treatments (4), continued tapping of affected bark and (2), tapping panel opposite of affected have given different responses depending on the clone. On the whole brown bast trees of these two clones have given over the last 3 years yields high enogh to warrant exploitation of such trees on unaffected bark. (U. P. de S. Waidyanatha & D. K. Angammana)

Table 10. *Yield (g/tree/tapping) for 1980*

Treatment	*Yield*	
	RRIC 89	*PB 28/59*
Tapping virgin bark upwards on V cuts above affected	30·9	27·9
Tapping panel opposite of affected on S/2 d/2 downwards	32·3	11·2
Affected bark removed, Kankerdood applied and tapped as in (1)	21·1	28·2
Continued tapping of affected panel on 2½ d/2	10·1	35·8
Unaffected (normal) trees tapped S/2 d/2	21·4	26·2

Interaction of clone and tapping system 1977 Replantation St. George Estate, Matugama CT/77/3/F

The clones in Table 11 are to be compared with PB 86 and RRIM 600 (standard clones in a randomized experiment with 4 tapping treatments. Each plot has 40 trees. Four tapping treatments will be applied at tapping.

It is noteworthy that many of the RRIC clones, notably RRIC 101, 102, 103, 104 and 110 have significantly outgrown the standard clones PB 86 and RRIM 600. (U. P. de S. Waidyanatha & L. S. S. Pathiratne)

Table 11. *Tree girth (cm) in December, 1980*

Clone	RRIC 100	RRIC 101	RRIC 102	RRIC 103	RRIC 104	RRIC 105	RRIC 108	RRIC 109
Girth	29·0	32·1	33·9	32·4	37·2	29·1	28·0	28·3
Clone	RRIC 110	ITP 2427	RRIC 117	RRIC 113	RRIC 112	RRIM 600	PB 86	
Girth	34·2	33·0	29·9	30·0	32·8	27·7	28·4	

LSD (5%) 2·7

LSD (1%) 3·6

RAINGUARDS

Rainguard trial — 1963 Replantation Eladuwa Estate, Paiyagala (RG/77/1/F)

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

The rainguarded blocks recorded 13 more tapping days than the control blocks giving a total of 204 kg dry rubber for rainguarded blocks. The average crop/tapper/day for rainguarded blocks and control blocks were 3·62 kg and 3·76 kg respectively.

Rainguard trial — Udapolla Estate, Deraniyagala (RG/80/1/F)

This trial was started in 1980 and was in progress from July. There are five tapping tasks with rainguards. The rainguarded blocks recorded 9 days from July to November giving a total crop of 112 kg. The average crop/tapping/day for rainguarded blocks were 6·82 kg.

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

In this trial, started in 1979, there are eleven tapping tasks with rainguards and six tasks without rainguards.

In this trial no additional tappings were recorded for the year.

One important fact observed in all these trials was that the co-operation of the field supervisory staff is required to make these trials a success. (R. Satchuthananthavale, A. Nugawela and R. P. Karunasena)

PROPAGATION

Stock-scion relationships

Stock scion experiment, St. George Estate, Matugama (ST/SC/75/4/F)

In this experiment four scion clones RRIC 45, RRIC 103, PB 86 and Wagga 6278 have been budded onto seedling rootstocks of the same four clones in various combinations. Girth of scion at 5½ years are summarised in Table 12. (A. C. I. Samaranayake, R. B. Gunaratne and L. S. Kariyawasam)

Table 12. *Mean girths of scions for various combinations of rootstocks and scion (cm)*

Rootstock Clones	*Scion Clones*				*Rootstock Mean*
	PB 86	*RRIC 45*	*Wagga 6278*	*RRIC 103*	
PB 86	45·18	53·52	46·53	55·76	50·25
RRIC 45	46·29	51·89	46·36	55·57	50·03
Wagga 6278	43·95	49·63	46·29	51·95	47·96
RRIC 103	46·16	53·80	46·21	51·58	49·44
Scion mean	45·40	52·22	46·35	53·72	

L.S.D. (5%) = 1·76

As rootstocks seedlings of PB 86, RRIC 103, and RRIC 45 are better than Wagga 6278. Scion clones RRIC 103 and RRIC 45 are more vigorous than clones PB 86 and Wagga 6278.

Stock-scion experiment 1978 Replantation Eladuwa Estate, Paiyagala (St. Sc/78/5/F)

Clones PB 86, RRIC 13, 48, 52, 94 and RRIC 100 have been budgrafted on to seedling rootstocks of PB 86, RRIC 52, 94 and RRIC 100. This experiment was planted in a randomized block design replicated four times. There was extensive damage to plants by stray cattle and goats, two replicates had to be excluded from the experiment. Analysis of girth data recorded 2½ years after planting does not show any significant rootstock effects. (A. C. I. Samaranayake, R. B. Gunaratne and G. B. Amaratunge)

Rootstock-scion experiment, Frocester (St/80/6/F)

In this experiment clones RRIC 100, 101, 102, 103, 111, 52 and PB 86 are budgrafted onto seedling rootstocks of the same clones in various combinations. These 49 rootstock

combinations were planted in the field in July 1980, according to a randomized block design. The plot size varies from 10 to 20. (A. C. I. Samaranayake, R. B. Gunaratne)

CROWN BUDDING

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

Clones RRIC 45, 48, 101 and RRIC 600 grafted on to seedling rootstocks of Tjir 1 have been crown budded with clones RRIC 45, 48, 101, 102, 117 RRIC 600 and PB 86.

Girth data recorded 3 years after crown budding are summarised in Table 13. They indicate that the growth of the trunk is markedly affected by the nature of the crown. Growth of RRIC 101 and RRIC 48 was significantly reduced by PB 86 and RRIC 117 crowns. Growth of RRIC 45 and RRIM 600 trunks was significantly increased by RRIC 102 crowns. (A. C. I. Samaranayake & R. B. Gunaratne)

Table 13 *Mean girth (cm) of trunks in crown budded trees*

Trunk clone	*Crowns*	*Girth cm*
	RRIC 101	47·47
RRIC 101	PB 86	38·76***
	RRIC 117	39·90***
	RRIC 102	49·07
	RRIC 45	39·21
RRIC 45	PB86	39·19
	RRIC 117	39·42
	RRIC 102	46·31***
	RRIC 48	41·70
RRIM 48	PB 86	36·01*
	RRIC 117	34·50**
	RRIC 102	43·55
	RRIM 600	37·98
RRIC 600	PB 86	36·14
	RRIC 117	36·65
	RRIC 102	43·13*

L.S.D. = 4·37
(P = 0·05)

L.S.D. = 5·81
(P = 0·01)

L.S.D. = 7·56
(P = 0·001)

Preparation and establishment of three-part stumped buddings, Dartonfield (CB/79/2/F)

Three-part trees consisting of RRIC 102 crown, PB 86 trunks and RRIC 52 rootstocks were prepared as stumped buddings in a nursery and field planted in December 1979. The plants were mulched with saw dust and watered. Establishment was very satisfactory even though there was a severe drought. The crowns have got established well and the growth of plants is satisfactory. (A. C. I. Samaranayake & R. B. Gunaratne)

Comparison of green buddings with brown buddings, Eladuwa (PT/76/1/F)

Girth of plants at 4½ years of age shows no significant difference in growth between green and brown buddings. (A. C. I. Samaranayake, R. B. Gunaratne & L. S. Kariyawasam)

Reduction of the immature period

(a) Plants in polybag containers, Belmont Estate, Padukka (R1/78/1/F)

In this experiment established in the field in November 1978, the growth of plants raised in polythene bags is compared with bare root budded stumps after transplanting in the field. The average girth of plants at the end of two years is summarised in Table 14. (A. C. I. Samaranayake, R. B. Gunaratne & L. S. Kariyawasam)

Table 14. *Mean girth (cm) of polybag plants & bare root budded stumps used as planting material*

Treatments	*Mean girth of scion (cm)*
Polybag plants	18·07***
Budded stumps	12·02

$$t = \frac{4 \cdot 015}{\cdot 001}$$

(b) Use of stumped buddings, Eladuwa (R1/78/2/F)

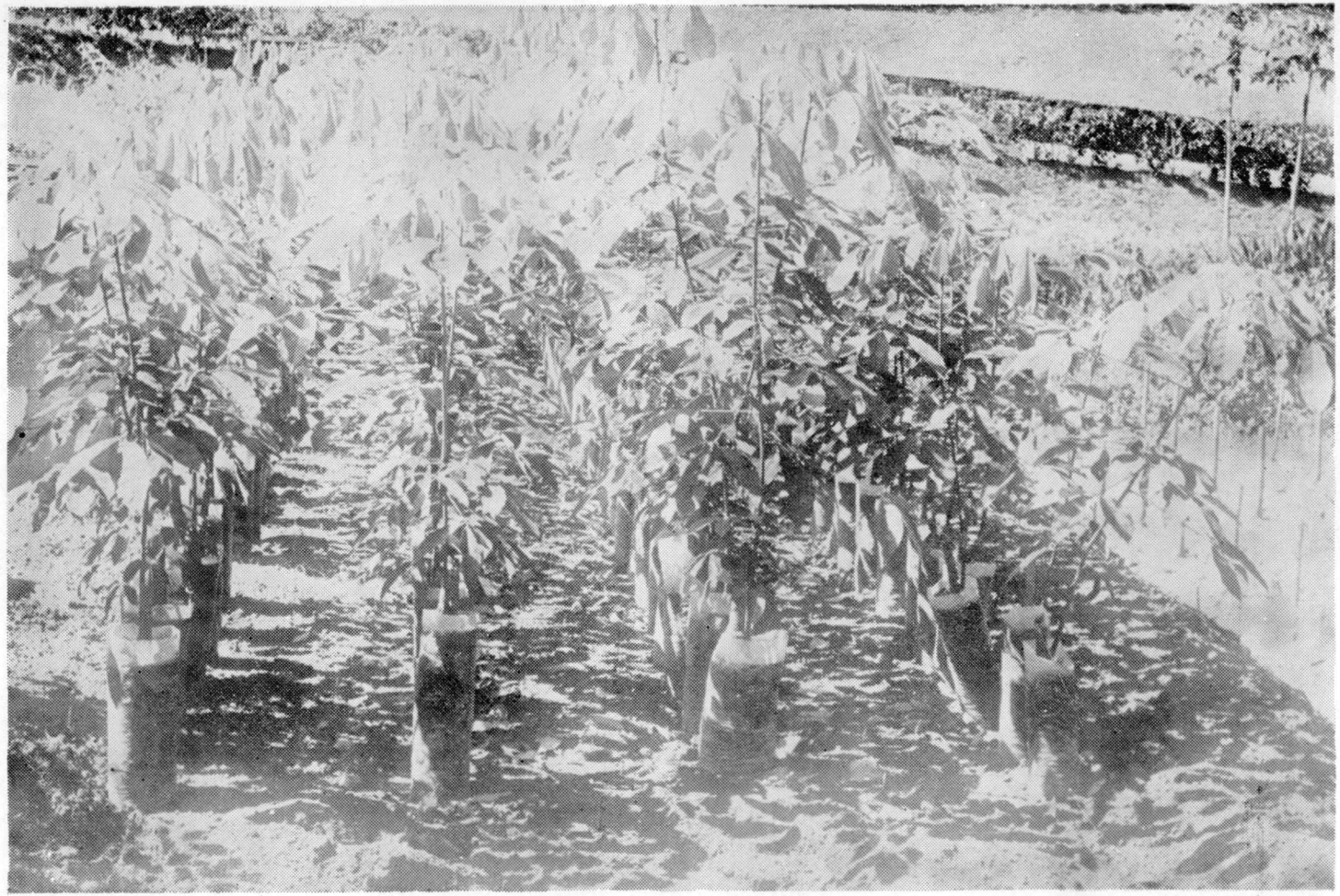
Growth rates of bare root budded stumps and stumped buddings field planted in June 1978 are compared in this experiment. The girth data recorded at 2½ years from field planting are given in Table 15. (A. C. I. Samaranayake, R. B. Gunaratne & K. A. G. B. Amaratunge)

Table 15. *Mean girth of stumped buddings and budded stumps*

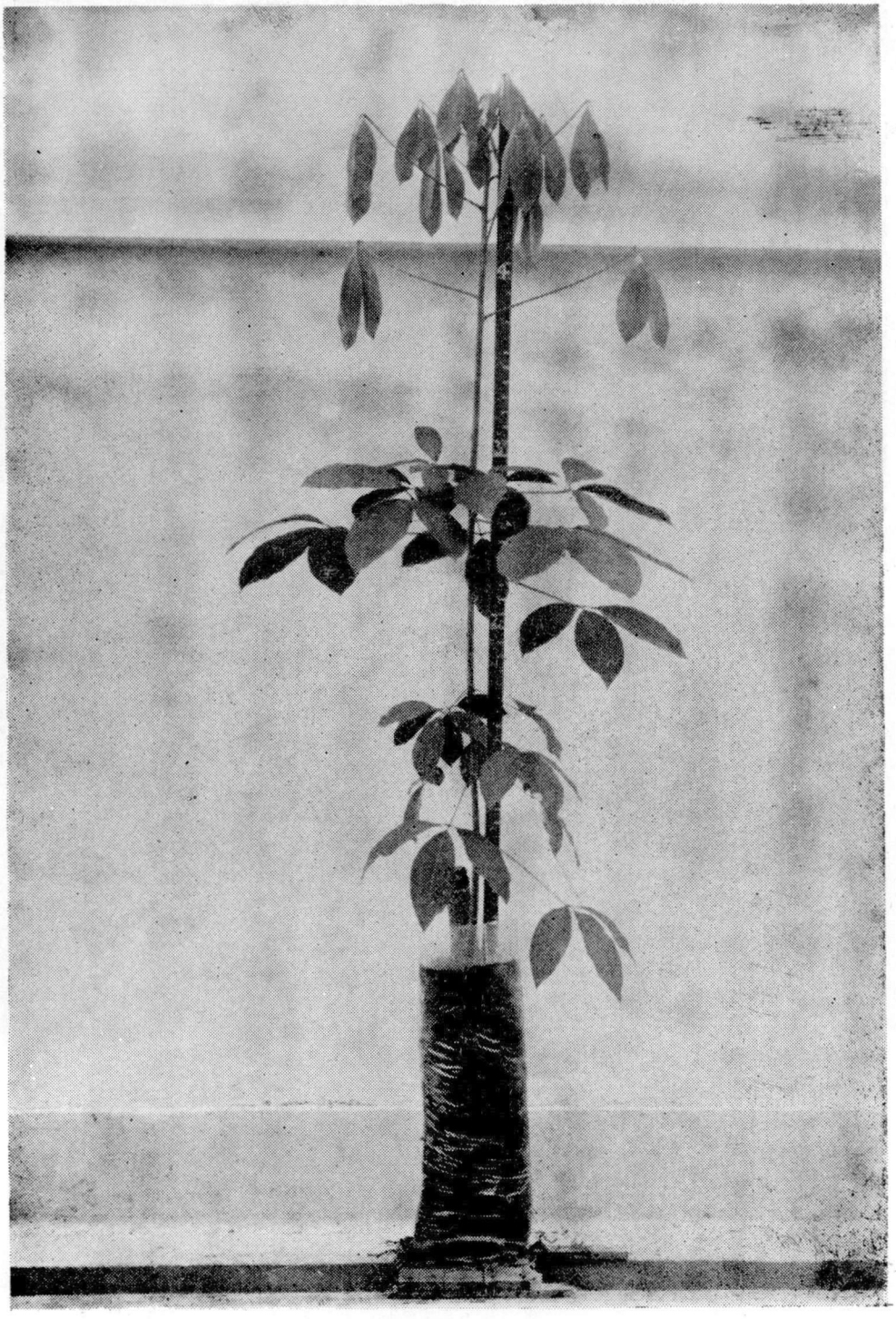
Treatments	*Mean girth of scions (cm)*
Stumped buddings	28·43***
Budded stumps	20·63

Comparison of planting techniques

Gallewatta Estate, Kalutara
Peenkande Estate, Ratnapura
Pallegama Estate, Niyadurupola (GB/79/2/F)



Buddings - in polybags



These three experiments, where 5 different methods of planting are compared, are sited in 3 estates, in three different planting districts namely, Kalutara, Ratnapura & Kegalle.

The following treatments are planted in randomized blocks with 40 — 60 tree plots replicated 8 times.

T_1 — Green buddings planted bare root

T_2 — Brown buddings planted bare root

T_3 — Green budded stumps grown in polybags upto two leaf whorl stage and transplanted in the field.

T_4 — Seedlings raised green budded in polybags and grown upto two whorl stage and transplanted in the field

T_5 — Seedlings budded at stake in the field.

(A. C. I. Samaranayake, L. S. Kariyawasam & G. B. Amaratunge)

Fertilizer and density experiment — stock seedling nurseries, Nivitigalakele (NP/79/1/F)

The effect of three levels of fertilizers and two frequencies of fertilizer application and three planting densities on the growth of stock seedlings was studied. The experiment was laid out in the field on a split plot design with four replicates. The diameter of seedlings at 6 cm from ground level was measured as an assessment for buddability.

Very few seedlings survived in the treatment where no fertilizer was applied. An alalysis of the rest of the data showed that the two levels of fertilizer applied and the two frequencies of application did not have any effect on growth of seedlings. Only the 6" × 6" spacing of plants had retarded their growth. (A. C. I. Samaranayake, G. B. Amaratunga & U. S. Weerakoon)

IBA as a root inducing agent, Udapolla Estate, Deraniyagala (GR/80/2/F)

Two thousand budded stumps were graded according to the diameter of the rootstock. Three concentrations of a powder formalition of IBA in Kaolin were prepared and a slurry of this in water was applied on the roots before the stumps were planted in the field.

IBA had no significant effect on the rate of sprouting of the buds in small and medium sized stumps. The large sized stumps treated with 2000 ppm IBA sprouted earlier than the controls. The other two concentrations had no effect. (A. C. I. Samaranayake, R. B. Gunaratne & U. S. Weerakoon)

TREE SPACING AND DENSITY

Effect of tree spacing and density

1977 Replantation, Millewa (CD/77/1/F)

RRIC 101, 103 and PB 86 were established in June - July 1967 at six spacings and densities an a 3 × 6 factorial experiment with three replicates (Table 16). Of the 6 spacing as adopted 4 were contour plantings and the other 2 were triangular (equilateral) plantings. The two triangular spacings were intended to give equivalent densities as the two contour plantings, but due to an error in planting this has not become possible.

Each plot accommodates 64 to 156 plants depending on the density. The two outer rows in each plot will be considered as guard rows.

Table 16. *Plant spacing, density and girth in December 1980*

Spacing (*m*)	*Density* (*trees/ha*)	*Girth* *PB 86*	*RRIC 101*	*RRIC 103*
2·5 × 10·0	400	29·9	37·5	34·6
2·5 × 7·5	533	31·9	36·0	38·0
2·5 × 6·0	666	30·7	37·1	36·7
2·5 × 5·0	800	30·3	36·5	37·2
Triangular — 3·87	771	30·9	36·5	37·4
Triangular — 3·54	920	30·3	36·3	36·7
		N.S	N.S	N.S
Mean (Clone)		30·6	36·6	36·7
		LSD (5%) 1·89		
		LSD (1%) 3·13		

Tree growth has not yet been affected by spacing or density, but growth of RRIC 102 and 103 is significantly better than PB 86. (U. P. de S. Waidyanatha & W. A. Ariyaratne)

LEGUME COVERS AND NITROGEN FIXATION

Rhizobium isolation

Isolates from different locations are being maintained in agriculture and characterised on the basis of their reaction to antibiotics. Nitrogen fixation by ground covers and their effects on Hevea: PB 86 1976 Replantation, Padukka (NF/75/1F)

This experiment, the design and details of which were given in the 1979 Annual Review is being continued. Trees have now reached tappable girth. The established legume covers are rapidly being displaced by the more shade-tolerant *Desmodium ovalifolium* as the *Hevea* canopy closes.

Girth measurements taken in December 1980 reveal no difference in growth in legume cover plots (*Pueraris* or *Calopogonium*) whether the legumes were cultivated or naturally established by selective weeding. However, tree growth in all legume plots surpasses that in the plot of naturals.

Table 17. *Girth of Hevea trees in December 1980*

Treatment		*Girth (cm)*
1. *Pueraria* inoculated with *Rhizobium*		47·2
2. *Pueraria* not inoculated		47·5
3. — do — + 100 g N/ha/yr to the cover		48·3
4. *Calopogonium* inoculated with *Rhizobium*		45·0
5. *Calopogonium* not inoculated		47·5
6. — do — + 100 g N/ha/yr to the cover		47·5
7. Naturally established legume cover		47·4
8. Naturals (without *Mikania*)		45·5
	LSD 5%	2·1

MYCORRHIZA

Effect of Mycorrhizal endophytes

Infectivity of *Gigaspora margarita, Glomus mosscae, Glomus fasciculatus* and E 3 (*Glomus* species) on *Hevea* seedling roots was investigated in a pot experiment. Root samples were taken at regular intervals fixed and stained with typhan blue. Infectiveness was assessed by recording the number of 1 cm root pieces infected out of a sample of 50 pieces.

Infectiveness was not observed until 3 weeks after germination. *Gigaspora* was the most infective followed dry *Glomus mcsscae* and G. *faciculatus* Infection by E 3 was poor.

In another experiment investigating growth responses of *Hevea* seedlings to infection by the four endophytes in sterilized and unsterilized soils revealed no striking treatment effects, exeept that leaf dry weight of plants infected with *G. margarita* in sterilized soil was significantly greater than in the control. This was not so in unsterilized suil in whicn the overall growth of plants was comparable with that in sterilized soil.

A further experiment with *Hevea* seedlings in pots was designed to examine whether Mycorrhizae facilitate uptake of water by the plants. Plants were grown with or without mycorrhiza in sterilized soil at three watering, regimes viz., watering to field capacity daily, third daily 7th daily or 10th daily. Plant growth was directly correlated to the frequency of watering whether or not mycorrhiza was present. These was no interaction between mycorrhiza and watering regimes showing that both types of plants responded similarly to water stress. However the mycorrhizal plants grew better than the non-mycorrhizal. (U. P. de S. Waidyanatha & A. H. R. Jayaratne)

TISSUE AND ORGAN CULTURE

Callus culture from different clones

Callus initiation and rate of callus growth were compared between callus cultures established from two different clones noted for their difference in growth vigour, namely clone RRIC 52 (vigorous grower) and PB 86 (average grower).

Callus cultures were established from both seedling and clonal stem explant of comparative age from both clones. The explants were grown on the M & S medium and under identical conditions.

Callus initiation was quicker in seedling stem explants of clone RRIC 52 than in that of PB 86. Comparison of callus wet weights showed that callus growth was faster in RRIC 52 than in PB 86. (R. Satchuthananthavale & I. R. M. Amarakoon)

Callus cultures established from clonal stem explants also showed a similar trend indicating that callus initiation and growth were better in clone RRIC 52 than in PB 86. (R. Satchuthananthavale & I. R. M. Amarakoon)

Differentiation and organ formation

Experiments on root differentiation in callus cultures of different ages indicated that there is a loss in the ability of callus to form roots with advancing age. This is in agreement with the reported behaviour of callus cultures of most other plant species. (R. Satchuthananthavale & I. R. M. Amarakoon)

Histological studies of callus cultures grown on different media

Histological studies were initiated with callus grown on different media to observe the pattern of cellular differentiation under different treatments. (R. Satchuthananthavale & Sunitha Wijesekera)

CLONE CHARACTERS

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

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

Ten clones of varying yield potentials were selected and a field experiment was planted in 1977 at Eladuwa Estate, Paiyagala. (Details 1978 Ann. Rev.)

Clone RRIC 101 was the most vigorous grower as indicated by girth measurements, followed by RRIC 52, RRIC 100, RRIC 88, RRIC 45, and GT 1. Clones PB 86 and IRCI 2 and LCB 870 showed average growth and clone RRIM 600 the lowest girth.

Same plants were microtapped for the third year in succession. Yield trend was the same, the accepted high yielding clones giving high yields except clones RRIC 100 and GT 1.

Microtapping yields and girth measurements are summarised in Table 18.

Table 18. *Microtapping yields and girth measurements*

Clone	*Yield g/t/tap*	*Clone*	*Girth (cm)*
PB 86	1·051	RRIC 101	39·06
RRIC 101	0·919	RRIC 52	34·44
RRIM 600	0·862	RRIC 100	34·12
IRCI 2	0·727	RRIC 88	33·80
RRIC 52	0·673	RRIC 45	33·14
RRIC 100	0·527	GT 1	32·77
GT 1	0·455	PB 86	32·61
RRIC 45	0·409	IRC 2 — IRCI 2	32·31
RRIC 88	0·370	LCB 870	32·15
LCB 870	0·111	RRIM 600	30·49

Figures joined by a vertical line do not show significant differences according to the multiple range test. (A. C. I. Samaranayake, U. P. de S. Waidyanatha, Amitha Ekanayake and L. S. Kariyawasam)

Anatomical studies

Studies on the anatomy of the leaf of the 10 clones were completed and an analysis of the data showed that the leaf thickness, palisade thickness and spongy layer thickness differ significantly among clones. (A. C. I. Samaranayake, U. P. de S. Waidyanatha, Amitha Ekanayake and G. B. Amaratunga)

GROWTH SUBSTANCES

The wheat coleoptile test which has given very inconsistent results was improved by varying the environmental conditions. Solvent extraction of growth substances in dormant buds indicate that there may be a seasonal variation in the levels of growth promoters and inhibitors. Further investigation will be made when fascilities for quantitative assessments of growth substances are available. (A. C. I. Samaranayake & L. S. Kariyawasam)

A study of promoters and inhibitors of wheat coleoptile segment growth in young *Hevea* shoot apices showed, beside Auxins and ABA, another distinct zone of inhibitor activity in the chromatograms. (A. C. I. Samaranayake, M. K. S. A. Samaraweera & *W. U. de Alwis)

BIOLOGICAL SUPERPHOSPHATE

The principle of biological superphosphate was described in detail in the 1978 Annual Review. The hypothesis is that availability of phosphorus from rock phosphates is increased when mixed or pelletised with sulphur. Experiments investigating the hypothesis were continued.

Field experiment on immature Hevea (PB 86); 1978 Replantation, Lowmont (BS 4/78/F)

The design of the experiment, treatments and other experimental details were reported last year (Ann. Rev. for 1979). The quantities of phosphates were increased to 18 g P/Plant for 1980.

Both imported rock phosphate (RP) and local apatite (A) gave significantly better tree growth when mixed with sulphur but not when pelletised. When applied straight, although RP, increased growth over the controls the differences failed to attain significance. By contrast girthing was significantly better for superphosphate when applied straight but not when mixed with sulphur.

It thus appears that mixing RP or A with sulphur is of practical value in improving the response of young rubber trees to these phosphates, which possibility is due to increased P availability. This however is not revealed in the % P in leaves which was not significantly different between treatments (Table 19).

* Final year Chemistry student — University of Sri Lanka, Peradeniya.

Table 19. *Dry matter yield and growth of trees for various treatments in two experiments*

Treatment	*Hevea Experiment* *Tree girths (cm)*	*Pueraria Experiment* *Dry matter yield (g)*
A + S (10 : 1)	19·2	47·7
A + 2S (10 : 2)	19·3	—
A + S pellets (10 : 1)	18·8	38·5
A + 2S pellets (10 : 2)	17·7	—
RP + S (10 : 1)	18·8	61·2
RP + S pellets (10 : 1)	18·2	46·5
(SP + S (10 : 1)	18·1	45·1
(SP + S pellets (10 : 1)	—	—
A + gypsum	—	—
RP + gypsum	—	—
CSP + gypsum	—	58·9
A	17·8	48·4
RP	18·5	63·5
CSP	19·9	47·9
S	16·6	19·9
2S	18·4	—
Gypsum	—	28·4
Nil + Latex	16·7	24·0
LSD (5%)	± 2·1	± 13·5
LSD (1%)	—	± 18·2

A = Local apatite, RP = Imported rock phosphate, CSP = Conc. Superphosphate. Ratio of phosphate to sulphur is 10 : 1 or 10 : 2 ; sulphur content in gypsum is equivalent to that of S in 10 : 1 ratio mix.

Highly significant responses were obtained to application of all three sources of phosphate to *Pueraria* (Table 17). Addition of sulphur did not improve this response and there was some indication that pelletising deprived the dry matter yield for both RP and A. Response to RP was significantly better than for both A and CSP. It has to be concluded that mixing rock phosphates with sulphur may not be of benefit in the case of *Pueraria*. (U. P. de S. Waidyanatha & W. A. Ariyaratne)

FORAGE GRASSES AND LEGUMES

Productivity of three grasses grown singly and in combination with two legumes and their effects on *Hevea* (FP/1/75/F).

The experimental treatments and design were described fully in the Annual Review for 1979. The experiment has now completed five years.

The dry matter yield of forage has greatly decreased this year compared to the last year due to heavier shading by the closing rubber canopy. At the end of 1980 dry matter yields were negligible and hence harvesting of forage was terminated. However tree growth measurements will continue.

The zero-grazed forage dry matter yield differences between treatments were highly significant (Table 20). but neither N nor P treatments significantly affected yields. Pure stands of *Brachiaria brizantha* and *Panicum maximum*, as well as mixed pastures of these two grasses with *Pueraria* or *Centrosema* gave significantly higher yields than *B. miliformis* alone or mixtures thereof with the legumes. There was a higher percentage of legumes in the *Pueraria*-based pasture than in the *Centrosema*-based pasture. There was also a higher proportion of legumes in *B. miliformis* based pastures and at 60 kg P/ha/yr., the legume dominated the *B. miliformis* and *Pueraria* pasture. (U. P. de S. Waidyanatha, W. A. Ariyaratne & D. S. Wijesinghe)

Table 20. *Dry matter yield of forage and girth of Hevea trees for 1980*

	forage yield (kg/ha/yr.)			*Tree girth (cm)*		
	100 kg N/ha/yr.	*200 kg N/ha/yr.*	*Mean*	*100 kg N/ha/yr.*	*200 kg N/ha/yr.*	*Mean*
P. maximum (Pm)	2032	2323	2178	34·7	33·8	34·3
B. brizantha (Bb)	1994	2100	2047	31·7	30·5	31·1
B. miliformis (Bm)	1083	1404	1244	38·4	40·5	39·5
	30 kg P/ha yr.	*60 kg P/ha/yr.*	*Mean*	*30 kg P/ha/yr*	*60 kg P/ha/yr*	*Mean*
Pm + *Centrosema*	2189 (5·7)	2234 (7·9)	2212 (6·8)	35·1	34·8	35·0
Pm + *Pueraria*	1875 (13·6)	2219 (11·2)	2047 (12·4)	36·4	36·6	36·5
Bb + *Centrosema*	2017 (3·4)	2503 (5·0)	2260 (4·2)	31·6	29·2	30·4
Bb + *Pueraria*	2473 (8·2)	2480 (14·9)	2477 (11·6)	32·0	30·7	31·4
Bm + *Centrosema*	1210 (18·3)	1248 (32·5)	1229 (25·4)	39·4	40·3	39·9
Bm + *Pueraria*	1277 (20·4)	978 (57·8)	1128 (39·1)	40·3	40·4	40·4
	LSD (%) 799		568			
Pueraria Cover (Uncut)	LSD (%) 1053		799	—	—	42·7
Natural Cover	—	—	—	—	—	40·8
					LSD (5%)	3·4
					(1%)	4·5

% legume in forage in paranthesis

Varietal testing of forage grasses and their effect on *Hevea*, 1975 Replantation, Eladuwa (FP2/75/F)

With closure of the *Hevea* canopy and increasing shade the dry matter yields have declined this year further and in many plots there is little forage for harvest. *B. dictyoneura, P. plicatulum*, Guinea A and Green Panic appear rather more shade tolerant than the other species.

Generally the more productive grasses specially Guinea A and B. *dictyoneura*, have also been more competitive to *Hevea* as shown by the tree girth data (Table 21). U. P. de S. Waidyanatha, W. A. Ariyaratne & D. S. Wijesinghe)

Table 21. *Dry matter yield of forage grasses and girth of rubber trees in 1980*

Forage Grasses	*Forage yield (kg/ha)*	*Tree girth (cm)*
Brachairia miliformis	1255	44·1
B. ruziziensis	1860	35·2
B. mutica	45	43·5
B. dictyoneura	2465	34·6
Pennisetum purpureum (NB 21)	1501	37·6
Setaria anceps	1883	40·0
Paspalum plicatulum	2264	37·9
Panicum maximum (Guinea B)	1479	38·2
P. maximum (Guinea A)	2623	32·8
P. maximum (Green Panic)	4214	43·6
Naturals cover	—	39·3
LSD (5%)	628	5·3
LSD (1%)	829	7·2

Productivity of *Panicum maximum* grown singly or in combination with *Pueraria* and their effects on growth *Hevea* (FP3/77/F)

This experiment has been described in detail in the Annual Review for 1979 and has now completed three years.

Dry matter yield of forage has declined compared to the previous years and so has the percentage of *Pueraria* in the forage. The cover of *Pueraria* now in the grass + *Pueraria* plots is rather sparse. Evidence yet continues that the productivity of the legume based pasture is marginally better than the nitrogen-fertilized.

Table 22. *Dry matter yield of forage and tree girths for 1980*

Treatment	*Dry matter yield (kg/ha)*			*Treee girths*
	Grass	*Pueraria*	*Grass & Pueraria*	
P. maximum + 100 kg/ha/yr				
1·0 m space *	10162	—	10162	31·7
1·5 m space*	9802	—	9802	33·1
P. maximum + *Pueraria*				
1·0 m space*	11596	717	12313	32·1
1·5 m space*	11117	707	11824	34·2
Uncut *Peraria* cover	—	—	—	39·2
		LSD (5%)	1339	3·5
		LSD (1%)	1793	4·7

* Radius of circular space around bole of trees not cultivated with forage grasses; % *Pueraria* in the forage in parenthesis.

All pasture plots had significantly poorer tree girths than *Pueraria* cover plots. There is also some indication that the competition is slightly less when the space between grass and the bole of the rubber tree is 1·5 m than when 1·0 m, and also that grass + *Pueraria* system was slightly less competitive than grass alone. (U. P. de S. Waidyanatha, W. A. Ariyaratne, D. S. Wijesinghe)

REVIEW OF THE INTERCROPPING DEPARTMENT FOR YEAR 1980

BY

L. B. CHANDRESEKERA

SUMMARY

The three crops banana, passion fruit and coffee are promising for intercropping among rubber during the immature phase. Field experiments have been set down for testing these crops on a wider scale. Intercropping with passion fruit has given substantial returns at the end of the first year. Diuron 80% has proved effective in suppressing weeds among pineapple in the wet zone for a period upto 8 months. The use of this pre-emergent weedicide should help to reduce costs of pineapple cultivations. Other promising crops that await further trials are pineapple, papaw, pepper and cocoa.

DETAILED REVIEW

In order to give more exphasis to intercropping in *Hevea* plantations, a new Department was formed in March 1980. The following is an account of the work of the new Department during 9 months of 1980.

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 during the period under review.

Visits

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

Technical advice was also provided to the Advisory Services Department of the Institute on Intercropping with banana, passion fruit, coffee and pineapple particularly in connection with the smallholder rubber rehabilitation projects.

Staff training

A training was given to the staff of the Intercropping Department on methods of propergation, planting, training and management of the various crops that are to be tested as intercrops in *Hevea* plantations.

FIELD EXPERIMENTS

The weather conditions that prevailed during the year 1980 were far from satisfactory for successful establishment of the selected crops owing to drought. Nevertheless a few trials were set down in the various planting districts with frequent watering and shading of the crops where necessary.

Selection of crops

Based on the results of early experiments carried out by the Department of Botany in 1979, banana, passion fruit and coffee were selected for testing out as intercrops among immature rubber in some districts. The following trials were planted.

Field Exp. No.	*District*	*Estate*	*Crops*
IC/80/1 (F)	Kalutara	Eladuwa Estate	Banana, Passion fruit Coffee
IC/80/2 (F)	Ratnapura	Kiribatgalle Group	,,
IC/80/3 (F)	Kegalle	Pallegama Group	,,

The design of each trial is a randomised layout with four treatments replicated six times A single row of banana, passion fruit and coffee were planted centrally between each pair of rubber rows (planted at spacings of 2·4 m × 9 m) spaced 3·6 m, 6·0 m and 2·4 m along the row respectively.

At Elston Estate in the Avissawella District, where rubber is planted at spacings of 3·6 m × 6·0 m an experiment was laid down (Field Exp. No. IC/80/5 (F) with the following treatments, with a single row of the intercrop planted centrally between each pair of rubber rows.

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 coffee plant between each pair of Banana plants.

The four treatments are replicated five times. Owing to the rocky nature of the land, the number of treatment combinations and replications in this trial had to be limited.

At Udapolla Group, Deraniyagala, a trial (Field Experiment No. IC/80/4 (F)) involving the interplanting of papaw was set down during the North East Monsoon season in 1980. The rubber is planted at a spacing of 2·4 m × 9 m. The treatments are as follows :

1. Control
2. One row of papaw spaced 2·4 m along the row
3. One row of papaw spaced 3·0 m along the row
4. Two rows of papaw spaced 2·4 m along the row
5. Two rows of papaw spaced 3·0 m along the row

The experimental design is a randomised layout with five replications. The establishment of papaw has been very satisfactory.

One trial for each of the crops pineapple, pepper and cocoa was planned for 1980, but could not be carried out owing to postponement of replanting rubber to 1981 by the estates concerned.

Smallholder trials

Owing to the limited extents of rubber replanted in smallholdings, it was not possible to set down statistically designed field trials in this sector. It was therefore decided to set down small scale demonstration plots in the various planting districts of selected crops mainly to serve as propaganda and to evaluate the economics of intercropping in smallholdings. Careful records are kept of the costs of maintenance, crops harvested and income.

Generally, the smallholder preference was for bananas in all planting districts and Passion fruit in the Kalutara District. These two crops are less labour intensive and have a ready market in the respective districts. Particulars of demonstration plots that are in progress in 1980 are given in Table 1. (see in next page).

The rubber in all instances is planted at spacings of 2·4 m × 9 m. A single row of the intercrop is planted centrally between each pair of rubber rows spaced 3·6 m and 2·4 m. for banana and coffee respectively. Passion fruit was planted at a spacing of 4·5 m along the row at the request of the smallholder concerned. Until more experimental results are available, higher densities of intercrops will not be introduced into smallholdings.

It is evident from the data presented in Table 1 that intercropping with passion fruit gives a quick return while the income from banana is gradual.

Cultural details

Pending further experimentation, the following cultural methods were adopted for the various crops that are under investigation. It was observed that magnesium deficiency was a common symptom in all crops that are planted in the wet zone. Magnesium sulphate was therefore incorporated into the standard fertilizer mixtures that are recommended by the Sri Lanka Department of Agriculture.

Banana

planting hole — 0·6 m × 0·6 m × 0·6 m

fertilizer mixture

parts by wt. —	Urea	— 2
	Concentrated super phosphate	— 1
	Potassium chloride	— 3
	Magnesium sulphate	— 0·5

application — 0·8 kg of mixture per plant 2 months after planting.

0·6 kg per clump every three months thereafter. 2 kg Dolomite per clump once a year in December.

Excessive suckers must be removed every 2 months leaving about 4 suckers of varying sizes and ages to ensure continuous production of bunches.

Table 1. *Smallholder demonstration plots intercropped with Banana and Passion fruit*

District	*Village*	*Year planted*	*Crop*	*Extent (ha)*	*Costs todate (Rs.)*	*Income todate (Rs.)*	*Profit (Rs.)*
Kalutara	Bulathsinhala	1979	Passion fruit	0·4	1412	4944	3532
Kalutara	Welipenna	1979	Banana	0·4	1099	569	—
Kalutara	Pitigala	1979	Banana	0·5	1233	578	—
Kalutara	Gamagoda	1980	Banana	0·8	996	—	—
Kalutara	Gamagoda	1980	Coffee	0·4	565	—	—

Passion fruit

planting hole — 0·45 m × 0·45 m × 0·45 m

fertilizer mixture parts by wt. —

Urea	1
Conc. super phosphate	— 1
Potassium chloride	— 1
Magnesium sulphate	— 0·25

application — first year
0·2 kg of the mixture and 0·2 kg Kieserite in the planting hole.
6 months after planting — 0·2 kg/plant.

second year
Two applications — 0·4 kg/plant/application at 6 months intervals.

third year
Two applications — 0·6 kg/plant/application at 6 months intervals.

fourth year
Increase each dose by 0·2 kg/plant/application every year.

Passion fruit creepers are trained on to horizontal/wires/trellises and kept circle weeded.

Coffee

planting hole — 0·6 m × 0·6 m × 0·6 m

fertilizer mixture parts by wt. —

(A)	Sulphate of ammonia	— 8
	Muriate of potash	— 8
	Epsom salt	— 1
(B)	Urea	— 3
	Conc. super phosphate	— 2
	Muriate of potash	— 2
	Epsom salt	— 0·25

application — 3 months after planting
mixture A at 120 g per tree

9 months after planting
mixture A at 120 g per tree

second and third year
mixture B at 280 g per tree per year
in two applications of 140 g per application.

Dolomite at the rate of 0·8 kg. per tree is applied once a year in about December and the plants are kept circle weeded.

Papaw

planting hole	—	0·6 m × 0·6 m × 0·6 m	
fertilizer mixture parts by wt.	—	Urea	— 1
		Conc. super phosphate	— 2
		Muriate of potash	— 2
		Epsom salt	— 0·5
application	—	In the planting hole — 0·2 kg of the mixture.	
		two months after planting — top dress with 0·2 kg per plant	
		six months after planting — top dress with 0·2 kg per plant	
		Thereafter top dress every three months with 0·2 kg of the mixture.	

The trees are kept circle weeded.

Weedicides

One of the most expensive items in growing pineapple in the wet zone has been the costs of weeding. An unreplicated observation plot was therefore laid out at Dartonfield in 1979 in order to test the effectiveness in suppressing weeds as well as toxicity to pineapple of two pre-emergent weedicides Lasso and Diuron 80%. The following treatments were tested.

(1) Control — hand weeded

(2) Lasso — at a concentration of 1·5 l in 225 l water

(3) Diuron 80% — 900 g in 225 l water

(4) Mulching with coir dust

(5) Mulching with Guatamala grass (*Tripsicum laxum*)

Both Lasso and Diuron 80% were non toxic to pineapple when the spray was directed on to the ground which was first weeded before planting pineapple suckers. However, Diuron 80% effectively suppressed weeds for a period of around 8 months while the effects of Lasso lasted only 3 months.

Coir dust and Guatemala grass effectively suppressed weeks, but the grass mulch had to be renewed at the end of every 3 months. Best growth of pineapple were observed in the plot with grass mulch. In the control plots, hand weeding had to be carried out once every two months. It is proposed to carry out more comprehensive trials based on these preliminary observations.

ANNUAL REVIEW OF THE GENETICS AND PLANT BREEDING DEPARTMENT — 1980

By

D. M. Fernando

SUMMARY

Budwood nurseries of clones RRIC 103, 117, 121, 130 were increased five-fold in order to assist implementation of the Accelerated Smallholder Replanting Project financed by the World Bank. The South American Leaf Blight resistant clones RRIC 117, 121, 130 showed very high yields. Genotype/environment trials established by the Geneticist confirmed substantially increased vigour of the RRIC 100 series.

DETAILED REVIEW

Staff

Mr. D. M. Fernando functioned as Head of the Department in addition to duties as Assistant Director during the year. Dr. N. E. M. Jayasekera, Geneticist, was on duty throughout the year.

Mr. P. Samaranayake, Experimental Officer, Mr. B. M. S. G. Peiris, Senior Experimental Assistant, and Messrs. K. B. A. Karunasekera, K. W. Rupatunga, Technical Officers, were on duty during the year. Mr. W. D. Gunadasa was appointed to the post of Processing Assistant in the Advisory Services Department in November 1980. Experimental Assistants, Messrs. D. S. Gamage, A. K. M. S. Senaratne and Field Attendants, Messrs. W. D. Armon and D. S. Dedduwakumara were also on duty throughout the year.

Research students

Mr. L. C. Wijetilleke continued to read for the degree of M.Sc. on the subject of South American Leaf Blight Resistance, on a National Science Council Grant.

Visits

The Head of the Department visited Brazil as a Consultant from January to April 1980, eight research stations connected with rubber, fifteen estates varying in size from 500 to 10,000 hectares and number of Government nurseries were visited through courtesy of the Brazilian Government and valuable information obtained on control and virulence of South American Leaf Blight, acceleration of rubber planting programmes to 25,000 hect. per year and possibilities of clone exchange. The Rubber Research Institute of India Jubilee Conference was attended in November 1980. The Moneragala District was visited in connection with the implementation of a new rubber planting scheme on Belgian Aid.

The Geneticist and supporting staff visited all estates where experiments were located.

SPC Seminars at Galle and Kalutara were attended in connection with planting advice.

Training

Trainee Assistant Superintendents were given lectures and field demonstration during programmes organized by the Institute of Plantation Management.

Publications

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General

In view of the necessity for utilizing new clones in replanting the yields expressed as kg/ha of dry rubber per year are given for the different clones in Table 1A.

Genotype/environment trials, have confirmed vigour leading to earlier opening in RRIC 102 and RRIC 103 over a range of planting districts. The estimates of yield and growth have been collected through a period of land reform and the future appears to hold for the industry an increasing fertilizer cost. A positive attitude towards the planting of appropriate clones is therefore an urgent necessity.

Reports from estates which have planted RRIC 100, and 103 commercially from 1971 indicate an intake of 3 kg of dry rubber at 5 years of age, 6 to 8 kg at 6 years, and 8 to 10 kg per task of 250 trees at the 7th year.

Analysis of yields and girth figures

The analysis of yields and girth figures for the different experiments and an estimate of the variability of growth and yields of the different clones in the different districts show that RRIC 100 leads in yield and adaptability to climate in the first year ; RRIC 102 and RRIC 103 show the best yields and general adaptability in the second, third and fourth years of tapping. The later RRIC series have not come into tapping yet on Genotype/Environment experiments laid down by the Geneticist. However in small scale clone trials RRIC 104, 110, 117 and 121 show yields and growth comparable to RRIC 102 and RRIC 103. Therefore, these clones could also move into general planting though available budwood would restrict the extents planted.

Table 1A. *Yields in kg/ha of various clones in different planting districts*

Exp. No.	*Clone*	*District*	*No. of trees*	*Age of trees at tapping (years)*	*Yields from large scale trials — Year of tapping**								
					1st	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*	*8th*	*9th*
17	RRIC 100	Sabaragamuwa	540	6	891	1366	1754	2428	2931 (2600)	3241 (3000)			
20	RRIC 100	Bibile	441	7	638	626	1362	1704	2046	2314			
7	RRIC 102	Sabaragamuwa	100	6	474	1148	1334	1419	1901	2675			
16	RRIC 102	Kalutara	324	$4\frac{3}{4}$	725	1258	2071	1956	1818	2186	2234	1161	
14	RRIC 102	Kalutara	330	9	725	1407	1508	1414	1117	1423	1709		
26	RRIC 102	Kalutara	200	6	1274	1183	1472	1723	1785	1647			
12	RRIC 103	Kalutara	348	6	623	772	1128	1841	2093	1744	1750	2276	21
16	RRIC 103	Kalutara	520	$4\frac{3}{4}$	438	1539	1706	2129	1952	2983	2358	2320	
23	RRIC 103	Kalutara	366	6	1196	1358	1447	1473	2300				
26	RRIC 103	Kalutara	200	6	867	1035	1440	1328					
16	RRIM 623 (control)	Kalutara	396	$4\frac{3}{4}$	736	1319	1748	1393	1516	1968	1726	1426	
17	RRIM 623	Sabaragamuwa	511	6	901	1294	1642	1921	2376	2133			
14	RRIM 623	Kalutara	181	6	866	799	1445	710	981	790	1507		
Estate	RRIM 623	Galle	8 hect — Estate		535	985	1211	1553	1444	1263	1260		
Malaysia	RRIM 623	RRIM			1000	1290	1470	1630	1640	1880	2100	2000	19
Malaysia	RRIM 600	(Malaysia)			720	1210	1600	1860	2310	2320	2350	2470	27
Estate	RRIM 600	Galle	4 hect — Estate		708	1000	1512	1673	2062	2209			
26B	PB 86	Kalutara	300	7	915	942	1196	1381	1116	1116	1292	1439	14

* Yields in kg/hectare ( ) — corrected

Matale District

Kaikawela (VC/65/10)

The drought in the first part of 1980 affected yields adversely. Economic yields were however obtained from RRIC 103 (Table 1). (D. M. Fernando and D. S. Gamage)

Table 1. *Clone trial — Matale VVC/65/10*
Tapped S/2, d/2 100%

Clone	*Trees tapped*	*Mean Girth Cm 1980*	*Yield g/t/t 1979*	*1980*
RRIC 103	10	69·1	33·1	33·5
RRIC 118	76	55·5	31·9	22·3
IAN 710	67	60·0	21·6	21·3
RRIC 116	53	65·5	22·7	20·2
1108 (Control)	34	62·0	21·9	15·7

Wariapola, Matale (V/65/25)

The clone IAN 710 which is reported to give very high yields in the volcanic soils of Mexico but whose resistance to South American Leaf Blight has broken down in Brazil gave the best yields in this area. (Table 2) The Dept. of Minor Crops situated nearby is interested in intercropping. With regular attention even with inter-crops the yields should show substantial improvement. (D. M. Fernando and B. M. S. G. Peiris)

Table 2. *Girth and yield of different clones at Matale*
Tapped S/2, d/2, 100% in 1980 S/2, d/1, 200% in 1979

Clone	*Yield g/t/t 1979*	*1980*
IAN 710	40·8	33·2
RRIC 101	28·6	29·9
RRIC 103	23·0	27·8
RRIC 100	26·0	27·4
RRIC 102	23·0	23·7
RRIC 45	24·8	20·4
1004	16·2	18·4

Moneragala and Bibile Districts

Kumarawatte (V/65/9)

Yields (Table 3) decreased substantially in this area in the course of a long and protracted drought, RRIC 102 and RRIC 103 however continued to give economic yields. However some increase in girth was shown in all clones. (D. M. Fernando and D. S. Gamage)

Table 3. *Girth and yield of different clones planted in Moneragala in 1965*
Tapped S/2, d/2, 100%

Clone	*Trees tapped*	*Girth cm*		*Yield g/t/t*
		1979	*1980*	*1980*
RRIC 103	16	63·6	67·5	23·7
RRIC 102	16	60·0	61·6	22·2
RRIC 112	21	59·8	61·7	15·4
RRIM 623	29	60·7	62·1	14·3
RRIC 101	23	57·2	58·6	13·0
IAN 710	27	56·9	58·5	12·4
RRIC 104	19	64·9	65·4	12·0
RRIC 45	24	60·1	61·5	11·3

Kumarawatte (V/66/13)

Again the yield of RRIC 103 (Table 4) was substantially better than the control clone RRIM 623. (D. M. Fernando and D. S. Gamage)

Table 4. *Girth and yield of some of the clones planted in 1966, Moneragala*
Tapped S/2, d/2, 100%

Clone	*Trees tapped*	*Girth cm*		*Yield g/t/t*	
		1979	*1980*	*1979*	*1980*
RRIC 103	204	70·5	72·7	39·3	36·0
RRIM 623	198	61·1	64·1	20·6	22·2

Bibile (V/67/20)

It was observed in the course of this experiment that reduction to 67% intensity from 100% gave a annually higher yield and the whole estate adopted this system in 1980 for other clones as well with an appreciable increase of total intake. The yields of the experimental area are given in Table 5. Girth differences were significant; when yields were adjusted for girth RRIC 100 yields were significantly better than RRIC 112, IAN 710, RRIC 101, and RRIC 45.

Table 5. *Yield of clones planted at Bibile and tapped S/2, d/3, 67%*

Clone	*Girth cm*	*Yield*	
	1980	*1979*	*1980*
RRIC 103	70·9	43·9	57·1
RRIC 100	63·5	48·8	55·5
RRIC 101	63·2	55·6	53·5
RRIC 112	66·8	48·0	43·4
IAN 710	72·7	53·4	43·2
RRIC 45	66·5	39·0	40·2

Kalutara District

Small scale clone trial, Dartonfield (VSM/65/8)

The best growth and yield in this trial were shown by the South American Leaf Blight resistant clones RRIC 121 (Table 6) and RRIC 117. (D. M. Fernando and D. S. Gamage)

Table 6. *Girth and yield of clones planted at Dartonfield and tapped S/2, d/2, 100%*

Clone	*Trees tapped*	*Mean Girth cm*		*Mean yield g/t/t*		*Dry trees*
		1979	*1980*	*1979*	*1980*	
RRIC 121	13	83·1	84·6	40·7	46·0	1
RRIC 117	14	71·9	75·2	41·1	44·1	
RRIC 102	8		68·5		42·2	
RRIC 114	12	62·2	66·2	42·1	38·0	
RRIC 120	8	74·0	75·5	46·2	36·6	3
RRIM 623	12	71·4	72·9	26·8	31·5	1
IAN 710	13	71·0.	72·4	34·7	31·0	
RRIC 45	14	68·0	69·2	34·1	29·3	4

Nivitigalakele (VC/67/14)

The yields of RRIC 102 were better than RRIC 101. RRIC 111 (Table 7) which shows a higher rate of girthing than RRIC 102 shows promise as a clone with later high yields. (D. M. Fernando and K. Sumanadasa)

Table 7. *1967 Nivitigalakele VC/67/14*
Tappted S/2, d/2 100%

Clone	*Trees tapped*	*Mean Girth cm 1980*	*Yield g/t/t*		*Dry trees*
			1979	*1980*	
RRIC 102	302	71·5	43·1	43·5	16
RRIC 101	310	69·3	34·6	35·2	29
RRIC 111	392	76·4	23·0	31·2	16
RRIM 623	145	70·7	28·3	28·1	11

Hedigalla (VC/19, 23/67, 68)

In this trial (Table 8), which was split into a 1967 NE and 1968 SW trial owing to non-availability of cleared land at time of planting, the differences in yield were not significant though RRIC 103 showed the best yields. (D. M. Fernando and K. W. Rupatunga)

Table 8. *Data from Hedigalla No. 19 and 23 67/68*
Tapped S/2, d/2 100%

Clone	*Trees tapped*	*Mean Girth cm 1980*		*Mean yield g/t//t 1980*		*Dry Trees*
		Exp. No. 19	*Exp. No. 23*	*Exp. 19*	*Exp. 23*	*Exp. 23*
RRIC 101	468	62·4	63·9	28·4	30•3	9
RRIC 103	792	75·5	73·7	39·8	45·5	4
RRIC 45	653	59·4	58·9	21·9	24·0	3

Sirikandura (VC69/26)

RRIC 102 and RRIC 103 showed very similar yields and percentage of trees tapped in this experiment (Table 9). (D. M. Fernando and K. W. Rupatunga)

Table 9. *Data from clone trial planted in Sirikandura*
Tapped S/2, d/2, 100%

Clone	*Trees*	*Mean Girth*	*Mean yield g/t/t*		*Dry Trees*
			1979	*1980*	
RRIC 102	181	66·7	30·6	30·1	3
RRIC 103	180	66·1	30·2	29·3	1
RRIC 101	175	57·6	21·3	25·8	27
RRIC 45	157	56·5	25·1	23·0	5

Sabaragamuwa District

Peenkande (VC/67/17)

RRIC 100 showed the best yields (Table 10). RRIC 111 yields have obviously increased with increasing girth. (D. M. Fernando and W. D. Armon)

Table 10. *Girth and yield from 1967 Clone Trial at Peenkande*
Tapped S/2, d/2, 100%

Clone	*Trees Tapped*	*Girth cm*		*Yield g/t/t*	
		1979	*1980*	*1979*	*1980*
RRIC 100	401	76·5	79·4	54·7	65·7
RRIC 101	409	67·3	70·6	46·7	57·2
1004	289	79·2	83·0	45·8	51·4
RRIC 111	386	·8	93·3	56·7	57·5
RRIM 623	391	71·6	75·4	41·3	50·7
RRIC 45	307	64·2	66·9	32·7	36·9

Small scale trials at Kuruwita Sub-Station

The yields of the small-scale trials at Kuruwita Sub-Station are given in Table 11, 12 and 13. RRIC 121 and RRIC 130 both found resistant to South American Leaf Blight have shown very satisfactory yields as well. Two thousand budded stumps of the newer clones were released for experimental work and 5,000 stumps to the SPC, JEDB and small-holders from this Sub-Station. The budwood nursery was increased by 5,000 plants in order to meet the accelerated small-holder replanting programme requirements from 1981 onwards. Four hundred and forty yards of budwood for multiplication purposes were released to the SPC and JEDB. The issues consisted mainly of RRIC 121, RRIC 103, RRIC 102 and RRIC 117 and RRIC 130. (D. M. Fernando and B. M. S. G. Peiris)

Table 11. *Small scale clone trial — Kuruwita (VSM/67/15)*
Yield abstract for 1980

Clone	*Trees tapped*	*Girth cm at 150 cm*	*Yield gm/tree/tapp.*
RRIC 121	20	86·2	69·9
10570	20	81·1	63·6
RRIM 623	36	68·7	50·4
5682	23	81·9	47·1
7281	16	72·6	44·5
10727	14	66·9	41·4
8794	10	75·6	38·8
8501	12	86·4	33·3
8798	22	95·2	23·8
RRIC 122	5	67·3	48·0

The SALB resistant clone RRIC 121 was significantly (5% level) better in girth than the control RRIM 623 ; RRIC 121 also showed significantly better yields (gm/t/t) than all the other clones in the experiment excepting 10570.

Tabel 12. *Small scale clone trial — Kuruwita (VSM/68/21)*

Clone	*Parentage*	*Trees tapped*	*Girth cm at 150 cm*	*Yield 1978*	*gm/tree/tapp. 1979*	*1980*
RRIC 121	PB 28/59 × IAN 873	19	86·6	74·7	78·3	105·3
RRIC 130	IAN 710 × RRIC 52	19	67·7	105·5	86·4	98·3
RRIC 110	LCB 1320 × RRIC 7	25	74·1	70·9	74·0	88·8
5 — 90	IAN 710 × RRIC 45	16	93·8	59·6	70·3	75·8
RRIC 131	PB 86 × F 1633	22	73·9	75·5	77·8	71·5
RRIC 104	RRIC 52 × Tjir 1	26	86·6	70·7	68·0	69·2
RRIC 123	IAN 710 × CH 26	18	76·5	72·7	61·8	67·4
RRIC 112	RRIC 41 × Ch 26	18	74·6	64·0	62·5	64·9
RRIC 113	RRIC 52 × RRIC 36	20	76·4	53·1	55·9	63·1
7263	FX 3482 × RRIC 52	23	72·8	54·9	49·6	61·4
RRIC 102	RRIC 52 × RRIC 7	23	73·5	78·4	82·3	60·8
RRIC 45	RRIC 8 × Tjir 1	27	61·3	48·8	49·7	58·8
RRIC 120	RRIC 36 × FX 516	21	66·5	59·7	47·0	52·1
6 — 541	RRIC 36 × RRIC 36	18	75·5	45·1	41·8	46·5

LSD for yield = 27·04 ; LSD for girth = 8·23. (For 1980 figures).

Table 13. *Small scale clone trial — Kuruwita (VSM/69/28)*
Yield of Clones Tapped S/2, d/3, 67%

Clone	*Parentage*	*Trees tapped*	*Girth cm at 150 cm*	*Yield 1978*	*gm/tree/tapp. 1979*	*1980*
RRIC 127	Ch 26 × 1458	12	66·7	72·8	54·2	75·4
RRIC 128	RRIC 102 × Ch 26	22	75·4	77·6	65·5	64·8
RRIC 129	Ch 26 × RRIC 100	23	81·9	70·3	53·5	61·9
RRIC 124	Ch 26 × RRIC 111	20	65·7	56·1	44·1	58·9
7 — 1415	RRIC 86 × Ch 26	22	66·4	62·7	45·0	56·2
6 — 746		14	68·2	—	—	56·2
7 — 1189	RRIC 102 × RRIC 89	23	64·4	69·5	47·9	54·3
RRIC 126	RRIC 103 × Ch 26	20	70·1	55·7	46·2	54·3
7— 1413	RRIC 89 × Ch 26	17	71·5	63·7	55·2	53·9
RRIC 45	RRIC 8 × Tjir 1	5	64·4	52·4	39·8	49·7
7 — 1176	Ch 26 × RRIC 111	22	75·2	51·6	48·3	47·8
7 — 1077	Ch 26 × RRIC 111	21	81·5	41·1	38·5	47·7
RRIC 125	RRIC 102 × RRIC 89	20	56·9	54·1	46·3	44·5
7 — 1218	RRIC 102 × Ch 26	21	72·4	46·0	27·8	27·1

Differences in girth were not significant.
Critical differences for yields (1980) according to replications are :

3,3 — 19·8
3,2 — 22·1
2,2 — 24·2

Genotype/environmental experiments and later selections

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

Budwood was available, in sufficient quantities, only from 52 slections of the 1974 hand pollinated seedlings. Using these selections five small scale clone trials have been established during 1980. RRIC 100, RRIC 103, RRIC 121 and RRIM 600 have been used as control clones. The details are given in Table 14.

Table 14. *Details of the small scale trials established using 1974 selections*

Estate	*No. of Selections*	*No. of plants per selections*	*Date of planting*
Yatadola S.P.	18	20	10th & 11th July 80
Perth S.P.	16	20	17th & 18th July 80
Moralioya Estate	52	10	22nd & 23rd July 80
Dartonfield	33	10	18th & 19th Aug. 80
Arapolakanda S.P.	18	20	17th & 18th Oct. 80

At Moralioya Estate all 52 clones were included in a single experiment. The experiment at Dartonfield was planted in order to make use of excess planting material and PB 86 was also included as a control clone. In all 5 experiments individual tree randomization was adopted.

Selections from the 1975 hand pollinated seedling population are in the multiplications nurseries. Once sufficient quantities of budwood are available, these selections will also be included in small scale clone trials. (N. E. M. Jayasekera, K. W. Rupasinghe, D. S. Gamage and K. B. Karunasekera)

Genotype Environment interaction studies (GE/75/1 (F))

The annual girth measurement was recorded during November and December of 1980. The mean girth for each clone in each experimental site is given in Table 15, along with the mean girth for 1979. In both years RRIC 52 had the highest mean girth and Bentota was the best environment. (N. E. M. Jayasekera, P. Samaranayake, and K. B. Karunasekera)

Selection of 1976 hand pollinated seedings (HPS/76/2 (F))

The seedling population received from 1976 hand pollination programme was screened 52 promising seedlings were selected from a total of 232 seedlings. The selections will be multiplied in budwood nurseries prior to the establishment of small scale clone trials. The details of the selections are given in Table 16. (N. E. M. Jayasekera and K. W. Rupatunga)

Table 16. *Parentage of the selected seedlings*

Family	*No of seedlings selected*
RRIC 100 × PB 86	6
,, 101 × PB 86	11
,, 100 × RRIC 101	11
,, 82 × ,, 101	6
,, 101 × ,, 100	1
,, 100 × ,, 52	7
PB 86 × ,, 82	1
RRIC 101 × ,, 52	3
,, 103 × PB 86	1
,, 101 × RRIC 82	2
PB 86 × ,, 103	1
RRIC 82 × ,, 86	2
Total	52

Table 15. *The mean girth (cm) for ten clones planted in genotype — environment interaction experiment*

Clone	*Densworth*		*Pimbura*		*Hunuwella*		*Golinda*		*Bentota*		*Monrovia*		*Bibile*		*Clone Mean*	
	1979	1980	1979	1980	1979	1980	1979	1980	1979	1980	1979	1980	1979	1980	1979	1980
RRIC 36	29·0	40·84	31·2	41·50	28·7	38·48	27·3	35·01	38·0	46·6	34·5	44·2	27·4	34·0	30·8	40·1
RRIC 52	36·2	40·05	39·2	57·43	38·1	50·63	30·5	37·50	48·5	58·7	40·3	48·6	32·6	39·4	37·9	48·6
RRIC 100	31·7	41·50	35·8	48·50	32·0	44·40	29·7	23·34	39·5	49·4	34·0	44·6	27·5	25·2	32·8	42·4
RRIC 101	39·2	50·68	37·2	49·12	38·5	49·74	31·1	41·81	41·1	51·9	37·8	50·3	32·5	38·2	36·8	47·3
RRIC 102	37·8	47·55	36·2	49·82	39·1	51·52	26·6	33·31	38·2	49·8	32·7	45·9	26·0	34·3	33·8	44·6
RRIC 103	34·2	44·94	39·0	50·81	39·7	50·83	32·4	41·42	41·7	51·3	36·0	47·0	31·7	37·5	36·3	46·2
RRIM 600	33·2	43·48	33·9	44·77	32·0	42·22	29·7	36·62	37·8	46·5	30·9	40·8	25·8	31·6	32·0	40·8
RRIM 623	34·9	45·61	36·5	48·72	34·3	44·72	28·2	37·08	38·9	48·1	36·4	47·0	26·6	32·7	33·6	43·4
PB 86	29·6	38·88	32·9	42·20	32·6	41·50	31·7	38·00	34·7	42·6	33·0	41·0	24·6	28·1	30·9	38·8
IAN 45/710	31·4	39·68	34·4	45·38	32·7	43·71	32·0	40·03	34·4	43·6	31·2	40·8	25·4	34·6	31·6	41·1
SITE MEAN	33·7	44·12	35·6	47·82	34·8	45·77	30·04	37·41	39·2	48·8	34·6	45·0	28·0	34·6	33·6	43·3

Dialled progeny (GEN/71/1/(F))

Two girth measurements, at 6 - months intervals were recorded. With the help of the Pathology Department, plants were assessed for the severity and incidence of *Oidium* leaf disease. (N. E. M. Jayasekera, P. Samaranayake and K. B. Karunasekera)

Variability in monoclonal stands (VAR/78/2/(F))

In 1980 12 test tappings were completed. This experiment was first started in Hedigalla S. P. using RRIC 100, RRIC 101, RRIC 102, RRIC 103. In 1980 it was decided to test tap mono-clonal stands of RRIC 100, RRIC 101, PB 86 and RRIM 600 at Eladuwa S. P. In December 1980 test tapping was started both at Hedigalla S. P. and Eladuwa and will be carried out every month for a period of 12 months. Prior to test tapping, girth, length and height of tapping cut and the thickness of bark were recorded for each tree. (N. E. M. Jayasekera, P. Samaranayake, K. B. Karunasekere, W. K. Rupatunga and W. D. Armon)

Rootstock scion trial using dialled design (SC/79/1/(F))

The annual girth measurement was recorded during 1981. Arrangements have been made to analyse the data. (N. E. M. Jayasekera, P. Samaranayake, K. B. Karunasekera and K. W. Rupatunga)

Selection of 1976 hand pollinated seedling population (HPS/76/2/(F))

The 1976 hand pollinated seedlings have been screened for their yield potential and vigour. The diameter girth, petiole latex content and microtapping yield have been used as selection criteria. Fifty two promising seedlings have been selected from the total population of 232 hand pollinated seedlings.

Testing of 100 series (CET/79/1/(F))

Plants of this experiment were numbered and routine maintenance work was done. (N. E. M. Jayasekera, K. B. Karunasekera and K. W. Rupatunga)

Hand pollination programme — 1979 (HPS/79/2/(F))

Seedlings raised from 1979 hand pollinated seeds were planted at Eladuwa S. P. during 1980 S. W. Seasons. Fully randomized single tree design was adopted in this experiment. (N. E. M. Jayasekera, K. B. Karunasekera, K. W. Rupatunga & P. Samaranayake)

Hand pollination programme 1980 (HPS/80/1/(F))

Hand pollination programme for 1980 was carried out at Kuruwita Sub-Station and Eladuwa S.P. The details of the programme are given in Table 17. (N. E. M. Jayasekera, B. M. S. G. Peiris, A. K. M. S. Senaratne and P. Samaranayake.

Table 17. *Details of the hand pollination programme for 1980*

Cross	No. of pollination		No. of pods	
	Kuruwita	*Eladuwa*	*Kuruwita*	*Eladuwa*
RRIC 103 × RRIC 121	903	—	9	
,, 103 × ,, 103	2133	—	43	
,, 130 × ,, 121	104	—		
,, 102 × ,, 121	597	—	2	
,, 102 × ,, 130	1159	380	8	
illegitimate × ,, 100		1026		
,, × ,, 101		979		
,, × ,, 102		840		
,, × ,, 103		755		
,, × ,, 130		95		
RRIC 100 × ,, 121		4046		
, 101 × ,, unknown		4393		
,, 100 × ,, 130		113		
,, 102 × ,, unknown		4434		
Total	4896	17061	62	

Clone trial at TRI Ratnapura (CLT/1980/2(F))

A clone trial was established at T.R.I. Sub-Station Ratnapura. In this trial 10 clones were included with 30 fully randomized plants per clone. The clones included in the trial are given below. (N. E. M. Jayasekera, K. B. Karunasekera, and B. M. S. G. Peiris)

RRIC 100	RRIC 121
RRIC 101	RRIC 130
RRIC 102	IAN 45/710
RRIC 103	PB 86
RRIC 110	RRIM 600

ANNUAL REVIEW OF THE PLANT PATHOLOGY DEPARTMENT 1980

BY

A. de S. LIYANAGE

SUMMARY

Incidence of *Oidium* and *Gloeosporium* leaf diseases was low but a heavy incidence of *Phytopthora* leaf fall and bark rot was reported.

In the laboratory, clones RRIC 100 and 103 were resistant to *Oidium heveae*. The germination and growth of conidia were poor on inert surfaces but no such effect was detected on leaf discs.

Studies on the nomenclature of *Phytopthora* spp., indicated that the most predominant species of *Phytopthora* in rubber in Sri Lanka is *P. meadii*. Puncture tapped trees remained susceptible to infection up to 72 h after inoculation. It was possible to recover P. *meadii* up to 5 mm depth in wood (maximum tested) after artificial inoculation of tapping panels. Rainguards had little effect in preventing incidence of bark rot. However, much less spread of the fungus was recorded in trees with rainguards compared to unprotected trees.

In compatible clones, *C. gloeosporioides* penetrated leaves in 24 h and produced secondary conidia in 72 h. Discolouration of epidermal and palisade cells was evident in incompatible clones. A few inhibitory compounds were isolated from clones resistant to *Colletotrichum*. The amount of total phenol and ortho-dihydric phenols did not correlate with susceptibility to *Colletotrichum*.

The spread of *R. lignosus* is higher in the wet than in dry districts. In wet districts the increase in infection for one year ranged from 0·4 - 1·2%. It was seen that two trees towards the inside of an infected patch and two stumps towards the center of an infected patch had viable inoculum. New centers of infection in the replanting always originated from infected debris left around the patch. Sprinkling of sulphur and mixing it with soil were both effective but the latter was more expensive. Soil amended with urea and sulphur gave good results in controlling *R. lignosus*. Application of 3% BAS 389 - 01F to healthy roots protected with Barkosan was effective in stopping the spread of this fungus. Mason's Mixture 3 was as effective as Fomac 2, when the trees were slightly infected. When heavily infected trees were treated the response was poor. Root stocks of the clone LCB 1320 appeared to be consistantly resistant to *R. lignosus*.

Twenty six Sri Lankan clones were evaluated for their resistance to SALB using as criteria the number of lesions, perithecia and conidia produced, the percentage necrotic leaf area and leaf fall. Clones RRIC 117, C 7, RRIC 116, RRIC 119, RRIC 121, RRIC 130, SL 30 and SL 34 were resistant while RRIC 123, RRIC 115 and RRIC 131 were less resistant. The remaining clones were susceptible although C 10 produced significantly less perithecia and C 14 suffered no leaf fall. There was a correlation between SALB resistant clones and glycosidase content.

Treatment of rubber seeds with Benlate T, especially at higher concentrations, affected their germination.

The dirt content, plasticity, PRI and volatile matter were more affected than nitrogen and ash content when rubber sheets were contaminated by mould.

Staff

The Director, Dr. O. S. Peries was in charge of the Plant Pathology Department in the absence of its Head Dr. A. de S. Liyanage, on overseas studies, during a part of the year.

Mr. C. K. Jayasinghe, Assistant Plant Pathologist, who was on duty throughout the year, assisted the Director in carrying out the regular duties in the Department.

The Experimental Officer, Mrs. N. I. S. Liyanage, Technical Officers W. Amaratunga, S. Wettasingha, A. Dharmaratna, B. Fernando, S. S. Warnapura, E. A. T. Senadheera and Mrs. J. L. P. Wettasingha were on duty throughout the year.

The Head of the Department, resumed duties on the 10th November 1980, after being away in Trinidad and U.S.A. for one year, on a FAO Fellowship to study South American Leaf Blight.

The Senior Technical officers Z. E. Irugalbandara and D. M. Dantanarayana resumed work on the 29th March and 26th May, respectively, after completing their training programmes in England.

O. S. Peries continued to work in the Department, with the assistance of Mrs. N. I. S. Liyanage and D. M. Dantanarayana and Z. E. Irugalbandara.

Research students

P. K. Samaradeewa, L. C. Wijetilake and V. Perera continued their studies on the respective projects leading to the M.Sc. degree. They are financed by the National Science Council.

Visits

The following visits were paid by the departmental staff.

Experimental	..	310
Advisory	..	33
Miscellaneous	..	18
Total		361

Meetings

C. K. Jayasinghe addressed the Planters' Conferences held at Tebuwana and Galle on "White root disease — a Potential hazard to *Hevea* cultivation in Sri Lanka."

D. M. Dantanarayana addressed the Galle Planters' on '*Phytopthora* and *Gloeosporium* diseases of rubber.'

Training courses

The Department staff were involved in training planters and Rubber Extension Officers who have been recruited by the Ministry of Plantation Industries and Rubber Research Institute, respectively.

Publications

The following papers were published :—

Peries, O. S. Annual Review of the Plant Pathology Department — 1980.

Peries, O. S. and Liyanage, N. I. S. The use of sulphur for the control of white root disease caused by *Rigidoporus lignosus*. Paper presented at the International Rubber Conference in India, November, 1980.

Liyanage, A. de S. and Chee, K. H. The occurrence of a virulent strain of *Microcyclus ulei* on *Hevea* rubber in Trinidad. Paper presented at the International Rubber Conference in Brazil, July, 1980.

සී. කේ. ජයසිංහ — කුඩා රබර් පැලවලට වැළඳෙන අසාමාන්‍යතා (රබර් පුවත්)

සී. කේ. ජයසිංහ — සුදු මුල් රෝගය (උපදේශක පත්‍රිකාව)

General

As a result of the extremely dry weather that prevailed during the refoliation season, the incidence of *Oidium* leaf fall was negligible. However, a number of estates reported a heavy incidence of *Phytopthora* leaf fall and bark rot during the monsoon season. *Gloeosporium* leaf disease was widespread but did not cause serious damage. White root disease is still the most serious disease in rubber, especially in the wet districts. Black root disease has been reported from another estate in the Kurunegala District. No further occurrences were reported in *Fusarium* wilt of rubber.

LABORATORY INVESTIGATIONS

Diseased specimens :

The following diseased specimens were sent to the Institute, for identification.

	Identity of the disease	*Number of specimens*
(a) Fungi	*Phytopthora* spp.	3
	Rigidoporus lignosus	1
(b) Other causes	Sun scorch	2

LABORATORY INVESTIGATIONS

BIOLOGY

Oidium heveae

Susceptibility of cultivars (O/76/1) : Leaf discs of several clones were inoculated with conidia of *O. heveae* to assess germ tube growth at different times. It was observed that clones RRIC 100 and 103 were resistant. Under these conditions parents of these clones viz. PB 86 and RRIC 52 showed a similar pattern of growth, although under field conditions RRIC 52 behaved as a tolerant clone. (A. de S. Liyanage, A. Dharmaratna, E. A. T. Senadheera and J. L. P. Wettasinghe)

Factors affecting germination and growth (O/76/1) : The germination and growth of conidia on an inert surface without moisture was very poor. However, substantial germination and growth were recorded on leaf discs of susceptible (RRIC 45) and tolerant (RRIC 52), under similar conditions. No marked difference in germination and growth was recorded, whether water is applied to the leaf discs as fine droplets or bigger droplets, immersed in water or incubated at 100% relative humidity.(A. de S. Liyanage, S. Wettasinghe and S. S. Warnapura)

Phytopthora spp.

Nomenclature (P/76/1) : Studies on the nomenclature of *Phytopthora* spp., isolated from Rubber, Cacao and Coconut in Sri Lanka was done by D. M. Dantanarayana at the Commonwealth Mycological Institute (CMI), with the assistance of Miss Grace Waterhouse, Dr. Jean Stamps, Dr. C. Brasier and Dr. Eva Sansome.

Out of 33 isolates from *Hevea* only one (RRISL No. 439) conformed to *P. palmivora* and the rest were identified as *P. meadii*, indicating that the latter species is predominant on rubber, in Sri Lanka. The isolates obtained from Cacao and Coconut were also identified as *P. palmivora.* Several other isolates from the CMI Mycotec were also examined.

Starch hydrolysis was tested as an added diagnotic feature to separate *P. palmivora* from *P. meadii.* However, the results were irregular. A paper on this subject is being prepared for publication in an international journal. (O. S. Peries and D. M. Dantanarayana)

Host - parasite relationships

Oidium heveae

Histological basis of resistance (O/76/2) : Disease free copper brown and apple green leaves of several clones were inoculated with conidia and removed at different intervals to examine the post-penetration events. These studies are still in progress. (A. de S. Liyanage, A. Dharmaratna and E. A. T. Senadheera)

Phytopthora spp.

Process of infection (P/75/2) : Leaf discs and petioles of resistant and susceptible cultivars were inoculated with a zoospore suspension of culture No. 362 to study the mode of infection and the penetration process.

Bark samples were collected from naturally infected field material and free hand sections were cut to examine the process of infection. These studies are still in progress. (O. S. Peries and Z. E. Irugalbandara)

Colletotrichum gloesporioides

Process of infection (G/76/2) : The fungus penetrated the epidermal cells of clones RRIC 52, 105, PB 86 and Tjir 1 in 24 h, but only a few penetrations were detected in the resistant clones RRIC 52 and 105. In these clones more epidermal cells were discoloured and very often infection had not proceeded beyond the epidermal cells even after 72h. Discolouration of the palisade cells below the penetration points was also a common occurrence. In susceptible cultivars the fungus penetrated beyond the epidermal cells in 24h and at 72h acervuli were formed. (P. K Samaradeewa, L. C. Wijetilake and A. de S. Liyanage)

CONTROL

Phytopthora spp.

Screening fungicides (P/77/3) : Aliette was screened against *Phytopthora* spp., using the contact sterile filter paper disc method and the well technique. It was found that it was not effective at 0·4%, 0·8% and 1·6% levels *in vitro*. (A. de S. Liyanage, C. K. Jayasinghe and B. Fernando)

Rigidoporus lignosus

Efficacy of fungicides (F/76/7) : Two fungicides, Morut and BAS 389 — 01F, were screened against *R. lignosus* with the standard methods used for screening other fungicides. *In vitro* the latter was effective but not the former.(C. K. Jayasinghe and A. de S. Liyanage)

Biological control (F/76/7)

Bacteria and actinomycetes were isolated from Agalawatta, Parambe, Ratnapura, Boralu, Homagama and Deniya soil types under different covers. The antagonistic behaviour of the bacteria and actinomycetes towards *R. lignosus* was assessed using the modified Herr's triple agar layer technique. This experiment is in progress. (C. K. Jayasinghe and J. L. P. C. Wettasinghe)

RESISTANCE

Colletotrichum gloesporioides and Microcyclus ulei

Substances associated with leaf surfaces (G/76/2) : Bioassays with crude chloroform extracts revealed the presence of a few inhibitors in clones resistant to *Colletotrichum.* Spore germination tests and germ tube growth measurements with other fractions at different dilutions indicated that the higher concentrations are inhibitory. Although the amount of leaf waxes varied slightly between clones RRIC 52, 105, PB 86 and Tjir 1, there was no relationship to resistance. (P. K. Samaradeewa and A. de S. Liyanage)

Total phenol and ortho-dihydric phenol content in healthy and infected leaves (G/76/2) ; The amount of total phenols and ortho-dihydric phenols bear no correlation to the degree of susceptibility to *C. gloeosporioides.* However, the ortho-dihydric phenol level increased initially with infection, but markedly decreased 72 h after inoculation. (P. K. Samaradeewa and A. de S. Liyanage)

There is no relationship between SALB susceptible and resistant clones and total phenol and ortho-dihydric phenol content. (L. C. Wijetilaka, D. M. Fernando, P. A. J. Yapa and A. de S. Liyanage)

Peroxidase and polyphenol oxidase activities in Hevea leaves (OGP/75/1) : The enzyme activity showed a marked variation in different clones. Peroxidase activity increased greatly with the infection. Polyphenol oxidase activity was very low in healthy leaves, but a slight increase was noticeable with infection. More work is in progress on this aspect. (P. K. Samaradeewa and A. de. S. Liyanage)

Peroxidase activity increased with maturity in both South American Leaf Blight (SALB) resistant and susceptible clones. (L. C. Wijetilaka, D. M. Fernando, P. A. J. Yapa and A. de S. Liyanage)

Glycosidase content (G/76/2) : Results shown in Table 1, indicate that there is a correlation between SALB resistant clones and glycosidase content. (L. C. Wijetilaka, D. M. Fernando, P. A. J. Yapa and A. de S. Liyanage)

Table 1. *Glycoside content of SALB resistant and susceptible clones*

Clone	*Field susceptibility rating for SALB*	*Optical density*
RRIC 114	5	196
RRIC 115	3	186
RRIC 119	2	184
RRIC 121	1	141
RRIC 130	1	151

Mean of 4 replicates •
5 very susceptible
1 resistant.

Histochemical studies (G/76/2) : Sites of peroxidase activity and relative amounts of polyphenols of SALB resistant clones could be detected by the method of Hussey and Krusberg. The peroxidase activity was lower in resistant clones than in susceptible ones but no difference was observed in polyphenols. (L. C. Wijetilaka, D. M. Fernando and A. de S. Liyanage)

MISCELLANEOUS

Mould growth on properties of rubber (MO/78/1)

The nitrogen content, dirt, Wallace Plasticity (Po), Plasticity retention index (PRI), Volatile matter (VM), Mooney viscosity (VR) were recorded on unaffected fresh rubber, rubber contaminated with mould and aged rubber

Table 2. *Effect of mould growth on properties of rubber*

Type of rubber sample	*Dirt*	*Po*	*PRI*	*Nitrogen (%wt)*	*V.M.*	*Ash*	*VR*	*Acetone extract*
Unaffected Fresh rubber	0·04	59·50	70·60	0·3990	0·644	0·1880	85·87	2·55
Aged rubber	0·08	60·85	58·61	0·3976	0·481	0·1535	94·20	2·28
Mould affected rubber	0·025	66·6	52·39	0·3967	0·663	0·1566	95·64	2·04

This experiment, carried out initially in 1978 (Annual Report 1978), was repeated. The results (Table 2) of this trial indicated that mould growth significantly affected the dirt content, plasticity, PRI and volatile matter. Nitrogen and ash contents were also slightly affected. (A. de S. Liyanage, P. A. J. Yapa and B. Fernando)

Effect of Benlate on viability of rubber seeds.

Seeds treated with formalin (1 : 200) were air dried followed by dusting with Benlate (a mixture of 30% Benomyl and 30% Thiram) at two rates viz. 1% and 2% (w/w), 1% (w/w) Gamma BHC was incorporated into the mixture, 1 kg samples of seeds were kept in the dark in perforated polythene bags at room temperature (Table 3). It was observed that treatment of seeds with Benlate T affected their germination. It was marked at higher concentrations. There was also a gradual decline in germination with time. (C. K. Jayasinghe)

Table 3. *Effect of Benlate T on germination of rubber seeds*

Treatment	*Germination %*							
	0	1 day	3 days	5 days	8 days	33 days	17 days	27 days
1% BENLATE T + A.C.	89·0	71·6	81·2	86·1	75·4	56·0	40·9	16·8
2% BENLATE T + A.C.	61·6	24·6	21·5	38·0	46·1	45·3	31·7	3·4
Control	90·6	88·4	90·6	88·5	80·9	73·3	63·7	20·6

A.C. — Agrocide Gamma BHC

Host - Parasite relationships

Phytopthora spp. (P/76/2)

Depth of penetration : Virgin and renewed bark of PB 86 trees were artificially inoculated using the strip method. The frequency of reisolation of the fungus one month after inoculation is given in Table 4, for various depths.

Table 4. *Frequency of recovery of* Phytopthora spp., *at various depths*

Panel	*depth (mm)*		
	Surface	2	5
Virgin	100	50	30
Renewed	65	60	40

The fungus was easily reisolated from the surface of the wood. It was also recovered at a depth of 5 mm. (A. de S. Liyanage, O. S. Peries, N. I. S. Liyanage and B. Fernando).

Transfer of infection by tapping knife : It was possible to cause infection of the tapping panel of virgin and renewed bark by tapping the panel soon after dipping in a viable zoospore suspension. 56 and 21% of virgin and renewed panels, respectively, were infected by this method. (A. de S. Liyanage and B. Fernando)

Bark rot on the yield : Fifty PB 86 trees were tapped for 6 weeks (13 tappings) to assess the pre-treatment yield. These trees were inoculated with a zoospore suspension and the infection was allowed to spread for a month. They were then tapped for a further 6 week period (12 tappings). An increase in yield was observed. This experiment is being repeated. (A. de S. Liyanage and B. Fernando)

Puncture tapping on the incidence of bark rot : Puncture tapped trees inoculated with a zoospore suspension of 10^4 zoospores/ml, 24, 48, 72 h after tapping without removal of scrap indicated that even at 72 h after tapping, the fungus could cause infection of the panels. (A. de S. Liyanage and B. Fernando)

EPIDEMIOLOGY

Oidium heveae (O/74/1)

Pattern of wintering and incidence of Oidium : The pattern of wintering and the incidence of *Oidium* leaf fall were recorded on the clone RRIC 45. The dry weather that prevailed during this period helped in rapid and even wintering and refoliation, causing little or no infection. (A. de S. Liyanage)

Trapping of Oidium spores : Rod traps were used with sellotape as the sticky surface. In addition, the Burkard spore trap was also used. (A. de S. Liyanage)

Phenology and disease development : The progress of *Oidium* leaf disease was studied in relation to host tissue development. However, due to the low incidence of the disease not much information was collected. (A. de S. Liyanage)

Phytopthora spp.

Infection and sporulation on rubber pods (P/77/1) : Rubber pods of different sizes (1, 2, 3, 4 and 5 cm diameter) were inoculated commencing from 23 April. Sporangia were collected only from the drip water of 5 cm diameter pods. Nine inoculations were done on mature green pods from 11 June - 22 August. The incubation period varied depending on the weather conditions at the time of inoculation and during the incubation period. (A. de S. Liyanage and A. Dharmaratna)

Rigidoporus lignosus

Spread from a known source of inoculum (F/76/5) : Infected roots, 0·6 cm diameter, did not cause any external or internal infection of roots, 9 - 12 months after placement. Only external symptoms were noted with 2·5 and 5·0 cm diameter roots, during this period. Although inoculum pieces, 7·6 cm diameter, showed internal infection on some roots, 9 months after inoculation, none was recorded at 12 months as shown in Table 5. (O. S. Peries, A. de S. Liyanage, N. I. S. Liyanage, S. S. Warnapura and E. A. T. Senadheera)

Table 5. *External & internal spread of the disease on artificially inoculated lateral roots*

Inoculum diameter (cm)	*9 months after inoculation*		*12 months after inoculation*		
	Towards collar	*Away from collar*	*Towards collar*		*Away from collar*
	External infection	*Internal infection*	*Internal infection*	*External infection*	*External infection*
0·6	0	0	0	0	0
	0	0	0	0	0
	0	0	0	0	0
	0	0	0	0	0
2·54	119·5	0	0	52·0	0
	0	0	0	0	0
	76·0	0	58·0	0	0
	0	0	0	0	0
5·08	79·5	0	0	68·0	0
	0	0	0	0	0
	54·0	0	0	0	0
	13·0	0	14·0	44·3	30·0
7·62	133·0	0	57·0	0	0
	0	0	0	87·0	90·0
	85·0	38·0	40·0	0	0
	40·0	49·0	49·0	68·0	82·0

In another experiment observations taken 3 months after inoculation revealed that the fungus had spread towards and away from the collar (Table 6). The viability of some of the food bases 0·6 and 2·5 cm diameter was lost in 3 months ; occasionally 5·08 cm diameter and rarely 7·6 cm diameter roots also lost their viability. The roots of smaller diameter, especially those 0·6 cm diameter, decayed very rapidly. (O. S. Peries, A. de S. Liyanage, N. I. S. Liyanage, S. S. Warnapura and E. A. T. Senadheera)

Table 6. *External spread of the disease on artificially inoculated lateral roots*

Inoculum diameter (cm)	*Inoculum*		*Spread (cm)*	
	State	*Viability*	*Towards collar*	*Away from collar*
0·6	1	NV	0	0
	1	NV	0	0
	1	V	69	35
	1	NV	0	0
2·54	1	NV	0	0
	1	NV	0	0
	1	NV	20	0
	1	NV	44	49
5·08	1	V	21	33
	1	V	47	39
	1	NV	0	0
7·62	1	V	72	62
	1	V	22	30
	1	NV	38	72
	1	V	0	3
0·6	2	—	17	38
	2	—	0	0
	1	NV	49	13
	1	V	14	31
2·54	1	V	0	5
	1	NV	0	0
	2	—	0	0
	2	—	0	0
5·08	1	V	18	0
	1	V	55	54
	1	V	49	42
7·62	1	NV	67	59
	1	V	72	0
	1	NV	52	25
0·6	2	—	0	0
	1	V	0	0
	1	NV	0	0
	1	V	0	0
2·54	1	V	56	79
	1	V	0	0
	1	NV	33	68
	2	—	34	6
5·08	1	NV	98	36
	2	—	53	40
	1	V	58	13
	2	—	53	0

Continued on Table 6

Inoculum diameter (cm)	*Inoculum* *State*	*Viability*	*Spread (cm)* *Towards collar*	*Away from collar*
7·62	1	V	23	32
	1	NV	42	26
	1	V	0	33
0·6	2	—	0	0
	1	NV	0	0
	1	NV	0	0
	2	—	0	0
2·54	2	—	48	0
	2	—	17	0
	1	NV	20	0
	2	—	0	0
5·08	1	V	0	0
	1	V	0	0
	1	V	0	0
	1	V	19	15
7·62	1	NV	0	0
	1	V	0	24
	1	V	0	0
	2	V	0	0

1 = Decaying
2 = Decayed
V = Viable
NV = Non-viable

Natural spread (F/76/5) : It can be seen from Table 7 that in wet districts the number of infections and dead plants were higher than in the dry areas. (A. de S. Liyanage, O. S. Peries, N. I. S. Liyanage, S. S. Warnapura and E. A. T. Senadheera)

Table 7. *Natural spread of white root disease*

Estate	*Infection* *No. trees infected*	*% increase*	*Dead* *No. trees infected*	*% increase*
Peenkande	3	0·7	7	1·6
Doloswela	19	2·5	27	3·6
Moralioya	7	0·7	20	2·0
Mahaoya	15	2·1	18	2·6
Urumutta	7	0·8	17	2·0
Ambadeniya	1	0·1	3	0·4
Golinda	4	0·6	7	1·1
Galewatta	12	3·2	4	1·0
Kiriwanaketiya	17	1·9	33	3·7
Padukka	24	2·7	36	4·2
Stokesland	17	2·5	30	4·4

Decay and viability of food bases (F/76/5) : Two patches in each of the eight estates in different districts selected for this study revealed that at least two rows of standing trees from the edge of an infected patch had viable inoculum. Similarly, two infected stumps, from the edge of the patch towards the center also had viable inoculum. (A. de S. Liyanage, O. S. Peries, N. I. S. Liyanage and S. S. Warnapura)

Effect of planting distances on the spread (F/80/1) : An experiment was started to determine the effect of four planting distances viz. $4{\cdot}6 \times 4{\cdot}9$ m (15′ × 16′), $3{\cdot}7 \times 6{\cdot}1$ m (12′ × 20′) $3{\cdot}1 \times 7{\cdot}3$ m (10′ × 24′) and $2{\cdot}4 \times 9{\cdot}2$ m (8′ × 30′), on the spread of the disease. (A. de S. Liyanage, S. S. Warnapura and E. A. T. Senadheera)

Studies on the action of sulphur (F/76/7) : Different amounts, methods, and timing of sulphur application are being tried out both under (a) natural conditions (b) artificially inoculated conditions. The trial is in progress. (O. S. Peries and V. Perera)

Rigidoporus patch utilization (F/76/4) : The feasibility of introducing substitute crops, to vacant patches is being looked into from the economic angle. The crops established are papaw, passion, banana, sugar cane, pineapple, four varieties of grasses, Ipil-Ipil and Habarala. (O. S. Peries and V. Perera)

Biological control of Rigidoporus (F/76/7) : Wood dowels infected with *Penicillium* spp. *Trichoderma* spp., and *Aspergillus* spp., have been tested to determine antagonistic behaviour to the growth of *Rigidoporus.* These three fungi gave encouraging results especially with soils amended with urea and sulphur. (O. S. Peries and V. Perera)

Biological control of Rigidoporus (F/76/7) : Different soil amendments were tried out and the variation in growth of *Rigidoporus* was checked with seedlings in pots. In pots to which urea was added, the fungus appeared to have degenerated faster than in those to which gypsum, cowdung, compost were added. Sulphur seemed to have supplemented the action of urea. (O. S. Peries and V. Perera)

Relationship of leaf nutrients to Rigidoporus infection (F/76/7) : Leaf nutrients are being assayed in relation to the advancement of the disease. (O. S. Peries and V. Perera)

Fungicidal application as a method of control (F/76/7) : Mature and immature trees have been treated with water immiscible fungicides Calixin, Barkosan and Collar Protectant and are being compared with the control. In mature trees yields are being recorded weekly, after the application of fungicides. (O. S. Peries and V. Perera)

Fungicidal drenching as a method of control (F/76//7) : Drenching with water miscible fungicides is being carried out at different intervals. This method of chemical control is being studied in comparison to chemical application under (a) natural conditions (b) on artificially inoculated plants. (O. S. Peries and V. Perera)

The role of indicator crops (F/76/6) : An observation trial has been established to check the infection of *Crotalaria anagyroides* under (a) natural soil conditions (b) inoculated soil conditions. (O. S. Peries and V. Perera)

The role of cover crops in the control of the disease : Six different covers are being grown on beds to assess their ability and time taken to decay *Rigidoporus* infected roots when compared with natural covers. (O. S. Peries and V. Perera)

Control

Oidium heveae

Effect of nitrogen on incidence (O/77/1) : Three levels of urea were applied to the experimental block in four estates in the Ratnapura and Kegalle Districts in May - June. There was no difference between the treatments on the incidence of *Oidium* leaf fall. Yield assessments indicated that there was a slight increase in yield when the amount of urea was doubled. There was a better response in estates located in Ratnapura than in Kegalle District. (A de S. Liyanage, N. Yogaratnam and B. Fernando)

Efficacy of fungicides (O/77/2) : Five rounds of Bayleton and sulphur were dusted at weekly intervals starting from 8 February to 7 March 1980. The results shown in Table 8 indicate that the level of infection was low due to the dry weather conditions that prevailed during this period. There was better control with sulphur and this trial has to be repeated when the infection is high. (A. de S. Liyanage and S. S. Warnapura)

Table 8. *Effect of fungicides on the incidence of* Oidium *leaf fall*

	Mean leaf fall		
Leaf count No.	*Bayleton*	*Sulphur*	*Control*
1	0	0	2
2	0	0	2
3	26	20	22
4	57	54	36
5	31	22	22
6	12	10	13
7	33	18	40
8	288	71	270
9	118	31	97
10	181	47	114
11	61	34	44
12	78	52	90
13	66	50	71
14	82	56	75
15	52	39	49
16	47	47	56
17	32	22	33
Total	1164	573	1036
Mean	77·5	38·2	60·9

Defoliation on the yield of latex (OGP/77/1) :

This experiment was continued and yield assessments were obtained at 2 - weekly intervals. The results shown in Table 9 indicate that at all levels of defoliation there was a reduction in yield when compared to the control. This trial is being continued. (A. de S. Liyanage and E. A. T. Senadheera)

Table 9. *Effect of artificial defoliation of the canopy on the yield of dry rubber*

Level of defoliation	*Mean yield (g/t/t)*
100	6·6
75	16·7
50	17·3
25	21·6
Control	27·4

Phytopthora spp.

Rainguards on bark rot (P/76/4) : Panels protected with rainguards and control trees in a field planted with RRIC 36 were affected by bark rot under natural conditions. Most of the rainguards were detached partially or completely allowing the drip water with inoculum to reach the panel and cause infection.

In another experiment, 120 PB 86 trees were fitted with rainguards on 15 March-1980. Artificial inoculations were done from May - September by pouring a 50 ml suspension of 10^4 zoospores/ml soon after tapping at a point 30 cm from where the rainguards were fixed. Results shown in Table 10 indicate that trees protected with rainguards and the controls were both affected within 2 months after fixing them.

Table 10. *Lesion size of artificially inoculated trees with and without rainguards*

Month	*Lesion size (cm^2)* *rainguard*	*control*
May	39·7	53·1
June	21·5	54.8
July	63·9	29·6
August	84·9	176·4
September	87·1	132·7

This suggests that the zoospores could still seep through between the tree and the rainguards. However, the lesion area was smaller in the trees with rainguards than in the unprotected trees. The increase in the lesion size in plots with rainguards with time possibly indicates that more of the inoculum is able to get through, due to the gaps created by improper sealing of the rainguards. (O. S. Peries, A. de. S. Liyanage, N. I. S. Liyanage and B. Fernando)

Latex based fungicides (P/77/3) : Application of low ammonia centrifuged latex with Antimucin (LACLA) or water miscible Antimucin was better than the untreated control. The LACLA formulation was better when diluted 6 than 12 times or applied neat. (A. de. S. Liyanage and B. Fernando)

In another experiment Aliette used at a concentration of 0·4%, when applied prior to inoculation was not as effective as Antimucin (1 : 120), one month after inoculation. (A. de S. Liyanage, C. K. Jayasinghe and B. Fernando)

Rigidoporus lignosus

Efficacy of fungicides (F/76/7) : Only about 16% of the trees recovered when BAS 389 — 01F was applied after removal of infected roots. A similar percentage of plants got reinfected while another 68% of the plants failed to respond and died.

Another experiment laid out to examine the protective ability of 3% BAS 389 — 01F applied on to healthy roots, followed by sealing with Barkosan (Table 11), revealed that it is effective in preventing the advance of the fungus in artificially inoculated roots. (A. de S. Liyanage, C. K. Jayasinghe, S. S. Warnapura)

Table 11. *Spread of* R. lignosus *on the roots after artificial inoculation following fungicide application*

Treatment	*Spread (cm)* *1st census*	*2nd census*
BAS 389 — 01F	1·3	10·1
Control	38·9	50·7

In a third experiment roots at various stages of infection were selected (1) tap root infected (2) lateral roots infected (3) laterals and the tap roots heavily infected (4) tap roots and laterals slightly infected. In the first category a mixture of RRI A and RRI B was ineffective. Application of BSF resulted either in death of trees or reinfection. Applications of Mason's Mixture 3 and Fomac 2 resulted in complete recovery of at least 50% of the treated plants. An equal number of control plants were either killed or recovered only after surgical treatment. However, when the tap root was infected only a few trees recovered on application of Mason's Mixture 3 and Fomac 2. But when laterals were only infected, removal of infected roots as in the control plants, was sufficient to cause recovery of most of the plants. BSF was only partially effective when laterals and the tap root were heavily infected, but when there was a slight infection most of the plants treated with Mason's Mixture 3, Fomac 2 and BSF recovered. (A. de S. Liyanage, S. S. Warnapura and E. A .T. Senadheera)

Clonal resistance of rootstocks (F/76/3) : Seedlings of twenty clones were screened for resistance to *R. lignosus* in a pot trial using a virulent strain. The results showed that LCB 1320 was consistently resistant, while other clones were in varying stages of susceptibility. (A. de S. Liyanage and W. Amaratunga)

Methods of clearing on disease incidence (F/75/1) : Trials laid out in five estates in 1975, 1976 and 1977 are being continued with regular assessments of growth and disease incidence. It was observed that new centres of infection in the replanting, mostly occur at points where there were infected trees, especially near those that bordered infected patches in the old stand. Very little infection was observed at the centres of infected patches in the old stand. This observation will help to eliminate the potential sources of infections and conserve on the application of sulphur. (A. de S. Liyanage and W. Amaratunga)

Treatment of infected patches on disease incidence (F/76/4) : Treatment of infected patches with or without sulphur after grubbing or leaving the infected stumps ; removal or retention of edge row inoculum with and without addition of sulphur gave no clear indication, even 12 months after planting, on the spread of *R. lignosus.* This trial is in progress. (A. de S. Liyanage and S. S. Warnapura and E. A. T. Senadheera)

Efficacy of different methods of amendment of soil with sulphur (F/76/4) : Of the several methods examined, sprinkling of 114 g of sulphur on the surface of the soil after planting or thoroughly mixing the same amount of sulphur with the soil added to the planting hole, gave the best results. However, the latter was laborious and more expensive. (A. de S. Liyanage and S. S. Warnapura)

Effect of different levels of sulphur on the pH (F/76/4) : Examination of the pH, two years after amendment of soil with sulphur indicated that it had not reached the original level in most cases. However, in some instances it is even higher than the original level. (O. S. Peries, N. I. S. Liyanage and S. S. Warnapura)

Xylaria thwaitesii

Efficacy of fungicides (B/75/1) : The treatment of 180 trees affected with black root disease was completed. The treatments were those reported earlier ; Annual Review, 1977. (A. de S. Liyanage, S. Wettasinghe and A. Dharmaratna)

Rate of decay (B/79/1) : Three sizes of roots, 7·5 – 12·5 cm, 5·0 – 7·5 cm, and 2·5 cm diameter were buried at different depths to assess decay. Density determinations were done prior to burying the inoculum. This trial is in progress. (A. de. S. Liyanage, S. Wettasinghe and A. Dharmaratna)

RESISTANCE

Oidium heveae

Incidence and severity (OGP/75/1) : 124 clones were cut back and assessments on the incidence and severity of *Oidium* were made. The findings are similar to those reported earlier. (A. de S. Liyanage, D. M. Fernando, S. Wettasinghe and A. Dharmaratna)

Phytopthora spp. (P/76/4) : Budwood nurseries were planted in 12 new locations in different rubber growing districts to raise clones RRIC 100 — 130. There are 10 plants from each clone. (A. de S. Liyanage, N. E. M. Jayasekera, A. Dharmaratna and S. Wettasinghe)

Colletotrichum gloeosporioides (OGP/75/1) :

Incidence and severity : During the South-West monsoon season assessments were made on 124 clones to confirm the findings of previous assessments. (A. de S. Liyanage, D. M. Fernando, S. Wettasinghe and A. Dharmaratna)

In another experiment it was observed that RRIC 105, 118, 104 and 100 were resistant and that PB 86, GT 1 and RRIC 101 were susceptible. (A. de S. Liyanage and P. K. Samaradeewa)

SURVEYS

Rigidoporus lignosus

Incidence of white root disease (SUR/76/1) : Three estates which have been surveyed before were resurveyed to assess the increase in the incidence of the disease. The results indicated that the increase in percent area infected from 1978 to 1979 in Kiriwanaketiya (Kalutara) Udabage (K.V.) and Pussella (Ratnapura) was 0·4, 1·2 and 0·7 respectively. (A. de S. Liyanage and W. Amaratunga)

Effect of plant vigour on white root disease (F/76/3) : Growth Measurements were continued. (C. K. Jayasinghe and A. de S. Liyanage)

MISCELLANEOUS

Microcyclus ulei

Pathogenic races : Laboratory inoculations were done using the ' mild ' strain and an isolate obtained from the clone IAN 2664, which was infected recently, indicated differences in susceptibility on several differential clones. These studies indicated that the isolate obtained from IAN 2664 was more virulent than the ' mild ' strain. (A. de S. Liyanage)

Evaluation of resistance : Clones C2 (RRIC 117), C7 (6004), C 12 (RRIC 119), SL 26 (RRIC 121) SL 27 (RRIC 123), SL 28 (RRIC 130), SL 30 (7263) and SL 34 (RRIC 132) were classified as resistant with low disease susceptibility ratings of 1 and 2 based on the percentage leaf area necrosis scale. These clones produced few lesions, generally lacked conidial sporulation and perithecia, and suffered no leaf fall. Among them RRIC 117, RRIC 123, SL 30 did produce conidia and RRIC 123 also shed its leaves after infection.

C8 (RRIC 115), C 13 (RRIC 116) and SL 29 (RRIC 131) were moderately susceptible (range 3). They had few conidial lesions and perithecia but were free sporulating and only RRIC 116 was resistant to leaf abscission.

Clones C 10 (5334), C 11 (5997), C. 14 (2427), SL 25 (RRIC 120), SL 31 (71 — 147), SL 32 (71 — 148) and SL 33 (72 — 23) were susceptible (rating 4). These clones exhibited fairly extensive leaf necrosis, produced a substantial number of conidia and perithecia and the leaves fell to different degrees. C 14 is a notable exception in that with this clone there was no leaf fall.

Clones C5 (RRIC 117), C 15 (6005), C 20 (10798), C 22 (8778), C 23 (8794), C 24 (8798), SL 36 (74 — 222) and SL 39 (6 — 99) were highly susceptible (rating 5) in that leaf necrosis was extensive and sporulation abundant. Infection caused the leaves to abscis but in C 24 and C 20 it was much less severe. (A. de S. Liyanage)

Transmission and scanning electron microscopy : The infection process of a susceptible and a resistant clone was studied using transmission and scanning electron microscopy. Several interesting features were observed which will be published separately. (A. de S. Liyanage)

REVIEW OF THE SOILS AND PLANT NUTRITION DEPARTMENT FOR THE YEAR 1980

BY

N. YOGARATNAM

SUMMARY

The Department is mainly concerned with the study of the responses of rubber trees to factors affecting the supply of nutrients and water to them and to soil management practices. It appears that some nutrients (in particular potassium) are required by the rubber trees (PB 86) in replantings, at higher levels than that recommended currently for Boralu soils. Moreover, the nitrogen and potassium requirements of the RRIC 100 series clones appear to be still higher than that of PB 86. There were also indications in general of higher yields with applications of N, P and K. Yield increases ranging from 5 to 27% over no fertilizer plots, have been recorded.

Yield data obtained from an experiment that has been in progress for the last 8 years indicated that urea is as effective as sulphate of ammonia as a source of nitrogen for mature rubber growing in Boralu soils. Other experiments also showed similar tendencies. With regard to sources of phosphate, Eppawela apatite appears to be as efficient as imported rock phosphate as a source of phosphate for immature rubber. Increasing the concentration of P, irrespective of the source of phosphate used, is not likely to increase its efficiency. Among the three sources of magnesium *viz* : commercial epsom salt, kieserite and dolomite, it seems that even a sparingly soluble form of Mg such as dolomite could be used in replantings. Based on these findings, fertilizer recommendations to rubber had been revised in order to accommodate urea and dolomite, the cheapest sources of N and Mg available in the country, in the fertilizer schedule.

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

Investigations on soil conservation practices showed that, until the establishment of a good leguminous cover in a new or replanting, the use of mulch is a good agronomic practice. But once a good cover of a leguminous crop is established, soil losses can be considerably reduced. Therefore, an attempt should be made to establish good legume covers without resorting to clean weeding, as early as possible. Spraying with latex alone or compounded latex is not likely to be beneficial under our conditions.

Based on the mineralogy of sand fractions (200 — 50 micron) the rubber soils of Sri Lanka can be placed in three distinct groups of weathering stages *viz* : Oxic, Demi-oxic and Inceptic. The Boralu, Cabook and the Homagama series belong to the Oxic group, the Agalawatte series to the Demi-oxic group and the Ratnapura, the Parambe and Matale series to the Inceptic group.

DETAILED REVIEW

Staff

Dr. N. Yogaratnam, Agronomist, was appointed as the Head of the Department in September 1980. Mr. C. G. Silva, Soils Chemist relinquised his services from the RRI in September 1980 to join the National Fertilizer Secretariat of the Ministry of Plan Implementation. Dr. M. K. S. A. Samaraweera, Asst. Soils Chemist, was promoted to the post of Agricultural Chemist with effect from June 1980.

Mr. F. P. W. Silva, Experimental Officer, resigned his post to join the Sri Lanka Sugar Corporation. Mr. D. P. Panditharatne and Miss Mangalika de Costa were appointed as Technical Officers on 3 March and 16 March 1980, respectively. All other staff except Mr. L. J. Wickremasinghe were on duty throughout the year.

Mr. W. M. Jayatilaka Bandara joined the Institute as a temporary post-graduate research worker in July 1980, to undertake a research project leading to the M.Sc. degree under the supervision of Dr. M. K. S. A. Samaraweera. He is studying the problem of ' Some Analytical Methods in Plant Nutrition Studies', and is funded by the National Science Council.

Research students

The following research students were supervised by M. K. S. A. Samaraweera and worked in the Soils & Plant Nutrition Department on the projects given below :

Mr. S. Amarasiri Fernando of the Dept. of Chemistry, University of Colombo : ' Determination of calcium, magnesium, manganese, zinc, copper, iron and molybdenum, using the atomic absorption spectrophotometer and nitrogen, phosphorus and potassium in rubber seeds using the autoanalyser.

Mr. W. U. de Alwis of the Dept. of Chemistry, University of Peradeniya : ' Plant growth substances in young leaves of rubber '.

Mr. L. R. K. Amarasinghe of the Dept. of Chemistry, University of Peradeniya : ' Physical & chemical properties of tolyl mercaptan '.

Visits

N. Yogaratnam, paid 42 experimental visits, 6 advisory visits and 24 other visits. M. K. S. A. Samaraweera paid experimental and other visits. Routine visits to the experimental areas were made by the experimental officers, technical officers and experimental assistants.

Working groups and committees

N. Yogaratnam served on the following :

1. Co-ordinating Committee on ' Fertilizer Supplies ' of the Ministry of Plan Implementation.
2. Technical Committee of the Tender Board of the Ceylon Fertilizer Corporation.
3. Technical Committee of the Bureau of Ceylon Standards of the Ministry of Industries and Scientific Affairs.
4. Agriculture Group of the Atomic Energy Authority (AEA) of Sri Lanka.
5. Working Group on ' Studies related to the use of Neutron Moisture Probe for assessing availability and conservation of soil water in plantation crops in Sri Lanka' sponsored by the AEA of Sri Lanka.
6. Working group on ' Phosphate fertilizer efficiency studies' sponsored by the AEA of Sri Lanka.
7. Sub-committee to draw up an internal co-ordinated programme on the use of ^{15}N in soil/plant studies, by the AEA of Sri Lanka.
8. Executive Committee of the Soils Science Society of Sri Lanka.

M. K. S. A. Samaraweera served on the following :

1. Section B of the SLAAS as the Secretary.
2. Panel of Judges for the Inter School Science Quiz competition of the SLAAS.
3. Executive Committee of the Soil Science Society of Sri Lanka.

Meetings

N. Yogaratnam addressed the Estate Superintendents of the Sri Lanka State Plantations Corporation at Seminars held in Galle, Kalutara and Ratnapura regions on fertilizer usage in rubber plantations.

M. K. S. A. Samaraweera attended the 26th assembly of the International Rubber Study Group held in October 1980 in Malaysia. He also spoke to the members of the Soil Science Society of Sri Lanka.

Training courses

N. Yogaratnam lectured to the Asst. Estate Superintendents (trainees) on 'Fertilizer usage and ground cover management'.

M. K. S. A. Samaraweera conducted a course of lectures on Analytical Chemistry at the Department of Chemistry, Sri Jayawardenapura University,.

RESEARCH

Response to Fertilizers

Immature rubber (F/76/1, F/76/3, F/76/4 & F/76/5)

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

In an experiment, F/76/1, started on Pembroke Estate, effects of five levels of N, P, K and Mg on clone PB 86 growing in Boralu soils, was studied in a central composite second order design. This experiment was designed to study the response surface of the nutrients N. P. K and Mg by fitting the function Y (girth response) $= b_0 \pm b_1N \pm b_2P \pm b_3K \pm b,N, b_5P_2 \pm b_6K_2 \pm b_7NP \pm b_8NK \pm bgPK$. Analysis of the girth measurements made at the end of 1980 indicates a significant linear response to application of potassium and curvilinear response to applications of nitrogen and phosphorus as reported in the previous year. It therefore appears that the amount of potassium required by the tree in replantings is higher than that recommended currently for Boralu soils. (N. Yogaratnam & W. C. Dayaratne)

Two other experiments, F/76/3 and F/76/4 were laid down on Agalawatte and Homagama soils to study the effects of different levels of nitrogen, phosphorus and potassium on growth of immature RRIC 100 series clones in comparison with that of clone PB 86. The rate of growth of all RRIC clones was greater than that of PB 86 and there were significant responses to application of potassium (Table 1). This effect was similar in all the clones tested. But the effect of nitrogen on growth of plants has been significantly different between clones, the responses in RRIC 100 series, in particular in the RRIC 102 was higher than that in PB 86. This indicates that the N requirement of RRIC 102 is higher than that of PB 86 (Table 2).

Table 1. *Effect of three levels of potassium on growth of PB 86, RRIC 100, 101 & 102 on Boralu soils*

Clone	*Girth (cm)*	*Levels of potassium*	*Girth (cm)*
PB 86	27·67	k_0	27·23
RRIC 100	30·30*	k_1	32·75*
RRIC 101	31·93*	k_2	32·11*
RRIC 102	32·36*		

Table 2. *Effect of three levels of nitrogen on growth (girth in cms) of PB 86, RRIC 100, 101 and 102*

Clone	*Nitrogen* n_0	n_1	n_2
PB 86	26·19	28·73	28·11
RRIC 100	29·05	30·90	30·94
RRIC 101	30·75	32·28	32·79
RRIC 102	27·26	31·46	39·93

Another experiment, F/76/5, was laid down on Boralu soils to compare the effects of three levels of potassium on clones PB 86, RRIC 101 and RRIC 102. Provision was also made in the experimental design to compare the effects of three tapping systems during the mature phase. Analysis of girth measurements made at the end of 54 months from planting (Table 3) showed a significant interaction (P 1·0) between clones and levels of potassium indicating that the potassium requirement of the RRIC 100 series clones is higher than that of PB 86. (N.) Yogaratnam & J. G. de Mel)

Table 3. *Effect of three levels of potassium on growth of PB 86, RRIC 100 and 102 on Boralu series soils*

Levels of k	*Clones* *PB 86*	*RRIC 100*	*RRIC 101*
k_0	28·60	33·48	32·95
k_1	31·45	36·90	39·52
k_2	33·55	36·60	40·08

Mature rubber (F/61/1, F/61/2, F/76/6, F/76/8 to 11)

Eight experiments studying the effects of fertilizers on growth and yield of mature rubber were in progress, covering Boralu, Agalawatta, Ratnapura and Parambe series soils. Experiment F/61/1 in progress at the Kuruwita Sub-station, compared the effects of two levels of N, P and K on the performance of clone PB•86 in Boralu soils. Yield data obtained in 1980 (Table 4) showed that applications of fertilizers at the currently recommended rates are likely to give yield increases in the order of 7%, 8% and 27% with regard to N, P and K respectively.

Table 4. *Effect of two levels of nitrogen, phosphorus and potassium on yield of PB 86 in Boralu series soils*

Treatments	*Yields (kg/ha)*	*Relative Yields (%)*
n_0	1946	100
n_1	2072	106
p_0	1911	100
p_1	2107	110
k_0	1768	100
k_1	2254	127

Yield data obtained from another experiment, F/61/2, in the same site, comparing the effects of three levels of N and P also showed (Table 5) similar yield increases. Results of this experiment also indicated that increasing the levels of N and P beyond the currently recommended rates is not likely to be beneficial.

Table 5. *Effect of three levels of N and P on yield of PB 86 in Boralu series soils*

Treatment	*Yields (kg/ha)*	*Relative Yields (%)*
n_0	1376	100
n_1	1568	117
n_2	1568	118
p_0	1400	100
p_1	1582	114
p_2	1568	114

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

Bark renewal (F/71/1)

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

Stimulation (F/60/1, F/78/1 and F/72/2)

Three experiments to study the effects of different levels of N, P and K in relation to stimulation with Ethrel were in progress. There were no significant effects of fertilizer treatments on yield in relation to stimulation, in the second year of these experiments. (N. Yogaratnam, M. Abeysinghe and M. A. Mendis).

Intercrops (F1/79/1 and 2)

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

A second experiment FI/79/2, was started to evaluate (1) the feasibility (2) the economics of growing coffee under rubber with provision for studying the effect of the intercrop on the yield of rubber. The treatments that are being tested in a split plot design are three levels of nitrogen and phosphate and two spacings for coffee ($30^1 \times 8^1$ and $15^1 \times 8^1$). This experiment was also started on Parambe soils using clone PB 86. Assessments made at the end of one year do not show any treatment effect on growth of rubber plants. (N. Yogaratnam and M. A. Mendis)

Efficiency of Fertilizer utilization

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

Sources and placement of nutrients (F/76/2, F/72/2, F/73/1, F/76/12 & F/76/17)

Nitrogen : Experiment F/76/2, was designed to compare the effects of three forms of N, viz : sulphate of ammonia, urea and ammonium chloride, three forms of P, viz : imported rock phosphate, Eppawela apatite and concentrated super phosphate and three forms of Mg, viz : commercial epsom salt, dolomite and kieserite on growth PB8 6 in Boralu soils. Girth measurements made at the end of 54 months after planting did not indicate any significant differences in growth due to the different forms of nitrogen.

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

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

Treatment	*Yield (kg/ha)*	*Relative Yields (%)*
Nil nitrogen	1666	100
Sulphate of Ammonia	1974	118
Urea, broadcast	2014	120
Urea, forked-in	1974	118

Phosphorus : There are four experiments (F/73/1, F/76/2, F/76/12 and (F/76/17) to compare the effects of different forms of phosphate on the performance of rubber in different soils. In experiment F/73/1, at Dartonfield, the effects of imported rock phosphate are compared with those of Eppawela apatite on growth of immature RRIC 101. Girth measurements made at the end of 7 years from planting did not indicate any treatment of differences on growth of rubber.

The effects of these two sources of phosphate were compared at three levels of P in experiment E/76/17, on the performance of PB 86 in Boralu soils. Girth measurements recorded at the end of 54 months after the commencement of this experiment indicate (Table 7) a significant positive response to application of phosphate fertilizers irrespective of the source of phosphate applied to immature rubber in Boralu soils. Increasing the concentration of P did not also have any beneficial effect on growth, suggesting that P availability may not be increased with increase in the levels of phosphates beyond the presently recommended rates.

Table 7. *Effects of imported rock phosphate and Eppawela apatite on growth of immature rubber*

Treatments	*Mean Girth (cm)*	*Relative girth (%)*
Nil phosphate	46·59	100
Eppawela apatite : Level 1	50·90**	109
Level 2	49·56**	107
Imported rock phosphate Level 1	50·32**	108
Level 2	58·28**	117

Magnesium : The effects of three sources of magnesium viz : commercial epsom salt, dolomite and kieserite on the growth of *Hevea* were studied in two experiments (F/76/2 and F/76/12). Assessments made at the end of 54 months after the commencement of the experiments did not reveal any significant differences on growth and yield due to different sources of magnesium. It seems that even a sparingly soluble form of Mg such as dolomite could be used in replantings. (N. Yogaratnam, M. A. Mendis and J. G. de Mel)

Foliar nutrition (FN/77/1 to 5)

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

TRACER AIDED STUDIES

Root activity pattern of *Hevea* (P-32/79/2)

Studies on the root activity pattern of *Hevea* using ^{32}P as the tracer were continued. An experiment laid down at Clyde State Plantation to test ten combinations of fertilizer placement viz : two vertical depths, 0 – 15 cm and 15 – 30 cm and five lateral distances, 0·75 m, 1·5 m, 3·0 m and 3·37 m was in progress. Routine fertilizers were applied to all the experimental plants and ^{32}P labelled super phosphate was applied according to the experimental design. (N. Yogaratnam, and B. Arsekularatne)

Evaluation of Eppawela apatite using ^{32}P (P - 32/79/1)

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

NURSERY INVESTIGATIONS

Sources and levels of N, P and K (FP/79/1 to 3)

Three experiments to study the effects of two sources of nitrogen viz : urea and sulphate of ammonia, three sources of phosphate viz : imported rock phosphate, Eppawela apatite and super phosphate at three levels of N, P and K on growth of nursery plants grown in ' poly bags ' were completed. Results indicate that fertilizer practices presently in use in field nurseries are applicable to the plants grown in ' poly bags ', as well. (N. Yogaratnam, C. Samaranayake and L. J. Wickremasinghe)

COVERS AND COVER MANAGEMENT

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

Types of covers (C/72/2, C/77/1 to 7)

In experiment, C/72/2, an attempt was made to determine whether legumes are superior to naturals in promoting growth of immature rubber. If so, whether application of extra nitrogen to non-legume covers could improve growth during immaturity and yield during early maturity. Girth measurements made in November 1980 (Table 8), indicate that plants that were in legumes are still superior to the ones that were in naturals. But the girth increments over the last 12 months were greater in trees that were in natural than those in legumes

Table 8. *Effect of covers on growth of immature rubber*

Treatments	*Mean girth (cm)*	*Girth increment (1979 to 1980)*
Naturals (control)	52·58	5·21
Legumes	59·26***	4·18
Elimination of non-legumes	56·78**	5·44
Naturals with extra nitrogen	56·51**	7·00
Naturals with extra nitrogen based on leaf analysis	54·16	2·33

Studies on the effect of various leguminous covers viz : *Pueraria phaseoloides, Calapogonium muconoides, Desmodium ovalifolium, Mimosa invisa, Centrosema pubescens* and *Stylosanthus guyanensis* (*gracilis*) on growth and production of *Hevea*, were in progress in several sites. The control plots in these experiments are in naturals. Girth measurements made 42 months after planting (Table 9) indicated that in general, the growth of trees in legume plots was superior to the trees in plots with naturals. (N. Yogaratnam, B. Arsecularatne & G. de Mel)

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

Treatments	*Mean girth (cm)*			
	C/77/2	*C/77/3*	*C/77/4*	*C/77/6*
Naturals	22·28	26·92	24·17	20·17
Pueraria	26·24	28·64	28·63	24·99
Calapogonium	27·24	27·85	28·12	25·38
Desmodium	27·90	28·37	28·98	24·35
Mimosa	27·41	24·85	24·30	24·75
Stylosanthus	24·38	27·71	25·02	22·17
Centrosema	26·95	—	26·51	24·76

Nutrition of legumes (C/70/2, C/77/8)

Phosphate : The influence of phosphate application to covers was studied in an experiment (C/70/2) at Pussella Estate, Parakaduwa. The ground covers did not grow from 1974, due to heavy shade and the phosphate treatments were also discontinued from 1974. Rubber trees that received phosphate continued to grow better (Table 10) than the trees that did not receive any phosphate during the immature phase. This effect was shown irrespective of the type of cover grown. Further, application of P to covers continued to show a long-term residual effect beneficial to the growth and yield of rubber in comparison with P applied direct to the rubber tree. (N. Yogaratnam and M. Abeyasinghe)

Table 10. *Effect of phosphate application on growth and yield of rubber*

Treatment	*Mean girth (cm)*	*Mean yield kg/ha*
Nil phosphate	58·6	1008
P to rubber	60·06*	1050
P to cover	62·44**	1176*
P to rubber and cover	63·01**	1199*

Potassium : The influence of potassium application to the ground covers was investigated in an experiment (C/77/8) on Boralu series soils. Results obtained at the end of 42 months after planting (Table 11) indicate that unlike phosphate, potassium is more effective when applied direct to the rubber tree than when applied to the ground covers, especially on potassium deficient soils such as the Boralu series. (N. Yogaratnam and B. Arsecularatne).

Table 11. *Effect of potassium on growth of immature rubber in Boralu series*

Treatments	*Mean girth (cm)*
Nil potassium	20·88
Potassium to rubber	26·36
Potassium to cover — level 1	24·96
Potassium to cover — level 2	26·70
Potassium to rubber + cover — level 1	29·14
Potassium to rubber + cover — level 2	29·27

Soil conservation (SC/77/1)

Studies on the influence of ground covers, mulch and soil consolidation with natural rubber formulations on run-off and soil losses were continued. Results obtained in 1980 (Table 12) confirmed the previous years findings that mulching with Guatamala grass loppings and growing leguminous covers can reduce run-off and soil erosion losses markedly, as compared to clean weeded and bare land.

Of the natural rubber treatments, latex-oil emulsion gave effective protection against erosion. It therefore appears that until the establishment of legume covers in a new or re-planting, the use of mulch is a good agronomic practice for soil conservation. Attempts should also be made to establish good legume covers without resorting to clean weeding. (N. Yogaratnam & W. C. Dayaratne)

Table 12. *Effect of ground covers on soil erosion*

Treatments	*Soil loss (kg/hectare)*
Control (bare)	18·8
Naturals	8·0
Legumes	242·0
Mulch	3029·0
Latex only	51264·0
Latex + oil	9356·0
Compounded latex	41672·0

Weed control

A new pre-emergent herbicide (Goal) was tested for reducing hand weeding costs when establishing legume covers in replantings. It has been claimed by the manufacturers that a single application of Goal at 1·8 litres per ha, immediately after seeding of *Calpogonium caerulium*, *C. muconides* and *Pueraria phoseolodes* provides approximately 10 - 15 weeks of residual weed control, depending on weed pressure and environmental conditions.

Preliminary results appear to show that Goal may be used as an effective pre-emergence herbicide in replantings. More experiments are planned. (N. Yogaratnam and W. C. Dayaratne)

SOIL SURVEY AND CLASSIFICATION

Mineralogical studies

This study was carried out as part of a comprehensive investigation into the chemical, physical and mineralogical properties of major rubber soils of Sri Lanka aimed at assessing their origin, genesis and fertility status. The ultimate purpose is to arrive at a classification system at a low categorical level for practical use in rubber growing. This is being done in collaboration with the Royal Tropical Institute, Netherlands.

This study is divided into two parts ; that concerning the mineralogical studies on the sand fractions (part I) and that concerning the fine silt and clay fractions (part II). Work on part I of this study has now been completed. Based on the mineralogy of the sand fractions (200 - 50 microns) the rubber soils of Sri Lanka can be placed in three distinct groups of weathering stages.

Group I — Oxic

This group is characterised by material of a very oxic nature, having virtually no weatherable minerals left in the solum. The material is strongly weathered. Quartz is predominantly present in the 200 - 50 micron fraction (85 - 90%) the remainder being mainly opaque minerals and limonitic materials. The percentage of opaque minerals in the heavy sand fraction is very high 80% in the surface horizon, decreasing to 50% in the lower B horizon. Boralu, Cabook and Homagama series belong to this group.

Group II — Demioxic

This group is characterised by material approaching the oxic stage, but with still 10 - 20% weatherable minerals left in the solum. The oxic nature diminishes with depth, unless rejuvenation has taken place through colluviation. Quartz is predominant in the 200 - 50 micron fraction (70 - 85%). The percentage of opaque minerals in the heavy sand fraction is high but this depends on the origin of the material. In this group can be placed the Agalawatte series.

Group III — Inceptic

This group still contains more than 20 and up to 50% weatherable minerals in the 200 - 50 micron fraction. Quartz content is appreciably lower than in Group II (70 - 50%). In this group can be placed the Ratnapura, the Parambe and Matale series. The micaceous Parambe is exceptional because of its flood of biotite in the 200 - 50 micron fraction, lowering the quartz content to even below 30%. This could be as a result of breakdown of the mica flakes during pretreatment and may not be a natural phenomenon.

The weatherable minerals predominantly present in all soils are biotite and orthoclase, whereas in the Matale series appreciable amounts of pyroxene and amphiboles are also present. Biotite and orthoclase would release potassium on weathering, the orthoclase however very slowly, whereas weatherable minerals present in the Matale soils would also release Ca and Mg and keep the pH at a neutral level.

The materials of A and B horizons of both the Boralu and Cabook series appear to have gone through an earlier weathering process and are probably appreciably older in absolute and relative terms than the materials of the other series. The materials of the Matale series are probably the youngest pedogenetically.

The fact that garnet appears to be more prone to weathering than is generally thought is worth noting. Excellent weathering phenomena can be seen in the Boralu and Agalawatta series. The fact that garnet is absent in old materials is therefore not conclusive to the derivation of the latter. It may have disappeared through pedogenetic processes

There is a general trend to be observed in all soils that limonitic material tends to increase with depth even into the C horizon. The cause for this needs further investigation and cannot be revealed by mineralogical analyses only. Probably homogenization and break-up of particles in the upper horizons may be one cause, leaching and precipitation of iron in lower horizons may be another

As far as fertility is concerned it is to be expected that, possibly only the soils with appreciable amounts of minerals releasing potassium relatively fast would show a significant difference in K-response. This is of course also dependent on the amount of very fine sand in the soil (see texture analysis). Although significant amounts of orthoclase are present in all series of Group III, probably only the micaceous Parambe may have sufficient power to replenish the potassium which is taken up by perennial crops such as rubber. (N. Yogaratnam and J. P. Andriesse*)

SOIL CHEMISTRY AND FERTILITY

Micronutrients

Studies on the micronutrient status of the rubber growing soils and their effect on nutrient concentrations in the leaf were continued. (N. Yogaratnam and M. A. Perera)

SAND CULTURE

Rubber plants grown in nutrient free sand were treated with modified ' Hewitt's solution ' in order to induce nutrient deficiency symptoms. This technique will be used to study the process of uptake, translocation and redistribution of mineral nutrients in rubber plants. (M. K. S. A. Samaraweera and M. de Costa)

ANALYTICAL CHEMISTRY

Routine analyses

Routine chemical analyses of survey, experimental and advisory, soil and leaf samples of the Department were done. Requests from other Departments, Research Institutions, the University and other organisations such as the Janatha Estates Development Board and the Ceylon Fertilizer Corporation were also accommodated. A break down of the number of samples analysed in 1980 is given in Table 13. (N. Yogaratnam, M. K. S. A. Samaraweera, M. Perera, I. Denewaka, P. Samarakoon, C. Mahipala, Nandasiri Silva and U. Dingiriamma)

Analytical methods

Methods suitable for quantitative analysis of the nutrient content in plant tissues and latex were tested. Different methods of destructing the organic matter in plant tissues were tested. There were indications that the type of tissue used, the nutrients analysed and the method of destruction would influence the final analytical value. This study is being continued. (M. K. S. A. Samaraweera and W. M. J. Bandara)

* Head, Soil Science and Agro-chemistry Division, Royal Tropical Inst., The Netherlands.

Fertilizer recommendations

The foliar survey programme for 1980 commenced in the first week of June. Estates covering an approximate area of 4,478 hectares were surveyed this year. Of this 1,244 hectares were new surveys and 3,234 hectares were resurveys. Fertilizer recommendations to all these estates were sent in December. (N. Yogaratnam, F. P. W. Silva, S. Wasanthadewa and B. Arsecularatne)

Fertilizers to oil palm

Fertilizer recommendations to Oil Palm grown in Nakiadeniya State Plantation have been made by us. A foliar survey programme covering an extent of 1,180 hectares, was implemented and fertilizer recommendations have also been sent to the Estate on the basis of this survey. The leaf analytical data of the mature areas that are in production indicated a decrease in the concentrations of N. and K in comparison with the values observed in the previous years. (N. Yogaratnam, F. P. W. Silva and B. Arsecularatne)

OTHER INVESTIGATIONS

Brown bast

Tissues sampled at different stages of the growth cycle from brown bast affected trees as well as from the susceptible trees were analysed for nutrient contents. Different type of tissues such as leaves, stems, bark and the three different fractions of centrifuged latex were analysed. This confirms our earlier findings (*Yogaratnam, 1978) that this physiological disorder also appears to be associated with localized deficiency of some mineral nutrients. (M. K. S. A. Samaraweera, P. Samarakoon and D. P. Panditharatne)

Synthetic growth regulations

The growth regulator, N-dimethylaminosuccinamic acid was applied to young rubber plants of the clone RRIC 102. Measurements of the rates of growth of the treated plants and untreated plants were made. (M. K. S. A. Samaraweera)

Growth substances

Methanol extracts of young leaves of the clone RRIC 101 were separated into acidic, basic and neutral fractions. Further purification of these fractions was done by thin layer chromatography and by paper chromatography. Different regions of the chromatograms were subjected to the ' Wheat coleoptile straight growth test ' as well as to the ' Cress seed germination test '. The presence of a group of inhibitors other than abscissic acid (ABA) was clearly seen. (M. K. S. A. Samaraweera, C. Samaranayake and W. U. de Alwis)

Bleaching agent RRI 7

Thin layer chromatography of the commercial product, RRI-7 revealed that there is only one aromatic component in this product. Methods were then developed for the quantitative analysis of metallic contaminants in the commercial products. Work is in progress for a method for quantitative analysis of tolyl mercaptan content in the commercial product. (M. K. S. A. Samaraweera, A. M. A. Perera and L. R. K. Amarasinghe)

Rubber seeds

Samples were collected at seed germination and at critical stages of development of seedlings. Tissues such as cotyledons, endosperms, roots, stems and leaves were analysed for :

(*a*) total nutrient content.

(*b*) water soluble nutrient content in them.

Computation of these results will give information regarding the relative mobility of different nutrients. Changes occuring in the composition of other constituents such as growth substances and fatty acids during seed germination, would also be studied. (M. K. S. A. Samaraweera, D. P. Panditharatne and S. Nandasiri Silva)

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*Yogaratnam, N. (1978) Annual Review for 1977, Rubber Research Institute of Sri Lanka, March 1978.

Table 13. *Chemical Analysis done in 1980*

Department/Institution	*Sample*	*N, P, K, Ca Mg and Mn*	*Trace elements Mo, Cn, Zn, Fe and B*	*Mechanical analysis CEC and Org. C*	*K_2O, P_2O_2 Moisture content*
Soils and Plant Nutrition	Leaf	4550	16	—	—
	Soil	64	—	64	—
Plant Science	Leaf	940	—	—	—
	Soil	8	8	8	
Plant Pathology	Leaf	72	—	—	—
	Soil	78	—	18	—
Rubber Chemistry	Bark	38	—	—	—
	Water	6	6	—	
Water Resources Board	Soil	6	6	6	—
Coconut Research Institute	Leaf	410	168	—	—
	Soil	410	200		
University of Colombo	Soil	8	—	—	—
	Water	30	—	—	—
	Leaf	8	8	—	—
Ceylon Fertilizer Corp.	Fertilizer	—	—	—	18
Nakiadeniya Oil Palm S. P.	Oil Palm Leaves	65	—	—	—
University of Peradeniya	Litter	4	—	—	—
	Soils	84	84	—	—
	Water saturated	24	—	14	—

REVIEW OF THE RUBBER CHEMISTRY DEPARTMENT

By

S. W. Karunaratne

SUMMARY

The crepe rubber industry was faced with several problems, the major one being the price of pale crepe which stumbled to levels far below RSS 1 ; several estates switched over manufacture from crepe to RSS. Some already had the facilities while others erected new smoke houses. The Department assisted in bringing about these changes in the most economical way.

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. RRI 7 commercially marketed as Nexobleach was found to be a suitable alternative to the scarce RPA 3 as a bleaching agent in crepe manufacture : most of the initial problems were attributed to contamination from the storage cans and this problem is sorted out now. Consumption to date has been approximately 0·5 MT per month which is about 40% of the total consumption of bleaching agents for crepe manufacture. Reports on the colour coding scheme for crepe rubber are awaited with interest.

Several short term projects were undertaken under the supervision of Departmental staff and these are highlighted in the review. A major area of research was on the structural modification and new applications for NR. Two members of the staff were involved in working on a UNIDO project to develop thermoplastic NR.

Use of latex/bitumen and latex/cement mixes as sealants for the construction of inexpensive irrigation tanks and channels were tested extensively and in a number of instances, on a commercial scale.

A large quantity of road marking paint based on cyclised rubber was supplied to the Highways Departments Research Unit for further testing. The competition for enamel paints based on alkyd resins made from rubber seed oil (RSO) became more pronounced during the year. A research student worked full time to improve the drying characteristics and clarity of RSO alkyd resins.

In the field of biochemical studies, enzyme deproteinization of *Hevea* latex was continued. Rubber, prepared from pineapple juice assisted biological coagulation, would cyclise readily and completely with p-toluene sulphonic acid.

DETAILED REVIEW

Staff

Mr. S. W. Karunaratne, Acting Head of the Department was appointed Head of the Department with effect from 1st April 1980. The Biochemist, Dr. P. A. J. Yapa, Rubber Chemist, Dr. M. R. N. Fernando, Research Assistant, Mr. M. C. S. Perera, Assistant Development Officer, Mr. M. D. R. J. Goonetilaka, Assistant Specifications Officer, Mr. P. A. D. T. Vimalasiri and Mr. S. W. Karunaratne were on duty throughout the year. Dr. A. Coomarasamy, who proceeded to U. K. on 1979-07-01 to work at the Malaysian Rubber Producers' Research Association (MRPRA) on a joint project for the development of thermoplastic natural rubber returned in July 1980 after a 12 months assignment. This work is being continued by Dr. W. S. E. Fernando who has been working at the MRPRA since July 1980. This project

is sponsored by UNIDO on behalf of the Association of Natural Rubber Producing Countries (ANRPC). Dr. L. M. K. Tillekaratne, Specifications Officer, was awarded a Nuffield Foundation Scholarship to do Post-Doctoral research in the U.K. for a period of one year with effect from 1 October 1980. He is attached to the University of Aston and is continuing to work on the use of nitro, nitroxy and nitroso compounds as antioxidants and the use of nitrobenzene in the photo oxidation of NR. This work is carried out under the guidance of Professor Gerald Scott.

Dr. A. M. A. Amarapathy, Rubber Chemist, and Mr. R. Tharmalingam, Chemical Engineer, left the services of the Institute with effect from June 1980 and July 1980 respectively Mr. Tharmalingam continued to work as a Consultant for a short period.

Mr. L. B. K. Silva, Mr. K. C. Croose, Mr. P. W. Sedirishamy, continued to work as Experimental Officers. Mr. T. S. Amarawansa, Experimental Officer, left the services of the Institute with effect from 16th November 1980. Miss C. P. Wickramasinghe joined the Biochemistry Section as Experimental Officer in early June 1980.

Mr. A. S. Dekumpitiya, Mr. D. D. Medagama, Mr. S. Kasinathan and Mr. P. P. Jayasinghe, served as Senior Technical Officers throughout the year.

Technical Officers, Messrs. K. A. R. M. Perera, D. G. Samaneris, W. D. Dharmasena, N. M. U. Mithrananda, A. de Silva, Mrs. D. Nirmala, Mrs. N. Baduge, Mrs. S. Weeraman and Misses M. G. Manel, W. C. M. Perera, R. L. Perera, were on duty throughout the year. Technical Officers Mr. W. A. Lionel, Mr. R. Mendis and Mr. G. Dodangoda, left the services of the Department towards the end of the year.

Specifications Assistants, Messrs. W. A. S. Wijesekera, T. M. Ahamadeen, T. A. S. Siriwardena, G. Wanigatunga, A. G. R. S. Perera, R. Wickremaratne, K. B. Abeysundera and Mrs. M. D. K. Gunawardene, were on duty throughout the year.

Mr. R. L. Fernando, Stores Assistant, left the Department in October 1980.

Research Students

Five students on National Science Council (NSC) grants to carry out research leading to a M.Sc. degree continued the following research projects supervised by Departmental staff.

Miss K. G. K. Jayatillake's project on 'Some aspects of modification of NR' was supervised by Dr. A. Coomarasamy.

Miss A. M. I. Jayawardena's project on 'Synthesis of new types of antioxidants for NR' was supervised initially by Dr. A. M. A. Amarapathy and subsequently by Dr. A. Coomarasamy and Mr. S. W. Karunaratne.

Miss A. Angammana's project on 'The effect of metal salts of higher fatty acids on sulphur vulcanisation of NR and its blends' was supervised by Dr. W. S. E. Fernando and Dr. A. Coomarasamy.

Mr. S. P. Prematilaka's project on 'Serum proteins' was supervised by Dr. P. A. J. Yapa.

Miss H. D. W. M. Perera's project on 'Liquid NR and chemical modifications thereof' was supervised by Dr. L. M. K. Tillakeratne and Dr. A. Coomarasamy.

Outside links organisations

The Department took an active part in the formulation of standards on rubber and rubber products and worked in close liaison with the Bureau of Ceylon Standards. The

drafting committees on natural rubber, household gloves, foam rubber and rubber thread were chaired by S. W. Karunaratne, who is also a member of the Technical Advisory Committee on rubber and rubber products. M. R. N. Fernando functioned as Chairman of drafting committee in the formulation of standards for erasers and rice huller rollers. He is also a member of the drafting committee on fibre glass. Both M. R. N. Fernando and L. M. K. Tillekeratne are members of the Technical Advisory Committee on rubber and rubber products. M. R. N. Fernando served as a committee member of the Plastics and Rubber Institute.

P. A. J. Yapa functioned as the Hony. Secretary of the Committee for the Popularisation of science (CPS) of the Sri Lanka Association for Advancement of Science (SLAAS) and attended 10 meetings during the year. He also served as Chairman of its Editorial Sub Committee.

P. A. J. Yapa was appointed an external faculty member of the Applied Science Faculty of Sri Jayawardenapura University in February and he attended eight faculty meetings during the year.

Lectures and meetings

Departmental staff addressed two planters conferences held at Galle and Avissawella during the year. M. C. S. Perera delivered a lecture on the importance of colour coding. Lectures were given on broad aspects of raw rubber manufacture to Trainee Planters, Divisional Rubber Extension Officers (DREO's) and Rubber Extension Officers (REO's) both at Agalawatta and Colombo. The Biochemist, P. A. J. Yapa, addressed two batches of Trainee Superintendents on the role of non rubber constituents. M. C. S. Perera delivered 3 lectures to the DREO's and REO's under the Rubber Industry Smallholdings Development Authority (RISDA) training programme. M. C. S. Perera and M. D. R. J. Goonatilaka delivered five lectures on crepe rubber manufacture to trainee Superintendents.

Publications

The following papers were published :—

Solar powered crepe drying tower by R. Tharmalingam. *Karmantha, Journal of the Industrial Development Board, Sri Lanka.* **8,** No. 9, 1980.

Prospects for Sri Lanka Pale Crepe by S. W. Karunaratne. *Rubber Reporter, India,* April 1980.

Some studies on cyclisation of bromelain treated rubber by P. A. J. Yapa and W. A. Lionel (1980). *Journal of RRI Sri Lanka* (in press).

Replanting and rubber production (in Sri Lanka) by S. P. Prematillake. *Rubber Puwath* (1980) (in press).

The following reports were submitted for internal circulation :—

Regional Co-operation Agreement (RCA) sub project for Asia and the pacific on industrial applications of radiation technology by S. W. Karunaratne.

A report on the UNIDO project to increase the competitiveness of natural rubber by A. Coomarasamy.

Patents

Use of Pine Apple Juice (PAJ) as a coagulant for NR latex and the use of PAJ treated rubber in cyclised rubber manufacture by P. A. J. Yapa and W. A. Lionel.

Sri Lanka Provisional Patent Application No. 7713. An application for a Sri Lanka Patent on the use of natural rubber in leak proofing applications was made in the names of M. R. N. Fernando, M. Nadarajah and K. A. R. M. Perera.

SLAAS Annual Sessions

The following papers were read at the 36th Annual Sessions of the SLAAS held in December 1980 :—

Radiation vulcanisation of Natural Rubber Latex — S. W. Karunaratne.

Network structures and technological properties of room temperature vulcanisation — M. R. N. Fernando, K. A. R. M. Perera, K. C. Croose and W. C. M. Perera.

Use of acrylic polymers for the preparation of granular NR — K. C. K. Jayatilake, A. Coomarasamy and W. S. E. Fernando.

NR analogues of styrene diene thermoplastic rubbers — A. Coomarasamy *et al.*

Production of CV 50 using high viscosity rubber latices from smallholders latex — L. M. K. Tillekeratne, P. A. D. T. Vimalasiri and A. de Silva.

The heretability of raw rubber properties in a *Hevea* population — P. A. J. Yapa *et al.*

International Conferences

M. R. N. Fernando presented a paper entitled ' Low temperature vulcanisation of NR' and A. Coomarasamy *et al* submitted a paper for presentation on 'Natural Rubber Analogues of Styrene Diene Thermoplastic rubbers' at an International Conference on Structure Property relationships held in Kharagpur, India, in December 1980.

P. A. J. Yapa presented a paper at the Indian Rubber Conference (IRCIND) organised by the R. R. I. of India in December 1980. Yapa also read a paper written by R. Tharmalingam, M. C. S. Perera, M. D. R. J. Goonatilaka on ' New developments in production and marketing of Sri Lanka latex crepe ' at the same conference.

S. W. Karunaratne participated in a Workshop on ' Radiation Processing ' sponsored by the Atomic Energy Authority of Japan from 1 to 16 of July 1980.

S. W. Karunaratne also functioned as a technical expert to collate information to process the final document for UNDP assistance on a multifaceted radiation processing programme for developing countries. The discussions were held in Jakarta, Indonesia, during the period 4 to 8 of November 1980.

Lectures

Our Officers continued to give lectures to students preparing for the following diplomas and degrees :—

Licentiateship of the Plastics and Rubber Institute (LPRI), Technician, Plastics and Rubber Institute (TPRI), National Diploma in Technology (NDT Moratuwa University), M.Sc. in Chemistry and Technology of Polymer (Sri Jayawardenapura University), Applied Science Course (Moratuwa University) and other undergraduate courses in Chemistry (Colombo University).

The following were the main contributions :—

M. R. N. Fernando delivered 32 lectures on Rubber Chemistry and Technology and M. C. S. Perera delivered 33 lectures on Polymer Kinetics and Polymer Physics to M.Sc. students at Sri Jayawardenapura University.

M. C. S. Perera delivered 10 lectures for the Applied Science students and 10 lectures for the NDT students at Moratuwa University.

M. R. N. Fernando delivered 6 hours of lectures to TPRI students.

RUBBER CHEMISTRY

Thermoplastic NR

'Comb' graft copolymers of polystyrene on NR and synthetic cis 1, 4 polyisoprene were prepared by dry mixing of the rubber with azotipped polystyrene of controlled molecular weight. Chemical combination of the rubber backbone and the polystyrene prepolymers occurs *via* an end reaction of the terminal azodicarboxylate functional group with the polydiene. The dry mixing reaction can be carried out in a torque rheometer or in a Banbury ; but the temperature of mixing must exceed the softening temperature of polystyrene and the mix must be subjected to high shear for a minimum of one third of the total reaction, for the dry mixing reaction to be effective.

The efficiency of grafting can be very high, based on the azo functionality of the polystyrene. But with NR the grafting efficiency varies with the composition of the mix and with the grade of rubber. This is due to the non rubber substances present in NR. The grafting efficiency can be increased by pretreating the rubber with certain additives. An oil dispersion of calcium oxide at 3 – 6% on rubber was found to be very effective in improving the grafting efficiency. The products of the dry mixing reactions exhibited the common characteristics of thermoplastic rubbers.

The graft copolymers could be granulated by a mechanical communition process using a Blackfriers cutter without the use of any partitioning agent. The compounding of the graft copolymers with additives such as crystal polystyrene, naphthenic oil, whiting and stabilizers could be carried out at 130° — 150°C in a torque rheometer or in a Banbury. Compounded mixes with different amounts of these additives were prepared and their tensile and flow properties were measured. The results obtained show that the tensile modulus values in general are higher and elongation at break are lower for the compounded mixes prepared with graft copolymers than those of the compounded mixes of comparable compositions prepared with block styrene diene thermoplastic rubber.

This work was carried out at the MRPRA Laboratories in U.K. under a UNIDO sponsored project to increase the competitiveness of Natural Rubber. (A. Coomarasamy *et al*)

Epoxidation of NR

Epoxidation of NR in the latex form was carried out using the *in situ* method and with preformed peracetic acid. A series of samples were prepared by varying the quantity of the epoxiding agent. The oxirane content was estimated by a metric method using hydrogen bromide as the reagent. The degree of unsaturation was estimated by the iodine monochloride method. Vulcanisates were prepared with the modified rubber samples and their technological properties were measured. (I. Iddamalgeda, project student, A. Coomarasamy, D. Nirmala and P. W. Sedirishamy)

Granular NR

Polymers containing carboxyl groups were prepared by the free radical polymerization of acrylic acid, methacrylic acid and the mixture of the two, using potassium persulphate/

sodium metabisulphite as the initiator system at moderate temperatures (50° — 80°C). For the preparation of granular rubber firstly the solutions of these polymers as their sodium salts were mixed with the deammoniated natural rubber latex at varying proportions (ranging from 5% - 15% on drc) and subsequently flocculated with the rubber using a 10% solution of potash alum. The flocculated acrylic polymer/NR blend was separated from the serum by filtration and dried in an air oven at 60°C, to form granular NR, which is in a form such that the aluminium salt of the acrylic polymer encases the NR particles.

Raw rubber properties such as nitrogen content, volatile matter, Po, PRI, and ash content were estimated using the standard methods. Cure characteristics of the compounded mixes were studied using the Monsanto Rheometer. Technological properties such as tensile strength, modulus, resilience, abrasion resistance, hardness, stress relaxation, cross link density and swelling in solvents were also measured. The results obtained indicate that, at certain proportions of acrylic polymer, the tensile properties obtained are superior to those of the control samples.

Samples were also prepared using sodium alginate and the hydrolysed form of an acrylic copolymer which are available commercially as the encapsulating agents.

Calcium stearate was also used as partitioning agent in the formation of granular rubber by the double encasement method. (K. G. K. Jayatilake NSC, Research Assistant, A. Coomarasamy and D. Nirmala)

Synthesis of antioxidants

The following Mannich bases were prepared from 2, 6 di tertiary butyl phenol and (N cyclohexyl) amine, piperidine and morpholine, according to the method described in the U. S. Patent 3,173,952 of March 16, 1965.

(a) N-cyclohexyl bis (3, 5 di-tert-butyl-4 hydroxy benzyl) amine

(b) N - (3, 5 di-tert-butyl-4 hydroxy benzyl) piperidine

(c) N - (3, 5 di-tert-butyl-4 hydroxy benzyl) morpholine.

These compounds were recrystallised from 95% alcohol with good yields and their melting points were recorded.

Dithio-carbamates were prepared by the addition of carbon disulphide to the Mannich bases prepared by the following combinations of chemicals :—

1. 2, 6 Di-tertiary butyl phenol, formaldehyde and dimethyl amine

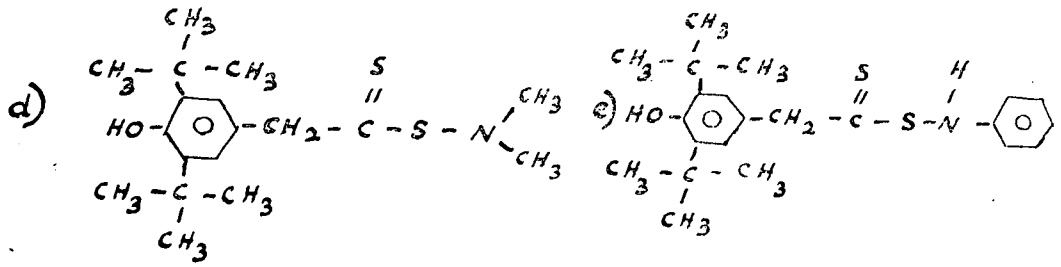
2. 2, 6 Di-tertiary butyl phenol, formaldehyde and aniline.

The procedure for synthesising dithiocarbamates may be outlined as follows :—

$$\text{Amine} + \text{Aldehyde} + \text{Phenol} \xrightarrow[\text{(few hours)}]{\text{reflux}} \text{Mannich base}$$

$$\text{Mannich base} + \text{carbon disulphide} \xrightarrow[\text{reflux}]{125^{\circ}\text{C} - 75^{\circ}\text{C}} \text{Dithiocarbamate}$$

The products (ie. the dithiocarbamates) are expected to have the following structures :



The products were recrystallised from ethanol. The yields and the melting points were recorded.

The structure of the final products were elucidated using the Nuclear Magnetic Resonance (NMR) spectral data and Infra Red (IR) spectral data. The structures of b, c & d have been confirmed by the above methods. The other compounds synthesised are being recrystallised again to obtain new sets of IR and NMR spectra in order to confirm their structures.

Cardanol in pure form was obtained by vacuum distillation of cashew nut shell liquid (CNSL) at 240°C–85°C under 5–10 mm pressure.

The purity of the distillate was checked by

1. Infra red spectroscopy
2. Nuclear Magnetic Resonance spectroscopy and
3. Thin layer chromatography (TLC)

The possibility of preparation of Mannich bases using cardanol and different amine (aniline and dimethyl amine) in the presence of formaldehyde was also investigated.

The synthesis of sterically hindered derivatives of CNSL was also attempted using :

1. Decarboxylated CNSL and styrene in the presence of acetic acid and H_2SO_4
2. Decarboxylated CNSL and styrene in the presence of anhydrous aluminium chloride.

(I. Jayawardena, A. M. A. Amarapathy, A. Coomarasamy and S. W. Karunaratne)

Liquid NR

Depolymerization of crepe IX rubber in the presence of nitrobenzene, meta dinitro benzene, monochloro acetic acid, carbon disulphide, chloranilic at 0·5%—2% concentration was studied using sunlight and UV light as the light source. The effect of stearic acid, metal stearates and tri phenyl phosphine on depolymerization with nitrobenzene was also studied. The extent of depolymerization was studied by measuring the solution viscosity of the samples using 1% solutions in toluene. It was noted that the depolymerised samples harden on storage and the storage hardening also could be studied by solution viscosity measurements.

Trials carried out on storage hardening with fractionated bleached crepe, unfractionated bleached crepe and yellow fraction indicate that the non-rubber substances also contribute to the storage hardening.

Epoxidation of depolymerised rubber was carried out using peracetic acid formed *in situ* at two different temperatures ie. 50°C and 80°C. The epoxidised liquid rubber (ELR) samples were treated with 4-amino diphenyl amine with a view to binding the amine antioxidant grouping to the polymer. The antioxidant activities of the samples prepared are being compared with that of IPPD by incorporating them in natural rubber compounds. (H. D. W. M. Perera, NSC Research Assistant, L. M. K. Tillekeratne and A. Coomarasamy)

Activators for vulcanisation

Metal stearates of Ca, Ma, Ba, Pb, Ni, and Fe in ferric form were prepared by mixing the soluble salts of these metals with sodium stearate solution. The metal salts of coconut oil fatty acids were also prepared using the same procedure. The effectiveness of these metal stearates as activators of sulphur vulcanisation was studied by preparing rubber compounds based on ACS 1 formulation. Curing behaviour and activation energy of the vulcanisation reactions were studied using the Monsanto Rheometer. Relaxed modulus (Mod 100), free sulphur content of the samples containing varying levels of metal stearate were determined. Cross link densities of the samples were also studied by a swelling method.

Metal stearates were also used in compounds with china clay as the fillers to determine their activities on S-vulcanisation of NR by varying both the filler content and the metal stearate content. The MBTS/TMTM accelerator system was used for the preparation of these compounds. The Monsanto Rheometer was again used to determine the cure characteristics. Compounded mixes were cured at 140°C at their optimum cure times, and physical properties such as modulus at 100% and 300% elongation, elongation at break, tensile strength and hardness were determined. Cross link densities of these samples were also determined.

The results so far obtained indicate that the activity varies with the type of metal stearate. Barium and lead stearates produced vulcanisates with high relaxed modulus and cross link densities than the samples prepared with stearic acid and other metal stearates. (M. Angammana, W. S. E. Fernando and A. Coomarasamy)

Synthesis of antioxidants with hindered phenolic and amino groups

The antioxidants belonging to the above category were synthesised by first preparing the aldehyde of the hindered 2, 6 - ditertiary butyl phenol by hydroformulation followed by the condensation reaction of the aldehyde group with the amino group present in aniline and 4-amino diphenyl amine. The antioxidant of these compounds in natural rubber vulcanizates were studied before and after ageing.

This amino phenol incorporated vulcanisate shows better ageing properties, than those with 2, 5-ditertiary 4-hydroxybenzene aldehyde and 4-amino diphenol amine. (A. M. A. Amarapathy, P. W. Sedirishamy and C. Samaneris)

Low temperature vulcanisates

A large number of low temperature vulcanising systems were analysed for their technological properties and network characteristics. The assessment of Tensile Strength, M-100, M-300 and Elongation at Break of vulcanisates prepared at room temperature showed that the maximum potential with regard to these properties is higher in the case of room temperature vulcanisates in comparison to those of vulcanisates prepared at 100°C. Vulcanisates prepared at 100°C were subjected to a complete network characterisation. Stress strain measurements were used to determine the cross link density and the amounts of mono di- and poly-sulphidic links in these vulcanisates were determined by using the chemical probes, thiol amine reagent and hexane thiol. The extent of main chain modification was assessed by measuring the combined sulphur content before and after treatment with triphenyl phosphine.

The ternary systems containing DPG contained large proportions of monosulphidic links and high cross link densities. The ageing properties of these systems were much better than conventional systems when assessed by continuous stress relaxation at 80°C. Results of this work was presented at the 1980 SLAAS sessions and at the International Rubber Conference at Kharagpur, India. (M. R. N. Fernando, K. A. R. M. Perera, K. C. Croose and W. C. M. Perera)

Effect of Fe^{2+}/Fe^{3+} ions in the stability and colour of NR

The thermal and photochemical breakdown of raw rubber with ferric stearate, Cu stearate and Fe (DEDC) were studied in the presence and absence of glucose. At 95°C even after 30 hours there was no significant drop in Mooney Viscosity. Buffing dust, treated with these chemicals did not give favourable results. (W. S. E. Fernando and M. C. S. Perera)

RUBBER TECHNOLOGY

Latex/bitumen and latex/cement mixes

Mixtures of formaldehyde stabilised natural rubber field latex containing room temperature vulcanising sytems and bitumen emulsion were found to be very effective waterproofing materials. The use of these mixtures was tested in sealing cracks in cement/concrete surfaces and for constructing cheap irrigation tanks and channels. In contrast to other commercial materials available for sealing cracks in concrete roofs, the above latex bitumen mix has the capability to penetrate even into the very fine cracks in cement surfaces and seal them with a film of bitumen/vulcanised rubber.

In instances where the service conditions are more demanding the performance of the above mixes has been further improved by the use of thin latex/cement mixes.

The channel that ultimately carries the water to the field is one of the vital links between agriculture and the irrigation schemes. The above becomes more and more important due to the accelerated Mahaweli Scheme, and also other similar projects which include the Wind Energy Programme of the Water Resources Board. In the case of windmill irrigation systems the necessity of the storage tank is also unavoidable. Thus, channels and tanks are important constituents of present day irrigation and agriculture. Due to various reasons the construction of these items by conventional methods has now become extremely expensive and therefore new cheap alternative methods will have to be found. In a channel or a tank, the main qualities expected are water impermeability and sufficient strength. Rubber is a material which can be conveniently used to achieve the required seepage resistance and thus when used in conjunction with some other cheap base which provides the necessary strength, channels and tanks could be constructed at a lower cost. Work was done to investigate this at a number of sites in collaboration with the Agriculture Department and Water Resources Board. Trials were carried out at Thirunelvely Farm, Jaffna, Hembarawa Farm, Mahiyangana, Government Farm, Vavuniya, Kalawewa and Oyamaduwa.

Rubber bitumen mixes containing formaldehyde stabilised latex (compounded with room temperature systems) and shellkote bitumen emulsion have been used to achieve the seepage resistance and rubber/cement mixes prepared from low ammonia centrifuged latex and portland cement were employed to obtain a flexible but strong layer. In certain instances clay bricks were used to achieve the base strength. In the case of water tanks, bricks were used as the base without any cement plastering and a layer of latex/bitumen emulsion was applied on top.

A laboratory experiment was also carried out to study the effect of using different latex, bitumen, latex/bitumen, and latex/cement layers to reduce the seepage through clay bricks. It has been observed that it is possible to make the surface of a clay brick waterproof by applying a thin layer of rubber latex. In order to test the performance characteristics, room temperature vulcanising latex was also used. A 0.31 cm thick layer of latex/cement remarkably improve seepage resistance properties of a clay brick in comparison with an ordinary cement/cements mortar.

Further work on using latex/bitumen and latex/cement mixes for waterproofing concrete roofs and water tanks was continued. Technical advice and materials were supplied to a number of organisations to solve the problem of leaking concrete roofs and water tanks. Consultancy services were provided to waterproof the 1,365,000 litre water tank on the top floor of People's Bank, Headquarters. Remedial action was also recommended to prevent water seepage through the side walls in this building.

A Sri Lanka Patent has been applied for the above processes and a leading engineering organisation in the country has commenced the manufacture of these materials on a commercial scale. (M. R. N. Fernando, K. A. R. M. Perera and W. C. M. Perera)

Room temperature curing latex in cloth combining

In canvas shoe manufacture it is necessary to combine two layers of canvas in order to achieve the required stiffness and other properties. Natural rubber solutions, which contain special accelerators have been used for this purpose. Due to recent increases in the prices of solvents, it has become impossible to use such solvent based adhesive systems. Trials were carried out by us to investigate the possibility of using room temperature curing formaldehyde stabilised centrifuged latex for this purpose. After carrying out the initial work on a laboratory scale, field trials were done at Bata Shoe Co., and at D. Samson Industries. In both instances very satisfactory results have been obtained. The latex based system can easily provide he required bond strength, stiffness etc. and the footwear manufacturers are eager to use this new material and process. Work was done to solve the teething problems in switching over from one process to the other and to arrive at a satisfactory factory procedure. It has been found that it is possible to obtain the high viscosity required by using thickening agents like carboxymethyl cellulose, vulcastab T, etc. The required whiteness is achieved by adding a small amount of titanium dioxide into the mixture. (M. R. N. Fernando, K. A. R. M. Perera and W. C. M. Perera)

Synergestic accelerator systems in carpet backing and ebonite formulations

The use of synergistic accelerator combinations to vulcanise thin films of rubber latex in sunlight for carpet backing, and to vulcanise ebonite engineering compounds within practicable cure times was continued in collaboration with the industrialists concerned. (M. R. N. Fernando and K. A. R. M. Perera)

NR rice huller rollers

The development of improved formulations, based on natural rubber, for the manufacture of rice huller rollers was studied. In order to achieve the specified hardness, strength and other characteristics which result in a satisfactory performance of the roller at the rice-milling stage, compounds of the following compositions were prepared and tested (Table 1).

Table 1. *Trial Compound formulations for rice huller rollers*

Compound	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
RSS 1	80	85	90	95	85	85	80	85	90	85	85
High Styrene Resin	20	15	10	5	15	15	20	15	10	15	15
ZnO	5	5	5	5	5	5	5	5	5	5	5
Stearic Acid	1	1	1	1	1	1	2	2	2	2	2
Clay	50	50	50	50	60	70	50	50	50	60	70
Vulcasil S	40	40	40	40	30	20	40	40	40	30	20
Wax	1	1	1	1	1	1	1	1	1	1	1
Nonox WSP	1	1	1	1	1	1	1	1	1	1	1
CBS	1·5	1·5	1·5	1	1	1	1·5	1·5	1·5	1	1
MBTS	1·5	1·5	1·5	1	1	1	1·5	1·5	1·5	1	1
Sulphur	3·0	3·0	3·0	3·0	3·0	3·0	3·0	3·0	3·0	3·0	3·0
TMTM	0·5	0·5	0·5	0·5	0·5	0·5	0·5	0·5	0·5	0·5	0·5
Renacit VII	0·11	0·11	0·11	0·11	0·11	0·11	0·11	0·11	0·11	0·11	0·11
Properties											
Hardness IRHD	95	96	96	92	90	90	94	85	89	92	8
% Resilience	39	43	37	40	38	39	37	45	41	40	40
Abrasion Loss (Vol loss min)	1929	0·1830	0·1750	—	—	—	0·1086	0·1036	0·0911	0·188	0·1797
Elongation at Break %	320	368·3	357	476·2	401	390	281	342	347	342	383
Tensile Strength (MW/M²)	14·5	15·2	12·5	17·2	10·2	15·9	10·8	12·5	12·3	12·3	14·3

It has been found that in order to reach the required hardness level of 93 IRHD, the presence of at least 10 phr of high styrene resin and 30 phr of silica is essential in the formulation studied. Further work is being continued. Assistance was also provided to Bureau of Ceylon Standards in preparing the Sri Lanka Standards for rice huller rollers and also in testing a number of rollers manufactured locally by industrialists. (M. R. N. Fernando, K. C. Croose, K. A. R. M. Perera and W. C. M. Perera)

NR based paints

Technical assistance was given to a leading company to manufacture road marking and floor paints from cyclised rubber. Trials were carried out using an easily soluble grade of cyclised rubber made from papain coagulated rubber with p-toluene sulphonic acid as the cyclising agent in the presence of a peptiser. A pearl mill was used for making the paints. A sample of road marking paint made with cyclised rubber was supplied to the Department of Highways for field trials. (A. Coomarasamy, S. W. Karunaratne and L. B. K. Silva)

Rubber compounds

The Department continued to evaluate rubber compounds to a number of rubber products manufacturers for which a service fee was levied. About 100 samples were tested for the Tyre Corporation. (D. D. Medagama)

Indigenous minerals as fillers

For preliminary studies we were supplied with six different samples, viz. calcite, quartz, silica sand, kaolinite, feldspar and ground tile all in powder form directly from the production lines of a wall tiles manufacturer.

In order to evaluate the physical properties imported by these fillers on rubber, the following comparisons were made using conventional rubber fillers as the standard.

(a) Calcite with Winnowfil S (precipitated calcium carbonate).

(b) Quartz and silica sand with Vulkasil S (precipitated silica).

(c) Kaolinite, feldspar and tile powder with kaolin.

The properties tested so far, viz. Tensile Strength, Modulus Hardness and Mooney Scorch Values using the above fillers have yielded results that compare favourably with the conventional fillers.

This project is conducted in collaboration with Lanka Wall Tiles Limited. (W. S. E. Fernando, P. P. Jayasinghe and M. G. Manel)

Viscosity variation in block rubber

The term ' knuckles ' refers to high viscosity spots in an otherwise uniform low viscosity matrix in the individual bales of block rubber. In order to ascertain whether block rubber produced in Sri Lanka is free of knuckles, a random block rubber bale from one producer who uses a mixture of RSS and brown crepe was selected, cut into several small pieces and the Mooney Viscosity was determined. In spite of the variable nature of the raw material there was a striking uniformity in the viscosity along the length and breadth of the bale. This could be due to the efficiency of homogenisation of the rubber in the mascerator prior to granulating and further blending. Experiments are being conducted to vary the production process in order to induce ' Knuckle ' formation in block rubber. This information would be useful if knuckles in block rubber are to be avoided. (S. W. Karunaratne)

Testing of masterbatch rubber

The amount of C/B or any other high SG filler in a masterbatch could be determined approximately by a floatation method using either a density column or a series of solvent systems of varying density. The solvent system is based on a mixture of formic acid and methanol. Activators such as zinc oxide used in masterbatch preparation could be spotted if a curometer trace is obtained of a suitably compounded stock containing all the vulcanising igredients except zinc oxide into which is mixed the masterbatch containing zinc oxide. On comparison of the curometer trace with standard traces it is possible to determine (a) whether zinc oxide is present (b) the quantity of zinc oxide used in the masterbatch. (S. W. Karunaratne, P. P. Jayasinghe and D. D. Medagama)

Properties of skim rubber

Samples of skim rubber from three different sources were tested for raw rubber and vulcanisate properties and compared with brown crepe 1X, 2X and 3X in formulations containing different proportions of brown crepe. Cure characteristics of skim rubber varied with the source from which it was obtained. The cure rate of skim rubber is dependant on the method of coagulation of skim latex. Both sulphuric acid and spent acetic acid are used to coagulate skim latex and in instances where spent acetic acid is used the cure rate is much faster compared to sulphuric acid coagulation. (S. W. Karunaratne, M. G. Manel and Leela Perera)

Custom compounding

The peptising action of four chemicals was studied at different temperatures and for different clones. The effect on technological properties of different formulations were studied. The thiol ester was found to be inactive as a peptiser. (M. C. S. Perera and D. G. Samanaris)

Cure retardation by phthalic anhydride

The effect of retardation by phthalic anhydride is found to be different from system to system. The effect of scorch time, activation energy and tensile strength, by phthalic anhydride in each of these systems was studied. (W. S. E. Fernando, M. C. S. Perera and K. R. U. Mithranande)

Drying of DPNR

This project was done by one of the students for her M.Sc. dissertation. The effect of carboxy methyl cellulose (CMC) and poly acrylic acid on papain and pineapple juice coagulated rubber was studied. Both these chemicals tend to reduce the drying time. The technical and technological properties were also carried out. (M. C. S. Perera and S. Hewage)

Processing of raw rubber

Smoke sheet manufacture : Necessary advisory services were given to the following factories to improve their production of quality sheet rubber :—

Pimbura State Plantation, Agalawatte.
Usk Valley State Plantation, Lathpandura.
Vykumbra Estate, Passara.
Petigahalande Estate, Tudugala.
Matugama Rubber Mills, Matugama.
Ambatenna State Plantation, Matugama.
Ambanpitiya Estate, Ambanpitiya.
(R. Goonatilake and S. W. Karunaratne)

Smoke houses

As R. S. S. was fetching better prices than pale crepe most producers requested advice to convert their existing buildings to smoke houses and also to construct new smoke houses. We have inspected these buildings and provided suitable plans for the conversions. The following Estates were given advice after undertaking factory visits.

Helamade Estate, Polgahawela.
Wea-oya Estate, Yatiyantota.
Petiyalande Estate, Tudugala.
Mirishena State Plantation, Welipenna.
Sri Kandura State Plantation, Matugama.
Vykumbra Estate, Passara.
Polatagama Estate, Yatiyantota.
Eduragala Estate, Ingiriya.
Ambanpitiya Estate, Ambanpitiya.
Matugama Rubber Mills, Matugama.
(R. Goonetilake, M. C. S. Perera & S. W. Karunaratne)

DRC determination

Three trial coagulations of latex were done during the year for the following factories :—

Dalkeith State Plantation, Lathpandura.
Eheliyagoda State Plantation, Eheliyagoda.
Petiyalande Estate, Tudugala.

Existing metrolac charts had to be modified on the basis of the results obtained in the trial coagulations. (R. Goonetilake)

Centrifuge unit

The Centrifuge Unit of the Department continued to function at Dartonfield during the year. Altogether about 2500 litres of latex were prepared and supplied for research and other purposes in 1980. (P. A. J. Yapa)

Manufacture of SLR 5 (CV 50)

Preliminary laboratory scale trials on this project were carried out successfully during the 1st quarter of this year. The first trial batch of 500 kg was manufactured at the Block Rubber Factory, Mawanella and sent to M/s. Weber & Schear, West Germany for further investigations. After evaluating the quality M/s. Weber & Schear have requested a commercial batch of 16 MT from State Rubber Manufacturing Corporation.(L. M. K. Tillekeratne, P. A. D. T. Vimalasiri and G. A. de Silva)

Low viscosity CV rubber

Attempts were made to incorporate a cheap peptiser (Renecit VII) into crumbs of scrap rubber by soaking them in Renecit VII dispersion. It acts effectively at the drying temperature of block rubber (165°c) hence reducing the viscosity of rubber. By this means it was possible to make CV rubber of Mooney Viscosity (20 CV 20) which has a limited demand in West Germany according to M/s. Weber & Schear. Due to low viscosity of this rubber it tends to flow when it is packed in crates. Therefore a new method of packing is being considered. (L. M. K. Tillakeratne, P. A. D. T. Vimalasiri and G. A. de Silva)

Liquid rubber

The role of liquid rubber (depolymerised NR) as a plasticiser, is being investigated. A shipment of 500 kg, of SLR 20 rubber containing 5% liquid rubber was sent to M/s. Weber & Schear for further investigations. (V. A. Randeniya and L. M. K. Tillekeratne)

Mould growth and raw rubber properties

This investigation originally carried out in 1978 was repeated in 1980. The results are being analysed. (P. A. J. Yapa in collaboration with Plant Pathology Department)

Smallholders latex

There is a growing demand for the use of smallholders latex in the manufacture of concentrate for rubber products manufacture. Latex was sampled from five centres within a radius of 10 miles from Colombo. 250 ml samples were removed from the bulked latex into wide mouthed polythene bottles and ammoniated to a concentration of 0·5% on the latex phase. Tests were carried out in the laboratory to ascertain DRC, TS's, VFA, Viscosity and pH. DRC of the field latex was over 30 which is quite acceptable for centrifuging. VFA values recorded were rather high out on subsequent centrifugation the VFA dropped to about half the value recorded for field latex. Viscosity of the latex fluctuated from 7·5 to 13·0 cps. (S. W. Karunaratne and S. Amarawansa)

CREPE RUBBER DEVELOPMENT UNIT

Bleaching agent

There has been a confusion among the users of both the new bleaching agents namely Emulsion A concentrate and RRI - 7 (Nexobleach). Detailed instructions were given at a one day visit to the Ratnapura region arranged by John Keels Ltd., regarding the preparation of the emulsion. A letter was circulated through M/s. Mackwoods Ltd., the distributors of emulsion A concentrate, to the users. When complaints on Nexobleach were examined, it was found that the barrels containing the chemicals had a sediment which when analysed contained iron and zinc. The users were advised to decant the liquid before use. Chemanex Ltd., was further requested to inform about this sediment to their producers overseas in order to eliminate it. No further complaints were received during the last quarter. (R. Tharmalingam, M. C. S. Perera and R. Goonetilake)

Colour coding of crepe

A meeting was arranged with Rubber Shippers, Brokers and Producers with the objective of implementing the colour coding scheme. It was agreed to implement it from 1st October 1980. In the second meeting it was agreed to print the bands on the polythene bags. Circulars have been sent to producers (JEDB/SPC/SRMC) to use appropriate coloured labels according to the scheme from 1 September 1980 in order to assist the shippers to implement the scheme from 1 October. But some of the producers have not started the labelling yet. The Crepe Rubber Development Unit is following this up. (R. Tharmalingam and M. C. S. Perera)

Crepe rubber factory development scheme

The following subsidy visits were made during the year :

Dehiowita Private Estate
Paiyagala Estate
Bentota Group
Avissawella Rubber Mills (2 visits)
Putupewela Estate
Muwankande Estate.

The reports on these visits were sent to the Rubber Controller. (S. W. Karunaratne, R. Tharmalingam, M. C. S. Perera and R. Goonetilake)

Drying towers

In spite of increased charges for electricity, two more factories namely Vogan State Plantation, Matugama and Mahaoya Estate (JEDB) have installed electrical heated systems for drying of crepe. In many factories, Browns boiler radiator systems were not functioning properly. A compromise was reached after discussion with the relevant authorities and Superintendents to find ways of modifying them. Opata Estate was visited regarding a problem in the drying tower mainly due to inefficient boilers and radiators. (R. Tharmalingam, M. C. S. Perera and R. Goonetilake)

Crepe rubber surveys

A questionnaire was sent to all crepe producing factories through the regional officers to evaluate the reasons for the drop in crepe production and some data regarding the factory subsidy scheme. The unit is still receiving the completed survey forms. (M. C. S. Perera and R. Goonetilake)

Advisory services

The following factories were visited during the year.

Usk Valley State Plantation
Matugama Rubber Mills
Padukka Private Estate
Nakiyadeniya State Plantation
We-oya Estate.

RRIC 100 series clones for latex crepe

The technical and technological properties of crepe produced by clones PB 86, RRIC 100, 101, 103, 112 and RRIM 600 were evaluated. Several trials were carried out to study seasonal variations. According to the results obtained there is no indication of significant changes in the latices obtained with seasonal variation. This project was abandoned. (M. C. S. Perera, R. Tharmalingam, W. S. E. Fernando and R. Goonatilake)

Mould growth on crepe rubber

Work on this project is in progress. It has been found that mould growth on yellow fraction and unfractionated rubber is very much faster than that on fractionated rubber. (L. M. K. Tillakeratne, P. A. D. T. Vimalasiri and G. A. de Silva)

Properties of pale crepe

Preliminary trials were carried out on three grades of pale crepe classified on the method of manufacture *viz.* Fractionated bleached (FB), Unfractionated bleached (UB) and Yellow Fraction (YF) in order to study their individual technical properties and performances in various applications.

These included the evaluation of cure properties based on the ACS 1 mix and physical properties such as tensile strength, resilience, hardness and abrasion resistance.

It is proposed to collect these data and publish them as a booklet in due course. (S. W. Karunaratne, R. Goonetilake and P. P. Jayasinghe)

Properties of sole crepe

A study was undertaken to supply the consumers with all the technical information on sole crepe produced in Sri Lanka. Sole crepe samples from various plantations were obtained. The following tests have been done.

Po, PRI
Raw Mooney Viscosity
Mo at 50%, 100% Elongation
Tensile Strength

A paper on this project will be submitted to the Rubber Bulletin in due course. (S. W. Karunaratne, R. Goonetilake and P. P. Jayasinghe)

Solar drying

The use of a solar collector for drying crepe laces is being investigated. A 4·5 m^2 flat plate-collector has been fabricated for this purpose. The objective is to estimate the area of the solar collector required to obtain the required amount of heat. An approximately 200 kg capacity drying tower has also been built in the Institute premises at Ratmalana for these studies. Trials are in progress to find out the approriate storage system for solar heat. Investigations into the use of a packed bed consisting of clay brick pieces shows that such a system could be adopted. The technical and economic aspects of using a solar system is being investigated. (R. Tharmalingam and M. D. R. J. Goonatilake)

SPECIFICATIONS

Block rubber

During the period 26,793 samples were tested from all Block Rubber Factories in Sri Lanka, an average of nearly 130 samples per working day. Code names of factories, intensity of testing and the grades of block rubber produced are given in Table 2. In addition to this 735 miscellaneous rubber samples, 11 acid samples, 30 latex samples and 5 water samples were also tested. (P. A. D. T. Vimalasiri, A. S. Dekumpitiya)

Masterbatches

The Sri Lanka Customs requested the RRISL to analyse masterbatch samples and issue quality reports for all lots of masterbatches to be exported stating whether they are classifiable under BTN/40·05. Under this scheme 970 masterbatch samples were analysed during this period and reports issued to the Sri Lanka Customs. Out of this lot 811 samples were from Associated Motorways, Kalutara, 100 from Ceypa Factory, Boralasgamuwa, 31 samples from Atco Rubber Factory, Ekala and 22 samples from other producers. (S. W. Karunaratne and P. A. D. T. Vimalasiri)

Inspection visits

5 visits were made to Mawanella Block Rubber Factory for routine inspection and CV 50 trials during this period. The Specifications Officer visited Star Rubber Co., Ltd., Block Rubber Factory at Parakaduwa and Sherman Sons Ltd., Block Rubber Factory at Ingiriya for inspection of the factories for approval. The facilities available for the production of SLR rubber at these factories being satisfactory, they were registered as SLR producers of Sri Lanka. Visits were also made to Statcon Factory, Getahetta, Cenat Factory, Paiyagala, Ceymac Factory, Horana and Sherman Sons Ltd., Colombo.

Visits were also made by the Asst. Specifications Officer to inspect and sample masterbatches mixed at Associated Motorways Ltd., Kalutara, Atco Rubber Factory, Ekala and Ceypa Factory, Boralasgamuwa. (P. A. D. T. Vimalasiri)

Table 2. *Identity and main grades of block rubber produced in Sri Lanka*

Factory/Establishment	*Code Number*	*Main Grades of SLR produced*	*No. of samples tested during the year (1980)*
(1) Mawanella Block Rubber Factory	AA	5L, 5, 10	3637
(2) Cenat Block Rubber Factory	AB	5, 10, 50	4545
(3) C. W. Mackie & Co., Ltd.,	AC	5L, 5 (RSS)	3830
(4) Statcon Block Rubber Factory	AD	5, 10, 20, 50	7972
(5) Sherman Sons Limited	AE	5L. 5, 5 (RSS), 20, 50	29·7
(6) Ceymac Rubber Co., Ltd.,	AF	5L, 5 (RSS)	3177
(7) Orient Rubber Products Ltd.,	AG	5	52
(8) Lanka Star Rubber Works Ltd.,	AH	20, 50	673

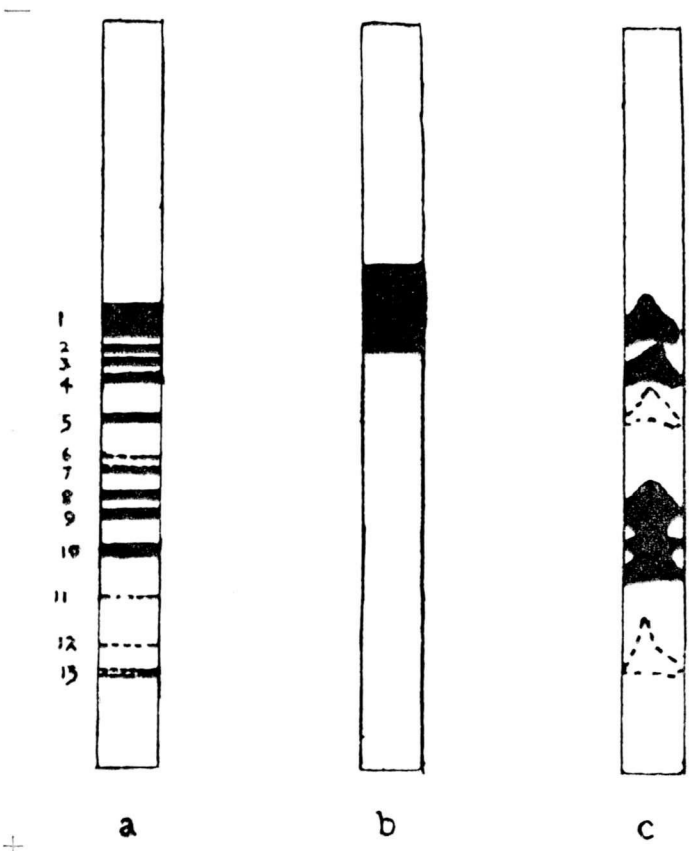


Fig. 1 Electrophoretic seperation of proteins in a) fresh pine apple juice (**Annas cosmus**), b) purified Bromelain obtained form pine apple stem and c) pine apple juice + $NaHSO_3$, one week old, on polyacrylamide gel 7·5%.

Enzyme deproteinisation

Studies on enzyme deproteinization of *Hevea* latex were continued. Some preliminary studies carried out with rubber prepared from latex treated with pineapple juice (PAJ) showed that it can be cyclized readily and completely by the p-toluene sulphonic acid method. An investigation was undertaken to study the proteolytic action of bromelain (the proteolytic enzyme present in pineapple) on *Hevea* latex and also to explore the possibilities of using PAJ in DPNR manufacture.

The proteolytic action of purified bromelain and unfractionated PAJ obtained from *Annas cosmus* on *Hevea*, proteins was studied. Both were found to be effective in hydrolysing *Hevea* proteins resulting in a low protein rubber which satisfies the specification for DPNR. It showed a temperature optimum around 45°C and a broad pH max near 8·0. The highest deproteinization (63·15%) was observed at 0·08% w/v bromelain on latex. PAJ treatment of latex is simple and economically feasible and therefore is of obvious commercial importance.

Disc electrophoresis of PAJ (crude) obtained from ripe fruits of *Annas cosmus* showed 13 bands on acrylamide gel (fig. 1). Bands 1, 2, 3 & 4 were very prominent. Purified bromelain obtained from pineapple stem (commercial products) also showed a diffused single band in the same area. Buffered PAJ (with tris-glycine buffer, pH 7·5) and also PAJ with $NaHSO_3$ (added as a preservative) also gave 13 bands similar to those of crude PAJ.

When one week old chemically unpreserved PAJ kept at 4°C was subjected to electrophoresis on acrylamide gel, only six bands which were also mostly in a diffused state as shown in fig. 1, were obtained. Some of these diffused bands appeared to be formed from a combination of several bands. Buffered PAJ showed a better band pattern than unbuffered PAJ, here the bands 1, 2, 3, 4 & 5 were clear enough although slightly affected, bands 8, 9, 10 were also fairly clear. However, the bands 6, 7, 11, 12 & 13 were not clear.

Sodium bisulphite preserved PAJ also showed a streaking effect similar to that of unpreserved PAJ. There was no change in the electrophoretic pattern of purified bromelain which again gave a single diffused band after standing at ambient temperature for one week.

The cyclization patterns of PAJ and papain treated rubbers were studied. The rate of cyclization of PAJ treated rubber was generally comparable to or better than that of papain treated rubber (Table 3). Sodium bisulphite was found to activate the reaction whilst the action of Nonidet T and RPA 3 was somewhat inhibitory PAJ treatment can be used in crepe, block and sheet rubber manufacture and the resulting rubbers can all be cyclized easily. Use of PAJ as a part coagulant with acid improves drying characteristics without any adverse effects on cyclization. (P. A. J. Yapa, W. A. Lionel, M. D. C. Seneviratne)

Quebrachitol. Further work was carried during the year. A purified product (MP 190°C) was obtained. The possibility of using solar energy at the initial evaporation stages was also investigated. A little over 50% reduction in volume of fresh serum was obtained in 8h during the months of March and April. A sample of crude quebrachitol, prepared from sheet serum was found to contain about 25% quebrachitol (Annual Report 1978). This is considered to be relatively high compared to samples prepared by other countries. However, the quebrachitol content of samples prepared from block rubber serum obtained from Mawanella Block Rubber Factory was found to be low. This is thought to be due to formation of a complex due to the preservative system which contains boric acid. (P. A. J. Yapa & Kasinathan)

Low protein sheet rubber (LPSR): Commercial possibility of preparing air dried sheet rubber (ADS) and low protein sheet rubber (LPSR) were investigated in response to a request made by a West German Firm. One of the major drawbacks of ADS is its susceptibility to mould growth. The addition of sodium benzoate and also oxalic acid had little success in controlling mould growth. It was observed again that only the enzyme deproteinization of latex could control it appreciably. Papain and pineapple juice were used in these trials successfully as a part coagulant, with acid. This was necessary mainly to improve the drying characteristics since the use of enzyme as the sole coagulant would take an unacceptably long time to dry. Resistance to mould attack and improved technological properties have been reported to be the major advantages of LPSR. Preliminary discussions were held with the JEDB management who showed a keen interest in manufacturing this new form of sheet rubber on a commercial scale. (P. A. J. Yapa & M. D. C. Seneviratne)

ATP-ase activity. A new investigation was initiated during the year to study the ATP-ase activity in *Hevea* latex. (C. P. Wickremasinghe & P. A. J. Yapa)

Heretability of raw rubber properties : The statistical analysis of results of this experiment, carried out in 1979 (see Annual Review 1979) was completed during the year. The heretability was found to be low in the *Hevea* population investigated. However, some useful correlations between certain properties such as nitrogen content and Wallace plasticity, ash content and Mooney viscosity, colour and volatile matter, nitrogen content and Mooney, were observed. The prospects of breeding for particular desired characteristics are remote in the context of the *Hevea* population investigated in this study. (P. A. J. Yapa, D. M. Fernando, B. M. S. G. Peries & M. D. C. Seneviratne)

Phenolics in Brown Bast Bark : Bark of trees affected by Brown Bast was analysed for phenolics. Of the three fractions investigated, the highest phenolic concentration was observed in the basic fraction. Phenolic content of the basic fraction obtained from Brown Bast trees was markedly higher than that of healthy trees. Preliminary attempts were made to separate individual phenolic compounds and identify them by using paper chromatography. (C. P. Wickremasinghe & P. A. J. Yapa)

Table 3. *Protein content of enzyme treated rubbers and their cyclization patterns*

Treatment	*Protein content %*	*% reduction compared to control*	*Cyclization reaction*	*Reaction Time (sec)*	*Reaction pattern*
1. HCOOH 2% control	2·45	—	incomplete	300	very slow
2. Papain 0·05%	1·23	49·8	complete	226	slow
3. Papain (fresh) 0·05%	1·05	57·1	,,	86	very fast
4. Papain purified 0·05%	1·05	57·1	—	—	—
5. Bromelain 0·01%	0·88	64·0	complete	117	fast
6. PAJ (precipitated)	1·14	53·5	,,	127	normal
7. PAJ, 2% on latex	1·05	57·1	,,	147	,,
8. PAJ, 4% on latex	1·05	57·1	,,	105	fast

Rubber seed oil alkyd resin manufacture

The competition for enamal paints based on alkyd resins made from rubber seed oil became more pronounced during the year. In order to meet the challenge from paints based on imported alkyds, work to suggest improvements to the rubber seed oil alkyd had to be given priority. Partial replacement of glycerol by pentaerythrytol and the use of a small amount of maleic anhydride along with phthalic anhydride led to considerable improvements in the drying characteristics. 50% (by wt.) replacement of glycerol by pentacrythrytol yielded rubber seed oil alkyd resins of a higher viscosity and by 75% replacement the whole mass underwent gelling during the second stage of the reaction. Complete analysis of final and intermediate products was carried out in order to develp a convenient factory procedure for rubber seed oil alkyd manufacture. Thin layer chromatography was used to estimate monoglyceride content after the first stage of the reaction. Replacement at intermediate levels is being further investigated and large scale trials at factory level will be conducted at Ceylon Resinoplastics Ltd. Mr. R. Devendra of Resinoplastics Ltd. carried out a 3 month project on this subject at the Rubber Research Institute and his findings are presented in detail in his M.Sc. thesis for the polymer Science course of the Vidyodaya University. (M. R. N. Fernando, K. C. Croose and W. C. M. Perera)

ANNUAL REVIEW OF THE STATISTICS SECTION — 1980

By

W. N. WICKREMASINGHE

SUMMARY

Statistical assistance was provided, as usual, to other Research Departments throughout the year, as it was the main concern of the section. Altogether sixty one experiments were analysed during the current year. In addition to this, meteorological data were also collected without interruption.

DETAILED REVIEW

Staff

Mr. W. N. Wickremasinghe, Assistant Statistician was on duty throughout the year.

The Technical Officers, Mr. L. T. Pieris, Mr. R. A. P. Abayapala and Miss J. D. Nandanie, were also on duty throughout. Mr. V. Abeywardena continued to pay his visits as the consultant Biometrician.

Studies

The Assistant Statistician sat for the M.Sc. examination in Applied Statistics conducted by the University of Colombo, after completing a two-year part time course in the subject.

Visitors

Dr. Roger Stern of the Department of Applied Statistics of the University of Reading, U.K., and a team of several officers paid a visit to the Institute in July. During this visit he had useful discussions with the research staff regarding the necessity of increased computer usage with special reference to a package called " Genstat " which can handle most of the analyses used in biometry.

Statistical work

Since the main concern of the section is to assist other Research Departments in designing and analysing their experiments, most of the time was spent on routine statistical work.

The analytical work of the other Research Departments for the previous year's Annual Review, was completed during the first quarter of the current year.

During the second and the third quarters considerable time was spent on the analyses of Tissue Culture and Grass/Legume studies of two research students, reading for their Masters and Doctoral degrees, both attached to the Plant Science Department. Towards the end of the last quarter, again the rush of work for the 1980 Annual Review added to the usual cycle of routine work.

A break up of the approximate number of analyses provided during this year is given below.

Department	*Number of analyses*
Soils and Plant Nutrition	12
Plant Science	36
Plant Pathology	08
Plant Breeding	04
Advisory Services	01
TOTAL	61

Each of the above analyses consisted of two or more sets of data corresponding to various characteristics under investigation. The methods used extended from the simplest 't' test to more complicated ones such as composite designs, nested classifications with unequal number of observations per cell, Genotype- Environment interactions, confounded factorials, fractional replications and analyses involving missing plots and also double covariance analyses.

Computer applications were also made where they were necessary.

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 the Dartonfield Meteorology Station and also from Nakiadeniya and Atale Estates.

A new Thermohygrograph was installed at Nakiadeniya Oil Palm Plantation in addition to the available sunshine and rainfall recorders, to assist in Oil Palm research work. Arrangements were made to repair some rainfall recorders which were out of order. A mixture of quality local ink and glycerine was used as a substitute for imported recording ink, which resulted in considerable saving of funds for imports.

The graphs of rainfall, temperature and sunshine duration at Dartonfield are shown in Fig. 1.

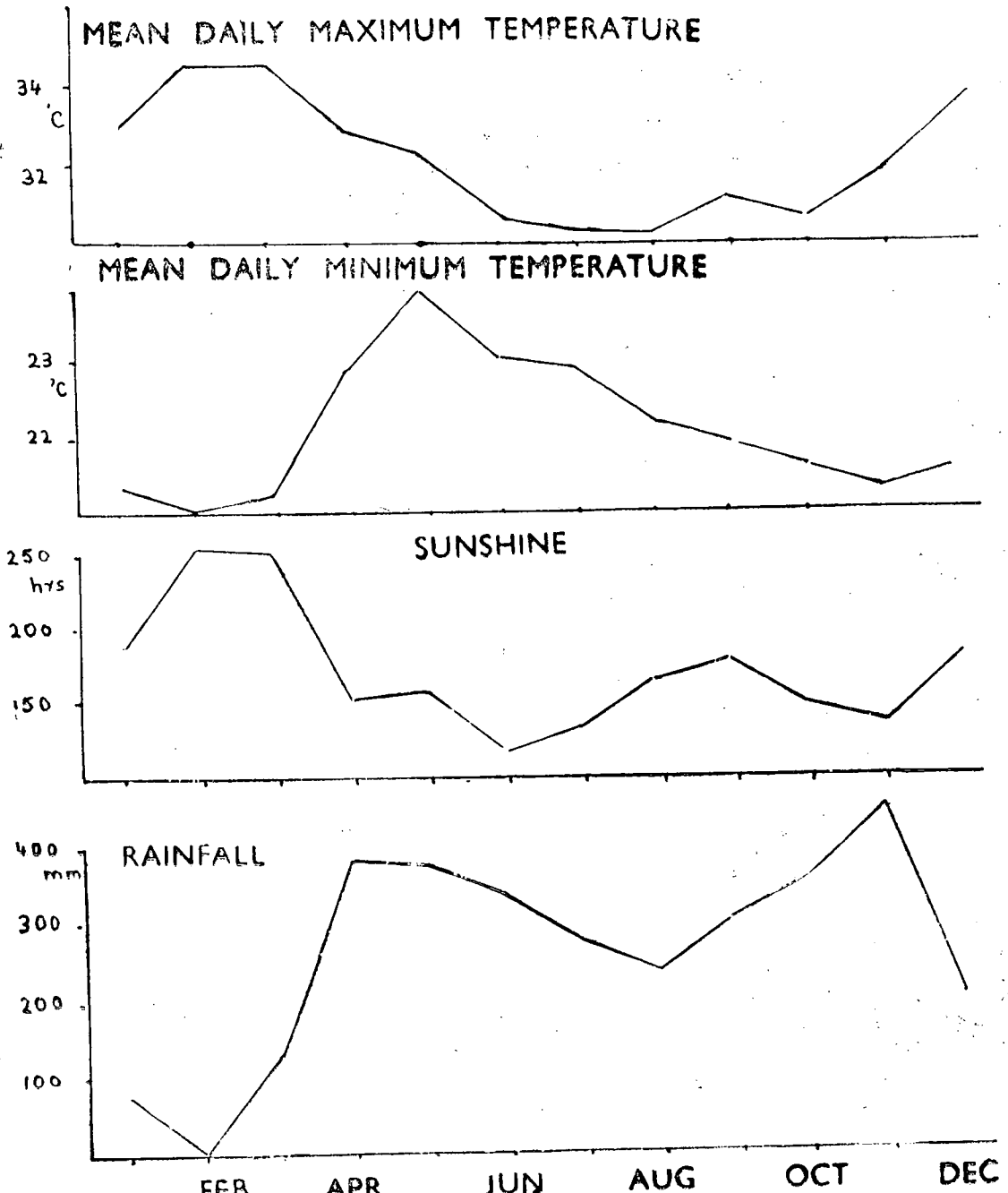


Fig. 1. Rainfall, duration of sunshine and temperature at D'field

REVIEW OF THE ADVISORY SERVICES DEPARTMENT AND AGRICULTURAL ECONOMICS SECTION FOR THE YEAR 1980

By

A. B. DISSANAYAKE

General

The Annual Review describes the work of the Department in : (*a*) Advisory services to smallholders (*b*) Advice to estates (*c*) Agro-economic studies.

Staff

The Head, Advisory Services Department and Agricultural Economics Section, the Deputy Head, and three Regional Advisory Officers were on duty throughout the year.

Mr. A. Widanapathirana, Regional Advisory Officer, Ratnapura joined the University of Sri Lanka for post-graduate studies. Mr. H. D. B. H. Gunasekera, Assistant Agricultural Economist, who was undergoing post-graduate studies at the Australian National University, Canberra, resigned during the third quarter. Mr. K. N. Atapattu, Assistant Agricultural Economist also resigned during the same period.

It is with deep sorrow that we record the deaths of Mr. G. Senarath and Mr. Victor Wijesinghe, Rubber Extension Officers, during the year. Mr. R. B. Heendeniya, R. E. O., Rambukkana retired from service on 28-03-1980 after serving the Department for 33 years.

As the Rubber Rehabilitation project for Ratnapura, Kalutara and Kegalle is to commence in January 1981 various changes in the Department were undertaken to suit the smooth working of this project. In the project area, two new DREO Divisions namely, Warakapola and Kiriella, and two new R.E.O. ranges were demarcated.

These changes are expected to help improve the rate of replanting and quality of rubber and also increase the extent of intercrops under replanted rubber.

During the year Messrs. H. R. Dias, D. D. Dassanayake, N. C. Katukurunda and W. E. W. de Mel were promoted as Divisional Rubber Extension Officers. Messrs. K. S. Peiris and Sirinimal Fernando were promoted as Senior Processing Advisors. Mr. P. P. S. Perera was promoted as the Assistant Training Officer.

Eleven Rubber Extension Officers were also selected and are under training to take over the vacant ranges. Also nine Processing Advisors were selected to serve in the project area.

All the field officers were called to Colombo in two batches and a refresher course was conducted. Senior Research Officers, Administrative Officers and Senior Officers of the Advisory Services Department gave lectures at this course. Courses were also conducted to train Processing Advisors and Senior Processing Advisors at the Rubber Chemistry Department.

A batch of eleven Rubber Extension Officers were trained at Dartonfield first and are now under training in the field.

A batch of fourteen Rubber Extension Assistants have been recruited and are being trained in the field by Rubber Extension Officers.

Publications

The following reports were submitted and papers were read during the year :—

To the Association of NR Producing Countries

Determination of the maximum production capacity of NR in Sri Lanka and the constraints in achieving a dynamic production policy for NR by A. B. Dissanayake.

Country report for Sri Lanka by A. B. Dissanayake.

An assessment of the training classes on rubber cultivation for smallholders by A. B. Dissanayake.

Socio-economic factors that affect the development of smallholders by A. S. Widanapathirana.

Some observations on Sri Lankan rubber smallholder practices with special reference to tapping by U. P. de S. Waidyanatha, A. S. Widanapathirana and R. P. M. de Zoysa.

The economics of central processing of smallholder rubber by N. K. Atapattu, A. B. Dissanayake and R. Tharmalingam.

Implications of the use of the metrolac in weighing smallholder latex by R. Tharmalingam and A. B. Dissanayake.

To the Central Bank

Centrifuged latex — supply position and price by the sub-committee consisting of R.R.I., J.E.D.B., S.P.C. and S.R.M.C.

Other Administrative Matters

Correspondence

Inward — 4121 (Applications for new planting, unregistered rubber lands and new planting permits).

Outward — 4006 (Preliminary reports, final and special reports).

From Rubber Extension Officers to Smallholders — 3931.

Advisory services to smallholders

New planting :

Visits : The following visits were carried out :

First visits	..	591
Subsequent visits	..	1,773
Preliminary reports	..	4,121
Final inspection and special reports	..	4,606

Lining

This year's permit areas		*No. of Permits*	*Acreage*
Soil conservation	..	455	591.3.30
Planting holes	..	476	645.3.21
Last year's permit areas			
Soil conservation	..	612	902.0.3
Planting holes	..	514	708.0.30

Replanting :

Visits		*No. of Permits*	*Acreage*
Permits issued	..	4265	54.21.21 (acres)
Visits to this year's permit areas	..	6795	
Visits to previous year's permit areas	..	11871	
Special reports	..	418	

Lining

This year's permit areas		*No. of permits*	*Acreage*
Soil conservation	..	2,131	2,714.2.6
Planting holes	..	2,320	2,931.2.1
Last year's permit areas			
Soil conservation	..	765	1,044.2.7
Planting holes	..	813	1,177.1.06
Marking of trees for tapping	..	147	4,877 trees

Special Inspections for Rubber Control Department

Visits for preliminary reports	..	4,121
Visits for final inspection reports and special inspection reports (new planting)	..	4,006
Visits for special inspection (replanting)	..	418
Visits for recommendation of subsidy payment by the D.R.E.OO. and R.E.OO.	..	6,195
Visits to planting material checks at Commodity Purchase Depots	..	74
Plants inspected	..	2,990

Meetings and Conferences

All staff Officers attended the Staff Meetings presided over by the Director.

The Head, Advisory Services Department and Agricultural Economics Section attended a number of meetings of the Steering Committee on the Smallholder Rubber Rehabilitation Project for Kalutara, Ratnapura and Kegalle Districts held at the Ministry of Plantation Industries.

The entire field staff including the Deputy Head, Advisory Services Department, three Regional Officers, Assistant Agricultural Economist, the D.R.E.OO. and R.E.OO. attended the 4th A.N.R.P.C. Seminar and Workshop on ' The Progress and Development of Rubber Smallholders' held at the Sri Lanka Foundation Institute, Colombo from 17 to 23 July.

Six papers were presented by Officers of the Department at this Seminar and Workshop.

The Deputy Director, National Fertilizer Secretariat, addressed six group meetings organised by our field staff at Agalawatta and Dodangoda Divisions to popularise the use of fertilizer in rubber.

During the period under review 37 smallholder group meetings and discussions were held at range level.

Improvement of Smallholder Sheet Rubber

The progress on the construction of Group Processing Centre is as follows :—

In production	..	100
Awaiting opening	..	3
Under construction		103

Loans to Group Processing Centres amounted to Rs. 17,000.00, recoveries amounted to Rs. 42,327.86 while another Rs. 1,532.00 were recovered from sales of coagulating pans.

Sales at subsidised prices

A total of 73½ squares of monel mesh were sold at subsidised rates.

Other Visits

A total of 3031 visits to Group Processing Centres and 573 visits to demonstration and ordinary smoke houses were made.

A competition among G.P.C. on their performance for 1978 was finalised and the prizes were distributed to the winners on the 15th March 1980 at the Ceylon Chamber of Commerce, Fort, Colombo. The Chief Guest was Mr. H. G. R. de Mel, the Chairman of the Rubber Research Board. Generous contributions were made by individuals and firms dealing in rubber towards finances necessary for hiring the hall, purchasing of trophies and printing of certificates.

Prizes were awarded for the following :—

1. G.P.C. with highest production for the year 1978.
2. G.P.C. with highest average production per day for the year 1978.
3. G.P.C. with the highest percentage of grade 1 RSS for the year 1978.
4. G.P.C. with lowest cost of production for the year 1978.
5. G.P.C. with the highest payment per lb. to members for the year 1978.
6. G.P.C. with the highest repayments of loans for the year 1977 and 1978.
7. G.P.C. with the highest membership.
8. The best G.P.C. in 1978 judged on the basis of total production quality of manufactured sheet rubber, cost of product and level of management.

As the lack of a legal status was a hindrance to the development of the scheme of Group Processing Centres the search for a legal framework for the G.P.C. was continued. The Attorney General's Department was consulted but they were unable to help. Therefore the co-operative by laws were taken up and amended to suit a "Production Cooperative" like a Group Processing Centre. After a series of discussions a new set of By Laws were approved by the Cooperative Department. These by laws are being circulated to every G.P.C. to enable them to discuss the By Laws, approve them and apply for registration as Cooperatives. A samples Feasibility Study was also provided to help G.P.C. in their applications.

Rubber Training Classes

A total of 14 training classes were organised for 612 trainees. However, only 288 trainees appeared for the test and 191 of them were successful. Certificates to those who were successful will be presented during the first quarter 1981.

Exhibitions

During the year the Department took part in exhibitions in the follcwing areas :

1. Loaned exhibits to the Commodity Purchases Depot for Mahapola Exhibition
2. Loaned exhibits to Royal College.
3. Exhibition stall at Madhyama Maha Vidyalaya (MMV) Matugama March 22nd — 23rd.
4. Exhibition stall at M.M.V. Kalutara April 4th — 6th.
5. Exhibition stall at Aranayake M.M.V. April 4th — 10th.
6. Exhibition stall at Gamudawa 80 June 23rd to July 2nd.

Intercropping Observation Plots

The smaliholdings for each Division selected for intercropping observation plots were planted and managed during the period.

Demonstrations

Sheet making	..	345
Tapping	..	457
Disease Control	..	365
Miscellaneous	..	585

Advice to Estates

37 visits were made to small and medium size estates during the quarter. These visits included advice on soil conservation, tapping, disease control, smoke house construction and defects in smoked sheets. In addition 14 visits were made for weighing of latex, smoke house construction and defects in smoked sheets. Smoke house plans were provided to a number of estates.

Agro-Economic Studies

Survey on the Economics of Production of rubber

The analysis of the data collected from 1400 holdings is being delayed due to lack of staff.

Long Term Record Keeping Survey

This survey was started in five villages, three in Kalutara District and two in the Ratnapura District. Five temporary supervisors have been appointed to initially supervise the entering of data twice a week. Supervision is being done now once a week only. The records are being maintained regularly.

The performance of the GPC scheme based on the monthly reports of the GPC were studied and the report on their performance for the whole year 1979 was submitted to the Director, RRI, Ministry of Plantation Industries and Ministry of Plan Implementation.

REVIEW OF THE ESTATE DEPARTMENT — 1980

By

R. G. Siriwardena

The Institute's Group of Estates known as Dartonfield Group comprises Dartonfield Division, Galawatta Division, Agalawatta, and Nivitigalakele Division, Matugama. The estate now has an extent of 335·00 ha (827 acres). The planted area is 284·11 ha of which 207·25 ha is in tapping.

The weather pattern during the year was favourable for harvesting of crop in comparison to 1979. The crop harvested was 200,436 representing an average of 1,014 kilos per ha. The crop to date fell short of the season's estimate by 3,064 kg but showed an increase of 19,327 kilos when compared with the same date last year (1979).

Budwood of clones RRIC 100 series and PB 86 continued to be much in demand and issues were made accordingly.

All agricultural operations were carried out in both mature and immature areas of the estate.

DETAILED REVIEW

Staff

Mr. B. H. Rodrigo, Chief Clerk, resigned from the Institute on 15th July 1980. Mr. L. H. Samaranayake, Field Officer, Nivitigalakele Division, left the services to join the State Plantation Corporation on 15th May 1980, and Mr. S. Nadarajah, School Master, retired from service in May 1980.

The Dartonfield cadre is as follows :—

Senior Staff	..	1
Assistant staff	..	12
Minor staff	..	5
		18

Hectarage summary

	DF	*GW*	*NK*	*TOTAL*
Mature Area	28·31	53·19	125·75	207·25
Immature Area	18·44	2·02	56·40	76·86
Nurseries	2·22	·50	4·13	6·85
Total	48·97	55·71	186·28	290·96

Hectarage summary	*DF*	*GW*	*NK*	*TOTAL*
Abandoned	3·95		5·88	9·83
Paddy fields		·25		·25
Food production		·50		·50
Bldgs/Roads	2·67	6·50	·32	9·49
Swamps/Roads			1·21	1·21
Jungle			·71	·71
Bldgs/sites	16·23		6·09	22·32
Streams/reservations	·03			·03
Grand Total	71·85	62·96	200·49	335·30

Agricultural adviser : The Agricultural adviser, Mr. R. C. Peries, of Elston Estate, Puwakpitiya, visited the property twice during 1980.

Crop : This year's harvest was estimated at 203,500 kg from 207·25 ha : The intake per tapper averages were DF : 5·3 kg, NK : 5·7 kg, GW : 5·7 kgs.

	1980	1979
Estimated ..	203,500	210,000
Harvested ..	200,436	181,059
Deficit ..	3,064	28,941

Tapping : Tapping continued throughout the year, including during the wintering period. Recovery tapping was done at Dartonfield Division for 45 days ; NK : Division 35 days ; and GW: Division 40 days. Tapping cuts were marked with appropriate guide lines for bark consumption.

(Estate Gauge) Comparative figures (mm) for 1980 & 1979 as follows :

	DF		*NK*		*NK*	
	1980	1979	1980	1979	1980	1979
January ..	79·9	87·4	26·2	90·4	80·5	96·0
February ..	—	205·5	61·6	431·5	21·6	204·9
March ..	134·1	133·3	146·5	280·9	100·6	106·7
April ..	393·0	348·2	326·7	499·2	390·6	334·8
May ..	383·8	434·3	269·8	585·2	408·6	389·6
June ..	345·0	530·2	330·5	697·4	340·8	639·6
July ..	287·9	342·3	286·2	478·5	324·3	333·0
August ..	243·7	99·9	189·2	99·5	233·0	31·5
September ..	314·3	983·2	301·8	366·2	122·7	364·4
October ..	365·4	338·1	577·2	537·0	163·9	134·7
November ..	434·1	456·6	440·2	916·4	187·6	185·2
December ..	203·4	446·6	148·0	166·3	74·0	191·4
Total ..	2,034·0	4,407·4	3,111·4	5,150·5	2,448·2	3,011·0
Total wet days	214		122		68	

Weather

	Rainfall in mm (Estate Gauge)		*Total wet days*
	1979	1980	1980
Dartonfield ..	4,407	2,034	214
Gallewatta ..	5,150	3,111	122
N'kele ..	3,011	2,448	68

Manufacture : A summary of the manufacture records during the year 1980 is as follows:

		Total kilos	*Percentages*
Latex No.	1 ..	152,236	93%
	2 ..	2,250	2%
	3 ..	9,400	5%
		163,886	100%
RSS	1 ..	3,500	96%
Scrap crepe	1 ..	7,706	43%
	2 ..	5,450	37%
	3 ..	3,500	20%
		16,656	100%

40 M. tons of thin crepe was contracted and supplied during the year.

Maintenance

Weeding : Normal weeding rounds were carried out satisfactorily.

Pests and Diseases : There was no significant attacks of *Oidium* in any of the divisions. There were no indications of any panel diseases even during the wet weather period even though no fungicide applications were made.

Manuring : Manure applications were done in accordance with the programme.

Nurseries : Routine weeding, manuring and other agricultural operations were carried out.

Field and technical Experiments : Necessary assistance by way of labour and various other requirements were rendered to the Research Departments to carry out their field and technological experiments. In addition, labour requirements to the Works Department and Engineering Departments were provided.

Roads : All roads were maintained in a satisfactory manner.

Estimates : The 1981 Draft Estimates were submitted to the Board for discussion and approval.

Labour rooms : Repairs were attended to where necessary.

Medical : With the aid granted by the 'unicef' authorities, building of two creches at Gallewatta and Dartonfield commenced this year and the work is in progress. Two new creche attendants will be recruited in 1981. Monthly poly clinics were conducted by the Assistant Medical Practitioner, with the assistance of the Medical Officer, at the Medical Centre, Dartonfield Group. Immunization against polio, vaccination of BCG and triple were carried out in the Medical Centre.

Births and deaths : 21 births and 3 deaths were reported during the year.

The care Sri Lanka Branch continued to provide infants with 'thriposha' free of charge under the Medically Selective Programme for mothers.

Manufacture

Latex continued to be supplied to the State Rubber Manufacturing Corporation Factory, Kuruwita, and the scrap rubber was despatched to Dartonfield Factory for manufacture. This was discontinued from January 1980 and the rubber sold to Station Block Rubber Factory, Getahetta.

Water supply

A new water storage tank was constructed for Assistant Staff Bungalows and the Plant Breeding Department building. In addition old corroded G.I. Piping of the main pipe line were replaced with S lon piping where necessary.

Cultivation

The manure applications were carried out according to the season's estimate.

General

The property has made a profit of over two and half lakhs during the season 1980.

A sum of Rs. 25,410/- was paid in 1980 to the Estate staff and workers as " Profit Bonus " for the year 1979 after approval by the Rubber Research Board.

REVIEW OF THE LIBRARY AND PUBLICATIONS SECTION 1980

By

Vijitha Jayaratne

Miss L. I. T. Ramanaden, Library Assistant and Assistant Publication Officer, attached to the Colombo Office Library, Mrs. V. S. Jayaratne, Library Assistant and Assistant Publication Officer, Mr. D. C. Thambawita, Library Clerk and Mrs. D. T. Danthanarayana, Clerk/Typist at Head Office Library were on duty throughout the year 1980.

Acquisitions

Seventy two books were added to the existing library collection, bringing the total number of books by the end of 1980, both in Headquarters and Colombo Office Library to 3665. Thirty five more books were included in the 1980 book order list but were not received during the year 1980.

To enrich the library reference collection, the new set of Encyclopaedia Britanica was purchased at the end of 1980 and the set which was already in the Head Office Library was transferred to the Colombo Library to fulfil the much wanted demand by the Colombo Staff.

About 225 titles of current periodicals are being received at both the Headquarters and Colombo Office Library of the Institute including 13 abstracting and indexing periodicals.

	Local	*Overseas*
On subscription ..	—	94
On exchange/gratis ..	35	96

Periodicals continued to be the most important medium for disseminating the results of research done throughout the world, and therefore a large sum of money was spent mainly to acquire periodicals. 301 Journals from both Head Office and Colombo Office Library were leather bound and added to the collection of bound volumes.

Inter library loans

We have continued to cooperate with other libraries on the inter library loan scheme and loaned 7 Journals and 6 books, and obtained 7 Journals and 5 books from various research libraries, on requests made by our Research Staff during the year 1980 and have been able to help other libraries as well as our research staff in obtaining the latest research papers. With the instalment of a photo copying machine we have been able to fulfil this scheme regularly without much delay and cost.

Information Service

The RRISL Library continues its service to the Research Staff by attending to publications, communication and dissemination of information etc., on behalf of the Institute. Through indexing of periodical articles that are relevant to our Research Officers we have been able to continuously keep them informed of the latest advances in various current research, done throughout the world.

We have also been able to extend the benefits of research and development done by the RRISL Research Staff, to all research officers throughout the world by our regular publications. Considerable thought has been given over the past year to improve the dissemination of RRISL research work. Steps are being taken to revise and change the format of the advisory publications in a more attractive way both in terms, of its looks and contents. 'Rubber Puwath' the only publication in Sinhala published mainly for the use of rubber smallholders was published again after a lapse of 4 years in a more attractive way, both in format and contents. As the cost of printing has arisen tremendously it was decided to change the subscription rates to :

Local	..	Rs.	90/-
and Foreign	..	Rs. 800	(£ 20)

Liaison with other libraries

The RRISL library continued to participate with the other Research libraries in the Union Catalogue of Scientific and Technical Publications (UNICAST) project managed by the National Science Council of Sri Lanka, by sending catalogue cards regularly as our contribution.

The Sri Lanka Scientific and Technical Information Centre (SLSTIC) of the National Science Council initiated a Network of Agricultural libraries and accordingly an Agriculture sub-system was established. As a member of this Agriculture Sub-system, the RRISL library too participated in the meetings conducted by the National Science Council. The main objective of the Network is to improve, exchange, acquire and transfer information and documents relating to Agricultural Sciences through resource sharing and co-operative activities among the Agricultural libraries. As an initial step in drawing up a co-operative acquisition scheme, the participating libraries decided to collect information about the holdings of Agriculture Journals in the participating libraries. Therefore a survey to collect this information from the libraries in the sub-system was conducted bv the SLSTIC and as a participating library of the sub-system the RRISL library too sent a list of Agriculture Periodicals acquired by the library.

The General Research Committee of the Sri Lanka Association for the Advancement of Science (SLAAS) held a meeting of librarians of Science libraries to discuss the possibilities of setting up of a Central National Reference Library in Science and Technology to obtain copies of all Journals in microfilms. The Rubber Research Institute too participated in this meeting.

Other activities

All arrangements are being made to establish a new charging system from1981, to enable us to get the books issued to officers back to the library at a specific time.

Mr. V. Micuda, a short term consultant in library Science, from Pennsylvania State University, visited our library and was very pleased with the systamatic organization of the library.

REVIEW OF THE KURUWITA SUB SECTION

BY

R. C. PERIES

Staff

Mr. R. C. Peries overlooked the Estate as Visiting Superintendent. Mr. S. G. Fernando continued as Assistant Superintendent and Mr. G. D. A. Weerasooriya continues as KP on the porperty.

Acreage statement

1961 Replanting	—	33·59	Hectares
1962 ,,	—	15·68	,,
1963 ,,	—	9 10	,,
1964 ,,	—	7·28	,,
1965 ,,	—	7·89	,,
1966 ,,	—	4·05	,,
1967 ,,	—	4·05	,,
1968 ,,	—	4·05	,,
1969 ,,	—	4·05	,,
Extent in tapping	—	89·74	,,
Nurseries	—	·86	,,
Paddy	—	2·23	,,
Roads, buildings etc.	—	7·01	,,
Total Extent	—	99·84	,,

Weather

Year	*Rainfall — Millimetres*	*Wet Days*
1979	4397·75	208
1980	3990·73	204

The year under review commenced with the seasonal drought and there after rain commenced in April. From April to December a prolonged period of wet weather continued, interfering with tapping.

Crop

Estimated crop for 1980	—	90,000	kilos
Crop harvested in 1980	—	76,228	,,
Shortfall	—	13,772	,,

Due to unfavourable weather conditions experienced and more particularly during the cropping months, the crop secured fell short of the estimate by 13,772 kilos.

The yields on this property can be compared with other commercial estates even though many experimental clones are planted.

General

All workers at Dartonfield Group were paid Holiday Pay and Incentive Bonus for the production year 1979.

Batches of Trainee Assistant Superintendents sent by the Ministry were trained in every aspect of Planting at the RRISL.

The estate commenced manufacture of RSS during the latter part of the year.