THE RUBBER RESEARCH INSTITUTE OF SRI LANKA

1987 Annual Review

RUBBER RESEARCH INSTITUTE OF SRI LANKA

ANNUAL REVIEW 1987

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ANNUAL REVIEW 1987

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Vacant

Lawyers

M/s F. J. and G. de Saram
Attorney-at-law
P. O. Box 212,
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M/s De Silva and Gurusinghe
Attorney-at-Law
157, Mihindu Mawatha,
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Mr Manilal Fernando
Attorney-at-Law
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Kalutara.

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Chartered Accountants
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Colombo 3.

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Bank of Ceylon, Matugama.
Bank of Ceylon, Agalawatta.

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THE RUBBER RESEARCH INSTITUTE OF SRI LANKA

STAFF

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Director	—	A. de S. Liyanage, BScAgric (Cey.) PhD (Lond.)
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Botanist	—	R. C. W. M. R. A. Nugawela, BSc (Cey.) MSc (Lond.)
Assistant Botanists	—	Miss G. P. W. P. Pushpika, BSc (Cey.) Miss M. S. Ranasinghe, BSc (Cey.)
Research Assistant(Intercropping)	—	V. H. L. Rodrigo, BScAgric (Cey.)
Experimental Officers	—	L. S. S. Pathiratne, M.I.Biol., M.Phil (Cey.) R. B. Gunaratne
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Experimental Officer	—	K. B. A. Karunasekera
Senior Experimental Assistant	—	B. M. S. G. Peiris
Senior Technical Officers	—	K. W. Rupatunga I. D. M. J. Sarath Kumara
Experimental Assistant	—	A. K. M. S. Senaratne

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Soils & Plant Nutrition

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Head of Polymer Chemistry Section	—	A. Coomarasamy, BSc (Cey.) PhD (Aston)
Head of Rubber Technology & Development Section	—	W. S. E. Fernando, BSc (Cey.) MSc (Aston), PhD (Aston)
Head of Specifications & Analysis Section	—	**L. M. K. Tillekeratne, BSc (Cey.) MSc (Aston) PhD (Aston)

Head of Raw Rubber Development Section	—	M. C. S. Perera, BSc (Cey.), MSc (Cey.), PhD (Aust. Nat. Univ.)
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Specification Assistant	—	G. Wanigatunga P. D. J. Rodrigo K. K. Austin B. Gunasiri W. W. Nandasena K. R. N. Karunatilleke ***M. A. Mendis
Clerk/Stores Assistant	—	Mrs L. Rukmanie
Clerk/Typist	—	Mrs S. A. Paranawithana Mrs I. Wijesinghe

Biometry Section

Biometrician	—	W. N. Wickremasinghe, BSc (Cey.) Dip. Stat. (Cey.) MSc (Iowa State)
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*	On study leave overseas
**	On sabatical leave overseas
***	On no pay leave overseas
+	On study leave locally

THE RUBBER RESEARCH INSTITUTE OF SRI LANKA

DIRECTOR'S REVIEW

By

A. de S. LIYANAGE

The total world natural rubber (NR) production in 1987 was about 4.655 million tonnes, of which approximately 4.535 million tonnes were consumed. The Sri Lankan export share was 106,045 MT and is the lowest on record. New technological developments in the tyre sector such as radialisation which has resulted in extending the tyre life, concept of multiple retreadability and regrooving with each retread having a life equivalent to that of a new tyre, development of precure retreading methods using styrene butadiene rubber (SBR) or SBR/polybutadiene rubber (BR) blends, development of cost saving automated rubber compounding and tyre building systems which eliminates multi-stage processing of tyre components with a 50% reduction of floor area and the development of unorthodox continental 'CTS' tyres mounted on special wheels have all contributed to the reduced demand for NR. The replacement market for new tyres will be reduced by 50% and NR consumption by 25%. Despite these developments, the consumption of NR is expected to grow at the rate of 2.6% compared to 2.5% for synthetic rubber (SR), principally because of its technical excellence and price competitiveness. Because of NR's proven quality compared to SR especially in relation to high green strength, ageing and wear resistance, tack quality, hot tear strength, resistance to heat build up and superior dynamic properties, it had been used widely in all applications which require tight specifications and stringent performance requirements.

West European and East European countries are the major consumers of RSS 1. West European and Asian countries, mainly China are important consumers of RSS 2 but 80% of the world consumption of RSS 3 is in the Asian region, with China again being the main consumer. However, there is little consumption of RSS in North America and negligible amounts are consumed in Latin America and Africa. Countries in Western Europe, Asia and to a lesser extent Eastern Europe and N America are the major consumers of latex crepe. There is a marked increase in the consumption pattern of TSR grades. In N America TSR 20 is the preferred grade but TSR 5 is also consumed in large quantities. There is a high demand for TSR 10 in W Europe but less so for TSR 20. In Asia the consumption of TSR grades has increased with TSR 5 being preferred over TSR 20. A similar pattern exists in E Europe but the

amount consumed is comparatively small. In Latin America too TSR grades are in demand. The demand for latex crepe from USSR and other East European countries has diminished over the past few years and this is reflected by the lower prices fetched by latex crepe during this year. The tendency of USSR and East European countries to change over from NR to polyisoprene and reduce imports from traditional NR suppliers in preference to new sources such as Vietnam and Kampuchea, where they have made heavy investments to establish rubber plantations, could have influenced the price structure of crepe rubber. The demand for centrifuged latex is rising especially in Asia and West Europe and to a lesser extent in North America, mainly due to the demand for manufacture of condoms and examination gloves created by the AIDS scare. Overall the consumption of rubber in the newly industrialized Asian countries and ASEAN countries is expected to rise but North American, Western European and EEC countries are expected to grow relatively slowly.

RSS grades which constitute 46% of rubber exported from Sri Lanka still occupy a pre-eminent position in the world market, in the manufacture of tyres. RSS grades exported from Sri Lanka are often contaminated with mould, improperly dried and have a high volatile matter content. Export of poor quality RSS grades has resulted in the payment of large sums of money in settlement of quality claims. The present method of packing RSS grades as bare backed bales should be improved. The problems can be eliminated if the bales are pressed to a standard size wrapped in polythene and then packed in crates with a pallet base as done for TSR. If bales are pressed, 20 tonnes can be accommodated in a 20 ft container compared to 17 tonnes of bare backed bales. This method of presentation will facilitate rapid unloading, reduce freight costs and eliminate the chances of mould contamination thereby minimising the payments for quality claims. The high Mooney viscosity of RSS grades exported from Sri Lanka is due to the use of latex from the clone PB 86. The main disadvantage of this type of rubber is that it is hard and requires more energy for mastication during milling but higher viscosity rubbers give higher green strength compounds and provide better extrudate, which are essential features in building steel belted radial tyres. Further the superior fatigue resistance and ability to withstand high temperature curing make RSS the preferred grade over TSR 20, by some manufacturers. It is therefore advantageous to highlight this beneficial trait of RSS and identify the markets for such rubbers, rather than attempt to produce constant viscosity grades of RSS by adding hydroxylamine salts as viscosity stabilising agents to latex before coagulation. This method gives rubbers with a Mooney viscosity of about 70 which is not in demand. Manufacture of CV rubbers with a lower viscosity of 50 or 60 requires addition of peptisers followed by heating and pressing into bales. A cost benefit analysis should be done before converting RSS grades into CV grades, as its cost of production is higher. Quality and consistency of NR are two essential ingredients of the modern rubber industry. The future of RSS can be assured only if dirt free rubbers with low volatile matter and

high PRI are marketed. This can be achieved by encouraging the smallholders to process RSS in Group Processing Centres rather than in scattered smaller units.

In the general products sector NR share has dropped from 45%, 25 years ago to 15% at present, but this sector is expected to grow at twice the rate of the tyre sector. Out of a total of about 5 million tonnes of rubber used in the non-tyre sector, only 1 million tonnes of NR is used. Of this 700,000 tonnes are used for latex applications and only 300,000 tonnes are used in all other non-tyre applications. There is wide scope for expansion of activities in this area. Latex crepe which accounts for about 30% of the exports of NR from Sri Lanka, is used mainly in the pharmaceutical, food and adhesive industries. At present, crepe is marketed as a visually graded raw rubber without technical specifications and a grading system to differentiate between different types of crepe. This approach has to be changed to overcome the stiff competition offered by TSR-L grades to crepe rubbers. Various operations carried out during the process of latex crepe manufacture can affect the quality of the final product. Removal of a fraction, addition of bleaching agents and acids for coagulation, number of passes and gear ratios during milling and temperature at drying can affect the properties of rubber. Therefore, standardization of procedures in the manufacture can help to reduce the variations in properties. Time is opportune to market crepe as special grades or tailor-made grades to meet the specific requirements of the consumers. This could be achieved only if there is a constant dialogue between the producers and consumers.

Sole crepe accounted for only 4.2% of the exports in 1987, and is mainly used as soles in the shoe industry. It's demand has fallen from 85%, 10 years ago to about 2% due to the availability of synthetic material such as PVC, polyurethane, and EVA, which can be injection moulded rapidly. Apart from these, several defects in the manufacture and packaging of sole crepe have contributed to the low demand. There are variations in the shapes and sizes of the grooves due to defects in the laminators. The Albizzia wood used for packaging is soft and fragile and crates made out of this material are damaged during transit causing contamination of rubber with wooden splinters. Further, packaging material contains over 30% moisture thereby providing ideal conditions to cause mould contamination during transit. Apart from these, disposal of wood and steel bands are causing a problem in western countries. Therefore, these defects should be rectified by installation of proper machinery to provide a uniform product and packing it in corrugated cardboard boxes with nylon straps. This has found wide acceptance in consuming countries. Sole crepe manufacture is labour intensive and can provide employment for many rural people. Further, the premium of sole crepe over latex crepe is around Rs 8/= per kg which gives a considerable benefit in foreign exchange earnings. Therefore, there is an urgent need to revive the stagnent sole crepe industry by providing a quality controlled product.

TSR exports amounted to only 9.3% of the production. There is an increasing demand for TSR grades for the tyre industry. The installed annual capacity in Sri Lanka of TSR is around 30,000 tonnes, at a total investment of about Rs 130 million in plant and machinery. Scarcity of raw materials and their high cost have been attributed as the main reasons for under utilization of full capacity. Attempts must be made to increase the production of TSR grades by utilizing the scrap crepe and low grades of RSS to produce TSR 10 and TSR 20. Consideration must be given to involve the two State Corporations in a joint venture with the State Rubber Manufacturing Company on a profit sharing basis. Reduced freight costs and fewer quality claims for TSR make it an attractive form to market rubber consistant in quality in order to meet the requirements necessitated by automation and computerisation.

The demand for centrifuged latex is increasing and is estimated to be around 329,000 tonnes (dry) in 1988 mainly due to the heavy demand for surgical and examination gloves and condoms. Further, there is a revived interest for latex foam for cushions and foam backed carpets, as restrictions have been imposed on the use of polyurethane foam in public transport, due to the toxic smoke generated from it on combustion. The installed capacity in the country is about 6000 tonnes (dry) and about 5000 tonnes are produced annually to meet the local demand and for the export market. Concentrated latex to the value of Rs 150 million has been exported from Sri Lanka in 1987. Immediate attention should be given to increase the existing capacity by another 5000 tonnes (dry) to take advantage of the prevailing high demand for this product for the manufacture of dipped products for both local and export markets. Export of latex based products provide added value. Further, less energy is consumed in manufacturing rubber products from latex and gives more employment opportunities.

Sri Lanka is a small producer contributing only less than 1% of the world's NR requirements, she is in a better position to supply special grades of rubber with superior properties. The availability of many small factories scattered throughout the rubber growing areas is an advantage. Low protein natural rubber (LPNR) with low nitrogen, low ash content and low affinity for water is ideal for under water and off-shore engineering applications. This rubber can be manufactured in the crepe form using existing machinery in crepe factories. The quantity marketed at present is very low and this product should be popularised by a vigorous marketing campaign. Tellurium rubber which is heat resistant is ideal for special applications such as under the bonnet rubber components, washing machine seals and heat resistant mouldings. This material has also been found to be satisfactory for tubings and gaskets. Special grades of rubber should be marketed to meet the needs of specific consumer requirements.

Local rubber industrialists utilize only 15-20% of the rubber produced in Sri Lanka. There are about 60 rubber based industries of which 6 have collectively utilized over 70% of the rubber consumed in Sri Lanka in 1986.

Rubber products manufacturing industries use lower grades of rubber. Non-availability of an adequate supply of these grades has resulted in an increase in prices of the raw material. This has forced them to utilize high value latex grades to meet the short fall. Since there is wide scope for the expansion of the rubber product sector, ways and means of overcoming the scarcity of raw materials should be carefully examined.

Amendment of the Rubber Research Ordinance: The Act has been amended as the Rubber Research (Amendment) Act No. 39 of 1987. The Section 3 of the Chapter 439 with regard to the constitution and proceedings of the Board was amended. The Chairmen, Vice-Chairmen and Members who served the Rubber Research Board during the period 1930-1987 are thanked for the dedicated services rendered by them.

Training: The staff of this Institute was involved in conducting the following training programmes :-

1. Refresher courses for the Rubber Extension Officers of the Advisory Services Department.
2. Refresher courses for Superintendents and Assistant Superintendents of SLSPC Board III.
3. Induction course for Planter Trainees of the SLSPC conducted by NIPM.
4. Special training course for Senior Assistant Superintendents of the SLSPC conducted by NIPM.
5. Diploma in Plantation Management.
6. Training of Assistant Managers of the Agricultural Development Authority.
7. Training of Apprentices for the National Apprenticeship Board.
8. Training of Factory Officers on rubber manufacture.
9. Training courses on tapping and budgrafting for smallholders.
10. Field days were conducted at Dartonfield Estate for Superintendents and Assistant Superintendents of the JEDB I, IV and SLSPC III. Attended a field day organised by SLSPC IV at Bentota S.P.
11. Training a FAO Fellow from Vietnam.

IRRDB: this is a voluntary association of the Rubber Research Institutes of rubber producing countries. Mexico was admitted as the tenth member of the IRRDB. The IRRDB Pathology Group held its inaugural meeting in Thailand under the Chairmanship of Dr A. de S. Liyanage, Director RRI, who was appointed as its first Liaison Officer. Eleven papers were presented at the two-day symposium.

This was followed by a business meeting to discuss the future programme of the Group. It was decided to compile a list of Plant Pathologists working in rubber indicating their area of expertise, develop a classification system to indicate the severity of diseases present in rubber growing countries, prepare a map indicating distribution of diseases in rubber growing countries, an early warning system to report on new or severe outbreaks of *Hevea* diseases and to prepare a bibliography. IRRDB also made a decision to form a Group to cover 'Technology and end uses' bringing the specialized groups of the IRRDB to four. Dr W.S.E. Fernando, Head of the Rubber Technology and Development Section was nominated to be the Sri Lankan representative of this Group. It will concentrate on (i) stimulating the consumption of natural rubber in engineering application in producing countries (ii) encourage the use of NR in tyres especially in developing countries and (iii) to develop new testing methods for technically specified rubber with special reference to processibility testing.

Research Highlights

Floral Biology

The low fruit set after controlled hand pollination reduces the chances of obtaining a genetically variable seedling population. The causes for the reduction in the fruit set were systematically investigated. A laboratory technique using fluorescent microscopy was perfected to study the pollen germination, growth of the pollen tube, and penetration of the ovule. Laboratory investigations confirmed the field observations made earlier that the pollination done in the afternoon at the time of anthesis gave a higher fruit set compared to the pollinations done during the morning. There were differences in fruit set between clones depending on whether they were used as female or male parents. The clone GT 1 produced a high percentage of abnormal stigma. The differences in the success rate between pollinators indicate that they require a proper training in handling female flowers and pollination techniques. Pollen grains were stored for 5 days at 5°C and 75% relative humidity, with only 22% loss of viability.

Evaluation of selections and clones

At Yatadola S.P., 12 selections from the 1974 hand pollination programme gave yields more than the control clone, RRIC 100 which had a mean yield of 29.2 grams/tree/tapping (g/t/t), with 74-213 giving the highest yield. At Moralioya Estate three new clones 74-90, 74-151 and 74-213 exceeded the yield of the control clone RRIC 121, which gave a mean yield of 45.9 g/t/t.

In small scale trials at Kuruwita, RRIC 121 in addition to being vigorous gave nearly twice the yield of RRIM 623.

In the International clone exchange trial RRIC 110 was the most vigorous as well as the highest yielder followed by BPM 24 which was not vigorous as the other clones.

When the yields were averaged over all sites in the Genotype x Environment trial, the clones RRIC 100 and 102 showed a slight decline, an increase in IAN 45/710, while it remained unchanged in RRIM 600. The less vigorous clones *e.g.* PB 86, IAN 45/710 and RRIM 600 have reached the same girth as vigorous clones *e.g.* RRIC 100 and 102, which showed high mean girth prior to opening the tapping cut.

Germplasm

A total of 5323 accessions collected under the auspieces of the International Rubber Research and Development Board (IRRDB) was received from the gene pool garden maintained at the Rubber Research Institute of Malaysia. An extent of 35 acres of land at Dickhena Division of the Neuchatel S.P. was released on a long term lease to establish the germplasm centre.

Tissue Culture

A significant achievement was the successful development of an *in vitro* propagation method to produce a large number of shoot tips of seedlings of *Hevea,* in both liquid and solid media. Under these conditions axillary shoot proliferation was obtained with successive subcultures together with the development of tap roots. However, clonal shoot tips could not be induced to proliferate satisfactorily in culture. Good callus formation was obtained in cultures established with nucelii of clones RRIC 100 and PB 86, but embryogenesis was not yet observed.

Early selection

Photosynthetic characteristics of different clones were studied to identify the parameters which could be used for early selection of genotypes. They were leaf size (la), mean leaf area in a single whorl (I), Co_2 assimilation rate (A), photo-respiration rate (Rp) and water use efficiency (WUE). None of these factors singly correlated with the yield. The mean photosynthetic capacity per leaf whorl of an year old budding, calculated with (A — Rp.La) and without (A. La), considering photorespiratory loss of carbon, correlated significantly with the yield. The ratio A — Rp. La/WUE shows a very close correlation with the yield.

Planting techniques

Growth of green budded stumps planted 13 months ahead of stumped buddings was superior. When polybagged plants (6 months old) and budded stumps were planted at the same time, the former showed a growth advantage throughout, over the latter.

Plant density

The density of plants of PB 86 can be increased from 420 trees/ha to 533/ha without affecting the yield. There was a significant reduction in the mean yield of this clone at densities over 533/ha.

Response to nutrients

Application of nitrogen significantly increased the girthing of all clones but the yield increase was not significant. A significant interaction between clones and potassium indicated that potassium requirements for growth vary with the clone. Application of higher doses of potassium significantly increased the yield. Antagonistic effects between the application of potassium and magnesium on calcium and manganese uptake were observed. Application of magnesium to rubber significantly increased the girthing. Application of double the currently recommended dosage of magnesium resulted in a significant reduction in the yield. Addition of organic matter (coir dust and straw) has a positive effect on the growth of trees.

A significant increase in yield has been obtained in smallholdings which have not been regularly fertilized. Yield increases upto 26% and 46% were obtained by the application of standard fertilizer mixtures and on the basis of soil and foliar analysis, respectively.

Soil and foliar survey

A total extent of 9599 ha of mature rubber was covered under the foliar survey programme and fertilizer recommendations up to 1990 have been issued, for the estates surveyed this year. The anticipated saving on fertilizer is estimated at Rs. 11.37 million.

Corynespora leaf fall disease

An island-wide survey done to assess the incidence of *Corynespora* leaf fall (CLF) disease of the clone RRIC 103 in the private and State sector estates, indicated that 1623 ha and 2409 ha respectively, had succumbed to the disease. Clonal screening under field conditions showed that RRIC 52, 103, 104, 106, 107, 118, NAB 12, IAN 873, Tjir 1 and RRIM 725 were susceptible. Clones PB 86, RRIC 100, 110 and 121 and RRIM 600 also showed slight spotting of leaves without causing any defoliation. CLF disease was detected in the drier areas of Bibile and Moneragala.

C. cassiicola, produced only a few spores in culture. To improve spore production several media were tested and the promising ones were variously treated. A culture grown on potato sucrose agar (PSA) produced large number of spores after scraping the mycelium, washing and slow dessication for 2 weeks.

A detached leaf technique was developed to assess the clonal susceptibility under laboratory conditions, using a standard spore suspension. A novel method was developed to screen clones using the culture filtrate of *C. cassiicola*, which presumably contains a toxin.

Four fungicides were available for effective control of CLF disease, but their repeated application was necessary to combat the disease. An economic analysis indicated that it was far cheaper to replace the infected trees than to spray fungicides continuously. However, base budding with a tolerant clone gave high percentage of success, provided that it was done before leaves were infected.

Collar rot disease

A stem rot of seedlings at the collar region was observed in a seedling nursery for the first time. The fungus was identified as *Sclerotium rolfsii* (perfect stage *Corticium rolfsii*).

Nitrogen Fixation

The maximum yield of *Pueraria phaseoloides* was obtained when the plants were supplied with 87.5 ppm N as $NH_4 NO_3$. Photosynthetic rate of *Pueraria* increased significantly upto 70 ppm N, beyond which a decline in the photosynthetic rate was observed.

Vesicular Arbuscular Mycorrhizae (VAM)

VAM spores were abundantly present in soils collected upto a depth of 10 cm. *Glomus fasiculatum, G. Macrocarpum, G. Multiculis* and *G. Mossae* were present in large numbers in all the soil types. *G. aurigloba* was found for the first time in Boralu Soils at Monrovia S. P. There was a gradual decrease in spore numbers with the increase in soil depth. Bare soils contain more spores than in soils under covers. The optimum level of soil phosphorus for growth of VAM infected *Pueraria* was around 0.65g/1.5kg soil.

Properties of crepe rubber

Examination of properties of different types of crepe rubber showed that mill breakdown is more when a fraction is not removed and/or bleaching agent is present. Mill shrinkage was lower, die swell was higher and abrasion resistance was better when non-rubber constituents were present. Bleaching agents affected the scorch time of free radical initiated vulcanisation system but not the polar system. Colour ageing and ageing in water were more in bleached rubber while unfractionated rubber underwent more tensile drop in water than air and also showed a greater discolouration.

Discolouration of latex crepe

Accumulation of serum substances as a result of delayed coagulation and milling was identified as the main cause for discolouration of latex crepe. Crepe rubber produced from RRIC 102 latex was subjected to enzymatic discolouration, especially during the period of wintering. It was necessary to remove a high fraction 17% to produce high quality rubber. The addition of 10% excess of sodium bisulphite improves the colour. However, during the rest of the year the quality of the rubber could be improved with much less fractionation. When the properties of sole crepe were studied it was observed that remilled sole crepe has a lower hardness and a higher specific gravity.

Superior process rubbers

Many formulations of superior processing (SP) rubbers have been developed under laboratory scale, for high temperature applications and the food industry. A method has been developed for the preparation of liquid rubber from stabilised latex using non-toxic chemicals. This method can also be used to prepare low Mooney rubbers. A raw rubber with low ash (<0.03%) and low nitrogen (<0.06%) has been prepared by treatment with enzymes. The possibility of using Methyl Methacrylate grafted (MG) rubber, for light coloured moulded goods such as rubber components for bottle holders, seals and pads is being explored. Heat resistant tellurium compounds are being evaluated under factory scale trials to manufacture curing bags for tyres. Thermoplastic natural rubber (TPNR) blends have been prepared using crepe, without vulcanization using injection moulding techniques. This method is useful in manufacturing a series of utility products under commercial scale, including latex collecting cups.

Low nitrogen natural rubber (LNNR)

Commercial production of a high quality low nitrogen natural rubber (LNNR) was continued using the maturation procedure developed at the Institute. Several estates in JEDB and SLSPC have commenced commercial manufacture of LNNR, with the assistance of officers of the RRI.

Liquid rubber

Analysis of the liquid rubber made by using Nitrobenzene as the photo-initiator was carried out using HPLC technique. It helped to estimate the storage hardening of liquid rubber.

Low molecular weight rubber

Work on the production of low molecular weight rubber was continued. In cross linking studies of epoxidised natural rubber latex (ENR), the maximum efficiency was obtained when oxalic acid was used.

Tyre tread compounds

A latex based cement with many advantages has been introduced for the tyre retreading industry. Rebuilt tyres using this method have performed well without any problem after 5000 km of road use. A tyre tread formulation based on brown crepe with improved storage stability has been developed. A new tackifying agent for latex, especially in adhesive formulations has been prepared from rubber seed oil.

Latex compounding

Most of the problems in the foaming process have been overcome by using blowing agents in latex. Stability of prevulcanized latex was improved when alkali and fatty acid soap containing 8–12 carbon atoms and non-ionic stabilisers were used.

Coast conservation

The idea of using rubberrised coir as a sand filter to control sea erosion has been accepted by Coast Conservation Department of the Ministry of Fisheries for investigation.

Rice huller rollers

Improvements in the quality of rice huller rollers were achieved with better rubber to metal bonding and use of silica provided better reinforcement of rubber, improved the hardness and abrasion resistance of these compounds.

A comprehensive study on latex crepe was undertaken, at the request of Export Development Board (EDB). The availability of sufficient quantity of good quality water, use of air tight containers to store chemicals and bulking of latex without carrying out outside coagulation were identified as the most important conditions to improve the quality of rubber. The report also recommended the manufacture of crepe rubber tailor made to meet specific consumer requirements and also to market sole crepe as a finished product, based on market intelligence reports. Stabilisation of prices and adjustment of export duty based on crepe rubber prices were also suggested to improve the marketing of latex crepe and plantation sole crepe.

Physiology of brown bast

The accumulation of free proline in latex was found to be significant in brown bast trees indicating a possible link with water stress.

Analysis of TSR samples

Over 12,500 samples received from six registered technically specified rubber (TSR) factories were analysed and test certificates were issued during the year. Besides over 1400 miscellaneous samples were also analysed. TSR exports in 1987 have been reduced to 6932 t compared to 12185 t in 1986. This has been mainly attributed to the high prices of raw material.

Packaging

Visits made to major dealers and consumers of Sri Lankan plantations sole crepe in UK have revealed that planks of albizzia are contaminated with surface mould and contain more than 25% moisture. Further, most packages are damaged when they arrive at the final destination. It has been disclosed by consumers that the present method of packing sole crepe is unacceptable and requires improvement in presentation. Samples of sole crepe have been despatched with deep grooves for testing for better grip especially on slippery surfaces and also soles made of constant viscosity rubber which does not harden on storage. To overcome the problems associated with packing, corrugated cardboard boxes were used strapped with polyester bands. Consumers have already expressed their satisfaction with this new method of packing.

Effluent disposal

Work on effluent disposal from factories to reduce pollution received high priority. Investigations using water hyacinth in the anaerobic facultative ponding system were continued. Green house trials using crepe serum showed significant reductions in the BOD and COD levels but overall efficiency with skim was poor. Investigations on the use of water hyacinth for improving the efficiency of conventional ponding systems, were abandoned as growing, transportation and dissemination of this plant are prohibited by law. The performance of the activated sludge treatment system was monitored and necessary technical advice was provided to install oxidation ditch and rotating biodisc systems in estates. Work on the use of effluent as a source of fertilizer is being evaluated.

STAFF

Appointments

Dr A. de S. Liyanage, Deputy Director (Research) and Head of Plant Pathology Department was appointed Acting Director with effect from 1 January and was later appointed as Director on the 19 February 1987. He will continue to attend to the duties of the Head of Plant Pathology Department.

Mr S. W. Karunaratne, Head of Rubber Chemistry Department was appointed Deputy Director (Research) on the 01 October, 1987.

Training

Dr (Mrs) N. I. S. Liyanage, Assistant Plant Pathologist resumed duties on 12 January 1987, after successfully completing the PhD degree in Plant Pathology at the Imperial College of Science and Technology of the University of London, UK. She was also awarded the Diploma of the Imperial College of Science and Technology.

Miss N. M. V. Kalyani, Assistant Rubber Chemist continued her studies on latex technology leading to a PhD degree at the London School of Polymer Science, UK.

Mr M. D. R. J. Goonatilleke, Assistant Rubber Chemist continued his studies in Chemical Engineering with special reference to Tyre Technology leading to the PhD degree at the University of Aston in UK.

Mr E. D. I. H. Perera, Assistant Rubber Chemist is undergoing a course of training in Chemical Engineering on alternative Energies at the University of Reading, UK, leading to the PhD degree.

Mr W. M. G. Seneviratne, Assitant Rubber Chemist is pursuing studies leading to the PhD degree at the University of Sussex, UK.

Miss S. A. P. P. Sirimanne, Assistant Rubber Chemist is continuing her studies for a PhD degree at the University of Sussex, UK.

Mrs S. C. Dharmaratne, Assistant Geneticist and Plant Breeder continued her research project on floral biology leading to the PhD degree at the University of Glasgow in Scotland.

Mrs M. L. A. Samarappuli, Assistant Soils Chemist continued her studies leading to the MS degree at the Davis campus of the University of California, in United States of America.

Mr L. B. K. Silva, Research Assistant was granted 1 year duty leave to follow the MSc course in Polymer Technology conducted by the University of Moratuwa with effect from 20 July, 1987.

Mr S. de Silva, Assistant Agricultural Economist was released on duty leave for 1 year with effect from 29 September 1987, to follow the MSc course in Agricultural Economics at the Post Graduate Institute of Agriculture at Peradeniya.

Mrs M. G. M. M. Neelaweera, Technical Officer of the Rubber Chemistry Department resumed duties in July 1987, after following a course in the Rubber Technology at the RAPRA Technology Ltd., UK.

Mr P. Lelwala, Instrument Technician, left for UK on 12 November 1987 to follow a course of training at the Central Electronic Servicing Laboratory, UK.

Miss K. C. S. Dissanayake, Instrument Technician was released for the period from 27.03.85 to 28.11.85, for a training in Electronic Equipment Repairs at the Tea Research Institute.

Sabbatical leave

Dr L. M. K. Tillekeratne, Head of Specifications and Analysis Section who was on sabbatical leave at the University of Aston on a Fellowship awarded by the Royal Society of UK resumed work in October, 1987.

No pay leave

Mr M. A. Mendis, Specification Assistant, Rubber Chemistry Department was given a further extension of one year.

Director's Publications

The following publications were prepared by the Director with the assistance of the staff members, University staff and students, during the year:

Liyanage, A. de S. (1987). Investigations on *Corynespora* leaf spot disease in Sri Lanka. *Proc. of Int. Rubb. Res. Dev. Bd.* (In press)

Liyanage, A. de S. (1987). Management of *Corynespora* leaf disease under Sri Lankan conditions. *Proc. of Int. Rubb. Res. Dev. Bd.* (In press)

Liyanage, A. de S. (1987). Development in biological research in *Hevea* for increased productivity. *Proc. Pl. Rubb. Inst.* (In press).

Liyanage, A. de S., Jayasinghe, C. K., Liyanage, N. I. S. and Jayaratne, A. H. R. (1986). *Corynespora* leaf spot disease of rubber (*Hevea brasiliensis*) — A new record. *Jl. Rubb. Res. Inst. Sri Lanka*, **65**, 47–50.

Jayaratne, R., Liyanage, A. de S. and Phalawattaarachchi, W. (1986). Effect of VA mycorrhizal (*Gigaspora margarita*) on white root disease resistance in *Pueraria phaseoloides and Hevea brasiliensis. Jl. Rubb. Res. Inst. Sri Lanka*, **65**, 22–31.

Jayasinghe, C. K. and Liyanage, A. de S. (1987). A new leaf spot disease of "*Eugenia caryophyllus*" (Sporengal) Bullock and Harrison in Sri Lanka. *Proc. Sri Lanka. Ass. Adv. Sci.* 157.

Liyanage, N. I. S. and Liyanage, A. de S. (1986). A study on the production of a toxin in *Corynespora cassiicola. Jl. Rubb. Res. Inst. Sri Lanka*, **65**, 51–53.

Senaratne, L. K., Wijesundera, R. L. C., Fonseka, R. N. de, and Liyanage, A. de S. (1987). A comparative study of two isolates of *Colletotrichum gloeosporioides* from rubber on *Hevea brasiliensis*. Muell. Arg. *Proc. Sri Lanka. Ass. Adv. Sci.* 122.

Senaratne, L. K., Wijesundera, R. L. C., Fonseka, R. N. de, Liyanage, A. de S. (1987). Some properties of Pectolytic enzymes produced by two isolates of *Colletotrichum gloeosporioides* Penz. from rubber *Hevea brasiliensis* Muell, Arg. *Proc. Sri Lanka. Ass. Adv. Sci.* 124.

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Reports

Liyanage, A. de S. (1987). Review of the Plant Pathology Department, *Ann. Rev. Rubb. Res. Inst. Sri Lanka.* 1986, 37–49.

Director's duties

The Dirctor served on the following bodies during the year:

Member and Vice Chairman of the Rubber Research Board (upto 13. 10. 87).

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

Member of the Board of the National Institute of Plantation Management.

Member of the Rubber Replanting and Advisory Board.

Member of the Pesticide Formulary Committee.

Member of the Steering Committee of the Smallholder Rubber Rehabilitation Project.

Member of the *Corynespora* Monitoring Committee.

Member of the Scientific Committee.

Editor of the Journal of the Rubber Research Institute.

The salaried staff of the Institute at the end of year (1987) was as follows :–

Director	—	01
Deputy Director (Research)	—	01
Officers in Grade I — IV	—	42
Officers in Grade V — XI	—	125
Officers in Grade XII — XIV	—	102
Total		271

VISITORS

Visitors to the Institute included :

Dr S. P. Long, University of Essex. UK.
Dr Krishnamurthi, Director, Sugarcane Research Centre, Fiji.
Dr (Mrs) M. Sedgley, Waite Agriculture Research Institute, Australia.
Mr K. Nabholz, Sandoz Ltd., Switzerland.
Professor R.J. Soper, CIDA Fertilizer Project, Canada.
Mr R. Raturi, FAO, World Bank Co-operative Programme, Rome.
Mr R.F. Mikillop, Thedden Agribusiness, Australia.
Mr John A.V. Routledge, FAO, UK.
Mr R.S. Hindmarch, RAPRA Technology, UK.
Professor C.K. Parker, University of Western Australia, Australia.
Mr Anat Rojanathaibulya, ORRAF, Thailand.
Mr Sombat Soichstra, ORRAF, Thailand.
Mr Sanphong Chairerk, ORRAF, Thailand.
Mr Song Chinawn, ORRAF, Thailand.
Mr Tance Koaypokaisawas, ORRAF, Thailand.
Mr R.V. Ramakarishna, World Bank.
Professor R.E. Litz, University of Florida, USA.
Dr J.N. Anderson, Exeter University, UK.
Mr Pham Ngoc Giao, RRI, Vietnam.
Dr N. Hag. South Hampton University, UK.
Dr J. Benren Kumming, Institute of Botany, Kumming.
Mr J. Bernie, BASF, West Germany.
Mr Thun Phong Sukumtho, Thailand.
Mr Anona Austragul, Thailand.
Mr P. Jollands, FAO Consultant, UK.
Dr Peter Jolly, Industrial Development, University of Queensland, St. Lucia, Australia.
Mr Tan Hong Tong, FAO, Holland.
Dr S. Reynolds, FAO, Rome.
Mr Haut Bruia, BKH, Consulting, The Netherlands.
Dr I.V. der Putter, BKH Consulting, The Netherlands.
Mr P.V. Prasd, Soil Conservation, Kerala State, India.
Mr M. Mosharraf Hossain, Bangladesh.
Dr M. Shahidul Islam, Bangladesh.
Mr R.N. Behra, Soil Conservation, Orrisa State, India.

REVIEW OF THE PLANT SCIENCE DEPARTMENT

BY

CHANDRA SAMARANAYAKE

SUMMARY

Seedling shoot tips of *Hevea* could be established and induced to proliferate to produce a large number of shoot tips in culture, where as clonal shoot tips could not be induced to proliferate. The rate of assimilation of CO_2 was significantly lower when leaves of the clone RRIC 103 were slightly infected with CLS disease. Cuttings of the clone RRIC 100 rooted easily compared to those of the clone RRIC 121. $\frac{1}{2}$S d/4 system of tapping with 3 monthly application of Ethrel gave high yields in clones RRIC 100 and RRIC 101. There was a significant reduction of yield in all the clones under study in densities over 533 trees/ha., in the spacing and density experiment.

DETAILED REVIEW

Staff

The Head of Department Dr (Mrs) A. C. I. Samaranayake was on duty throughout the year. Mr A. Nugawela, Assistant Botanist was promoted Botanist and was on duty throughout the year. Miss G. P. W. P. Pushpika, Miss M. S. Ranasinghe and Mr V. H. L. Rodrigo, Assistant Botanists were on duty throughout.

Messrs L. S. S. Pathiratne and R. B. Gunaratne, Experimental Officers, Messrs S. Wilbert and U. K. D. Lewis, Experimental Assistants, Messrs L. S. Kariyawasam, K. A. G. B. Amaratunge, R. P. Karunasena, U. S. Weerakoon, S. L. G. Ranjith, R. S. Wijesundera, Mrs C. W. Ranasinghe, Mrs G. A. S. Wijesekera and Miss R. K. Aluthhewage, Technical Officers, Miss D. E. Jayasekera Clerk/Typist were on duty throughout the year.

Mr L. S. Kariyawasam was promoted Senior Technical Officer on 25.03. 1987.

Miss I. D. Gunatilleke, Temporary Research Assistant completed her studies and left the Department on 01.10.1987 and Miss P. H. A. P. Chandrakanthi was appointed as a Temporary Research Assistant on 01.10.1987.

Mr L. S. S. Pathiratne, Experimental Officer was awarded the MPhil Degree by the University of Kelaniya for his thesis on "Biological Means of Improving Phosphate Availability from Eppawela Apatite".

Mr J. D. Karunatilleke, Field Assistant passed away on 01.06.1987.

Visits

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

Staff of the Nursery Inspection Unit inspected all nurseries supplying plants to the Smallholder Rubber Rehabilitation Project. They inspected all seedling and budwood multiplication nurseries registered with the Rubber Control Department before the nurseries were permitted to sell plants.

All budwood multiplication nurseries in the country were inspected to identify clones prior to removal of clones susceptible to *Corynespora* leaf spot disease (CLS).

Department staff also visited State Plantations and Smallholdings to identify clones susceptible to CLS disease and over 1000 hectares in State Plantations alone have been inspected during these visits.

Meetings

Head of Department attended the following meetings.

Tissue Culture Group Meetings and the Tissue Culture Workshop organized by the Tissue Culture Group.

Corynespora Monitoring Committee Meetings.

Planting Material Meeting of the SRRP.

Training, Seminars and Field Days

Department staff were involved in the following training programmes.

Refresher Courses for the R.E.O.'O of the ASD

Induction Course for Planter Trainees of the SLSPC, conducted by the NIPM.

Refresher Course for Superintendents and Assistant Superintendents of the SLSPC Board 111 .

Special Training Course for Senior Assistant Superintendents of the SLSPC conducted by NIPM.

Training Courses on Tapping and Budgrafting for Smallholders.

Diploma in Plantation Management.

Training of Apprentices for the National Apprenticeship Board.

Field days for the Superintendents and Assistant Superintendents of the State Plantations in Avissawella, Kegalle, Kalutara and Galle Districts.

Training of Assistant Managers of the Agricultural Development Authority.

Publications

Nugawela, A., Jayasinghe, C. K., Aluthhewage, R. K and Wettasinghe, S. (1985). Effect of different levels of supplemental nitrogen on CO_2 assimilation rates and productivity of *Pueraria phaseoloides* (Roxb) Benth and *Desmodium ovalifolium* (Prain) Wallmex Ridley grown in Agalawatta soil series. *Jl. Rubb. Res. Inst. Sri Lanka* **64**, 21-28.

Nugawela, A. and Aluthhewage, R. K. (1986). Clonal differences in growth parameters of young *Hevea* buddings and their relation to field performance. *Jl. Rubb. Res. Inst. Sri Lanka* **66**, (submitted for publication).

Nugawela, A. and Aluthhewage, R. K. (1985). Gas exchange parameters for early selection of *Hevea brasiliensis* Muell. Arg. *Jl. Rubb. Res.Inst. Sri Lanka* **64**, 13-20.

Pathiratne, L. S. S , Waidyanatha, U. P. de S. and Peries, O. S. (1986). Response of five tropical pasture species to application of apatite. *Jl. Rubb. Res. Inst. Sri Lanka.* (submitted for publication)

Samaranayake, Chandra((1986). Budwood nurseries, *Bull. Rubb. Res. Inst. Sri Lanka* **22**, 1-2.

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Samaranayake, Chandra, (1986). Annual Review of the Plant Science Department.

Laboratory Investigations

Tissue Culture

Seedling shoot tips

Shoot tips of seedlings could be established on both liquid and solid, modified M. S and WPM media. Axillary shoot proliferation could be obtained and with successive subcultures a large number of shoots could be produced. Rooting was also induced. (Iranganie Gunetilake and Chandra Samaranayake)

Clonal shoot tips

Shoot tips of a number of clones could be established in culture. Axillary bud break was induced. However, the growth of buds into shoots was not satisfactory. (Priyani Pushpika, Chandra Samaranayake and Sunitha Wijesekera)

Somatic embryogensis

Good callus growth was observed in nucellar cultures established with nucelli of clones RRIC 100 and PB 86. Embryogensis was not observed in any of the cultures. (Priyani Pushipka, Chandra Samaranayake and Sunitha Wijesekera)

Gas exchange studies

Early selection

Photosynthetic characteristics *i.e.* light interception efficiency and conversion efficiency of mature canopies of clones RRIC 100 and PB 86 were studied. Total leaf area and the distribution between upper, middle and lower canopy were estimated. The angle and conversion efficiency of leaves at different levels of the canopy were studied to estimate canopy photosynthesis. The correlation of these parameters, with yield are being worked out. (A. Nugawela, R. K. Aluthhewage and R. P. Karunasena)

Gas exchange capacities of Hevea *leaves infected with* Corynespora *leaf spot disease*

Measurements done on healthy and infected leaves using a system based on an Infra Red Gas Analyser (ADC Mark 11) and Lee Integer Temperature/Humidity probes indicated that there was a marked drop in the CO_2 assimilation rate (A), even with a slight infection of the leaves of clone RRIC 103. In the clone RRIM 600, which is fairly tolerant, the drop in A is marked only when 50% or more of the leaf is infected. In RRIC 52, a susceptible clone, the drop in A due to infection is higher than that of clone RRIM

600, but lower than in clone RRIC 103. Measurements of stomatal conductance and internal CO_2 concentration done simultaneously along with 'A' suggests that the drop in 'A' is more likely to be due to the damage caused to the photosynthetic system. (A. Nugawela, N.I.S. Liyanage, A. de S. Liyanage and R. K. Aluthhewage)

Chlorophyll content in healthy and infected Hevea *leaves*

The chlorophyll content in healthy leaves and in uninfected areas in infected leaves were determined, in clones RRIC 103, RRIC 52 and RRIM 600. There was no significant difference in the chlorophyll content although the photosynthetic rates were different. The chlorophyll content in areas just adjacent to the infected region was significantly lower than in healthy areas. (A. Nugawela, N. I. S. Liyanage, A. de S. Liyanage and R. K. Aluthhewage)

Light interception by Corynespora *infected canopies*

Light measurements were done within the canopy and in a clear area simultaneously using Li-Cor quantum sensors. Two infected RRIC 103 clearings (5 and 6 year old) and two healthy clearings of similar ages were used for this study. Light was measured at 40 random points in each clearing. The light interception was less in infected canopies by 51 and 67 percent respcectively in 5 and 6 year old clearings. (A. Nugawela, N. I. S. Liyanage, A. de S. Liyanage and R. K. Aluthhewage)

Rooting of cuttings

Cuttings of clones RRIC 100 and RRIC 121 were rooted under continuous mist with and without growth hormones. The cuttings of clones RRIC 100 could be rooted easily when compared with those of clone RRIC 121. (Muditha Ranasinghe)

Latex physiology

Studies on latex sucrose levels in 10 different clones tapped on $\frac{1}{2}$S d/2 system of tapping indicated that sucrose levels in clone RRIC 101 was always much lower than in all the other clones. There was no significant correlation in the latex sucrose levels with yield. This study had to be suspended due to the breakdown of equipment. (Muditha Ranasinghe and L. S. Kariyawasam)

Field Experiments

Tapping

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

This experiment was started in 1981 to compare puncture tapping (PT) with conventional tapping (CT) under commercial conditions. After 2 years, puncture tapping was discontinued and conventional tapping was started on all puncture tapped trees

and were tapped on the ½S d/2 system. Five PT trees and 5 CT trees from each of the girth classes were selected and test tapped to study the effect of PT on future yield and growth of trees.

Results recorded in 1987 are summarised in Table 1.

Table 1. *Mean yield and girth increment in* (*T*/81/1)

Treatment			Yield (g/t/t)	Girth increment (cm)
T_1 less than 45.00 cm previously untapped			—	—
T_2 45.0 — 49.9 cm previously		PT	18.800	0.580
T_3 45.0 — 49.9 cm	„	CT	16.650	2.450
T_4 50.0 — 54.9 cm	„	PT	27.080	1.820
T_5 50.0 — 54.9 cm	„	CT	17.440	1.340
T_6 Greater than 55 cm	„	PT	42.300	2.240
T_7 Greater than 55 cm	„	CT	37.050	2.290
T_8 Greater than 45 cm	„	PT	8.350	1.500

(T_1 was removed as all the trees in this treatment developed brown bast)

There was a significantly higher yield from previous PT trees compared to CT trees in 1984. In 1985, only the trees of girth class 50.0 — 54.9 gave a significantly higher yield with previously PT trees compared to CT trees. From 1986 there has been no significant difference in yield of previous PT trees and CT trees and there was no difference in girth increment between different treatments. (Chandra Samaranayake and R. P. Karunasena)

PB 86, 1987 *replantation, Uruniwela* (*T*/84/3)

This experiment was started in 1984 to investigate whether economic yields could be obtained by commencing tapping at heights above the recommended level and tapping higher panels upwards before the normal base panels. All treatments were tapped on ½S d/2 tapping system.

Results recorded for 1986 are summarised in Table 2.

Table 2. *Mean yield of different heights of tapping*

Treatment	Yield (g/t/t)
T_1 Tapping cut marked at 105 cm height	21.97
T_2 Tapping cut marked at 120 cm height	21.77
T_3 Tapping cut marked at 135 cm height	22.40
T_4 Tapping cut marked at 105 cm tapped upwards	17.14

There was no significant difference in yield due to difference in opening of cuts at different heights or due to the difference in the direction of the cut. At the end of the year tapping upwards in T_4 was discontinued. Instead a new cut was open on the lower panels. (Chandra Samaranayake and U. K. D. Lewis)

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

This experiment was started to compare several initial girths for commencement of tapping for their effect on yield and subsequent girth increase. The following girth classes were included.

T_1 — 40.0 — 44.9 cm girth
T_2 — 45.0 — 49.9 cm girth
T_3 — 50.0 — 54.9 cm girth
T_4 — Greater than 55.0 cm girth

All trees were tapped on $\frac{1}{2}$S d/2 system of tapping in 1987. The yield data recorded for 1987 indicates that there was no significant difference in yield between treatments T_1 and T_2 whereas significantly higher yields were obtained in treatments T_3 and T_4. Girth increment was also significantly higher in trees with greater girths. (Chandra Samaranayake and R. P. Karunasena)

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

This experiment was started to compare several initial girths for commencement of tapping on conventional (CT) and puncture tapping (PT) system, for their effect on yield and subsequent girth increase. At the end of 1986, PT was discontinued and all treatments were tapped on $\frac{1}{2}$S d/2. Girth classes were the same as in (T/84/1).

The results recorded in 1987 indicated significantly higher yields with trees of greater girths. (Chandra Samaranayake and S. Wilbert)

High intensity tapping, Frocester (*IS*/84/1), (*IS*/84/2) *Nakiadeniya* (*IS*/84/3), (*IS*/84/4) *and Ambadeniya* (*IS*/84/6)

The objective of these experiments is to investigate suitable systems of high intensity tapping during the last few years of exploitation to obtain maximum possible yields. Four, intensification systems have been tested for 3 years (details in Ann. Rew. 1986). The frequency of tapping was increased from d/3 to d/2 in 1987 and an extra ¼S cut was introduced in treatment 4. Data for the year 1987 are summarised in Table 3.

Table 3. *Mean yield for different intensification systems*

Intensification system	Yield Kg/task/tapping				
	IS/84/1	IS/84/3	IS/84/4	IS/84/6	Mean
T_1 ½S + ¼S (↓ ↑) d/2	4.99	5.83	6.14	5.60	5.64
T_2 ½S + V (↓ ↑) d/2	4.84	5.39	6.51	7.32	6.02
T_3 ½S + ½S (↓ ↑) d/2	6.16	5.45	6.08	6.84	6.13
T_4 ½S + 2 × ¼S (↓ ↑) d/2	5.09	5.69	6.41	5.86	5.76

There was no significant difference in yield between different tapping systems in any of the experiments. (A. Nugawela, S. Wilbert and R. P. Karunasena)

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

The purpose of this experiment was to ascertain the most effective tapping system for different clones. The tapping systems tested up to end 1986 were changed in 1987, so that in treatment 3, an extra ½S cut was opened on panel BO-2 and the trees were tapped on 2 × ½S d/3 system. Puncture tapping in treatment 4 was discontinued and a ¼S cut was opened and tapped on d/2 frequency with a monthly application of Ethrel.

Treatments adopted during the 1st 3 years	Treatments adopted in 1987
T_1 ½S d/3	½S d/3
T_2 ½S d/2	½S d/2
T_3 ½S d/2	2 × ½S d/3
T_4 ½S d/2	¼S d/2 + E
for 8 months and Pg/100 (0.5) d/2 + E for 4 months	
T_5 PT d/2	PT d/2

The yields, girth and girth increment recorded for 1987 are summarised in Tables 4, 5 and 6.

Table 4. *Mean yield in clones x tapping systems (CT/77/3)*

Clone	Yield (g/t/t) in different tapping systems				
	½S d/3	½S d/2	2 × ½S d/3	¼S d/2	PT d/2
RRIC 100	40.1	41.1	70.7	22.9	27.1
RRIC 101	33.7	27.5	43.8	16.4	18.8
RRIC 102	51.3	40.6	67.8	28.3	36.9
RRIC 103	48.4	45.0	74.8	30.5	27.4
RRIC 104	29.9	30.5	48.1	20.0	22.1
RRIC 105	32.5	29.5	41.5	22.0	19.9
RRIC 108	35.3	34.3	40.7	18.1	21.1
RRIC 109	32.8	31.8	54.6	22.4	20.6
RRIC 110	47.0	55.2	79.8	33.8	38.0
RRIC 112	70.5	32.7	47.4	25.3	20.7
RRIC 113	41.0	31.8	48.9	32.9	26.4
RRIC 117	49.2	51.0	75.9	30.0	27.0
HP 2427	49.6	50.0	45.0	25.0	29.6
RRIM 600	35.6	41.9	85.3	32.1	26.5
PB 86	33.6	30.0	65.2	21.4	25.0

L.S.D. ($P=0.05$) To compare tapping system within a clone = 10.0

L.S.D. ($P=0.05$) To compare clones within a tapping system — 7.5

Very high yields were obtained with 2 × ½S d/3 systems of tapping with all clones except for HP 2427. Most clones have given low yields with PT and ¼S d/2 with Ethrel.

Table 5. *Mean girth and girth increment of different clones (CT/77/3)*

Clone	Girth (cm)	Girth increment (cm)
RRIC 100	62.73	1.88
RRIC 101	60.70	1.62
RRIC 102	63.16	2.06
RRIC 103	67.22	1.37
RRIC 104	70.86	0.63
RRIC 105	60.86	1.31
RRIC 108	59.61	1.73
RRIC 109	62.08	2.13
RRIC 110	65.94	1.56
RRIC 112	61.61	1.97
RRIC 113	66.67	2.29
RRIC 117	61.50	2.71
HP 2427	65.67	1.49
RRIM 600	62.25	1.88
PB 86	62.84	2.62
L.S.D. (P — 0.05)	2.08	0.662

Table 6. *Mean girth, girth increment for different tapping systems (CT/77/3)*

Tapping system	Girth (cm)	Girth increment (cm)
½S d/3	64.07	1.76
½S d/2	63.56	1.88
2 × ½S d/3	62.76	1.43
¼S d/2 + E	63.56	2.17
PT.D/2 + E	63.95	1.83
L.S.D.	—	0.229

RRIC 104 recorded the highest girth where as RRIC 108 recorded the lowest. There was no significant interaction in girth increment between clones and tapping systems. However, ¼S d/2 system have the highest increment in girth and 2 × ½S d/3 the lowest. (Chandra Samaranayake, L. S. S. Pathiratne and C. W. Ranasinghe)

K levels on tapping systems x clones—Eladuwa F/76/5

Effect of 3 levels of K and three tapping systems on the performance of clones PB 86, RRIC 100 and RRIC 101 is studied in this experiment laid out on a randomised block design with clones in the main plots and K levels on sub-plots. The three tapping systems are :—

T_1 — ½S d/2
T_2 — ½S d/3
T_3 — ½S d/4 + E

The yield and girth data recorded in 1987 did not indicate a significant effect of K levels on either clones or tapping systems. There was a significant interaction of clones and tapping systems (Table 7).

Table 7. *Mean yield in K levels, tapping systems and clones (F/76/5)*

Tapping system	Mean yield (g/t/t)		
	RRIC 100	RRIC 101	PB 86
½S d/2	41.1	22.7	26.5
½S d/3	39.2	41.6	31.3
½S d/4 + E	73.0	82.0	48.9

L.S.D. = 13.13 (to compare tapping systems within a clone) (P=0.05)

There was a significant increase in girth of colnes RRIC 101 and PB 86 with higher levels of K (Table 8).

Table 8. *Mean girth increment with different K levels*

Clone	Girth increment (cm)		
	K_0	K_1	K_2
RRIC 100	1.50	1.12	1.52
RRIC 101	0.65	1.08	1.30
PB 86	1.52	2.18	1.80

L.S.D. = 0.432 (to compare K levels within a clone) (P = 0.05)

(Chandra Samaranayake, N. Yogaratnam, S. Wilbert and J. G. de Mel)

Tree spacing and density

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

Clones RRIC 101, RRIC 103 and PB 86 were established at six spacings and densities on a factorial layout with three replicates in 1977. Yields recorded in 1987 are summarised in Table 9.

Table 9. *Mean yield (CD/77/1)*

Spacing (m)	Density trees/ha	Yield (g/t/t)		
		PB 86	RRIC 101	RRIC 103
S_1 2.5 × 10.0	400	26.9	30.2	24.7
S_2 2.5 × 7.5	533	27.9	25.2	26.7
S_3 2.5 × 6.0	666	22.9	25.2	21.8
S_4 2.5 × 5.0	800	21.6	26.2	19.2
S_5 3.87 triangular	771	21.2	25.8	19.4
S_6 3.54 triangular	920	21.2	23.5	20.1

There was no significant interaction between clones and spacings on yield. There was a significant difference in yield due to spacings and densities (Table 10) and also a significant clonal difference on yield (Table 11). Clone RRIC 103 recorded low yields, probably due to repeated defoliation caused by *Corynespora* leaf spot disease.
(Chandra Samaranayake and L. S. S. Pathiratne)

Table 10. *Effect of spacing on mean yield, (CD/77/1)*

Spacing & density	Yield (g/t/t)
S_1	27.267
S_2	26.622
S_3	23.222
S_4	22.489
S_5	22.111
S_6	21.578

L.S.D. = 3.499
(P = 0.05)

Table 11. *Mean yield of clones (CD/77/1)*

Clone	Yield (g/t/t)
PB 86	23.58
RRIC 101	26.08
RRIC 103	21.97

L.S.D. = 2.475
(P = 0.05)

Propagation

Stock-scion relationships

Stock-scion experiment, St. George (St. sc/754)

Clones RRIC 45,52, PB 86 and Wagga 6278 have been budded on to clonal seedling rootstocks of the same four clones in a diallel design.

Yield and girth data recorded in 1987 does not indicate a significant effect on yield or growth. (Chandra Samaranayake and K. A. G. B. Amaratunge)

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

Clones RRIC 100, 101, 102, 103, 111 and PB 86 have been budded on to seedling rootstocks of the same clones in a diallel design. Yield and girth data recorded so far does not indicate a significant effect on yield or growth. (Chandra Samaranayake, R. B. Gunaratne and U. S. Weerakoon)

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

Clones RRIC 100, 101, 103, PB 86 and GT 1 are used as scion and their seedlings as rootstocks in a diallel design. Growth in girth at 5 years from planting showed no significant rootstock effect. Plants of clones RRIC 103 got heavily infected with *Corynespora* leaf spot disease, and they were removed. (Chandra Samaranayake and L. S. Kariyawasam)

Crown budding

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

The effect of different crowns on growth and yield of the trunk and raw rubber properties is studied in this experiment. The yield and girth data recorded in 1987 indicated no significant differences in girth of trunks due to the effect of different crowns. There was a significant reduction in yield of RRIM 600, crown budded with clone PB 86. (Chandra Samaranayake and K. A. G. B. Amaratunge)

Planting techniques

Stumped buddings, Neuchatel (RI/81/3)

Green buddings were planted 13 months ahead of stumped buddings in the field and stumped buddings were planted with 13 months of growth after cutback in the nursery. Growth measurements recorded so far indicated that growth of budded stumps was superior to that of stumped buddings (Table 12). (Chandra Samaranayake and K. A. G. B. Amaratunge)

Table 12. *Mean girth of plants*

Plant material	Mean girth (cm)
Budded stumps	51.62
Stumped buddings	47.08
T=5.4 ***	

Polybags vs. bare root budded stumps, Gallewatta (PS/81/4)

Budded stumps grown for 6 months in polybags and bare root brown budded stumps transplanted in the field at the same time were compared in this experiment. Polybagged plants maintained their superiority in growth over bare root plants throughout. (Chandra Samaranayake and S. Wilbert)

Intercropping

Intercropping of coffee and pepper in rubber, Padukka (IS/87/1)

This experiment was started in a State Plantation at Padukka to study the feasibility of growing coffee and pepper as intercrops among rubber in the low country wet zone. Clone RRIC 130 has been planted at a spacing of 2.4m × 9m. Coffee, variety Robusta—S 274 and pepper, variety Pannyur were planted in the inter-rows as follows :

T_1 Rubber without an intercrop

T_2 Single row of coffee planted in the inter-row, coffee spaced at 2.4m along the row

T_3 Single row of pepper planted in the inter-row, pepper spaced at 2.4m along the row

T_4 A row each of pepper and coffee, planted in the inter-row, spaced at 2.4m x 2.4m. Pepper planted on either side of the rubber.

T_5 A row each of pepper and coffee planted at a spacing of 2.4m x 2.4m. Coffee planted on either side of the rubber

T_6 A row each of pepper and coffee planted at a spacing of 2.4m x 2.4m. Coffee planted next to rubber on one side and pepper on the other.

The experimental design is a completely randomized block design with four replicates. (V. H. L. Rodrigo, Chandra Samaranayake, L. S. Kariyawasam and U. K. D. Lewis)

Smallholder demonstration plots

Two demonstration plots of rubber inter-planted with banana during the immature period were maintained for the purpose of popularising intercropping in smallholdings. Another demonstration plot was established during the year. In this plot, three crops *viz.*, banana, pineapple and passion fruit were planted in the inter-row space. Details of these demonstration plots are as follows :

Plot No	District	DREO' Div.	Year planted	Intercrop	Extent
1	Kalutara	Bandaragama	1986 S.W.	Banana	0.4 hectares
2	Kalutara	Bandaragama	1986 N.E.	Banana	0.2 hectares
3	Kalutara	Dodangoda	1987 N.E.	a. Banana	0.4 hectares
				b. Passionfruit	0.4 hectares
				c. Pineapple	0.4 hectares

Plot	Expenditure 1986	Expenditure 1987	Income 1987
1	1742.50	1080.00	3319.10
2	753.00	790.00	1516.40
3 (*a*)		4665.00	
(*b*)		845.00	
(*c*)		1516.00	

(V. H. L. Rodrigo, Chandra Samaranayake, L. S. Kariyawasam and S. Wilbert)

REVIEW OF THE GENETICS AND PLANT BREEDING DEPARTMENT

BY

N. E. M. JAYASEKERA

SUMMARY

Dr Margaret Sedgley worked during the flowering season as an FAO consultant. A laboratory technique was developed to study the germination of pollen on the stigma and subsequent growth of the pollen tube in stylar tissue. Laboratory observations confirmed the earlier field observations that the hand pollination in the afternoon, at the time of anthesis, had a higher potential to set fruits. Pollen storage experiment revealed that pollen could be stored for 5 days at 5°C and 75% relative humidity with 22% loss of viability.

Small scale trials, established to test new selections made since 1974 were assessed for *Corynespora* leaf spot disease. Some trials had to be discontinued as most of the clones included in them were susceptible. These clones had at least one susceptible parent in their parentage. This suggested the importance of selecting tolerant parents to be used in future breeding programmes in order to avoid wasteful crosses.

DETAILED REVIEW

Staff

Head of the Department, Dr N. E. M. Jayasekera and Assistant Geneticist and Plant Breeder, Mr D. P. S. T. G. Attanayake were on duty throughout the year.

Mrs S. C. Dharmaratne, Assistant Geneticist and Plant Breeder continued her post-graduate studies at Scottish Crop Research Institute, Dundee UK.

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

Visits

The Department staff made regular visits to experimental areas for collection of data and observation purposes. Head of the Department visited all the small scale trials established to evaluate selections made since 1974.

Consultants and Visitors

Dr Margaret Sedgley of Department of the Plant Physiology, Waite Agricultural Research Institute, Australia worked at the Genetics and Plant Breeding Department from 23 February to 4 April as an FAO consultant on Floral biology.

Three post-graduate students of the Post-graduate Institute of Agriculture and two lecturers visited the Department on 27 July 1987.

Meetings

Head of the Department attended the seminar on *Corynespora* leaf spot disease, organised by the Rubber Control Department on 16 July and spoke on recommended clones.

Head of the Department addressed the Sri Lanka State Plantation Corporation's (SLSPC) Visiting Agents Conference held on 1 July 1987.

Head of the Department served as a member of the following committees and attended the meetings.

Scientific Committee of the Rubber Research Institute.

Corynespora Monitoring Committee.

Training and Field Days

The Head of the Department spoke on recommended *Hevea* clones in the following training and field day programmes.

Training Programme for Superintendents of Sri Lanka State Plantation Corporation (SLSPC) Board III.

Training Programme for Senior Assistant Superintendents of SLSPC organized by National Institute of Plantation Management (NIPM).

Training Programme for Assistant Superintendents of SLSPC Board III.

Three field day programmes on *Corynespora* held at Dartonfield for Superintendents of Janatha Estate Development Kelani valley and Kegalle and SLSPC, Kalutara.

Fourth Diploma Course in Plantation Management organized by NIPM.

Field day organised by SLSPC Galle.

Publications

Sedgley, M. and Attanayake, D. P. S. T. G. (1986). Floral biology of rubber and recommendations for increases in seed yield for plant breeding. *Jl. Rubb. Res. Inst. Sri-Lanka* **65**, 1-14.

Sedgley, M. and Attanayake, D. P. S. T. G. (1987). The breeding system of rubber (*Hevea brasiliensis*), an evaluation of controlled hand pollinations methods. *Euphytica* (in press).

Reports

Jayasekera, N. E. M. (1986). Annual Review of the Genetics and Plant Breeding Department.

Sedgley, M. (1987). Floral biology of rubber (*Hevea*). FAO project report.

General

Mr B. M. S. G. Peiris, Senior Experimental Officer stationed at Kuruwita Sub-Station participated in the identification and irradication of RRIC 103 as a measure of controlling *Corynespora* leaf spot disease (CLS) in Ratnapura District. This programme was jointly undertaken by the Rubber Research Institute, Rubber Control Department and Advisory Services Department.

Mr W. D. Armon also, on the request of Plant Pathology Department, visited smallholdings to identify RRIC 103.

Issues and receipts of budwood

Local

Budwood nurseries at Kuruwita and Nivitigalakele Sub-stations, maintained by Genetics and Plant Breeding Department, issued a total of 497 meters of nucleus budwood to SLSPC and JEDB estates and private sector. Details are given in Table I.

Table 1. *Details of issue of budwood (in meters)*

Clone	Kuruwita	Nivitigalakele
RRIC 100	115	190
RRIC 102	27	50
RRIC 121	15	—
RRIC 126	01	—
RRIC 131	01	—
RRIC 132	01	—
PB 86	05	—
RRIM 600	91	—
RRIM 701	01	—
Total	257	240

Laboratory Investigations

Floral biology of *Hevea* (*FBH*/86/2)

Fluorescent microscope purchased under the FAO project was received at the begining of 1987. Dr Margaret Sedgley, FAO consultant who worked at the Department carried out lab and field investigations to study the following aspects with respect to artificial hand pollination of *Hevea* and *Hevea* reproductive biology.

1. Pollinator efficiency
2. Timing of pollen germination and penetration of the ovule by the pollen tube.
3. Efficiency of the conventional hand pollination technique.
4. Effect of the time of pollination.
5. Pollen storage.
6. Comparison of self, and cross pollination.
7. Effects of male/female parent on the success of pollination.

Pollinator efficiency

Results obtained are presented in Table 2 which clearly show that there are differences between pollinators in all the parameters studied. Therefore, training of pollinators in proper handling of female flowers can increase the fruit set following artificial hand pollinations.

Table 2. *Effect of pollinator efficiency on pollen tube growth*

Pollinator	Percentage of damaged stigmas	Mean number of pollen grains on stigma	Mean number of pollen tubes in stigma	Mean number of pollen tubes per ovule	Percentage of pistils with all ovules penetrated by a pollen tube
1	72.41	4.91	1.14	0.11	4.55
2	38.24	18.99	9.00	0.56	31.82
A-Signifinance	**	***	***	***	*

A * Probability = 0.5
** „ = 0.1
*** „ = 0.01

Timing of pollen germination and penetration of the ovule by the pollen tube

Hand pollinations were done using conventional method and pistils were harvested at one hour, three hours, one day and two days after pollinations and observed under the microscope. Labelled open pollinated flowers were also harvested and studied. Clones RRIC 100 and RRIC 121 were used in this investigation. Results are presented in Table 3. Pollen grains had started to germinate on the stigma by 3 hours after controlled pollination in the morning. Penetration of the ovule by pollen tube was observed 24 hours after pollination. There were fewer pollen grains on stigmas of open pollinated flowers than on stigmas of hand pollinated flowers. This number was slightly higher for those flowers kept for 48 hours.

Table 3. *Timing of pollen tube growth*

Time after pollination (hours)	Mean number of pollen grains on stigma	Mean number of pollen tubes in stigma	Mean number of pollen tubes per ovule	Percentage of pistils with all ovules penetrated by a pollen tube
Controlled hand pollination				
1	18.14 ± 7.14	0.00	0.00	0.00
3	14.52 ± 2.45	0.24 ± 0.10	0.00	0.00
24	31.60 ± 3.50	12.67 ± 1.26	0.68 ± 0.05	40.00 ± 7. 3
48	20.16 ± 2.97	7.24 ± 0.91	0.61 ± 0.06	33.33 ± 7. 0
Open pollination				
24	0.53 ± 0.43	0.48 ± 0.43	0.03 ± 0.02	0.00
48	0.90 ± 0.47	0.58 ± 0.31	0.11 ± 0.05	7.50 ± 4.2

Efficiency of the conventional hand pollination technique

In this study flowers of four clones were pollinated by hand. Some flowers were labelled and left unpollinated to study the level of open pollination. Another set of unopened female flowers were just plugged with cotton wool smeared with latex in order to test the effectiveness of this method in preventing stray pollen depositing on stigma. Results are summarised in Table 4. Using the standard method of hand pollination in the morning 36.40% of the observed pistils had all the ovules penetrated by pollen tube and thus can be considered as having the potential to set fruit. In the case of open pollinated flowers only 7.5% flowers had all ovules penetrated.

Table 4. *Efficiency of conventional controlled hand pollination method*

Treatment	Percentage of pistils with no pollen grain on stigma	Mean number of pollen grains on stigma	Mean number of pollen tubes in stigma	Mean number of pollen tubes per ovule	Percentage of pistils with all ovules penetrated by a pollen tube
Conventional controlled hand pollination	7.54 ±1.13	15.60 ±1.09	6.18 ± .28	0.58 ± .02	36.40 ±2.06
Open pollination	85.00 ±5.63	0.90 ± .50	0.58 ± .31	0.11 ± .05	7.50 ±1.16
Unpollinated but plugged with cotton wool	100.00 ±0.00	0.00	0.00	0.00	0.00

Unopened flowers plugged with cotton wool had no pollen deposited on stigma.

Effect of time of pollination

Pollinations were done using the conventional method in the morning. In addition flowers were bagged in the morning and pollinated in the afternoon on the same day, at the time of anthesis, to study the effect of time of pollination on fruit set. In both cases flowers were sealed with cotton wool plugs. Flowers were harvested at 3 hours and 48 hours after pollination and fixed in a liquid medium and observed under fluorescent microscope.

Results are given in Table 5. It is seen from the table that afternoon pollination at the time of anthesis is superior to morning pollination.

Table 5. *Effect of time of pollination on pollen tube growth in pistils*

Time of pollination	Time to fixation (hours)	Mean number of pollen grains on stigma	Mean number of pollen tube in stigma	Mean number of pollen tube per ovule	Percentage of pistils with all ovules penetrated by a pollen tube
Morning	48	15.57	6.45	0.56	34.69
Afternoon	48	12.64	5.98	0.71	62.00
A-Significance		NS	NS	NS	**
Morning	48	15.36	4.76	0.49	24.00
Afternoon	48	26.28	15.46	0.93	80.00
A-Significance		***	***	***	***

A - NS – Not significant
** Probability = 0.1
*** ,, = 0.01

Pollen storage

Male flowers were collected and the staminal columns dissected out and placed in vials. The pollen was stored for 5 days under four combinations of 2 temperatures (5°C and 15°C) and two humidity levels (1% and 75% relative humidity).

Studies revealed that pollen could be stored for 5 days at 5°C and 75% R.H. with 22% loss of viability.

Comparison of self and cross pollination

There was no difference in pollen tube growth in pistils between self and crossed flowers with respect to percentage of penetrated ovules.

Effect of male/female parent on the success of pollination

A range of crosses were carried out using RRIC 100, RRIC 101, RRIC 102 and GT 1 as both male and female parents. The highest potential fruit set was achieved by RRIC 101 as a female parent followed by RRIC 100, RRIC 102 and GT 1. It was observed that GT 1 produced high percentage of abnormal stigmas.

On the basis of findings during 1986 and 1987 flowering seasons, hand pollination in future will be done in the afternoon. (Dr M. Sedgley, D. P. S. T. G. Attanayake, K. W. Rupatunga, and A. K. M. S. Senaratne)

Field Experiments

Breeding, selection and clone evaluation

Hand pollination programme for 1987 (*BST/HPS*/87/1)

In addition to the controlled crosses carried out to study *Hevea* floral biology, crosses of selected parents were made as a part of routine breeding and selection programme. Details are given in Table 6. As seen in Table 6 BPM 24, an Indonesian

clone which has given high yields consistently in all 1974 exchange trials (International clone trials), was crossed with RRIC 121 and RRIC 110. These two clones have given above 3500 kg per hectare per year in our small scale trials and therefore it will be interesting to study the performance of progenies derived by crossing BPM 24 with RRIC 121 and RRIC 110. About 386 seedlings were produced from 1987 hand pollination programme. (N. E. M. Jayasekera, and A. K. M. S. Senaratne)

Table 6. *Details of* 1987 *hand polination programme* (*BST* 1/*HPS*/87/1)

Cross	Site	Number of pollinations	Number of pods harvested	Number of seedlings
RRIC 100 x GT 1	Eladuwa S.P.	3811	50	74
RRIC 100 x RRIC 101	„	279	17	17
RRIC 100 x RRIC 110	„	971	12	16
RRIC 100 x RRIC 121	„	691	23	44
RRIC 101 x GT 1	„	663	26	54
RRIC 102 x GT 1	„	1090	2	6
RRIC 102 x RRIC 101	„	538	Nil	Nil
RRIC 102 x RRIC 110	„	575	Nil	Nil
RRIC 102 x RRIC 121	„	652	Nil	Nil
GT 1 x RRIC 101	„	815	Nil	Nil
GT 1 x RRIC 110	„	202	Nil	Nil
GT 1 x RRIC 121	„	353	Nil	Nil
RRIM 600 x RRIC 101	„	139	14	21
RRIM 600 x RRIC 110	„	40	Nil	Nil
PB 86 x GT 1	„	223	Nil	Nil
PB 86 x RRIC 110	„	1401	Nil	Nil
PB 86 x RRIC 121	„	2214	23	35
RRIC 110 x RRIC 121	Hewagama Estate	810	16	12
RRIC 110 x RRIC 100	„	662	7	13
RRIC 121 x RRIC 110	„	555	47	69
BPM 24 x RRIC 121	„	152	12	23
BPM 24 x RRIC 110	„	62	2	2
Total		16898	251	386

Selection of 1974, 1975 *and* 1978 *hand pollinated* (*H.P.*) *seedlings BST*1/*HPS*/74-75/1 *and BST*/*HPS*/74, 75, 78/1

A *Corynespora* leaf spot disease assessment was made in all small scale trials established to evaluate selections made since 1974. This assessment was done with the help of Plant Pathology Department. Highly susceptible clones in these trials were marked and estates were advised to uproot all highly susceptible new selections and susceptible control clones such as RRIC 103. Details of small scale trials evaluated for *Corynespora* leaf spot disease (CLS) are given in Table 7. Experiments at 3 sites were discontinued. Though none of the new clones at Padukka was affected one of the control clones, RRIC 103, was affected and therefore the estate management was very keen to uproot this experiment. Another reason for this decision was the location of the experimental block of 400 trees which was in the middle of a large RRIC 103 area which had to be uprooted.

Table 7. *Details of* Corynespora *assessment in BST 1/HPS 74–75/1*

Expt. No.	Site	No. of trees planted	Year of hand pollination	No. of susceptible clones removed	Other remarks
BST 1/HPS 74—75/1	Moralioya	52	1974	24	
,,	Yatadola	18	1974	Nil	
,,	Perth	16	1974	13	discontinued
,,	Arapalakanda	18	1974	13	discontinued
,,	Kuruwita	17	1974	06	
,,	Clyde	25	1975	Nil	
,,	Sorana	16	1975	Nil	
,,	Padukka	12	1975	Nil	discontinued

Out of the 69 genotypes (clones) selected from 1974 H.P. seedlings, 30 were susceptible. Their hand pollination numbers and the parentage are given in Table 8. It can be seen that all susceptible clones had RRIC 103 as one of their parents.

Table 8. *H.P. number of* Corynespora *susceptible clones and their parentage*

H.P. Numbers	Parentage
74– 1, 74– 4, 74– 5, 74– 6, 74– 9, 74– 14, 74– 22, 74– 25, 74– 34, 74– 35, 74– 43, 74– 44, 74– 45	RRIC 103 x 8501 (RRIC 52 x FX 360)
74– 58, 74– 90, 74– 91	RRIC 103 x RRIC 101
74– 93, 74–103, 74–111, 74–116, 74–120	RRIC 103 x 2427
74–130, 74–131, 74–140	RRIC 103 x 2418
74 – 141	RRIC 103 x 2417

(Contd.)

74–150, 74–151 } RRIC 103 x 5–90 (45–710 x RRIC 45)

74–154, 74–159, 74–160 } RRIC 103 x 6–704

A girth measurement was recorded from the *Corynespora* tolerant clones. In all the trials RRIC 121, which is one of the control clones, gave the highest mean girth. Mean girth of control clones and the new selections which exceeded the girth of the best control are given in Table 9 for the two trials established in Moralioya Estate and Yatadola S.P. to evaluate 1974 H.P. selections.

Table 9. *Mean girth of control clones and new selections with higher mean girth (BST/HPS/74/1, 2, 3)*

Site			
Moralioya Estate		Yatadola S.P.	
Clone No.	Girth (cm)	Clone No.	Girth (cm)
74—166	70.5	74—208	59.5
74—144	65.2	74—166	59.2
74—157	64.6	74—173	58.6
RRIC—121	64.6	RRIC—121	58.2
RRIC—600	53.1	RRIC—100	51.5
RRIC—100	52.8	RRIM—600	50.0

Trials on Moralioya Estate and Yatadola S.P. were test tapped. At Yatadola trial, RRIC 100 gave the highest yield out of the 3 control clones while at Moralioya the highest yielding clone was RRIC 121. The average yield of the control clones and the new clones that exceeded the best control clone are given in Table 10. It is seen from this table that the three new clones 74 – 193, 74 – 181, and 74 – 213 exceeded the yield of RRIC 121 which had a mean of 45.9 grams per tree per tapping (g/t/t) which could be regarded as high for the first year of tapping.

Table 10. *Mean yield of trials at Moralioya and Yatadola (BST 1/HPS/74—75/1)*

Yatadola		Moralioya	
New clones	Yield (g/t/t/)	New clones	Yield (g/t/t/)
74—173	39.6	74— 90	55.2
74—188	30.1	74—151	50.8
74—192	39.1	74—213	51.0
74—194	34.7		
74—202	33.9	Control clones	
74—204	32.4		
74—207	35.5	RRIC 121	45.9
74—208	31.7	RRIC 100	27.7
74—210	39.3	RRIM 600	29.9
74—213	46.1		
74—218	31.4		
74—220	37.2		
Control clones			
RRIC 121	27.6		
RRIC 100	29.2		
RRIM 600	25.0		

At Yatadola 12 clones yielded more than the average of the best control clone RRIC 100, which yielded 27.6 g/t/t. At Yatadola yield was low compared to Moralioya.

A girth measurement was recorded from the two trials established to evaluate 1975 H.P. selections. Mean girth of control clones and new selections that exceeded the best control are given in Table 11.

Table 11. *Mean girth of control clones and new selection which exceeded the best control clone (BST 1/HPS/75/1, 2)*

Sorana		Clyde	
Clone No.	Girth (cm)	Clone No.	Girth (cm)
75— 79	50.2	75—141	50.3
75—104	50.0	75—240	50.3
75— 71	47.9	75—143	49.8
75— 4	47.4	75—104	49.5
75—117	44.9	75— 79	48.4
75— 36	44.5	75—275	47.8
75—118	44.4	75— 39	46.8
75— 81	44.4	75—232	46.6
75— 40	43.9	75— 71	46.2
75—125	43.5	75— 40	46.1
RRIC 121	43.0	75— 36	45.6
RRIC 130	42.0	75—263	45.5
RRIC 100	38.2	75— 81	45.4
		75—166	45.3
		75—118	45.3
		75— 4	45.0
		75—117	44.5
		75—125	44.3
		RRIC 121	43.5
		RRIC 100	43.1
		RRIC 130	39.6
		RRIM 600	39.2

Evaluation of part of 1974, 1975 *and* 1978 *H.P. selections (BST/HPS/74, 75, 78/1) Paiyagala S.P.*

A girth measurement was recorded in this trial. *Corynespora* leaf spot disease was not observed in this trial. *Corynespora* affected control clone, RRIC 103 was removed. (N. E. M. Jayasekera, K. W. Rupatunga)

1976 *H.P. selections (BST/HPS/76/2) Tempo division, Hill Stream S.P.*

A girth measurement was recorded in this trial. There was no *Corynespora* leaf spot disease among the 29 clones tested in this trial. (N. E. M. Jayasekera, K. W. Rupatunga)

1979 *H.P. seedlings (BST 1/HPS/79/2) Eladuwa S.P.*

A girth measurement was recorded and seedlings were assessed for *Corynespora* leaf spot disease. Parentage of families, family size, mean girth of families and number of *Corynespora* susceptible seedlings in each family are given in Table 12.

Table 12. *Parentage, family size, mean girth and* Corynespora *susceptible seedlings (BST 1/HPS/79/2)*

Families	Family size	Mean girth (cm)	*Corynespora* affected trees
RRIC 101 x RRIM 600	294	51.6	6
RRIC 101 x RRIM 623	2	51.5	Nil
RRIC 100 x RRIM 600	18	55.7	Nil
RRIC 100 x RRIC 101	18	57.0	Nil
RRIC 102 x RRIM 600	26	48.6	6
RRIC 102 x RRIM 623	3	46.5	Nil
RRIC 103 x RRIM 600	9	47.7	4
RRIC 103 x RRIM 623	16	57.4	12
RRIC 103 x RRIC 101	5	57.3	4

These seedlings were brought into tapping towards the end of 1987 and assessment for yields will be undertaken in 1988. (N. E. M. Jayasekera, I. D. M. J. Sarath Kumara and K. W. Rupatunga)

1981 *H.P. seedlings (BST 1/HPS/81/2) Malaboda Division, Eladuwa S.P.*

A girth measurement was recorded in this trial. *Corynespora* susceptible H.P. seedlings were removed. Family and the number of susceptible seedlings removed are given in Table 13. (N. E. M. Jayasekera, K. W. Rupatunga)

Table 13. *Family and the number of* Corynespora *susceptible seedlings (BST 1/HPS/81/2)*

Family	No. of seedlings
PB 28/59 x IAN 45/710	2
RRIC 52 x IAN 45/710	1
PB 28/59 x RRIC 102	6
PB 28/59 x RRIC 52	4
Total	13

Clone evaluation (BST/V/73/37) Bibile Group

In this trial unregistered clone 1461 had the highest mean girth and yield. But the 1987 yield has dropped and this is the general trend in all the clones tested in this trial. This may be due to the fact that the tapping cut is approaching the bud union. Mean yields (g/t/t) and mean girth are given Table 14. (B. M. S. G. Peiris and R. S. K. Ranatunga)

Table 14. *Mean yield (g/t/t) and girth (BST 1/V/73/37), Bibile Group tapped S/2,d/2*

Clone	Trees tapped	No. of plots	Girth (cm) at 150 cm	Yield (g/t/t) 1986	1987
RRIC 110	107—118	3	71.6	60.9	51.8
1461	100—130	4	71.4	62.0	49.1
RRIC 112	155—190	4	68.6	46.0	43.3
RRIC 102	120—161	3	66.3	56.3	37.9
RRIC 117	39— 65	3	68.6	44.7	37.3
506	58— 92	3	59.9	42.0	36.0
RRIC 105	88—136	3	69.4	35.3	25.9

Evaluation of Ivory Coast clones (BST/ICC/85/2) Paiyagala S.P.

A girth measurement was recorded in this trial where 17 clones imported from Ivory Coast are tested. There was no *Corynespora* observed in this trial. RRIC 103 was removed from the trial. (N. E. M. Jayasekera and K. W. Rupatunga)

Clone trials at Kuruwita Sub-station (BST 1/VSM/67/5, BST 1/VSM/68/21 and BST 1/VSM/69/28)

All these trials are small scale trials and the mean yield and girth of experiment BST 1/VSM/67/5 are given in Table 15 along with the number of dry trees. As in last year highest average yield and mean girth were recorded by RRIC 121 which gave nearly twice the yield of RRIM 623 which was the second highest yielding clone.

Table 15. *Mean yield and girth (BST 1/VSM/67/5) Kuruwita Sub-station tapped S/2,d/2*

Clone	Trees tapped	Girth (cm) at 150 cm	Yield (g/t/t) 1986	1987	No. of dry trees
RRIC 121	17	105.4	87.5	75.1	04
RRIM 623	27	77.1	44.2	39.0	02
10727	15	72.2	62.5	34.6	02
7281	16	86.6	34.1	31.7	03
RRIC 122	05	75.0	38.9	29.8	01

In the second trial BST/1/VASM/68/21 ten RRIC 100 series clones are tested along with one unregistered clone and RRIC 45. In 1987 RRIC 121 continued to be the highest yielding clone followed by the unregistered clone 6–541. Yields of some clones particularly that of RRIC 131 and RRIC 133 have dropped when compared with last year as the tapping cut approached the bud union. Mean yield and girth for 1986 and 1987 are given in Table 16.

Table 16. *Mean yield and girth (BST 1/VSM/62/21 Kuruwita sub-station tapped S/2 d/2*

Clone	Parentage	Trees tapped	Girth (cm) at 150 cm	Yield (g/t/t) 1986	1987	No. of dry trees
RRIC 121	PB 28/59 x IAN 873	6	116.0	136.4	129.0	Nil
6–541	RRIC 36 x RRIC 36	7	88.8	75.3	79.2	Nil
RRIC 102	RRIC 52 x RRIC 7	18	85.8	68.9	78.0	8
RRIC 131	PB 86 x F 1633	7	83.2	81.5	76.7	1
RRIC 123	IAN 710 x CH 26	12	95.7	78.7	70.2	4
RRIC 133	IAN 710 x RRIC 45	8	119.3	94.9	69.3	Nil
RRIC 130	IAN 710 x RRIC 52	7	79.7	66.8	60.3	1
RRIC 113	RRIC 52 x RRIC 36	7	87.8	61.0	58.2	1
RRIC 110	LCB 1320 x RRIC 7	11	91.8	59.2	57.2	1
RRIC 112	RRIC 41 x CH 26	16	81.0	45.8	51.9	1
RRIC 120	RRIC 36 x FX 516	16	78.6	45.9	46.7	3
RRIC 45	RRIC 8 x TJIR 1	17	76.4	45.3	37.9	8

In experiment BST 1/VSM/69/28 ten clones are tested and six of them are RRIC 100 clones while the remaining ones are unregistered clones. In this trial RRIC 126 recorded highest mean yields followed by RRIC 128. RRIC 128 recorded the highest mean girth. Mean girth and yields are presented in Table 17. (N.E.M. Jayasekera, B. M. S. G. Peiris and R. A. S. K. Ranatunga)

Table 17. *Mean yield and girth (BST 1/VSM/69/28) tapped S/2, d/2*

Clone	Parentage	Trees tapped	Girth (cm) at 150 cm	Yield (g/t/t) 1986	Yield (g/t/t) 1987	No. of dry trees
RRIC 126	CH 26 x RRIC 111	14	90.9	102.5	82.1	03
RRIC 128	RRIC 102 x CH 26	17	92.0	82.5	70.5	02
7–1189	RRIC 102 x RRIC 89	16	74.2	62.8	53.9	05
7–1415	RRIC 86 x CH 26	15	81.3	56.8	46.6	03
7–1413	RRIC 89 x CH 26	18	82.9	52.0	44.5	02
6– 746	IAN 710 x CH 26	13	87.4	60.4	40.2	04
RRIC 125	RRIC 102 x RRIC 89	14	71.2	53.1	37.8	Nil
RRIC 127	CH 26 x 1458	10	75.8	54.4	36.8	04
RRIC 124	CH 26 x RRIC 111	16	72.2	45.5	35.7	04
RRIC 129	CH 26 x RRIC 100	10	82.0	47.0	33.2	03

Miscellaneous clone trials

International clone trial Hewagama Estate (BST 1/ICT/78/2 and BST 1/ICT/79/2)

A girth measurement was recorded in 1987. In 1978 area, RRIC 110 recorded the highest mean girth followed by RRIM 703. In 1979 replanting RRIC 121 recorded the highest average girth followed by RRIC 100. With respect to yield again RRIC 110 had the highest mean yield of 30 g/t/t in 1978 replanting. In 1979 area BPM 24 recorded the highest yield. Average girth and mean yields, are given in Table 18. In this trial RRIC 103 and RRIC 107 were affected with *Corynespora* leaf disease and were uprooted. The other two *Corynespora* susceptible clones, RRIM 725 and RRIC 118, so far did not show any attack of *Corynespora* leaf spot disease. (N. E. M. Jayasekera, D. P. S. T. G. Attanayake, B. M. S. G. Peiris and R. A.S. K. Ranatunga)

Table 18. *Mean girth and mean yields (g/t/t), (BST/ICT/78/2) and (BST 1/ICT/79/3)*

Year of planting	Clone	Trees tapped	Girth (cm) at 150 cm	Yield(g/t/t)
1978	RRIC 110	88— 97	58.8	30.7
1979	BPM 24	23— 57	44.6	28.2
1978	RRIM 703	103—111	55.1	25.9
1978 & 1979	RRIM 600	100—122	49.8	23.1
1979	RRIC 117	31— 62	46.6	22.7
1978 & 1979	RRIC 100	98—115	52.6	22.6
1978	RRIM 722	37— 43	54.1	21.1
1979	RRIC 121	75— 94	54.1	20.5
1979	BPM 22	66— 92	49.8	19.1
1978	PR 306	99—110	54.9	16.1
1979	BPM 3	18— 24	46.2	10.3

Rootstock—scion trial (SC/76/1) Rathmehera Estate and Gasnawa Estate

Two clones RRIC 52 and unregistered clone 1004, out of the four clones planted, were found to be susceptible to *Corynespora* leaf spot disease. In addition to this RRIC 103 planted as guard rows too were affected. The estate management was keen to uproot this area and replant with tolerant clones. Therefore permission was given to uproot the trial. (N. E. M. Jayasekera and K. W. Rupatunga)

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

Eleven clones are tested in this trial. Four of them, RRIC 103, RRIC 104, RRIC 107 and RRIC 118 are highly susceptible to *Corynespora* leaf spot disease. Estates were advised to uproot them. Since there will be vacant patches once these clones are uprooted, data will not be amenable to statistical analysis. Therefore, it was decided to discontinue this trial. Girth and yield data collected from two experimental sites are given in Table 19. (N. E. M. Jayasekera, K. W. Rupatunga, I. D. M. J. Sarath Kumara)

Table 19. *Mean girth and mean yields of BST/CET/79/1*

Clone	Mean girth (cm)		Mean yield (g/t/t)	
	Hathbawa Estate	Eladuwa S.P.	Hathbawa Estate	Eladuwa S.P.
RRIC 100	55.9	56.7	22.4	27.1
RRIC 101	55.7	57.1	25.3	32.6
RRIC 102	60.6	60.8	25.1	29.9
RRIC 105	56.9	59.1	11.5	16.0
RRIM 600	54.2	56.2	22.1	27.3
PB 86	51.4	50.6	18.6	23.3
GT 1	53.2	53.7	19.9	19.8

Genotype—environment interaction studies

RRIC 103 at some sites was affected with *Corynespora* leaf spot disease. In those sites trees were marked and estates were advised to uproot them.

A girth measurement was recorded and average girth of each clone at each site are given in Table 20. RRIC 52 recorded the highest mean girth. Even though RRIC 103 was affected it had the second highest mean girth when averaged over all sites. Other interesting feature is that less vigorous clones such as PB 86, IAN 45/710 and RRIM 600 have now caught up with average girth of vigorous clones such as RRIC 100 and RRIC 102 which showed high average mean girth prior to opening of tapping cuts.

Table 20. *Mean girth (GE/75/1)*

Clone	Girth (cm)							
	Miriswatte	Bentota	Densworth	Golinda	Monrovia	Hunuwella	Bibile	Clone mean
PB 86	71.9	68.0	67.8	71.7	65.4	64.9	54.3	66.28
RRIC 100	64.1	66.9	64.6	60.1	63.2	58.3	59.8	62.42
RRIC 101	63.2	63.6	69.7	58.5	64.6	63.9	59.7	63.31
RRIC 103	79.2	79.0	75.2	66.1	77.9	74.4	74.2	75.14
RRIC 52	83.9	90.0	87.8	72.7	81.3	78.2	78.0	81.70
RRIM 600	72.5	78.9	74.8	70.7	71.6	70.6	66.1	72.17
RRIC 36	59.1	67.9	69.6	62.5	66.5	56.0	62.7	63.47
RRIM 623	70.0	78.5	75.5	69.0	71.2	73.1	73.4	72.59
RRIC 102	65.7	70.4	69.6	58.2	64.3	68.5	69.5	66.6
IAN 45/710	80.0	80.5	76.4	68.4	69.8	74.2	68.2	73.92
Site mean	70.96	74.37	73.1	65.79	69.58	68.21	66.59	69.80

Table 21. *Mean yield* (GE/75/1)

Clone	Miriswatte	Bentota	Densworth	Golinda	Monrovia	Hunuwella	Bibile	Clone mean
PB 86	41.1	30.2	31.4	24.9	29.3	21.8	32.1	30.1
RRIC 100	31.2	34.0	36.1	24.8	32.2	18.0	36.5	30.4
RRIC 101	30.6	23.3	42.9	14.3	29.4	20.2	35.0	27.9
RRIC 103	57.2	49.3	51.0	22.0	51.4	39.1	41.5	44.5
RRIC 52	27.2	32.5	32.5	15.4	24.9	22.6	20.5	25.0
RRIM 600	52.0	56.4	52.0	34.9	40.1	38.6	43.5	45.4
RRIC 36	21.6	33.8	36.1	26.5	31.9	17.2	43.2	30.0
RRIM 623	37.7	26.8	45.1	15.6	34.5	18.2	32.6	30.0
RRIC 102	35.3	39.1	38.5	23.1	31.0	33.7	39.7	34.3
IAN 45/710	61.3	57.5	47.1	26.9	38.6	30.0	37.4	42.6
Site mean	39.5	38.2	41.2	22.8	34.3	25.9	36.2	34.0
No. of test tappings	7	9	6	6	9	8	7	

Mean yield data collected from this experiment are given in Table 21. This year there is a slight drop in yields, of RRIC 100 and RRIC 102 when averaged over all sites while that of RRIM 600 remained more or less same and the yield of IAN 45/710 increased from 36.68 g/t/t to 42.6 g/t/t. (N. E. M. Jayasekera, K. B. Karunasekera, K. W. Rupatunga and I. D. M. J. Sarath Kumara)

IRRDB germplasm collection (*GPC/85/2*)

A total of 5323 IRRDB germplasm clones were received from RRI Malaysia, in 1987. These clones were budgrafted on rootstock seedlings. A part of the Dickhena Division of Neuchatel S.P. was acquired, on long term lease, to establish germplasm clones. Another 4000 clones are expected in 1988.

The clones received in 1987 have been established in multiplication nurseries developed at Dickhena Division. (N. E. M. Jayasekera, D. P. S. T. G. Attanayake, K. B. Karunasekera)

REVIEW OF THE PLANT PATHOLOGY DEPARTMENT

BY

A. de S. LIYANAGE

SUMMARY

The work in the Department was concentrated mainly on CLS disease, which has affected immature and mature rubber plantations of all rubber growing, districts. High priority was given to all aspects of work connected with this disease. An extensive survey of all smallholdings and clearings planted with RRIC 103 in the state sector plantations have shown that up to the end of this year approximately 2409 ha in the state sector and 1623 ha in the private sector were affected by this disease. A total of 3571 smallholdings were inspected and permits issued to 2705 holdings covering about 1620 hectares, recommending them to uproot infected trees. Although four fungicides were found to be effective, repeated application over long periods was required for effective control of the disease. An economic analysis revealed that replacing susceptible clones with tolerant clones was more advantageous. Unlike in other fungi, the causal organism of this disease produces a potent toxin, causing rapid defoliation.

Pueraria phaseoloides produced the maximum yield when the plants were supplied with 87.5 ppm nitrogen as ammonium nitrate. When the soil is supplemented with 35 and 70 ppm nitrogen the photosynthetic rate increased significantly.

Highest number of VA mycorrhizal spores were present in soil at 0–10 cm depth. There is a marked increase in spore numbers in soils collected from bare land. *Gigaspora aurigloba* was found for the first time, from local sand in soils collected from Monrovia Estate.

DETAILED REVIEW

Staff

The Head of the Department and Director Dr A. de S. Liyanage, Mr C. K. Jayasinghe, Dr (Mrs) N. I. S. Liyanage, Mr R. Jayaratne Assistant Plant Pathologists ; Messrs W. Amaratunga, S. Wettasinghe, B. Fernando, Senior Technical Officers; Messrs S. S. Warnapura, E. A. T. Senadheera, Mrs P. C. Wettasinghe, Technical Officers and Mrs P. Amarasekera, Clerk/Typist were on duty throughout the year. Dr (Mrs) N. I. S. Liyanage attended the International Congress of Plant Protection held in Manila, Philippines from the 5 – 8 October 1987, Mr R. Jayaratne went on a study tour on *Corynespora* leaf spot disease to Indonesia and Malaysia from the 7 March to 16 March 1987.

Research students

Mr M. A. P. K. Seneviratne, temporary research student funded by the Rubber Research Institute and Miss B. M. S. Geetha Kanthi of Ruhuna University successfully completed their research projects entitled "*Phytophthoras* of cocoa, its taxonomy, biology and resistance mechanisms" and "The effect of soil and fertilizer nitrogen on growth and nodulation of *Pueraria phaseoloides* (ROXB) Benth" respectively. Mr Seneviratne obtained a MSc degree from the University of Peradeniya.

Under the National Apprenticeship Board scheme, six students from the Hardy Technical College, Ampara were trained.

Mr V. Perera, Research student funded by the NARESA continued his work, for a post-graduate degree.

Visits

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

Experimental	94
Advisory	624
Miscellaneous	108

Meetings

Mr C. K. Jayasinghe, Dr (Mrs) N. I. S. Liyanage and Mr R. Jayaratne participated in field days organised by the RRI for SLSPC II, JEDB 1 and JEDB IV, and also attended the field day organised by SLSPC IV to specifically discuss all aspects of *Corynespora* leaf spot disease.

Training

Mr C. K. Jayasinghe, Mrs N. I. S. Liyanage, Mr R. Jayaratne were involved in the following training programmes.

1. Diploma in Plantation Management
2. Training course in Plant Pathology for officers of the Agricultural Development Authority, Rubber Extension Officers, Rubber Extension Assistants.

Publications

Fernando, E. B. and Hashim I. (1986). Reaction of oriental *Hevea* clones to isolates of *Mycrocyclus ulei* and the response of isolates to fungicides. (submitted for printing)

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Liyanage, A. de S., Jayasinghe, C. K., Liyanage, N. I. S. and Jayaratne, A.H.R. (1986). *Corynespora* leaf Spot disease of rubber (*Hevea brasiliensis*) – a new record. *Jl. Rubb. Res. Inst. Sri Lanka*, **65**, 47–50.

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Liyanage, N. I. S. and Wheeler, B. E. J. Survival of propagules of *Phytophthora meadii* in Sri Lanka soils. (in press)

Liyanage, N. I. S. and Wheeler, B. E. J. *Phytophthoras* on rubber (*Hevea brasiliensis*. Meull. Arg.) *Worldwide*. (in press)

Liyanage, N. I. S. and Wheeler, B. E. J. *Phytophthora castaneae* on cocoa – A new record. (in press)

Nugawela, A., Jayasinghe, C. K., Aluthhewage, R. and Wettasinghe S. (1985). Effect of different levels of supplimental nitrogen on CO_2 assimilation rates and productivity of *Pueraria phaseoloides* (Toxb) Benth and *Desmodium ovalifolium* (Prain) Wall ex Ridely grown in Agalawatta series soil. *Jl. Rubb. Res. Inst. Sri Lanka* **64**, 21–28.

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General

Corynespora leaf spot disease spread rapidly in rubber estates, reaching epidemic proportions during the year. The clone RRIC 103 was highly susceptible to the disease and almost all RRIC 103 trees were affected in the rubber growing regions of Kalutara, Ratnapura, Kelani Valley and Galle, whilst less damage was seen in dry areas of Kegalle, Bibile and Moneragala.

The entire staff of the Plant Pathology Department in collaboration with the officers of the Plant Science and Plant Breeding Departments, concentrated on carrying out work connected with this disease. An islandwide survey was carried out to assess the incidence of the disease in both state plantations and smallholdings. It was found that approximately 1620 and 2400 ha were affected in the smallholding and the state sector, respectively.

In the case of the smallholdings an operation was launched to eradicate the susceptible clones and replace the affected area using tolerant clones, with the assistance of the Advisory Services Department and the Rubber Control Department. In the state sector each estate was inspected to assess the incidence of the disease and methods adopted to overcome this problem were explained. The recommendations laid down by the Rubber Research Institute to eradicate CLS disease is now being implemented. An advisory circular on *Corynespora* leaf spot disease and its control was prepared during this year.

Incidence of the *Oidium* leaf disease was mild in most areas as dry weather prevailed during the period of refoliation but at higher elevation the disease was severe. During July, August and September a high incidence of *Phytophthora* leaf fall was observed in Ratnapura, Kalutara and Kelani Valley regions, due to the heavy build up of inoculum on pods during rainy periods.

Laboratory Investigations

Studies on *Corynespora cassiicola* (C/85/1)

Clonal screening

A detached leaf technique was developed to assess the clonal susceptibility under laboratory conditions using a standardized spore suspension. A spore concentration of 1000 spores/ml was found to be suitable for this test. Typical symptoms of the disease were produced on detached apple green leaves and not on mature leaves. It was found that leaves removed 3 weeks after bud burst are suitable for artificial inoculation. Clones RRIC 103, 104, 106, 107, 118, 52 were found to be highly susceptible to the disease. (A. de S. Liyanage and N. I. S. Liyanage)

Sporulation of Corynespora cassiicola

Production of a large number of spores in the laboratory was a problem encountered with *C. cassiicola.* Different media lima bean agar (LBA), potato dextrose agar (PDA), proline sucrose agar, potato sucrose agar, Sach's agar (SA), carrot agar (CA) and several other liquid media were tested for growth and sporulation. This fungus grew well on PDA without producing spores. Of the media tested potato sucrose agar and CA produced a large number of spores only after they were subjected to scraping, washing and slow dessication 2 weeks after vegetative growth. A second crop of spores was also obtained after a further period of 3 days. Sach's agar and proline sucrose agar did not give the desired number of spores as potato sucrose agar or CA. Varying periods of black light treatment and fluorescent light treatment did not induce sporulation in *Corynespora cassiicola.* (N. I. S. Liyanage and A. de S. Liyanage)

Leachate studies

Leaf leachates of the clones PB 86, RRIC 52, RRIC 100, and RRIC 103 were collected at 24, 48, 72 and 96h. Bioassays were done with spores of the fungus. Spores germinated better in RRIC 103 and RRIC 52 leaf leachates indicating that there is no inhibitory substance being produced. Although other clones gave a lower germination percentage, the differences were not marked. However, the germ tube length was markedly high in RRIC 52 leaf leachates. (N. I. S. Liyanage and A. de S. Liyanage)

Toxin production

Crude toxin obtained from culture filtrates of *C. cassiicola* causes a lesion similar to that observed under field condition. A method has been developed to use the crude toxin in clonal screening tests. Toxin when injected to polybagged plants of susceptible clones caused defoliation within 1 week of injection of the toxin. Experiments are in progress to identify the toxin. (N. I. S. Liyanage and A. de S. Liyanage)

Host-parasite relationships

The fungus germinated in 3–4 h and entered palisade cells inbetween epidermal cells and ramified intercellularly producing conidia at the opposite leaf surface 96h after inoculation. (A. de S. Liyanage, N. I. S. Liyanage and P. C. Wettasinghe)

Pathogenicity

Pathogenicity of *Corynespora cassiicola* was tested on hosts other than *Hevea.* It was observed that an isolate obtained from *Hevea* is highly pathogenic on papaw. A mild infection was seen on Mikania a weed usually present in rubber plantations. The fungus was not pathogenic on the cover crops *Pueraria phaseoloides* and *Centrocema pubesence.* (N. I. S. Liyanage and A. de S. Liyanage)

Field Investigations

Corynespora cassiicola (C/85/1)

Clonal screening

After the appearance of CLS disease, a programme of clonal screening was carried out under field conditions on 31 RRIC clones in 12 nurseries located in different agro-climatic conditions. In another investigation at Dartonfield Estate 109 rubber clones were screened. The following clones were found to be highly susceptible to *Corynespora* leaf spot disease, RRIC 52, 103, 104, 106, 107, 118, NAB 12, IAN 873, Tjir 1 and RRIM 725. Clone PB 86 which is widely grown in Sri Lanka and RRIC 100 also showed slight spotting on leaves in the field in certain locations without causing any defoliation. (A. de S. Liyanage, S. Wettasinghe and S. S. Warnapura)

Disease incidence

An island-wide survey was conducted to assess the disease incidence in both state plantations and smallholdings. A financial analysis carried out on *Corynespora* leaf spot disease control, revealed that it would be more economical to uproot and replace with resistant clones than continuously control the disease. (A. de S. Liyanage, S. de Silva and H. Talgaswatta)

RRI/ASD/RCD joint programme on CLS disease

With regard to the smallholdings a programme was launched to eliminate the susceptible clones and replace the affected area using tolerant clones with the collaboration of officers in the Advisory Services Department and the Rubber Control Department. This programme was conducted in all rubber growing areas and todate 3571 smallholdings have been inspected and 2705 certificates were issued covering about 1623 hectares recommending to uproot the infected trees for which a permit has to be obtained from officers of the Rubber Control Department. This programme is still in progress and the details are given in Table 1. (C. K. Jayasinghe, A. de S. Liyanage, N. I. S. Liyanage, R. Jayaratne, C. Sarmaranayake, N. E. M. Jayasekera, S. Wettasinghe, S. S. Warnapura, E. A. T. Senadheera, B. Fernando, B. Amaratunge, S. L. G. Ranjith, R. Samaradiwakara, A. Weerakoon and M. Peiris)

Table 1. *Incidence of CLS disease in smallholdings*

DREO range	No. of holdings visited	No. of permits issued	Area to be replanted (ha)
Agalawatta	391	362	171.38
Bulathsinhala	311	228	128.52
Kalutara	342	296	230.53
Horana	529	339	141.02

(*Contd.*)

Ratnapura	239	177	124.31
Kiriella	323	202	147.34
Nivitigala	81	70	60.10
Homagama	305	265	134.30
Gampaha	119	92	106.35
Hanwella	249	234	106.20
Elpitiya	143	70	53.34
Galle	62	22	27.27
Kegalle	91	51	26.43
Dehiowita	262	191	99.92
Warakapola	48	40	23.33
Ruwanwella	76	66	43.08
Total	3571	2705	1623.42

CLS disease survey in state plantations

A survey has been conducted in all rubber growing areas to study the extent affected with CLS disease in state plantations during the early part of 1987. After studying the results of this survey it was decided to advise each estate regarding the steps which should be adopted to eradicate *Corynespora* leaf spot disease. This programme is in progress and the results of the preliminary survey are summarised in Table 2. (A. de S. Liyanage, C. K. Jayasinghe, C. Samaranayaka, E. A. T. Senadheera, B. Gunaratne, A. Weerakoon, R. Samaradiwakara, S. L. G. Ranjith and M. Peiris)

Table 2. *Incidence of CLS disease in state plantations*

Region	Area under RRIC 103(ha)
Horana	758.53
Avissawella	785.31
Kegalle	363.82
Ratnapura	282.20
Galle	219.48
Total	2409.34

Control

Thermal fogging using "Leco" 120–D

Eight *Corynespora* infected RRIC 103 fields at five different estates *viz*. Dartonfield, Hedigalla, Elston, Padukka and Peenkanda were fogged using "Leco" 120–D thermal fogging machine. The fungicides, Dithane M 45, Benlate and Antracol were mixed with a lower grade of coconut oil for spraying. The concentration of fungicide varied from 100g/ha to 1 kg/ha. Fungicides were fogged at 6–day intervals for 4–5 rounds.

Visual observations were done once a week at Dartonfield and Hedigalla Estates. All new leaves showed disease symptoms when they were semi-mature. Most of the tender leaves too were infected resulting in complete defoliation. Similar, observations were made in other estates as well. (R. Jayaratne, A. de S. Liyanage, S. S. Warnapura and B. Fernando)

Thermal fogging using 'Pulsfog' K-20

Two infected fields were fogged using a 'Pulsfog' fogging machine with the fungicides Calixin and Difolatan separately. A lower grade of coconut oil was used as spray oil. Fogging was done at 5–6 day intervals for 4–5 applications. This operation too was unsuccessful in controlling the disease. (R. Jayaratne, A. de S. Liyanage, S. S. Warnapura, B. Fernando)

Spraying with Mistral dusting machine

Three estates, Polgahakanda (Private), Dartonfield, and West Charley Mount Estates were sprayed with fungicides using a Mistral dusting machine with a spray attachment.

At Polgahakanda Estate a block of 7 acres in the 1982 replanting was sprayed with Dithane M 45 at 0.3% concentration at 6-day intervals for 7 rounds.

No satisfactory control was achieved. Complete defoliation occurred about one week after completion of fungicide application. (R. Jayaratne, A. de S. Liyanage, E. A. T. Senadheera)

In the experiment at Dartonfield Estate, the 1983 replanting was divided into four blocks and the following fungicides were sprayed singly or alternately at 3–4 day intervals.

Dithane M 45	—	continuously	at 0.3%	concentration
Antracol	—	„	at 0.4%	„
Dithane/Benlate	—	alternately	0.3%	„
Captan/Benlate	—	alternately	0.3%	„

There were about 200–225 trees per each treatment. Only 8 applications of the fungicide could be done as the sprayer was out of order.

During this period Antracol gave a very good control of the disease. As soon as the fungicide application was stopped the leaves were affected and in about a week complete defoliation was observed in all treatments. This experiment clearly showed that continuous application of fungicides was required if *Corynespora* leaf disease was to be controlled. (A. de S. Liyanage, N. I. S. Liyanage, R. Jayaratne, S. Wettasinghe)

Experiments conducted at West Charley Mount Estate, an infected field of 3 acres in the 1982 replanting was artificially defoliated using a 2% 2.4.5.T in oil. A Mistral dusting machine with a spray attachment was used to spray the defoliant.

This was followed by spraying two rounds of Benlate (0.3%) at 5-day intervals. Antracol (0.3%) was sprayed at 5-day intervals continuously for 3 months. All fallen leaves on the ground were sprayed with Dithane M45 and were subsequently collected and burnt.

Complete defoliation was observed two weeks after spraying the defoliant. Few lower most small branches showed signs of dieback.

No satisfactory control was observed inspite of the continuous applications of fungicides for 3 months. (A. de S. Liyanage, R. Jayaratne and E. A. T. Senadheera)

Base budding

Two fields of RRIC 103 which were uninfected were base budded at South Charley Mount Estate and in West Charley Mount Estate, Weligama.

In South Charley Mount Estate two rounds of budgrafting were done using clone RRIC 102 budwood in a 5 Ac. area in 1984 replanting.

Total number of plants base budded	844
Total number of successful graftings	746
Percentage success obtained	88%

In West Charley Mount Estate two rounds of budgrafting were done using clone PB 86 budwood in a 4 Ac block in 1984 replanting.

Total number of plants base budded	632
Total number of successful graftings	524
Percentage success obtained	83%

This experiment indicated that it was possible to bud a tolerant clone before the leaves were defoliated by the fungus. (A. de S. Liyanage and R. Jayaratne)

Rigidoporus lignosus (*F*/76/7)

Several infected trees in Padukka State Plantations were drenched thrice with 10 litres of 0.04% solution of Morut 80% w.p. It was observed that *Rigidoporus* mycelium grew over the surface of the roots inspite of the presence of the fungicide. (A de S. Liyanage and S. S. Warnapura)

Studies on nitrogen fixation of leguminous cover crops (Nfxn/84/1)

An experiment was conducted in 5 kg pots to find the critical level of nitrogen (NH_4NO_3) inhibitory to nodulation of *Pueraria phaseoloides* and to study the change in the photosynthetic rate and growth of *P. phaseoloides* with the addition of fertilizer nitrogen.

P. phaseoloides produced the maximum yield when these plants were supplied with 87.5 ppm N as NH_4NO_3. Furthermore, percentage nitrogen content in the tissue also increased significantly ($P < 0.05$) when nitrogen fertilizer concentration was around 87.5 ppm.

In these pot experiments inherent combined soil nitrogen provided the optimum condition for nodulation in *Pueraria* and addition of fertilizer nitrogen beyond 17.5 ppm had inhibitory effects. Nodulation in *P. phaseoloides* was completely inhibited when fertilizer nitrogen was added at a concentration of 140 ppm to Agalawatta series soil.

When soil is supplimented with 35 and 70 ppm N, the photosynthetic rates increased significantly ($P < 0.05$). Further, increases resulted in a significant decline in photosynthetic rates. (C. K. Jayasinghe, A. Nugawela, B. M. S. Githakanthi)

Investigations on mycorrhizae (My/85/1)

Distribution of VA mycorrhizal spore numbers

Soil samples collected from six different rubber growing soils namely Boralu, Agalawatta, Ratnapura, Homagama, Parambe and Matale series were analyzed for the VA mycorrhizal spore types and their numbers (Table 3). Soils were also analysed for their major nutrients N, P, K and the pH was also determined.

Table 3. *Number of VA mycorrhizal spores*

Estate	Soil depth (cm)	Under cover No. spores	Bare land No. spores
	0–10	1217	1826
Monrovia	10–20	349	686
(Boralu series)	20–30	253	355
dry area	30–40	123	160
	40–50	27	79
	0–10	627	1320
Muwankanda	10–20	316	263
(Parambe series)	20–30	334	215
dry area	30–40	107	131
	40–50	47	65
	0–10	575	1742
Wariyapola	10–20	159	334
(Matale series)	20–30	128	276
	30–40	105	83
	40–50	60	57

(Contd.)

Pitiyakande	0–10	638	3118
(Homagama series)	10–20	359	934
dry area	20–30	314	802
	30–40	219	451
	40–50	56	316
Parambe	0–10	315	492
(Parambe series)	10–20	283	147
	20–30	245	207
	30–40	72	404
	40–50	69	118

It is confirmed that in all the soil samples that have been analysed the most number of spores were present in the 0–10 cm depth. There is a gradual decrease in spore numbers with the increase in depth. Bare land shows a higher number of spores than land which is under a cover. *Glomus fasiculatum*, *Glomus macrocarpum*, *Glomus multiculis*, and *Glomus mosseae* are the most abundant spore types in all these sites. *Gigaspora gigantea*, *Sclorocystis clavispora*, *Sclerocystis coremoioides*, *Acaulospora elegans*, *Acaulospora scrobicalata* were also present in lesser numbers.

Gigaspora aurigoloba was found for the first time from Sri Lankan soils in soil collected from Monrovia Estate (Boralu series, dry area). (A. H. R. Jayaratne, A. de S. Liyanage and P. C. Wettasinghe)

Production of VA mycorrhizal inoculum

A small scale pot experiment was carried out to explore the possibility of producing VA mycorrhizal inoculum in large quantities using coir dust. Autoclaved coir dust was used as the potting medium. Sands obtained from green-house pot cultures (*Gigaspora margarita*) were used as the inoculum. *Pueraria* seeds were grown on these pots with and without VA mycorrhizal inoculum. Plants were allowed to grow for six months.

Roots were observed for VA mycorrhizal infection. All inoculated pots had over 80% VA mycorrhizal infection while uninfected once did not have any infection. In infected pots coir dust was tested for the production of new spores. It was very interesting to note that not a single spore was found in these pots. This proves that under very high levels of organic matter there is no need for the fungus to produce any extra matrical spores which are mainly resting spores to survive under adverse conditions.

Therefore, it was concluded that coir dust alone would not be an ideal potting medium to produce VA mycorrhizal inoculum in large quantities. (A. H. R. Jayaratne and P. C. Wettasinghe)

Construction of phosphorus response curves for mycorrhizal and non-mycorrhizal Pueraria *plants*

Mycorrhizal and non-mycorrhizal *Pueraria* plants were grown at 5 different levels of added phosphorus as KH_2PO_4. Plants were allowed to grow for 3 months and the dry weight of shoots and roots were measured separately. Nutrient contents in shoots were also determined.

Table 4. *Mean shoot dry weight (g) per pot*

Treatment	Dry wt (g)	Treatment	Dry wt (g)
MP_1	1.330	M_0P_1	10.26
MP_2	10.928	M_0P_2	7.934
MP_3	12.946	M_0P_3	10.863
MP_4	11.017	M_0P_4	10.266
MP_5	10.171	M_0P_5	8.588

(SE $\pm$ 0.531) Between M and M_0
(LSD (5%) 1.073)

(SE $\pm$ 0.839) Between P levels
(LSD (5%) 1.695)

M — Mycorrhizal plants
M_0 — Non-mycorrhizal plants

P_1 — 0
P_2 — 0.5
P_3 — 1.0
P_4 — 1.5
P_5 — 2.0

g/pot of KH_2PO_4

There is a significant increase in growth of mycorrhizal plants from P levels 0.25g to 1.25g. Maximum growth response due to mycorrhizal association is shown at a P level 0.65g. There is a growth depression above the P levels 1.00 g. This depression is seen on both mycorrhizal and non-mycorrhizal plants. This decrease could be due to P – induced Zn – deficiency as suggested by D. A. Stanton *et. al.* in 1970. It could even be due to direct toxicity of high concentrations of Po^{2-}_4 ions to plants. Therefore, when working on VA mycorrhizal *Pueraria* plants, the ideal level of soil phosphorus would be around 0.65 g, and it is important to avoid P levels above 1.0 g/1.5kg of soil. (A. H. R. Jayaratne, and P. C. Wettasinghe)

Miscellaneous

Litter fall (VP/85/1)

Litter fall was recorded for a 2 year period and the analysis of the data are in progress. (V. Perera, N. Gunatillaka, A. de S. Liyanage and S. Pushpakumara)

Ground vegetation (VP/85/4)

Biomass studies were completed for all weeds and grounds covers. (V. Perera, N. Gunatillaka, A. de S. Liyanage and S. Pushpakumara)

Soil analysis VP/85/8

The major nutrients, organic carbon, cation exchange capacity were determined for 5 sites. (V. Perera, N. Gunatillaka, A. de S. Liyanage and S. Pushpakumara)

Collar rot of rubber seedlings caused by *Sclerotium rolfsii* (Mis/87/1)

During October 1987, a root rot disease of rubber seedlings was observed in seed germination beds, in the Rubber Control Department nursery at Urapola, Attanagalla. The pathogen was isolated and sent to the CMI for identification. The causal organism was identified as *Sclerotium rolfsii* sacc. (Perfect stage *Corticium rolfsii*) and its pathogenicity confirmed by fulfilling Koch's postulate. The most conspicous symptom was the yellowing of leaves, followed by collapse of plants. Seedling, affected by this disease showed typical rotting of the stem at the collar region and the presence of white cottony mycelium on the stem and the sead coat. Experiments on the control of the disease are in progress. No such disease has been previously reported on this crop in Sri Lanka. (C. K. Jayasinghe, A. de S. Liyanage, S. S. Warnapura)

REVIEW OF THE SOILS AND PLANT NUTRITION DEPARTMENT

BY

N. YOGARATNAM

SUMMARY

Research on improvement of soil fertility, increasing efficiency of nutrient uptake, economizing on fertilizer use, better methods of soil, water nutrient conservation and weeds and weed control have been the main objectives of this Department.

Responses to fertilizer application have been obtained in both immature and mature rubber and in the former mainly for application of N and K containing fertilizers. It was also observed that when Mg containing fertilizers are applied to mature rubber at double the currently recommended rates there was a reduction in yield.

In the smallholder sector where fertilizers may not have been applied regularly, it was possible to obtain yield increases in the region of 26% with application of conventional standard fertilizer mixtures and about 46% with fertilizer application on the basis of soil and leaf analysis, thus emphasising the need to use fertilizer in the mature areas of the smallholder sector.

Soil and foliar survey programme continued to be popular in providing fertilizer recommendations to mature rubber in the estate sector. Over nine thousand hectares were surveyed this year and the anticipated savings on fertilizer bill would be approximately rupees 11.37 million in the estate sector.

Staff

The Head of the Department Dr N. Yogaratnam, the Agricultural Chemist Dr M. K. S. A. Samaraweera and the Assistant Soils Chemist Mr D. M. A. P. Dissanayake were on duty throughout the year. Mrs Lalani Samarappuli continued her post-graduate studies under IAEA training programme at the University of California, Davis, USA.

The Experimental Officers Messrs W. C. Dayaratne, A. M. A. Perera, F.P.W. Silva and H. D. S. P. Perera and the Technical Officers Messrs J. G. de Mel, S. N. Silva, P. Karunadasa, U. Mitrasena, A. N. Yakandawela, B. A. Nandalal, Messrs C. K. Maheepala, Manel Mahanama, R. Munasinghe and Specification Officer Mr T. M. Ahamadeen and the English Stenographer Miss Lakshmi Rupasinghe were on duty, Miss Anusha Jayaweera resigned to join the Sri Lanka State Plantation Corporation.

Research students

Mr Manitha Weerasuriya completed his studies for the M Phil degree of the University of Peradeniya under the supervision of N. Yogaratnam. S. M. M. Iqbal commenced his studies for the MPhil degree of the University of Peradeniya under CIDA funded programme.

Research students of the Faculty of Agriculture, University of Ruhuna worked on the following research projects in partial fulfilment of the requirement of the specialization course in soil science, under the supervision of N. Yogaratnam.

W. Mallika — Influence of soil nutrient contents on chemical composition of weeds and their distribution in rubber plantations.

T. Karunaratne — Distribution of weeds in rubber plantations and their effect on soil nutrient content.

Visits

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

Meetings

The research staff participated in the following meetings.

Seminars

SLSPC Visiting Agents seminar, Colombo.

Training programmes

Rubber Extension and Advisory Services Department
Planter Training Programme organised by the National Institute of Plantation Management

Working groups and committees
N. Yogaratnam served on the following :

Co-ordinating Committee on fertilizer supplies of the Ministry of Plan Implementation.
Technical Committee of the Tender Board of the Ceylon Fertilizer Corporation
Technical Committee of the Sri Lanka Standards Institution
Agriculture Group of the Atomic Energy Authority
Technical Evaluation Committee of the analytical laboratories of the Sri Lanka State Plantation Corporation

Co-ordinating Committee of The Sri Lanka Agricultural Research Programme funded by the World Bank
Scientific Committee of the Rubber Research Institute
Corynespora Monitoring Committee of the RRB
Land Slide Monitoring Committee – Kalutara District (M.K.S.A. Samaraweera)

Laboratory Investigations

Carbon and mineral nutrition

Several aspects of the carbon and mineral nutrition, physiology and biochemistry of the rubber tree are being examined, employing field grown trees at Eladuwa State Plantation and seedlings raised in a green house in Dartonfield, Agalawatte. The emphasis is on how resources such as absorbed water and nutrients and photosynthetically derived carbon are being allocated within the tree. Application of nutrients according to the design was carried out.

Assessments were made regularly to quantify the physiological status of the trees. Most of the isotopically labelled compounds and chemicals ordered through the IAEA, Vienna were used and equipment installed.

Trees were harvested from an experiment to study the nitrogen metabolism and assimilation in young rubber. There were four N levels, 1,4,12 and 24 mili molar N, and four replicates. Composition of nitrogenous compounds in different plant parts such as xylem sap, leaves, bark, stem, roots is being determined. (M.K.S.A Samaraweera, W. C. Dayaratne, H. D. S. P. Perera)

Field Experiments

Response to K

In experiment F/76/5 in progress at Eladuwa State Plantation, Matugama the effects of 3 levels of K and 3 tapping systems on the performance of clones PB 86, RRIC 100 and 101 is being studied. Girth measurements made in November 1987 indicates a significant interaction ($P < 0.001$) between levels of K and clones (Table 1) suggesting that the K requirements for growth would vary between clones. However, the yield data did not suggest any such interacting effects. (N. Yogaratnam, S. M. M. Iqbal and U. Mitrasena)

Table 1. *Effect of* 3 *levels of K on mean girth (cm) of PB* 86, *RRIC* 100 *and RRIC* 101

Clone	Level of K		
	K_0	K_1	K_2
PB 86	52.2	60.5	59.7
RRIC 100	60.9	62.8	64.5
RRIC 101	51.8	62.7	63.3
		SED 1.33	

Response to NK

Effects of N and K on growth and yield were compared on clones PB 86, RRIC 100, RRIC 102, and RRIC 101 in experiment F/76/4. Girth measurements made in November 1987 indicate a significant interaction ($P < 0.05$) between levels of applied K and clones, suggesting again that for girthing the K requirements of different clones can vary (Table 2). With regard to Nitrogen, its application significantly increased ($P < 0.05$) girthing of all clones equally (Table 3).

Table 2. *Effect of* 3 *levels of K on girthing* (*cm*)

Clone	K_0	K_1	K_2
PB 86	54.4	60.5	62.1
RRIC 100	54.9	62.2	62.0
RRIC 101	58.1	61.6	62.6
RRIC 102	57.4	66.1	68.8
		SED 1.24	

Table 3. *Effect of* 3 *levels of N on girthing*

Levels of N	Girth (cm)
N_0	60.00
N_1	60.83*
N_2	61.72*
SED	0.622

Yield data (Table 4) obtained in 1987 shows a significant ($P < 0.01$) increase in yield due to application of K fertilizers at both K_1 and K_2 levels in comparison with K_0 level. (N. Yogaratnam and J. G. de Mel)

Table 4. *Effect of* 3 *levels of K on yield*

Level of K	Yield (kg/ha/yr)	% increase
K_0	1640	100
K_1	1894**	115**
K_2	2079**	127**
SED	2.141	7

K/Mg nutrition

Experiments were carried out to investigate the effect of potassium and magnesium fertilizers on growth and nutrient concentration in clones PB 86, RRIC 100, RRIC 103 and RRIC 121. Attempts were also made to document the early and late symptoms of foliar deficiencies of these two elements. Three commercial fertilizers were evaluated as source of magnesium.

Two pot experiments and a field experiment were carried out, pot experiment 1, was carried out using a split-plot design with clones RRIC 100 and PB 86 in main plots and with two sources each of nitrogen and magnesium and three levels of potassium in sub plots. Pot experiment 2 was a randomized block design with four clones namely PB 86, RRIC 100, RRIC 121 at three levels each of potassium and magnesium. In the field experiment three sources of magnesium namely, commercial Epsom salt, kieserite and dolomite were in the main plots and three levels of potassium and magnesium fertilizers in the sub plots in a split plot design.

Assessments of growth were made by measuring diameter and height of stems. In the pot experiments, leaf area measurements, dry weights of plant parts such as leaves, shoots and roots were taken one year after planting. Foliar, bark and soil analyses were carried out for following elements N, P, K, Ca, Mg, Mn, N and P were determined by colorimetry and K, Ca and Mg and Mn were determined by atomic absorption spectrophotometry. Photosynthetic rates of detached leaves were measured by Infrared Gas Analysis.

It was found that symptoms of magnesium deficiency appear much earlier than those of potassium deficiency. During the first year of growth of budded plants symptoms of potassium deficiency appear as yellowish mottling on the lamina. The mottles later coalesce to form larger patches. During the second year potassium deficiency symptoms appear in a somewhat different manner; marginal paleness appears on the lamina and later becomes more pronounced followed by tip and marginal scorch.

Potassium requirement of clone PB 86 during the first year was found to be 33g K per year. It was found that clones RRIC 100 and RRIC 121 needed a higher amount of potassium than PB 86 during the first year. As potassium application was found to bring about an overall reduction in growth of clone RRIC 103 it appears that soil potassium level of 0.07 m.eq/ 100g soil is adequate for this clone.

Application of magnesium gave significant increases in total dry weight at both levels (11g and 22g of Mg) on RRIC 103. There was a further significant increase in total dry weight between Mg_1 and Mg_2 levels for this clone while the other three clones *viz.* PB 86, RRIC 100 and RRIC 121 did not show any effect to magnesium application.

Application of potassium and magnesium showed significant increases in the concentrations of these elements in the foliar tissues and bark of all clones examined.

Potassium was found to significantly depress the foliar and bark magnesium contents at the two levels of applications tested in this study. Application of potassium reduced the foliar magnesium content. In a similar manner the application of magnesium depressed the potassium content of the leaf tissues and bark at the two levels studied. This clearly suggests an antagonistic effect between potassium and magnesium.

While application of magnesium increased the content of this element it was found to significantly decrease the Ca and Mn content of the leaf tissues. This effect suggests an antogonistic effect of magnesium on calcium and manganese.

Studies on the effect of magnesium application on the potassium content showed that at the K2 level of potassium application, magnesium application at both Mg_1 and Mg_2 levels significantly decreased the leaf K concentrations as compared with zero level of magnesium.

Application of potassium at the K1 level significantly increased the net photosynthetic rates, but increasing the rate of application to K2 level however reduced the net photosynthetic rates to a non significant level. Application of magnesium too showed similar effects.

While this study was in progress it was found that resistance to shoot die back caused by *Botryodiploidia theobromae* increased significantly with the application of potassium. (M. Weerasuriya and N. Yogaratnam)

K/Mg nutrition

In experiment F/84/1, the effects of several pre and post treatment practices on the performance of immature rubber is being studied on six sites with 8 blocks in a split plot confounded design. The main plot treatments are :

T_1 — Control without organic matter and fertilizer, prior to planting
T_2 — K and Mg before planting
T_3 — Rice straw twice a year
T_4 — Coir dust twice a year

Four levels of K and Mg were applied in the sub plots. Girth measurements made 24 months after planting indicate a significant ($P < 0.05$) increase in girth to application of K at 270g muriate of potash/plant/year and no further effect was recorded to increase in K level to 400g/ year. There are indications that the organic matter (coir dust and rice straw) has a positive effect on the growth of the trees. Samples of soil and leaves are being collected and their nutrient contents and other important parameters are being assayed.

There was no significant difference in the response of the trees in treatments T_1 and T_2 and hence at the beginning of 1987 treatment T_2 was modified so that the following hypothesis could be tested.

"Fertilizer is conserved by utilizing ground cover as a sink and as a source (mulch) of plant nutrients".

Litter traps were constructed at Eladuwa State Plantation to monitor the defoliation pattern of the trees.

Note : There were outbreaks of *Corynespora* leaf spot disease in the experimental block at Padukka and trees were treated with suitable fungicides. (M.K.S.A. Samaraweera, W. C. Dayaratne, S. N. Silva, C. K. Maheepala and Miss K. Amaratunga)

Response to NPKMg

Girth data recorded at the end of 11 years after the commencement of fertilizer treatments indicates significant ($P < 0.001$) increase in girthing with application of nitrogen at level 1 and a further increase when nitrogen was increased to level 2 (Table 5).

Table 5. *Effect of nitrogen on girthing of RRIC 45*

Level of N	Girth (cm)	% Increase over control
N_0	65.20	100
N_1	68.59	106
N_2	71.05	109
LSD	1.958	3.01

There had been a tendency for the yield to be increased (Table 6) with application of nitrogen, this effect was however, not significant.

Table 6. *Effect of nitrogen on yield RRIC 45*

Nitrogen	Yield (kg/ha)	% Increase
N_0	1933	100
N_1	2011	104
N_2	2129	111
LSD	NS	NS

On the other hand application of magnesium at Mg_1 level significantly ($P < 0.05$) increased girthing but when magnesium application was increased to Mg_2 level (double the currently recommended dosage) there was a significant reduction in the yield (Table 7). (N. Yogaratnam and A. M. A. Perera)

Table 7. *Effect of magnesium on yield of RRIC 45*

Magnesium	Yield (kg/ha)	% Increase
Mg_0	1988	100
Mg_1	2188	110
Mg_2	1899	95
LSD	1017	5

Response to NPKMg in smallholdings (F/84/1)

Use of fertilizers in smallholdings is being investigated in an experiment on Godigamuwa Estate in Kalutara using clone PB 86 from a 1976 replanting. Fertilizer treatments consists of no fertilizer (control), standard fertilizer mixture and fertilizer on the basis of soil and leaf analysis. Yield data (Table 8) obtained in the third year of the experiment shows significant ($P < 0.001$) yield increases to application of conventional fertilizer mixture by 26% and an increase of 46% with fertilizers on the basis of soil and leaf analysis. As similar results were obtained in 1986 and 1987 also, it appears that significant yield increases could be obtained in all smallholdings with a history of irregular application of fertilizer during the mature period. (N. Yogaratnam and F. P. W. Silva)

Table 8. *Effect of fertilizers on yield of PB* 86

Treatment	Yield (kg/ha)	% Increase over control
No fertilizer (control)	1039	100
Conventional fertilizer mixture	1305***	125***
Soil & foliar analysis	1515***	146***
LSD	111	11

Response to NPKMg in seedling nursery

Two experiments that were started in a seedling nursery at Nivitigalakale in September, 1985 to study the effect of NPKMg on growth and mineral composition of *Hevea* seedlings to be used for green budding were terminated in April 1986.

In both experiment 3^4 factorial confounded design was used to apply 81 treatment combinations with all possible combinations of N, P, K and Mg at three levels (0, 1 and 2) urea, rock phosphate, muriate of potash and kieserite were used in the 1st experiment and ammonium sulphate was used instead of urea as the source of nitrogen in the second experiment.

Results at the end of the experiments showed that both urea and ammonium sulphate can significantly enhance plant performance in terms of plant height, stem diameter and mineral composition of leaves and the acceptable levels of application appear to be in the region of 15.6 and 34.0g/plant with urea and ammonium sulphate, respectively. Significant linear effects of applied nitrogen decreasing leaf calcium content were also observed. Although, applied potassium and magnesium increased their respective leaf nutrient contents, they failed to influence plant growth during the nursery stage. Applied P in the form of rock phosphate, did not influence leaf P content but increased soil Ca content. (D. M. A. P. Dissanayake and U. Mitrasena)

Foliar nutrition

Two experiments were started at Dartonfield to study the effect of foliar nutrition sprays on the performance of *Hevea* planted in polybags. The following 10 nutrient treatments were tested on clones RRIC 100 and RRIC 121.

T_1 — Nil
T_2 — NPK (soil) + Mg (soil)
T_3 — NPK (soil) + Mg (foliar)
T_4 — Nutraphos – N (foliar)
T_5 — Nutraphos super – K (foliar)
T_6 — Sorba spray (foliar)
T_7 — Nitrophoska liquid (foliar)
T_8 — NPKMg (soil) + urea (foliar)
T_9 — NPKMg (soil) + Nutraphos – N (foliar)
T_{10} — NPKMg (soil) + Nitrophoska liquid (foliar)

At the end of the experiments plant height was significantly increased by application of NPK (soil) + Mg (foliar), NPKMg + NPL, NPL ($P < 0.05$) and NPKMg + NPN ($P < 0.001$) in clone RRIC 121. But these effects were not recorded in clone RRIC 100. However, application of NPKMg + Urea significantly increased ($P < 0.05$) the height in clone RRIC 100 (Table 9).

Table 9. *Effect of nutrient on plant height*

Treatment	Plant height (cm)	
	RRIC 121	RRIC 100
T_1	46.5	65.33
T_2	56.067	59.92
T_3	61.00*	63.733
T_4	43.183	57.933
T_5	40.050	57.050
T_6	45.4	61.40
T_7	63.067*	56.017
T_8	54.1	89.783*
T_9	69.95***	66.00
T_{10}	62.33*	69.583
SED	6.4937	9.426

Similar effects of treatments were observed on stem diameter in both experiments at the age of 9 months. Application of NPK + Mg (foliar) ($P < 0.05$) NPKMg + NPL and NPKMg + NPN ($P < 0.01$) significantly increased stem diameter of plants of clone RRIC 121. Application of NPKMg + Urea was significantly increased ($P < 0.05$) stem diameter of RRIC 100 plants (Table 10). (N. Yogaratnam, D. M. A. P. Dissanayake and B. A. Nandalal)

Table 10. *Effect of nutrients on stem diameter*

Treatment	RRIC 121	RRIC 100
T_1	8.000	8.333
T_2	8.500	8.000
T_3	9.500*	8.667
T_4	7.833	8.000
T_5	8.000	8.5000
T_6	9.167	8.333
T_7	9.667*	8.833
T_8	8.833	10.333
T_9	10.500*	9.000
T_{10}	10.500*	8.833
SED	0.7313	0.7414

Micronutrients

The effect of two levels of B, Al, Mn and Fe under two soil management practices *viz.* with and without legume cover (*Pueraria phaseoloides*) on the performance of clones PB 86 and RRIC 103 is being studied in pots at Dartonfield Estate. The treatments were allocated in a fully randomized design with 2 replicates. (D.M.A.P. Dissanayake and B. A. Nandalal)

Efficiency of fertilizer utilization

The effects of different sources of nutrients on growth and yield of rubber is being studied in experiment F/76/2 and F/76/17 at Pembroke and Eladuwa State Plantations, respectively. The results obtained at the end of December 1987 on Eladuwa indicates that there is no significant effect on yield with applications of phosphate but there had been significant difference ($P < 0.001$) in girth to application of phosphate (Table 11). (N. Yogaratnam and J. G. de Mel)

Table 11. *Effect of phosphate on yield – PB 86*

Treatment	Yield		
	Girth (cm)	N (Kg/ha)	% Increase
No phosphate	61.8	1555	100
Eppawela rock phosphate – Level 1	66.3***	1662	103
Eppawela rock phosphate – Level 2	65.0***	1718	110
Imported rock phosphate – Level 1	66.1***	1656	107
Imported rock phosphate – Level 2	68.6***	1751	112
LSD	2.059	NS	NS

Covers and cover management

Residual effects of different leguminous covers grown during the immature phase on production of rubber during mature phase is being studied, at Lowment Estate, Kalutara and Muwankande Estate Mawathagama. The species considered are, *Pueraria phaseoloids*, *Desmodium ovalifolium*, *Centrosema pubescens*, *Stylosanthus gyneusis*, *Calapagonium muconoides*, *Mimosa invisa* and naturals. (N. Yogaratnam and J. G. de Mel)

Organic manures

The use of organic manures in immature *Hevea* plantations is being studied at Elston Estate, Puwakpitiya (BDN/OM/1) Paiyagala State Plantation (SPN/OM/2) and Hewagam Estate, Padukka (SPN/OM5).

The treatments tested are :

T_1 — NPKMg, ½ Normal, without organic fertilizer
T_2 — NPKMg, ½ Normal with organic fertilizer
T_3 — NPKMg, Normal, without organic fertilizer
T_4 — NPKMg, Normal, with organic fertilizer

Data obtained at the end of 1987 do not indicate any significant treatment effects. (N. Yogaratnam and F. P. W. Silva)

Nutrient cycling in rubber plantations

The work on a new project aimed at developing a predictive understanding of the functioning of biological processes and their contribution to soil fertility was initiated with a view to improving soil fertility and fertilizer use efficiency in rubber plantations by manupulating soil biological processes.

H-2b : The availability of fertilizers to plants can be delayed by microbial immobilisation on low quality litter, then decreasing the risk of losses by leaching.

H-3 : Increased soil organic matter results in an increased time of nutrient availability to plants even in the presence of high quality litter or fertilizers.

Experimental design: Individual tree responses to treatments can be measured in terms of changes in girth, size, latex yield and nutrient composition of the leaves and latex. The changes in defoliation-refoliation patterns will also be studied in managed plantations, replicate plots of 9 trees in each will be used to define experimental plots with the central tree assumed to optimally reflect treatment effects.

Testing of H–3 : The experiments for testing of H–3 done in the 1984 replanting at Eladuwa State Plantation, Paiyagala in Kalutara District. The land is with a slight slope and the separation between trees is 4–4.5m.

Table 12. *Details of the experiment for testing the hypothesis*, H–3

Treatment	Trees	Control (no trees)
No application (1)	+	+
Fertilizer (F)	+	+
Coir (low quality litter) (C) ±	+	+
Fertilizer & coir (C+F)	+	+

12 plots each containing 9 rubber trees, in there contours with three trees per contour were demarcated. Each plot is separated by the adjoining plots using a guard row of trees and the treatments were laid out as a randomised block. Soil sampling is done in the area round the tree where the fertilizer is applied. Within a plot soil samples collected from the three trees in the same contour are bulked and hence the total number of composite soil samples per plot is 3. Girth measurements of individual trees, soil pH, CEC, exchangeable bases, total nitrate and ammonia N, and % organic carbon were recorded. The soil sampling will be done at least twice a year. Control plots without rubber trees have been selected and legume cover is being established. Four litter traps (Two canopy and two ground) each $0.25m_2$ have been placed in each of the 9 tree plots and biweekly litter collections are being carried out. Experiments were initiated to study N mineralization.

The programme has two main objectives. They are :

1. To gain quantitative understanding of the spatial and temporal differences in nutrient cycles of *Hevea* rubber plantations at Eladuwa State Plantation and a lowland rain forest (Sinharaja, Man & Biosphere Reserve).

2. To investigate means of manipulating nutrient cycles in rubber plantations and specifically to determine whether the maximum nutrient availability under the prevailing prehumid ever-wet climatic conditions could be synchronized with the maximum nutrient demand by this deciduous tree crop by altering the soil biological processes.

Scientific rationale: The rationale is that a comparison of nutrient cycling and associated soil biological processess between natural forest and plantations with high and low management intensities may reveal the controls on nutrient pool and fluxes and the extent to which they sustain productivity. The results should provide insights into reasons for the low productivity of smallholdings compared with the forest communities which they replace.

Rubber trees are deciduous during the dry period January/February and the nutrient demand by the tree at the subsequent refoliation is quite high. The fertilizer applied during this growing period is not efficiently utilised by the plant due to heavy South–West monsoonal rains that wash away much of the soluble nutrients. Manupulation of fertilizer availability to the tree by immobilising the nutrients in various mulches such as coir, straw or Dicranopteris fern mulch and the release of them slowly to reduce fertilizer losses in run off is attemped.

Experimental approach: Three main hypotheses will be tested:

H–1 : The rate of decomposition and nutrient release from particular litter is primarily controlled by moisture and is most closely correlated with the onset of rain.

H 2a : Increasing the proportion of low quality litter inputs at the onset of rains extends the time period of nutrient availability to the plant.

Therefore, modified ten, $25 \times 25 \times 30$ cm^3 soil pits were used in each of the two treatment sites (rain forest and rubber plantations). The soil pits were dug 5m apart along a transect. Surface litter was collected separately from 25 cm^2 qudarat and sorted out for macrofauna. The soil layers were further subdivided into 3 layers, 0–10cm, 10–20cm and 20–30cm and macrofauna in each sample were counted and preserved in 4% formaldehyde for fresh (preserved) wieght determination. (M. K. S. A. Samaraweera, I. A. U. N. Gunatilleke (Department of Botany, University of Peradeniya), A. de S. Liyanage, K. G. S. Jayawardene, H. Jayaweera, (in collaboration with J. M. Anderson, Department of Biological Sciences, University of Exeter, U.K.)

Soil-Plant-Water relations

Water stress in relation to soil management practices was studied in experiment SM/82/5 at Clyde State Plantation in Kalutara where clean weeded area is compared with natural cover, mixed legumes and dead mulch cover on growth of immature rubber. Girth measurements recorded at the end of 1987 indicates that girthing in dead mulch area to be much higher than plants under other treatments (Table 13) confirming the observations made in the previous years.

Table 13. *Effect of some soil management practices on girth of immature rubber–PB* 86

Treatment	Girth (cm)
Naturals	38.32
Legumes	40.28
Bare (clean weeded)	42.82***
Dead mulch	48.21***
LSD	2.193

In another experiment (SM/83/1) where mulching was used to overcome moisture stress and the effect of this practice on nutrient uptake on N, P, and K is studied, showed (Table 14) that mulching significantly improved girthing. (L. Samarappuli, P. Karunadasa and U. Mitrasena)

Table 14. *Effect of mulching on girthing of immature* Hevea

Treatment	Girth (cm)
No mulch	22.97
Mulch	24.89**
LSD	1.068

Rubber cultivation under irrigation

Two experiments started at Girandurukotte in the Mahaweli system 'C' area were terminated. Diameter measurements for girth made at the end of 11 months after planting suggest that growing rubber in the Mahaweli system 'C' area under irrigation is a possibility. (N. Yogaratnam, A. Dissanayake, A. M. A. Perera and B. A. Nandalal)

Extension

Soil and foliar survey for fertilizer recommendations

All rubber plantations managed by the SLSPC and JEDB are non fertilized on the basis of soil and leaf analysis. The foliar survey programme in 1987 commenced in June and 9599 hectares were covered this year.

Computerised fertilizer programme for the next 3 years (1988, 1989 and 1990) were posted to all the estates by December. Urea and Eppawela rock phosphate were the only sources of nitrogen and phosphate recommended. Implementation of this programme would result in a saving of 11.37 million rupees in fertilizer bill to the estate sector of the rubber industry. (N. Yogaratnam, F. P. W. Silva, A. M. A. Perera, Manel Mahanama and T. M. Ahamadeen)

Chemical analysis

Routine chemical analyses of soil and leaf samples from surveys, experimental, and advisory work of the Department were done. Requests from Universities, JEDB, CFC, Sri Lanka/Standards Institute, Pelwatta Sugar Corporation were also considered. (N. Yogaratnam, A. M. A. Perera, M. K. Mahanama, Ranjani Munasinghe and T. M. Ahamadeen)

REVIEW OF THE RUBBER CHEMISTRY DEPARTMENT

BY

S. W. KARUNARATNE

SUMMARY

A significant progress has been made in the development of thermoplastic natural rubber (TPNR). The method is commercially attractive and the industrialists have shown a keen interest in the technology for the manufacture of a series of utility products. Bonding of glass fabric to NR using resins prepared from cashew nut shell liquid has been successfully carried out. Heat resistant formulations for the production of SP rubbers, both by the use of heat resistant tellurium compounds and conventional EV systems have been perfected. Factory trials on the manufacture of curing bags for tyres are in progress. Further investigations in the preparation of liquid natural rubber by the latex route and the dry rubber route were undertaken during the year.

HPLC studies on liquid rubber prepared using nitrobenzene as the photosensitizer have helped in evaluating the nature of storage hardening in liquid rubber.

Tyre tread formulations with improved storage stability were developed for the industry. For the first time a latex based cement for tread fixing has been perfected and field trials are in progress to test the durability of the bond. Improvements in the quality of the rice huller rollers were achieved with better rubber to metal bonding and the choice of improved formulations using silica fillers. Rubberised coir was used as a sand filter in sea erosion control. This idea has been accepted by the Coast Conservation Authorities. Improvements in the stability of prevulcanized latex have been achieved through an understanding of the type of soap and type of stabilizer used. A new tackifying agent for latex, especially in adhesive formulations, has been prepared from rubber seed oil.

Several inquiries from the rubber products sector were entertained and the services rendered by all the sections of the Department helped to overcome these problems speedily and accurately.

The Specifications and Analysis Section continued to fulfil its task in monitoring the TSR production in Sri Lanka. Regular testing of samples, issuing test certificates, inspection visits and analytical services of a general nature were continued by the section throughout the year. Packing of crepe rubber is much to be desired and several weaknesses in the existing packing methods have been highlighted including high moisture

content in the Albizzia wood used in packing sole crepe. Packing of sole crepe in corrugated cardboard boxes is suggested and work is in progress to evolve methods of packing more acceptable to the consumer.

The Raw Rubber Development Section was mainly concerned with studies on discolouration of crepe rubber during the first quarter of the year. Outside coagulation and delayed milling are two major contributory factors to discolouration of latex crepe. Among the recommended RRIC clones, RRIC 102 is prone to enzymatic discolouration specially during the wintering period. Use of 10% excess sodium bisulphite improves the colour. A study on the properties of sole crepe showed that the hardness of sole crepe is reduced by subsequent remilling operations. A comprehensive report on latex crepe was submitted to the EDB outlining methods to improve quality and marketing. Further investigations on solar drying of rubber were continued with the assistance of an expert on solar drying.

The Biochemistry Section's main interests were in enzyme deproteinization of *Hevea* latex and the prevention of environmental pollution from effluents discharged from rubber factories. A high quality low protein rubber was obtained by the maturation procedure developed by the Institute. There was a consistent demand for low protein rubber.

DETAILED REVIEW

Staff and staff movements

The Biochemistry Section was shifted back to Dartonfield Agalawatte in February 1987.

The Head of the Department Mr S. W. Karunaratne was appointed Deputy Director (Research) with effect from 1987.10.01.

Mr S. W. Karunaratne attended the Export Advisory Group meeting on Radiation Vulcanisation from 9 to 12 February in Indonesia.

Mr S. W. Karunaratne was requested by the IAEA to undertake a mission to Democratic People's Republic of Korea (DPRK) from 24 August to 4 September to explore the possibilities of setting up a radiation processing laboratory for upgrading of NR products.

Dr A. Coomarasamy, Head Polymer Chemistry Section attended the IRRDB/ UNIDO workshop on NR composites held in Indonesia from 23 to 27 February and presented a paper on bonding of natural rubber to fabrics for the construction of laminated bearings. He also visited CAIR, Batan, Indonesia.

Dr W. S. E. Fernando, Head Rubber Technology and Development Section attended the Rubber Conf. '87 held in Harrogate, UK from 1 to 5 June and presented a paper. This was followed by industrial visits in UK for six days.

He also attended the International Rubber Conference '87 held in Teheran, Iran from 19 – 25 September and presented a paper on metal stearate/process oil combinations for tyre treads and a country paper on tyre industry in Sri Lanka.

Dr (Mrs) Karnika de Silva, Rubber Chemist attended the Rubber Conf. '87 held in Harrogate, UK from 1 to 5 June and presented a paper.

Dr L. M. K. Tillekeratne, Head Specifications & Analysis Section attended the ISO/TC/45 meeting held in London from 12 to 22 October 1987.

Dr M. C. S. Perera, Head Raw Rubber Development Section attended the Macro '87 Conference in German Democratic Republic and presented a paper. He also visited Federal Republic of Germany and had discussions with NR importers and visited the Fraunhofer Institute in Froeburg.

Dr L. M. K. Tillekeratne, Head Specification & Analysis Section who was on sabbatical leave in the United Kingdom returned to the Island in November 1987.

Dr P. A. D. T. Vimalasiri, Assistant Specifications Officer vacated his post from 04 May 1987.

Mr B. P. Weeraratne and Mr N. Jayaweera assumed duties as Assistant Rubber Chemists on 1987.01.05 and 1987.01.12 respectively.

Mr L. B. K. Silva, Research Assistant was granted 1 year duty leave to follow the MSc course in Polymer Chemistry conducted by the University of Moratuwa from October 1987.

Mr H. N. K. K. Chandralal, Experimental Officer resumed duties after successfully completing the MSc course in Polymer Chemistry conducted by the University of Moratuwa.

Mr P. Lelwala, Instrument Technician was granted a scholarship under the British Technical Co-operation Training Award Scheme and proceeded to the UK for training in mid November 1987.

Mrs Chitrani Kahapolaarachi, Instrument Technician resigned from her post with effect from December 1987.

Mrs Manel Nilaweera, Technical Officer returned after an year's training at RAPRA, UK in June 1987.

Mrs Sriyanthi Weeraman, Technical Officer was promoted as Senior Technical Officer with effect from March 1987.

Mr W. D. Dharmasena, Technical Officer who was given an extension of service after retirement terminated his contract from 1987.02.13.

Mrs Sriyani Yapa, Technical Officer, Biochemistry Section was transferred to the Rubber Technology Section with effect from 1987.08.10.

Mr W. W. D. Y. Jayasinghe, Experimental Officer resigned from his post with effect from April 1987.

Miss K. P. Jayaweera, Temporary Research Assistant, Biochemistry Section continued her work during the year. She is supported by a NARESA grant.

Mr Susil Soyza joined the Biochemistry Section in October as a Temporary Research Assistant on a grant from CIDA.

Miss Samanmalie Jayaweera was engaged as a Casual Clerk/Typist in March 1987. Casual Clerk Typist/Internal Audit Section Miss Renuka Wijayaratna was transferred to the Rubber Chemistry Department from 1987.08.08.

Assistant Rubber Chemists Mr E. D. I. H. Perera, Mr R. Goonathilaka, Miss N. M. V. Kalyani, Mr G. Seneviratne and Miss Pushpa Sirimanne continued their post graduate studies in UK.

Mr B. K. Piyaratne was appointed as a Casual Labourer with effect from 1987.5.4.

Mr P. J. Perera, Laboratory Labourer tendered his resignation with effect from 1987.07.03.

Experimental Officers Messrs P. P. Jayasinghe, A. S. Dekumpitiya, S. L. Weerasinghe, H. N. K. K. Chandralal and D. D. Medagama were on duty throughout the year.

Mr Z. E. Irugalbandara, Senior Technical Officer was on duty throughout the year.

Technical Officers, Messrs K. M. U. Mithrananda, P. H. Sarath Kumara, M. D. C. Seneviratne, T. A. S. Siriwardene, C. Senanayake, Mrs Nanda Baduge, Mrs Sriyanthi Weeraman, Mrs Vasantha Gamage, Mrs Leela Wanigathunge, Mrs Sriyani Yapa, Mrs Indra Denawaka, Mrs Chithra Kuruppu, Miss Mangalika de Costa, Miss Champa Gallage, Miss Chintha Jayawardene, Miss Chandrika Malani and Miss Lakshmi Daundasekera were on duty throughout the year.

Miss Astrid Furlong, Instrument Technician was on duty throughout the year.

Specification Assistants Messrs W. A. S. Wijesekera, G. Wanigathunga, N. Karunathilaka, K. K. Austin, B. Gunasiri, P. A. J. Rodrigo and W. Nandasena were on duty throughout the year.

Mrs Anusha Paranavithane and Mrs Indrani Wijesinghe Clerk/Typists were on duty throughout the year.

Mrs Rukmani Liyanage, Stores Assistant was on duty throughout the year.

Meetings and Lectures

The departmental staff conducted several lectures for the benefit of the Estate Superintendents, Factory Officers, Extension Officers of the Advisory Services Department and staff of the Rubber Control Department. Lectures were conducted both at Sri Jayewardenapura and Moratuwa Universities for the MSc students and the NDT (Rubber Technology) students.

The Head of the Department, Mr S. W. Karunaratne attended 13 Board Meetings of the Co-operative Industries Union, the manufacturers of Ceyesta mattresses.

The Head of the Department and Head Rubber Technology and Development Section were associated with two Overseas Development Administration (ODA) experts Mr C. Karas and Mr R. Hindmarch of Rubber & Plastics Research Association (RAPRA), UK in connection with the development and marketing of special grades of natural rubber for specialised industrial applications.

Mr S. W. Karunaratne gave a lecture to the Institute of Chemistry on 'Value added chemically modified grades of NR'. He also gave two lectures on 'Post Harvest Technology' to groups of planter trainees and Assistant Superintendents at the National Institute of Plantation Management (NIPM).

Mr S. W. Karunaratne addressed about 30 planters which included Chairman, Directors, Manufacturing Advisors and Agricultural Advisors of the Janatha Estates Development Board (JEDB) Kegalle and Avissawella Boards at a seminar organised by H. W. J. Dias & Brothers (PVT) Limited.

Mr S. W. Karunaratne was nominated to serve a second period as a member of the Chemicals Divisional Committee of the Sri Lanka Standards Institution (SLSI) and he attended one meeting. He is also in the technical committees set up by both JEDB & SPC for the evaluation of tenders regarding purchase of rubber machinery under the MTIP.

The Head of the Department organised a seminar on Discolouration of Crepe Rubber on 17 of July at the ARTI Auditorium. He was ably assisted by Mr Z. E. Irugalbandara, (STO). The seminar was attended by senior planters, shippers, brokers and chemical suppliers.

The Head of the Department attended the following discussions, meetings, seminars and conferences during the year.

Visiting Agents' conference organised by the Sri Lanka State Plantations Corporation (SLSPC). All the Heads of Sections attended this conference.

Three meetings with the Export Development Board (EDB) and Rubber Controller regarding the formulation of a Master Plan for the Rubber Industry.

Three meetings of the technical evaluation committee to select the tender for the supply of rubber machinery to JEDB under the Medium Term Investment Programme (MTIP).

Seminar on radiation curing technology organised by the Atomic Energy Authority (AEA).

Discussion on the establishment of a latex based industry in Sri Lanka by Ansells, Australia. The discussions were organised by the Greater Colombo Economic Commission (GCEC).

The following lectures were given by Mr S. W. Karunaratne :

'Some research work carried out on the discolouration of crepe rubber' at the seminar on discolouration of crepe rubber.

'Importance of rubber wood and its further property enhancement by surface curing using atomic energy' at the AEA seminar on radiation curing technology.

'The rubber industry ; A scientist's point of view' at the seminar organised by the JEDB to brief Ansells, Australia on possibilities of latex product manufacture in Sri Lanka.

Mr S. W. Karunaratne served as a member of the council of the Institute of Chemistry. As Chairman of the drafting committee on NR set up by the Sri Lanka Standards Institution (SLSI), Mr Karunaratne attended one meeting to discuss standards for Low Nitrogen Natural Rubber.

Most of the Research Officers participated in the Annual Session of the Institute of Chemistry held from 16 to 18 June.

Dr A. Coomarasamy gave a lecture on chemical modification of NR for value addition on the theme seminar on 'Chemistry and Value Addition.'

Head Biochemistry Section delivered two lectures for NIPM Planters' Training Course.

Dr P. A. J. Yapa attended the Asian Science Congress held in October, Kuala Lumpur, Malaysia and presented a paper on 'A study on fertilizer value of rubber factory effluents on young *Hevea* seedlings.

Dr P. A. J. Yapa attended the Grantees Seminar organised by CIDA/NARESA held in June/July at Hotel Pegasus.

Head, Biochemistry Section also attended the following meetings

Working group on the control of environmental pollution in rubber plantations at Central Environmental Authority.

Steering Committee on proposed treatment systems at Frocester S. P. and Sorana S. P. at Central Environmental Authority.

Drafting committee for standards for rubber factory effluents at Sri Lanka Standards Institution.

Committee for popularisation of science of SLAAS and served as a member of the Editorial Committee for Vidya Viyapthi.

Dr A. Coomarasamy presented a paper on Developments in NR composites at the 1st Annual Session of the PRI (Sri Lanka) held on 30 April 1987.

Dr M. C. S. Perera presented a paper on properties of different types of NR at the same sessions.

Most of the Research Officers attended the Plastic & Rubber Institute (PRI), annual sessions held on the 30 April. Dr W. S. E. Fernando as Secretary of PRI played a major role in organising the session. Mr S. W. Karunaratne chaired the session.

Mr S. W. Karunaratne functioned as the external examiner in the viva voce of the MSc students from University of Moratuwa.

Mr S. W. Karunaratne participated in a seminar on 'small businessman as an exporter' conducted jointly by the NIBM and EDB.

Mr S. W. Karunaratne and Dr M. C. S. Perera attended a Planters' Association (PA) current affairs meeting and participated in the discussion on crepe discolouration.

Mr S. W. Karunaratne was nominated to serve in the task force set up by the EDB to draw up the National Export Development Plan and was co-opted to the sub committee to draw up the development plan for rubber.

Dr M. C. S. Perera was appointed to the committee of management of PRI for the year 1987/88.

Dr Perera addressed a Superintendents' Seminar at the Thebuwana Club on 1987.07.17 about the discolouration of crepe rubber and attended several meetings of Tea and Rubber Diploma (NIPM) examiners committee.

Dr A. Coomarasamy attended a Drafting Committee meeting on Low Nitrogen Natural Rubber at the SLSI, 26 May 1987 and 2 meetings on plastic garbage bags.

Dr W. S. E. Fernando in his capacity as Hony Secretary of PRI, Sri Lanka, represented Sri Lanka in the overseas secretaries meeting of the Plastic & Rubber Institute held on 1 June 1987 in Harrogate, UK.

Dr W. S. E. Fernando attended one meeting of the drafting committee for rubberised coir organised by Sri Lanka Standards Institution. He represents PRI (Sri Lanka) and is the Chairman of this committee.

A request made by the Chairman of Atomic Energy Authority for approval for Head Rubber Technology & Development Section to serve on the committee for radiation vulcanisation has been approved by the Director. He attended one committee meeting held in December.

Dr W. S. E. Fernando and Mr H. N. K. K. Chandralal, Experimental Officer attended one committee meeting of radiation vulcanisation committee set up by the AEA.

Dr W. S. E. Fernando attended a committee meeting of drafting committee for Elastic Braids organised by Sri Lanka Standards Institution.

Dr L. M. K. Tillekeratne held discussions with the leading dealers and the consumers of sole crepe rubber in the UK to see the possibilities of increasing the sole crepe consumption in the UK.

Mr H. N. K. K. Chandralal and Mr P. P. Jayasinghe assisted Head of Rubber Chemistry Department in the expansion joints project for Katunayake Airport.

Mr P. P. Jayasinghe attended six drafting committee meetings on rubberised coir, PVC coated fabric and automobile components of Sri Lanka Standards Institution.

Dr W. S. E. Fernando and Mr P. P. Jayasinghe attended a meeting summoned by the Minister of Fisheries to discuss the proposal put forward by Head, Rubber Technology & Development Section of the possibility of use of rubberised coir as geotextile for coast conservation.

Mr H. N. K. K. Chandralal attended a seminar on radiation vulcanisation of surface coating conducted by the Atomic Energy Authority.

Training

Mr S. W. Karunaratne, Dr A. Coomarasamy, Mr P. P. Jayasinghe and Mr S. L. Weerasinghe conducted a lecture/demonstrations to NIPM trainees at the Dartonfield factory on crepe manufacture in general, the procedure for the manufacture of LNNR and the manufacture of centrifuge latex.

Dr A . Coomarasamy conducted a lecture on Development in Natural Rubber for the National Institute of Business Management Training Programme for Rubber Factory Managers on September 4 1987.

Training was provided to six National Apprenticeship Board (NAB) students on various aspects of rubber chemistry and technology.

Mr P. N. Giao who was a FAO fellow from Vietnam was given a training by all the Heads of Sections in the Department for a period of six months ending 30 August.

Dr M. C. S. Perera addressed a seminar for the Superintendents on discolouration of crepe rubber.

Dr M. C. S. Perera also delivered a talk at a PRI organised seminar on Raw Rubber Selection.

Dr M. C. S. Perera served as a member in the examination board for the rubber manufacturing examination conducted by NIPM.

Dr (Mrs.) K. G. K. de Silva gave a talk on vulcanization processes to Factory Supervisors. The workshop was organised by the RRI.

Mr S. L. Weerasinghe delivered talks on RSS and crepe for the participants of the NIPM Diploma.

Mr P. P. Jayasinghe and Mr S. L. Weerasinghe conducted a demonstration for NIPM Planter Trainees on block rubber, sheet rubber manufacture and rubber products manufacture.

Staff of Raw Rubber Development Section organised an one day seminar for the Factory Officers in all the five regions.

Mr L. B. K. Silva and Miss A. Furlong of the Electronics repair unit attended a workshop on repair and maintenance of analytical equipment conducted by the British Council from 17 to 21 August.

Miscellaneous

Mr S. W. Karunaratne, Head, Rubber Chemistry Department formulated a project proposal to set up a modern R & D laboratory for the Rubber Chemistry Department under Japanese Aid Grant to Sri Lanka.

Dr A. Coomarasamy, Head, Polymer Chemistry Section held discussions with Mr Brian Foster, Director R & D Ansells, Australia and Mr John Morris, Consultant on centrifuged latex quality, availability in Sri Lanka, its manufacture and testing. The above foreign visitors were accompanied by officials from SPC and GCEC.

Dr A. Coomarasamy, Head, Polymer Chemistry Section had discussions with Mr A. D. G. Wijesekera and Mr Keerthi Wanigasekera regarding centrifuged latex manufacture and setting up of a centrifuged factory.

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Polymer Chemistry

Superior processing (SP) rubbers

Laboratory scale investigations have shown that SP rubbers for special applications can be tailor made by adjusting the formulations for prevulcanization of latex. Suitable formulations have already been developed for high temperature applications and food

contact applications. Arrangements are now being made to set up a pilot plant at the Institute's premises in Agalawatta for the production of SP rubbers and other special grades. This will enable us to study all the problems connected with large scale manufacture of specialised grades of rubber. Discussions were also held with officers of Associated Motorways Limited & Mawanella Block Rubber Factory, State Rubber Manufacturing Corporation regarding the manufacture and applications of SP rubbers for local use. Work has also been initiated by the Institute with the assistance from our Ministry and the Trade delegations abroad to explore the market potential for these grades abroad. (A. Coomarasamy, Mangalika de Costa, Chitra Kuruppu and Nihal Wickremasinghe)

Liquid rubbers & low Mooney rubbers

A method has been developed for the preparation of liquid natural rubber from latex. In the first stages of the process suitably stabilized latex is treated with non-toxic chemicals under a certain set of conditions to effect depolymerization of the rubber molecules. In the second stage the water is removed by coagulating/drying of the depolymerized latex. Drying is the most difficult and energy consuming unit operation and published information on drying on this type of product is being gathered with a view to set up a small pilot plant. This method of depolymerization could also be applied to prepare low Mooney rubbers. A Sri Lanka Patent Application has been filed on this process.

Work was also initiated on chemical modification of liquid rubbers and depolymerized latex, use of depolymerized latices in pressure sensitive adhesive formulations and other applications. (A. Coomarasamy, Nihal Wickremasinghe and Indra Denawaka)

MG rubbers

Small samples of MG 49 & MG 30 were supplied to the Industrial Development Board of Sri Lanka for investigating the possibilities of using these materials in light coloured moulded goods such as rubber components for bottle holders, seals and pads. Data gathered on the preparation of MG rubbers have been supplied to the University of Moratuwa for the purpose of designing a suitable reaction vessel for the pilot plant manufacture of these materials. (A. Coomarasamy)

Preparation of superior quality rubbers by enzyme treatment

An improved process for the preparation of raw natural rubbers with very low ash values (below 0.03%) and low nitrogen values (below 0.06%) for use in specialised applications has been developed. This process could be commercially adopted for the manufacture of these special rubbers. Work has also been continued on the manufacture of low protein natural rubber. (A. Coomarasamy, Nihal Wickremasinghe and Indra Denawaka)

Thermoplastic natural rubber blends (TPNR)

A very significant progress has been made in the development of thermoplastic natural rubber blends, using crepe based materials. These are also generally referred to as composite materials. Products can be made from these materials without vulcanization, using thermoplastic processing techniques such as injection moulding. The process developed by us in collaboration with C. W. Mackie & Co. Ltd and M. S. Mohammedhi & Co. could also be used to produce plastic products with high impact resistance. Thermoplastic rubber based latex collection cups have been made using the moulds available and field experiments on the use of these cups for latex collection has been initiated at Dartonfield.

Efforts are being made to produce these materials for commercial use in Sri Lanka, for export. (A. Coomarasamy, H. N. K. K. Chandralal and Manel Nilaweera)

Natural rubber based composites

One group of composite materials contains rubber layers alternating with layers of stiff materials such as metal plates, hard plastic or high performance fabric materials bonding of fabric materials based on glass and aramid to NR had been found to be a problem in the past but the work carried out on the UNIDO project on NR composites has shown that it is possible to achieve adequate bonding of glass fabric to NR. This work was continued in Sri Lanka for bonding glass fabric to NR using RF resins based on proprietory preformed resins and resins synthesised from cashew nut shell liquid, so that the know – how could be passed on to the industrialists in this country to sort out their bonding problems. (A. Coomarasamy, H. N. K. K. Chandralal and Nihal Wickremasinghe)

Cationic latex

Suitable methods have been developed for the preparation and stabilization of cationic latex for specialised applications. Such material could be used to effect certain modification reactions and also for blending with cationic emulsions and acidic materials. (A. Coomarasamy and Nihal Wickremasinghe)

Bleaching experiments

Work on the possibility of using non-toxic chemicals for bleaching of carotenoid pigments was continued. The mechanism of action of these materials on bleaching is also been studied. Trials conducted on latex crepe manufacture have given promising results. (A. Coomarasamy, Chitra Kuruppu and Nihal Wickremasinghe)

Test methods

Preliminary work has demonstrated that the microwave oven could be used for drying latex samples for drc & tsc determination. This enabled the measurements to be carried out within 46 minutes resulting in a significant reduction in the testing time. (A. Coomarasamy and Mangalika de Costa)

Heat resistant tellurium rubbers

Further experiments were conducted to improve the method of preparation and the technological properties of tellurium rubber during the past year.

Investigations were made to see the possibilities of using tellurium rubber locally in curing bag manufacture to replace butyl rubber. The preliminary trials were carried out at the Tyre Corporation, Kelaniya. They are now willing to carry out a factory trial with tellurium rubber blends. Bergougnan Lanka has also shown interest in using tellurium rubber blends in their solid tyre manufacture.

A paper entitled 'Heat resistant tellurium rubbers for extrusion and calendering applications' has been accepted for presentation at the 3rd International Conference on high temperature engineering polymers. (K. G. K. de Silva, Mangalika de Costa and Lakshmi Daundasekera)

Oil extended rubbers

Few samples of oil extended rubbers were prepared by adding an emulsion of napthenic oil to the latex. The technological properties of the rubber are to be tested for tyre retreads in the future. (K. G. K. de Silva and Lakshmi Daundasekera)

Low nitrogen latex

The stability, nitrogen values and gel contents of low nitrogen latices were tested with different amounts and types of stabilizers. It was observed that the gel contents and the stability of the low nitrogen latex increase with increased amounts of stabilizers. However, the rate of papain action on protein decreases in each case. (K. G. K. de Silva and Lakshmi Daundasekara)

Fertilizer encapsulation with NR/DPNR

Plants usually receive most of their nitrogen in the form of nitrates. When a nitrogen fertilizer (*e.g.* urea) is used, it will oxidise rapidly to nitrates in the moist soil. The unused nitrates are easily leached out from soil by rain water and washed into ground or water drains thus creating, an environmental problem.

The fertilizer encapsulated with NR in the form of vulcanized pellets is a good method to overcome the economic loss due to the waste of fertilizer and the increases of nitrates especially in public drinking water. A method developed by Dr Hepburn of UK was followed to bind the fertilizer urea into NR thus forming a matrix of rubber encapsulated fertilizer.

The NR was milled with urea and other chemicals and vulcanized at 115°C for 20 mts.

It was also attempted to use DPNR to decrease the moisture absorption from the soil. The oxidation of fertilizer is expected to reduce during the wet weather due to the use of DPNR.

Field tests will be carried out by the Department of Soils and Plant Nutrition. (K. G. K. de Silva, N. Yogaratnam and Manel Nilaweera)

Rubber Technology and Development

Rubber compounding

Tyre tread compounds

This section extended its support to a major retreaders to prepare retreading material required by an overseas consumer, to specifications laid down by the latter.

Further trials have been conducted to assess the storage stability of tyre tread compounds on the factory floor. The tread compounds based on brown crepe show highest stability (scorch time). There is approximately a 30% reduction in the scorch time at cure temperature (150 °C) for all compounds (Brown crepe, RSS 3 and SLR5L). The increase in compound Mooney is also very low for compounds based on brown crepe. (W. S. E. Fernando, D. D. Medagama, D. P. Wethasinghe and A. S. Dekumpitiya)

Rice huller rollers

The search for a suitable compound for RHR production involved the following aspects of compounding ;

(1) Rubber to metal bonding.
(2) Reinforcement of rubber by silica.

The two bonding systems investigated gave similar results in rubber to metal bonding. These two systems are chemlok based bonding, and silica to brass plated roll type bonding. Both systems were successful in holding rubber compound to the metal roller while in service.

Studies also shown that in addition to Silane coupling agents, the use of HRH system enhance reinforcement of rubber by silica. There is a considerable improvement in hardness and abrasion resistance in these compounds. The possibility of substitution of phenols with CNSL phenols was also investigated. (W. S. E. Fernando and H. N. K. K. Chandralal)

Compounds for sports footwear

Recommendations were made for suitable compounds to be used in transparent and coloured out – soles. Compounds suitable for fixing tape, calendered soles and adhesives formulations were recommended.

Factory scale trials have been successfully conducted and sports shoes are now made for export, based on our recommendations. (W. S. E. Fernando, B. P. Weeraratne, H. N. K. K. Chandralal and K. M. U. Mithrananda)

Use of rubberised coir in sea erosion control

A proposal made by the Rubber Technology Section to the Coast Conservation Department of the Ministry of Fisheries to investigate the possibility of the use of rubberised coir as a sand filter in erosion control was acceptable for further studies. The Honourable Minister of Fisheries directed the Coast Conservation Department to find a suitable site to further investigations. Ceylon Cooperative Industries Limited (CEYESTA) who is a major exporter of this item would assist the RRISL by providing necessary samples. (W. S. E. Fernando and P. P. Jayasinghe)

Evaluation of local clays

A study was undertaken to evaluate the clays found locally in Meetiyagoda, Boralasgamuwa and Balangoda to determine the most suitable location for the rubber industry. Preliminary studies such as determination of moisture, colour, density have been conducted. (W. S. E. Fernando and P. P. Jayasinghe)

Latex technology

Production and properties of pre – vulcanised latex

(a) Production of prevulcanized latex

It has been found that stability of prevulcanized latex depend on the type of soap and type of stabilizer used. Our experiments show that use of alkali and fatty acid soap containing 8 – 12 carbon atoms and nonionic stabilizer played a great role in stability of prevulcanized latex. Stability of prevulcanized latex prepared by this method is very high.

(b) Potassium salt of fatty acid soap containing 8 carbon atoms is suitable for transparent films. Further work would be carried out. (W. S. E. Fernando, B. P. Weeraratne and K. M. U. Mithrananda)

Foam rubber

This is an attempt to produce a sponge insole from heat sensitized latex foam. Two heat sensitizing agents were used.

(1) Ammonium Acetate
(2) Vulcastab LW

Ammonium Acetate is the heat sensitizer recommended in the literature. No information is found in the literature regarding the possibility of the use of vulcastab LW. The sample insoles obtained were half the weight of insoles currently produced in a shoe factory using dry rubber sponge.

Foaming process has been developed further using blowing agents in latex. This eliminates the use of foam beater and gives the operator considerable control of the process. Most problems in foaming process such as ageing properties can be avoided using this technique. Large scale factory trials will be conducted. (W. S. E. Fernando, B. P. Weeraratne and K. M. U. Mithrananda)

New technique for tyre rebuilding

Latex cement for tyre retreading industry has been introduced. The advantages of the process are as follows ;

(1) Visual Inspection and hence quality control for application of cement is now possible.

(2) The risk of fire hazard in using solvents is eliminated together with pollution and health problems.

(3) Mill mixing for dry rubber cement preparation is eliminated, thereby saving in energy.

(4) Saving in expenditure for solvent is anticipated.

Rebuilt tyres using latex cement have so far done 5000 km without any visible failure. (W. S. E. Fernando, B. P. Weeraratne, P. P. Jayasinghe and K. M. U. Mithrananda)

Emulsion

A new emulsification technique for oil and resin have been tried out. Experiments carried out using processed oil emulsions, reveals that 1 – 10% oil can be incorporated easily during RSS manufacture to obtain an oil extended rubber. This technique has further prospects to obtain Rubber Resin Master – batches which would be useful in preparation of adhesives. (W. S. E. Fernando, B. P. Weeraratne and K. M. U. Mithrananda)

Chemical modification

Attempted reaction of rubber seed oil 3 – *methyl phenols*

(*a*) *Chemistry of the reactions*: Phenolic resins used in industry are frequently modified by adding some unsaturated oils, to have flexibility, since the double bonds in unsaturated fatty acids under acidic condition react easily with phenols. There is no record of the use of rubber seed oil in a similar manner which consist 3 – unsaturated fatty acids constituents. This project is an attempt to study,

(a) the reaction of 3 – methyl phenol with rubber seed oil,

(b) chemistry and properties of rubber seed oil 3 – methyl phenol resin.

N. M. R. and I. I. Spectra and T. L. C. results confirm that rubber seed oil reacts with 3 – methyl phenol under acidic conditions. Further investigations would be conducted to separate different components of the reaction product.

(*b*) *Application of resin;* This resin can be incorporated to latex as tackifying agent. Tackiness is similar to other tackifiers such as C/I resin.

Rubber seed oil – phenol resin can also be incorporated into dry rubber as well. Investigation carried out during last quarter prove that there is a possibility of substitution of rubber seed oil for tall oil in the preparation of phenolic resins. (W. S. E. Fernando and B. P. Weeraratne)

Centrifuged latex production

The Rubber Controller was assisted by us to draw up a plan to extend the subsidy scheme to centrifuged latex manufacture. This will be a big incentive for the production of centrifuged latex.

Centrifuged latex manufactured by the JEDB at Vincit Estate, Waharaka was tested periodically. High variability in the magnesium content and the variability in the use of stabilizer were common defects noticed during the evaluations. (S. W. Karunaratne and Mangalika de Costa)

Evaluation of radiation prevulcanized latex (RPVL)

Work on this project was limited due to the non availability of RPVL. The gamma irradiator which was donated to the Atomic Energy Authority under the radiation vulcanization programme is not yet been installed even though the instrument was received over an year ago. A request was made, under the programme, to Indonesia and a 200 litre consignment of RPVL was received towards the end of the year.

Samples of products made from RPVL such as SP rubber were displayed at a seminar organised by the AEA. (S. W. Karunaratne)

Development of a sealent to cover the joints between concrete slabs in the air port apron

A room temperature vulcanizing NR compound extruded in the form of a cylindrical strip and wound on a specially constructed take up device was used as the main sealent. A resin was used to cover the rubber strip. A 100 Meter stretch of joint in the old apron area was treated with the rubber sealent. (S. W. Karunaratne and H. N. K. K. Chandralal)

Testing & Industrial Extension

(1) A total number of 130 seals and considerable number of textile reinforced seals were made in the laboratory at the request of Sri Lanka Army Engineers. (P. P. Jayasinghe and H. N. K. K. Chandralal)

(2) Following materials were tested during this year.

House hold gloves	Dipped Products Limited.
PVC tensile pieces	Maharajah Organisation.
Adhesive sample	Kelaniya University.
Insulating pads	Rubberite Limited
Abrasion test samples and rubber compounds	Richard Peiris & Company.
PVC coated fabrics	Standards Institution.
Raw rubber vulcanisation characteristics	C. W. Mackie & Company Ltd.
Tire retreading materials	A. M. W. Limited.
Rubber process oil	A. M. W. Limited.
Tubing joints	R. R. Industries Limited.
Tire retreading materials	Ratnayake Motors.
C-black masterbatch	Bata Company.
Rubber threads	Strechwell Ceylon Limited.

Technical assistance was extended for the manufacture of following ;

Insulation tape manufacture and coir dust pads	Industrial Development Board.
Compounds for outsoles	Korea Ceylon Footwear.
Calf teat compound	Polymer Products Limited.
Compounding for oil seals	State Engineering Corporation.

(i) Dutch Lanka Designs (PVT) Limited

This company in the FTZ make models of animals and funny figures, using plaster of Paris and cement/sand. The company employs around 100 people and make use of silicone rubber as casting compound. NR latex casting compounds were supplied and the initial experiments show that the strength of casting were much superior to silicone rubber. However, some rubber formation was evident. A compounds containing antifoaming agent was supplied and this is now being evaluated both here and in Holland. (W. S. E Fernando and W. D. Dharmasena)

(ii) Seals & coupling 125 nos of Johnson couplings were made in the laboratory for Polymer Products Limited. These items were made to statisfy specifications of Bs 2494. (W. S. E. Fernando and D. D. Medagama)

(iii) Nitrile Rubber compounds were made for State Engineering Corporation for oil seals. (W. S. E. Fernando and K. M. U. Mithrananda)

(iv) Special alcohol resistant seals (220 nos) for pathfinders were made using a mould designed in the Rubber Technology & Development section for Sri Lanka Army. (W. S. E. Fernando and P. P. Jayasinghe)

Raw rubber development

Discolouration of crepe

During the first quarter of this year a major problem of edge discolouration of crepe rubber was reported which was suspected to be due to sunlight exposure. To solve this problem as well as for academic interest a detail analysis was started. First an attempt was made to check whether the chemicals used were responsible but no considerable change was observed. Then the reactions among those chemicals were taken into account and the effect of sunlight and temperature were studied. Meanwhile samples of chemicals under different trade names were collected. However, the analysis showed that there was no significant difference in activities. Samples (edge discoloured sample, sample from the same crepe but not discoloured, a good crepe sample) were subjected to various solvent extractions and following tests were done on each.

(1) Oxidation
(2) Reduction
(3) Effect of metal ions
(4) Effect of complex forming agents
(5) Effect of sunlight
(6) Effect of temperature
(7) Spectral analysis

Finally the acetone extracts of the three samples were tested using thin layer chromatography (TLC) in different solvent systems and a significant difference was observed in the discoloured sample. To isolate this special component found in discoloured crepe, column chromatography was used. Now it has been separated and structural, spectral and chromatographic analysis are in progress.

According to the answers received for a questionnaire sent to the factories, from which such a discolouration was observed, it was clear that this effect is due to the coagulation and delayed milling. All these practices result in leaving more serum substances in the rubber. The findings have been sent to the relevant authorities for necessary action. (M. C. S. Perera, J. P. N. Jayaweera and C. Jayawardena)

Suitability of RRIC 102 *for crepe manufacture*

The trials done during the wintering period indicated that

(1) The rubber produced from RRIC 102 latex undergoes enzymatic discolouration.
(2) When 100% RRIC 102 is used and normal dosage of chemicals added, at least 17% fraction should be taken to produce a good rubber.
(3) The rubber produced undergoes enzymatic discolouration.

(4) 10% excess $NaHSO_3$ improves colour.
(5) Even 5% RRIC 102 with PB 86 latex discolour the rubber and this could be overcome by adding 10% excess $NaHSO_3$.

However, during the rest of the year good results were observed as shown below ;

	RRIC 102	PB 86	Fraction %	Grade
A	100%		8	1A
B	30%	70%	11	1
C	Ellakanda	Typical		1
D	100%		14	1
E		100%	8	1X

Normal doses of $NaHSO_3$ and BA were used. (M. C. S. Perera and C. Senanayake)

Raw rubber antioxidant

Further trials on the effect of a raw rubber antioxidant were done. It was found that there is no effect if a fraction is not taken but if a fraction is taken an increase of 21 unit in PRI was observed confirming the results of the previous trials. However, a drop in solution viscosity and Mooney viscosity was observed. (M. C. S. Perera and C. Senanayake)

Mould contaminations

Trials were carried out to find out the critical moisture content at which mould appear in different crepe rubbers. Fungi collected from the samples were sent for identification. (M. C. S. Perera, C. Senanayake jointly with R. Jayaratne of Plant Pathology Department)

Sole crepe properties

Sole crepe samples from different factories were tested to find out the variation in properties. As shown below it was found that remilled sole crepe has a lower hardness and a higher specific gravity. Work is in progress.

Factory	Product	Hardness	Specific gravity
1	Fresh	40	0.93
	Remilled	33	0.93
2	Fresh	40	0.88
	Remilled–1	35	0.91
	Remilled–2	32	0.92
3	Fresh	35	0.85
	Remilled–1	30	0.89

(M. C. S. Perera and S. Siriwardena)

Study of latex crepe

A detail study of the Sri Lankan crepe industry was carried out and the report was submitted to Sri Lanka Export Development Board for necessary action. The summary of recommendations are gvien below ;

(1) Quality maintenance :—

(a) Good quality and sufficient quantity of water is a must and it is necessary to construct simple treatment plants where such problems are encountered.

(b) Airtight containers should be used for chemicals.

(c) All latex should be bulked and no divisional coagulation should be carried out.

(2) Marketing

(a) Production of tailor made crepe rubbers should be exploited and should be handled through agents.

(b) Standard method of manufacture should be followed.

(c) Price of crepe should be stabilised.

(d) Export duty of crepe should be related to crepe rubber prices.

(e) Sole crepe and other miscellaneous products should be categorised as finished products.

(f) Market promotion team should visit the consumers. (M. C. S. Perera)

Study of centrifuged latex

A project report was submitted to study the suitability of smallholder latex to centrifuge latex manufacture. (M. C. S. Perera, W. S. E. Fernando and J. P. N. Jayaweera)

Properties of crepe rubber

A detailed study of the properties of different types of crepe rubber was undertaken. Following observations are made ;

(1) Mill breakdown is more when fraction is not removed and/or bleaching agent is present.

(2) Mill shrinkage is lower and die swell is higher when non-rubber are present.

(3) Bleaching agent affects the scorch time of free radical initiated vulcanization system but not the polar system.

(4) Better abrasion resistance is recorded when more non-rubber are present.

(5) Colour ageing at high temperature is more when bleaching agent is present and at low temperature the unfractionated rubber underwent more discolouration.

(6) Ageing in water is more with the bleached rubber at high temperature. The unfractionated rubber underwent more tensile drop in water than in air.

Application of shrinkrapped polythene for RSS drying

To eliminate the reaper marks of the RSS sheets, above mentioned polythene could be used to cover the reapers. Trials have been carried out at Dartonfield Estate, Dorset Estate, Andapana Estate and successful results were obtained. On the other hand after covering the reapers with this special polythene it is not necessary to turn the sheet everyday, hence the labour consumption also could be minimised. (M. C. S. Perera and S. Weerasinghe)

Factory Development

Factory subsidy

20 estates and factories were visited and reports submitted to the Rubber Controller. (S. Weerasinghe and S. Siriwardena)

Advisory visits

Following estates and factories were visited regarding RSS and crepe manufacture.

Crepe

(1)	Atale Estate	—	Discolouration.
(2)	Middlamulla Estate	—	Tackiness.
(3)	Homadola Estate	—	Discolouration.
(4)	Monaragala/Kumarawatta	—	Mottled/dull colour.
(5)	Kiribathgala SP	—	Dull colour.
(6)	Yatadola SP	—	Dull colour.
(7)	Peenkande SP	—	Discolouration.
(8)	Durampitiya	—	Dull colour.

RSS Manufacture

(1)	Ayr Estate	—	Design new smoke house.
(2)	Udapola Estate	—	Convert drying tower into smoke house.

(3)	Middlamulla Estate	—	New smoke house.
(4)	Clyde Estate	—	High thickness/delaying drying.
		—	Reaper marks/pinhead bubbles.
(5)	Ambetenna Estate	—	Initiate the RSS manufacture.
(6)	Pilagoda Valley Estate	—	Modification of smoke house.
(7)	Akuressa Estate	—	Modification of smoke house.
		—	Design new furnace system.
(8)	Shakerlly Estate	—	Modification of smoke house.
(9)	Andapana Estate	—	Modification of furnace system.
(10)	Suriyamal Estate	—	Reaper marks.

Drying

Solar drying of crepe rubber

A joint study was undertaken with Dr P. Jolly of the University of Queensland (visited RRI as an expert to Commonwealth Foundation in London). The preliminary report by Dr Jolly include following recommendations which will be pursued.

(1) Efficiency of the present air heaters at Dartonfield is very low.

(2) Distance of the present location is an additional disadvantage.

(3) Cheap collector could be constructed on the factory roof.

(4) Partitioning of the tower is necessary to get maximum use of solar heat. (M. C. S. Perera, S. Weerasinghe and S. Siriwardena)

Improving the existing drying facilities by increasing upward air flow (Reduced pressure system)

An experiment at Pallegama Estate was carried out to reduce the drying time with increasing the upward air flow, by exhaust fan. Before modification drying time was 05 – 07 days. Initially 30 watts fan was used and a reduction in the drying days was observed. Eventhough, introducing a 700 watts fan instead of 30 wattts fan the drying time increased remarkably.

The blower has now been handed over to be modified so that three different speeds would be used to find out the optimum drying condition proportionate to the drying tower capacity without affecting the temperature. (M. C. S. Perera and S. Weerasinghe)

Vacuum drier at Frocester SP

Two more trials were done in the above drier after further modification. The loading and subsequent operations were done by the Industrial Engineers Limited. The results are given below ;

First trial :—

Load	—	500
Weather	—	gloomy day, tem. 30°C.
Total time of vacuum	—	16.5 h
Total No. of KWH unit	—	59.2
Cost of power	—	17 cts/kg.

Samples were dried to moisture content of 0.3% but the PRI was very low indicating over drying.

Second trial

Load	—	850 kg.
Weather	—	No bright sun.
Total time of vacuum	—	15.5 h. (further 4 h fan only)
Total No. of KWH unit	—	55.7
Cost of power	—	9 cts/kg.

Samples are dried only upto 0.5% moisture content. As indicated, only 850 kg had been loaded in the second trial. Therefore further trials are required to give the final conclusion. (M. C. S. Perera, C. Senanayake & S. Siriwardena)

Equilibrium moisture content

A study was initiated to find out the equilibrium moisture content of different types of rubber from which the energy requirement to dry rubber could be calculated. (M. C. S. Perera)

Drying tower analysis

Analysis of drying towers in Wellandura SP, Pallegoda SP, Dewalakanda Estate were carried out and the results are given below:

	Wellandura	Dewalakanda	Pallegoda
Capacity	2808kg	2000 kg (Sole crepe)	5702.4kg
Radiator/surface area/kg	$12.99 \times 10^{-3} m^2/kg$	$16.06 \times 10^{-3} m^2/kg$	$11.03 \times 10^{-3} m^2/kg$
Firewood consumption kg of rubber (14 h)	62.3×10^{-3}	229.677×10^{-3}	87.68×10^{-3}
Heat imput (14 h)	248.59×10^{-7}	297.13×10^{-7}	333.74×10^{-7}
Heat generated by radiatur (14h)	58.97×10^{-7}	66.242×10^{-7}	76.93×10^{-7}
Heat requirement	193.596×10^{-7}	211.548×10^{-7}	295.5×10^{-7}
Inlet temp. (C°)	86	82	64
Outlet temp. (C°)	45	46	38
Proportion of heat generated heat required (%)	28.4	31.31	26.03

(M. C. S. Perera and S. Siriwardene)

Chemical modification

Natural rubber with hydroxyl termination

Work on this project was continued throughout this year. The system involving centrifuged latex H_2O_2 was tried using various power sources including sunlight. A product with molecular weight as low as 1.3×10^4 could be prepared.

The importance of this preparation is the active end group (*i.e.* – OH gp), since the – OH group can easily be converted into other groups and it is useful in synthetic chemistry.

Depolymerisation was studied by the determination of the drop in molecular weight and OH group content was observed in selected depolymerised samples by standard acetylation method followed by the titration against std NaoH solution. Structural studies were done using HNMR and IR spectroscopy. (M. C. S. Perera, J. P. N. Jayaweera and C. Nalini)

Diacid vulcanization

Cross linking of epoxidised natural rubber (ENR) latex using different diacids was examined. 10% ENR 30% ENR were investigated. Good results were observed with 30% ENR. Maximum efficiency was obtained using oxalic acid by varying the acid dosage from 0.1 ppm to 4 ppm. Extent of cross link formation was followed by the determination of swelling index of vulcanizate in toluene and acetone. HNMR and IR spectrum were used to check whether hydrolysis reactions had taken place while cross linking. In several samples OH group content were determined using standard acetylation method. Satisfactory results were obtained and the project will be continued with a series of diacid. (J. P. N. Jayaweera & M. C. S. Perera)

Sun dried sheet

Ribbed sheets were prepared with 12.5 drc, and samples were exposed to sunlight to various time intervals, and at different initial moisture contents. PRI of the samples were measured and it was found that if the moisture content was less than 1% at the time of loading, the rubber degrades.

Moisture content at the loading	PRI
7.41	79
1.63	78
0.89	68
0.62	65

(M. C. S. Perera and C. Senanayake)

Specification and Analysis

TSR testing was done continuously. Samples were received from six registered TSR factories. The number of samples received from each factory is given in table.

Table

Number of samples tested from each TSR factory during 1987

Code	Producer	No. of samples
AA	Sri Lanka (Cey) Rubber Manufacturing Co. Ltd., Natural Rubber Complex, Mawanella.	824
AB	Cenat Block Rubber Factory, Paiyagala.	30
AC	Ceymac Rubber Co. Ltd. Colombo.	6038
AD	Statcon Block Rubber Factory, Getahetta.	1492
AE	Sherman Sons Ltd., Colombo.	4105
AI	Associated Traders	132
	Number of miscellaneous samples tested	1461

These miscellaneous samples consist of the latex, rubber chemicals, water and masterbatch samples received from various places for analysis.

This year the export of TSR has dropped to 6932 MT from 12185 exported in the previous year indicating that the TSR industry is dying away under the present unrealistic raw material prices in the country.

Research projects

The Head, Specifications and Analysis Section was on sabbatical leave abroad throughout this year. The research project carried out by him at the Aston University, UK was titled 'Stabilisation of Polyolefins by Nitration'. A paper written on this work has been submitted for publication in the Journal of Polymer Science. A patent will be registered in the UK on this work.

Mechanism of action of thiols on carotenoid pigments

Work of this project was continued by the Head, Specifications and Analysis Section at the Aston University. Using HPLC technique, the mechanism of action of

the thiol on carotene in the presence of UV light was confirmed as a single thiol substitution reaction and not a poly – thiol substitution on the carotene molecule. A paper was published in the Journal of Degradation and Stabilisation of Polymers, 1987 December issue on these results.

Liquid rubber

Analysis of the liquid rubber made by using nitrobenzene as the photo – initiator was also carried out using the HPLC technique. From the out come of the results of this experiment a fair knowledge about the storage hardening of the liquid rubber and the ways of suppressing it was gained. Further work of this project is in progress.

Latex crepe and sole crepe

The Head, Specifications and Analysis Section visited major dealers and consumers of sole crepe in the UK and made enquiries about the problems faced by them in handling plantation sole crepe from Sri Lanka.

At these meetings it was revealed that the method of packing of sole crepe is highly unacceptable to the consumers in Europe. They are so dissatisfied about the presentation that they have now decided to switch over to synthetic rubber based soles unless we improve the presentation of plantation sole crepe early.

In order to rectify the problem the Head, Specifications and Analysis Section made arrangements to pack sole crepe sheets in corrugated cardboard boxes and strapped with polyester bands. The consumers were quite happy with this new way of packing. After holding discussions with the major shoe manufacturers arrangements were made to send samples of sole crepes with deep grove patterns as on tyre treads to grip well on slippery surfaces and also constant viscosity sole crepe soles which does not harden on storage.

The response of the consumers so far for these improvements is very good.

In the research carried out here on the packing materials, it was found that the Albizzia wood used for making sole crepe crates contain over 25% moisture and surface mould. Hence when sole crepe sheets are packed in them the mould contamination is unavoidable. (L. M. K. Tillekeratne and M. C. S. Perera)

Factors affecting mould contamination of rubber

Experiments are in progress to findout the effect of too much teepol solution and serum water used as lubricant for the sole crepe cutting knife on mould contamination of rubber under different humidity conditions. (L. M. K. Tillekeratne, M. C. S. Perera, S. Weeraman & Vasantha Rodrigo)

Effect of temperature of homogenization on P_o and PRI

This work was carried out as agreed at the ISO/TC 45 meeting held in Moscow in November 1986 to evaluate the effect of temperature of homogenization in the P_o and PRI of raw rubber. For this test we followed ISO 1976 – 1982 (E) method at 40°C $\pm$ 5°C, 70°C $\pm$ 5°C and 100°C $\pm$ 5°C.

Results obtained were statistically evaluated. Our results show that the reproducibility of test results on P_o and PRI is best when the homogenization temperature is 40 $\pm$ 5°C. The tests were not carried out at room temperature as this was not a requirement for the evaluation. (S. W. Karunaratne and A. S. Dekumpitiya)

Biochemistry

Enzyme deproteinization of *Hevea* Latex

Studies were continued. Attempts were made to study the occasional problems encountered with regard to reaching the desired nitrogen and ash levels. Generally, a high quality low protein rubber was obtained by the maturation procedure developed by the Institute. Some preliminary investigations were also carried out with a view to reducing the cost of production by adopting changes in the coagulation process but this was not successful.

LPNR group met twice during the year to review the progress. Several meetings were held by the Sri Lanka Standards Institution to formulate Sri Lanka Standards for LPNR, during the year under review.

Effluent disposal

Work on using water hyacinth in anaerobic facultative ponding systems was continued. Green house trials concentrated mainly on crepe serum and skim serum. Significant reductions in BOD and COD levels were obtained in crepe serum. However, the performance with skim serum was not satisfactory. Higher dilution levels were required for skim serum, even after which the general growth performance and overall efficiency in removing pollutants was not comparable to that of crepe serum. Dilutions ranging from zero to 1 : 20 were attempted. Nutrient uptake by water hyacinth were studied in different types of serum and the results are now being analysed. The performance of the activated sludge treatment system installed at Dewalakanda Estate by the CISIR was monitored for about two months with random sampling. It was found to reduce the COD and BOD levels satisfactorily. Accordingly construction of the first actual treatment system of this type, is now underway at Siriniwasa Estate of JEDB.

Biochemistry Section extended its assistance to Dutch Aid Team, by way of providing necessary general and technical information on rubber factory effluents in Sri Lanka, for the proposed treatment systems, oxidation ditch at Sorana State Plantation and rotating biodisc at Frocester State Plantation.

A steering Committee was formed to monitor the progress of this project and the two meetings were held towards the end of the year.

An Islandwide survey was carried out to find out the exact position regarding land availability for treatment systems. A summary of the findings of this survey is given below.

Number of estates contacted	166
Number of estates responded	104
Number of estates with land available for ponding systems	50
Number of estates without land	26
Number of estates with no rubber or no processing	28

Several estates with effluent disposal problem were visited by the staff during the year.

Investigations on the use of water hyacinth for improving the efficiency of conventional ponding systems, were abandoned in December as we were informed by the Chief Plant Quarantine Officer of the Department of Agriculture that transportation dissemination and growing of water hyacinth is prohibited by law in Sri Lanka. A request was made for relaxation of the law, allowing selective and discriminate use of water hyacinth in effluent treatment systems. However, this was not successful.

A new investigation on land application of rubber factory effluents was initiated during the year. This project is supported by CIDA who awarded a grant of Rs. 1.3 million for purchase of equipment etc. Two sites, *i.e.* Culloden State Plantation and Vincit Estate, were selected for this trial. Green house pot experiments are now in progress. (Krishanthi Jayaweera, Susil Zoysa & M. D. C. Seneviratne)

Studies on brown bast

Free proline accumulation in clone RRIC 101 of *Hevea brasiliensis* was investigated. The bark and the latex samples collected from both healthy and brown bast affected trees of RRIC 101 at Eladuwa State Plantation, were analysed for free proline content. The average bark proline concentration unit present in the brown bast trees was found to be considerably high ($P=0.10$) than that of healthy trees. The accumulation of free proline in latex was found to be significant in brown bast trees indicating a possible link with water stress. Further studies are in progress. (S. I. Wickremasinghe)

REVIEW OF THE BIOMETRY SECTION

BY

W. N. WICKREMASINGHE

SUMMARY

About 1000 datasets both from routine as well as special projects, were analysed and interpreted. Out of this, 60% of the analyses were related to the projects of research students.

As part of applied statistical research, the problem of curvilinear calibration in biological and chemical experiments was worked on. A proposal was made to work on the project to improve the accuracy of field assessment data from smallholder surveys.

Soil and foliar data base program was further improved and tested. The maximum use was made of the package INSTAT for analysis of *Corynespora* leaf disease data and data from 'Genotype x Environment x Year' experiment of the Plant Breeding Department.

DETAILED REVIEW

Staff

Mr W. N. Wickremasinghe, the Biometrician, was on duty throughout. Mr A. R. Weerasinghe, Programmer/Systems Analyst resigned from the services of the Institute with effect from March 1, to accept a position at the Open University, Nawala. Mr L. T. Peiris, Senior Technical Officer, was on duty leave from January 19 to March 25 to attend an English course, specially designed for those who seek training in the UK, at the British Council, Colombo. He then left for the UK in June, for a training in "Application of Micro Computers in Applied Statistics" at the University of Reading, Rothamsted Experimental Station and University of Edinburgh. Mr R. A. P. Abayapala, Technical Officer, was promoted to the position of Senior Technical Officer, on March 25, and was on duty throughout. Messrs L. P. P. Vitharana and T. B. Dissanayake, Technical Officers, were on duty except from March 9 to April 10 during which they were on duty leave to attend "Statistics and Computer Application in Agriculture" (SACAA) at the University of Colombo. Miss J. D. Nandani, Technical Officer, was on duty throughout.

Publications

Wickremasinghe, W. N. (1986.) On the curvilinear calibration in biological and chemical experiments. *Jl. Rubb. Res. Inst. Sri Lanka* **65**, 14-21.

අබේපාල, ආර්.ඒ.ඩී. (1984). ශ්‍රී ලංකාවේ රබර් පිළිබඳ සංඛ්‍යාණ තොරතුරු බිඳක්. රබර් සුවඳ 12 (1)

Wickremasinghe, W. N. (1987). Annual Review of the Biometry Section.

Routine Statistical Service

This consists of two types of services. One is the assistance given to Research Officers of the Institute in their routine projects as well as special projects leading to post-graduate degrees. The other is the assistance provided to Research Students and Temporary Research Assistants attached to research departments of the Institute, carrying out short term projects and projects leading to post-graduate degrees. These are summarized below under each department that used the services, in alphabetical order.

Biochemistry Section

The major work was that of the Temporary Research Assistant carrying out research leading to a Masters degree. This work consisted of the analysis and interpretation of 20 data sets from water hyacinth studies. Methods involved were simple 't' tests, regression and analysis of variance with mean comparisons. Apart from this, a few more simple analyses were also done on routine experiments of the section.

Genetics & Plant Breeding Department

The single largest analysis handled, was of the 'Genotype x Environment' experiment where there were 10 clones, 7 locations and 10 replicates, repeated over 10 years. However, due to missing observations on certain replicates, only 8 replicates were considered for a problem-free balanced analysis. Five pre-tapping and 5 post tapping girths were analysed separately, to study 'GXE' and 'GXE x Year' interactions and various other components in a combined analysis. During the first quarter about 50 data sets from a study on hand pollination, carried out by a foreign consultant, were analysed and interpreted.

Plant Pathology Department

Further assistance was provided to the continuing NARESA funded project "Some comparative biological aspects of nutrient cycling in rubber plantations, a *Pinus* plantation and a rain forest", carried out by a Temporary Research Assistant. This work alone with 166 data sets analysed during the year, claimed 85% of the total statistical analyses provided to this department. The other work involved were 16 data sets from the final phase of the project "Disease investigation of intercrops of rubber", of a Temporary Research Assistant, 10 data sets from a study on *Corynespora* leaf disease, involving spore count and several weather factors, for analysis and interpretation. Multiple regression techniques were used in the latter while most of the other analyses were simple correlations and analysis of variance.

Plant Science Department

A total of 16 data sets were analysed and interpreted. Out of these, 5 analyses corresponded to genetic correlation between sugar content and yield of latex and the others were from routine experiments with one-way or 2–way analysis of variance.

Soils and Plant Nutrition Department

A total of 694 analyses ranging from simple correlations to split-plot confounded designs, were provided during the year. A breakdown of this is given below.

Description	No. of analyses
Potassium and magnesium nutrition of *Hevea* and associated covers (MPhil project)	135
A study of nutrient deficiencies in immature rubber (CIDA project)	121
Weed project	260
Other (routine)	178
Total	694

Independent Research

Calibration in experiments

The section is involved in applied statistical research when time permits. This year, the Biometrician worked on a problem on calibration in biological and chemical experiments : A common application in biological and chemical experiments is to predict X from Y (calibration) when Y is related to X through regression techniques, where X and Y are 2 variables of interest. This study discussed the case when Y is a quadratic function of X with the quadratic response highly significant. Approximate confidence intervals were derived from X when Y is optimum. Alternatives and further extensions were also considered. (W. N. Wickremasinghe)

Smallholder surveys

In the area of sample surveys, the work done on 'non-sampling' or 'non-response' errors is relatively less. There is a bigger chance of coming across such errors frequently in rural agricultural surveys, mostly in developing countries. In Sri Lanka 70% of the rubber land is owned by smallholders, but their productivity in terms of both quality and quantity, is proportionately less. In the present, the focus has been on smallholder

oriented research with the aim of finding solutions to this problem. The Biometrician has already proposed to work on the problem of improvement of accuracy of field assessment data from smallholder surveys with the objectives of minimizing 'non-sampling' type errors and to obtain valuable information on smallholders with increased reliability at reduced costs. It is proposed that this study should be a preliminary step or to be carried out parallelly with other avenues of adaptive research proposed for rubber smallholders. (W. N. Wickremasinghe)

Computer Work

Soils and foliar data base program

Necessary documentation and some programming were done for user convenience on the soil and foliar data base program and help was given when necessary to use this program. It was further tested during the year and found to be error-free.

Corynespora analysis

A set of data on *Corynespora* leaf disease containing 5880 observations, was transferred from BBC to IBM-PC with the help of the University of Colombo. "Hourly spore count" data of this set, were partly handled using AUTOBJ package. A series of multiple regression analyses on this *Corynespora* data were done successfully using INSTAT package.

Genotype x Environment experiment

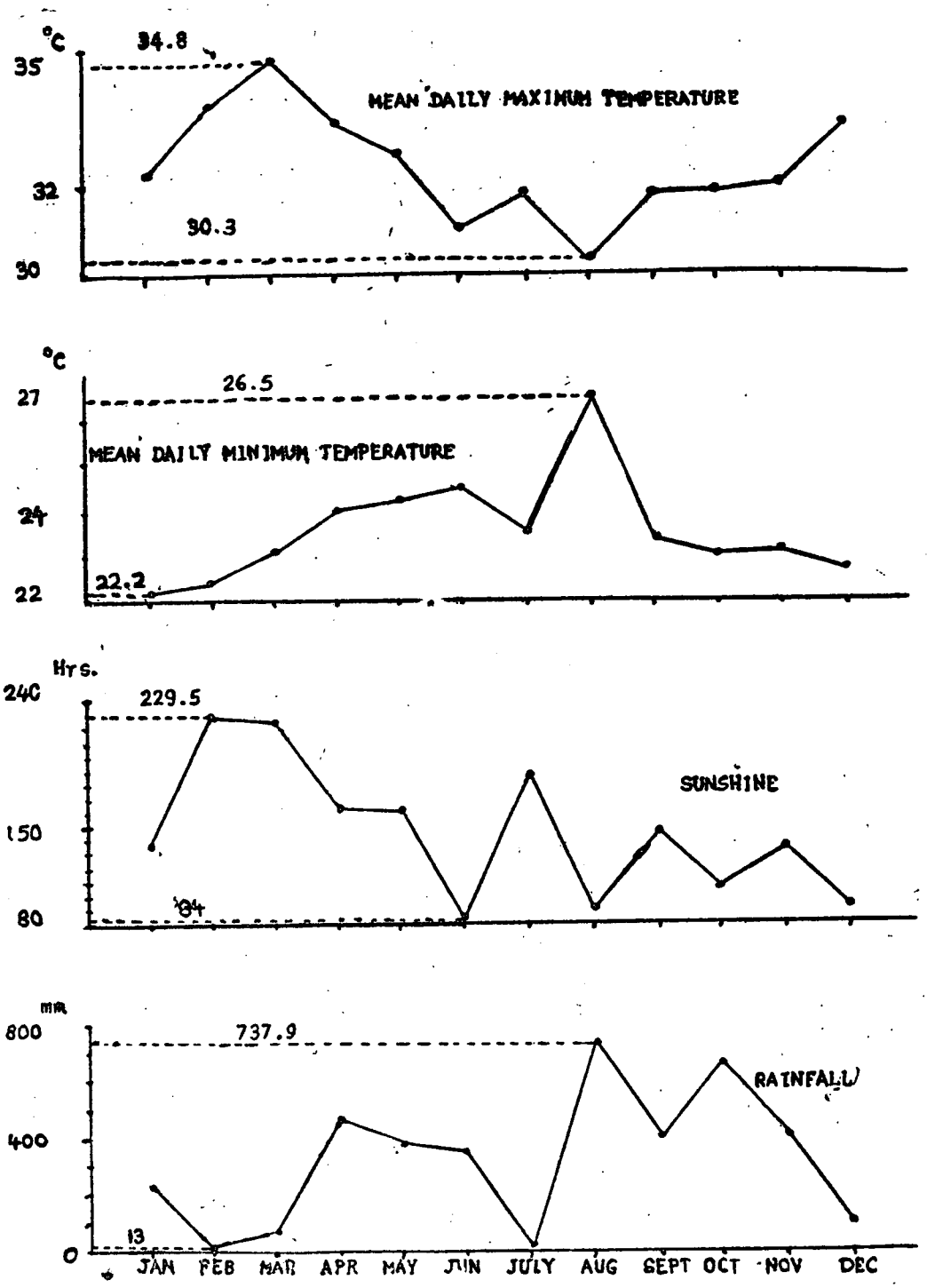
A lengthy combined analysis on this data (with 10 clones, 7 locations, 10 years and 8 replicates) was done successfully using INSTAT on BBC-Micro with 32k memory, using short cut methods.

Proposals for new system

Our attempts made in the previous year to go for a powerful machine with facilities to accomodate powerful software, seemed to be successful toward the end of the year. One of our proposals on this, submitted last year to the Chairman, RRB, received favourable consideration and as a result, an EPSON PC/AX 40MB system with LQ1000 printer, were ordered in December, from World Bank funds. We hope the machine would reach us in the early part of 1988 and open up new avenues for us for the efficient handling of complex and lengthy data sets.

Miscellaneous

The DG-CS/5 micro computer was out of function toward the third quarter and sent for repairs. Considerable time was spent on the computerizing of the NARESA funded project of the Temporary Research Assistant attached to the Plant Pathology Department. The management of the data base of survey on *Corynespora* leaf disease,


°C
34.8
35
MEAN DAILY MAXIMUM TEMPERATURE
32
30.3
30
°C
27
26.5
MEAN DAILY MINIMUM TEMPERATURE
24
22.2
22
Hrs.
240
229.5
SUNSHINE
150
84
80
mm
800
737.9
RAINFALL
400
13
0
JAN FEB MAR APR MAY JUN JULY AUG SEPT OCT NOV DEC

handled by the Assistant Agricultural Economists, was continued. Some routines were prepared to handle Agromet–1 data. Toward the end of the year, computers were fully occupied with analyses for the Annual Review.

Meteorological Work

The instruments installed at the Nakiadeniya State Plantation were removed. Summaries of data on rainfall and rainy days for the period July 1986 to June 1987, were sent to the Tea Smallholdings Development Authority, on request. All other routine activities of the Dartonfield meteorology station, were continued uninterrupted. The graph of rainfall, temperature and duration of sunshine at Dartonfield is shown in Fig. 1.

REVIEW OF THE LIBRARY AND PUBLICATIONS SECTION

BY

VIJITHA JAYARATNE

SUMMARY

The routine work of the Library and the Publications Section falls within two main areas : maintaining processing and publishing of the Institute's regular publications and collecting and disseminating of information on all aspects of natural rubber (NR). Work within these two areas, for the year 1987, was carried out successfully.

DETAILED REVIEW

Staff

Mrs Vijitha S. Jayaratne, Librarian and Publications Officer, Mr D. C. Thambawita, Library Assistant and Assistant Publications Officer and Mrs R. Amaratunge, Clerk/Typist, were on duty throughout the year. Mrs T. Dantanarayana was promoted as the Library Assistant and Assistant Publications Officer of the Ratmalana Office from 14 July.

Meetings

The Librarian and Publications Officer attended the following seminars regarding Library Services.

Seminar on Audiovisual Librarianship on 6 March.

Meeting of the SLSTINET (Sri Lanka Scientific and Technical Information Network) Librarians.

Seminar on International Standard Numbering System for books, software, mixed media etc. in publishing, distribution and Library practices. At this seminar the National ISBN Agency of Sri Lanka awarded Rubber Research Institute the publisher prefix 9022.

Acquisitions

Text books

As money needed to procure books was not sufficient, letters requesting for donations were sent to various Organisations. In response to these only 4 books on Computer Science were received from the American Centre. Further to this a list of books was also prepared to obtain them through the allocation made under the Agriculture Research Project. Fourty five books were received from the books order in 1986 and these were inventorised making the number of book to 3981.

Periodicals

The procurement of periodicals was maintained throughout the year 1987. No new numbers were introduced.

As arranged 118 titles of Journals were bound during the year and added to the collection of bound books.

Information Services

Dissemination of information

Necessary information required by the Staff were made available. Photocopies of contents pages of Journals were circulated among the Research Officers according to the relevant subjects required by each Department. Useful articles from Abstracting Journals were indexed and filed according to the subjects.

Agricultural Information Network (AGRINET)

Contents pages of 34 Journals requested by the AGRINET users were sent out regularly, and contents pages of Journals requested by our staff were circulated when received from NARESA.

Inter library loans

Sixty six photocopies of articles were sent to various Libraries on request and 51 photocopies of articles were distributed among our Officers who made requests for the articles. Eight photocopies of articles were received from the British Lending Library by sending British Council coupons.

Publications

Processing and publishing of all RRISL publications were continued. The following publications were published during the year.

Publications	Volume/year
Annual Review	1986
Annual Report	1986
Journal	64 & 65
Bulletin	22
Conference proceedings	2 (2)
Advisory leaflet on *Corynespora* leaf disease (in English & Sinhala)	

REVIEW OF THE ESTATE DEPARTMENT

BY

V. M. KATUGAHA

SUMMARY

Dartonfield Group belongs to Rubber Research Institute of Sri Lanka and comprises of 3 Divisions namely Dartonfield and Gallewatta in the Agalawatta electorate and Nivitigalakele Division in the Matugama electorate.

The total extent of the estate is 332.04 ha and the planted area is 278.70 ha of which 195.89 ha were in bearing during the year.

Dry weather prevailed at the begining of the year and thereafter wet weather was experienced. However, the weather improved towards the latter part of the year making it possible to recoup most of the loss in crop.

The uprooting of the old rubber trees in the area to be replanted in 1981 had not been completed, and as such the 1987 planting had to be postponed for 1988.

The trees in which wintering was delayed suffered some leaf fall owing to *Oidium*.

Budwood of clones of RRIC 100, 121 and PB 86 continued to be in demand and issues to all estates and smallholders were made accordingly.

All agricultural operations were carried out in mature and immature areas and nurseries of the group.

DETAILED REVIEW

Staff

Mr L. R. Dahanayake, the Estate Superintendent resigned from the Rubber Research Institute of Sri Lanka on 21 March 1987 to go overseas.

Mr E. A. Herman, Factory Consultant, Tea Smallholdings Development Authority and Agricultural Advisor for Dartonfield acted as the Superintendent up to the 12 November 1987. He was subsiquently succeeded by the writer from the above date.

Mr A. A. Ariyaratna, Chief Clerk resigned from the post of Chief Clerk which has since been vacant.

Mr A. K. D. M. Wickremasinghe Asst Field Officer was retired from service on the 28 July 1987 on reaching the age of retirement.

Mr N. L. D. Reggie was appointed as Field Supervisor w.e.f. 15/01/87. Mr A. K. A. Wickremasinghe was appointed as Junior Asst. Clerk with effect from April 1987.

Mr K. K. P. Gunawardena, Acting Senior Assistant Clerk, Mr K. D. Sumanasena, Junior Assistant Clerk, Mrs Chandrakanthi Dissanayake Junior Asst Clerk, Messrs N. L. D. Piyadasa, A. K. D. Hemapala, S. K. S. de Silva, J. A. Wimalasena and H. M. J. Premalal Field Officers, Messrs S. R. Vadival and T. Somarathna Field Supervisors, Messrs D. S. K. Ranaweera Rubber Factory Officer, W. D. D. Senanayake Factory Supervisor, Mrs C. S. Hettiarachi, Creche Attendent Mr H. W. Amaradasa, Tractor Driver and Mr A. K. Piyasena were on duty throughout the year.

The Dartonfield Group cadre stood at 17 at the close of the year made up as follows :

Senior Staff	01
Asst. Staff	13
Minor Staff	03
Total	17

Agricultural Advisor

Mr E. A. Hermon, Factory Consultant, Tea Smallholdings Development Authority visited the property as Agricultural Advisor during the year and preliminary work schedule report on this visit was submitted to the Rubber Research Board.

Hectarage

A summary of the hectarage is given in Table 1.

Table 1. *Land distribution in Dartonfield Group*

	Dartonfield	Gallewatta	Nivitigalakele	Total
Mature area	20.50	112.78	43.92	177.20
Immature	21.81	62.00	—	83.81
Nurseries	7.28	1.80	8.61	17.69
Paddy field	—	1.25	—	1.25
Abandoned area	—	—	8.06	8.06
Swamps	—	—	1.21	1.21
Uncultivated rocky area & earth slips jungle	3.25	1.40	2.62	7.27
Jungle	—	—	.71	.71
Stream reservations	.03	—	—	.03
Roads	3.27	1.29	.32	4.88
Buildings	16.14	6.00	7.79	29.93
Total	72.28	186.52	73.24	332.04

A recent servey on Dartonfield and Gallewatta Division were carried out of which a summary is given below :

	Dartonfield	Gallewatta
Cultivated extent	42.4027	169.5352
Gardens	16.1401	5.0723
Roads	3.2670	6.8594
Rocks	—	1.7954
Streams	—	0.8363
Deniya	—	1.2195
Waste land	2.9230	0.1814
Nurseries	7.2720	—
Statel and taken	0.2740	—
Total	72.2788	185.4995

Weather

Rainfall figures (mm) for 1987 and 1986 are given below in Table 2.

Table 2. *Rainfall distribution for* 1986 & 1985 *in Dartonfield Group*

	1987	1986
January	189.6	157.9
February	6.1	183.0
March	76.4	492.4
April	291.5	615.6
May	235.6	481.0
June	314.9	182.7
July	16.9	129.7
August	556.3	225.0
September	328.8	478.1
October	475.8	402.7
November	255.0	426.8
December	67.0	544.6
	2813.9	4319.5
Total wet days	176	229

The highest rainfall was recorded during the month of August and was 556.3 mm on 28 days, and the crop secured for the month was extremely poor.

Crop

The yield data for the last 5 years are given in Table 3.

Table 3. *Yield records from* 1983 – 1987 (*kg/ha*)

	1987	1986	1985	1984	1983
Dartonfield	1416	1015	825	865	838
Gallewatta	1229	1114	741	924	804
Nivitigalakele	729	648	635	781	667
Average	1128	1049	730	884	779
Estimated	1213	870	913	889	1052
Tapping ha.	117	196	213	097	204

The 1128 kg, yield per heactare recorded this year is the highest since 1983.

The crop secured for the season was 203004 kg against the estimated of 215000 kg.

94 days tapping was not possible on account of rain and recovery tapping was carried out on 58 days.

Tapping cuts were marked with appropriate guide lines for bark consumption according to the system of tapping adopted.

The tapping standard was good, and the tapping panels were treated with fungicides.

Manufacture

A summary of manufacture records during the year is given in Table 4.

Table 4. *Details of manufactured crop in Dartonfield (aggregate of latex & scrap percentage)*

Latex grade	Total (kg.)	Crop (%)
Pale Crepe No. 1	191101	80
Pale Crepe No. 3	10399	04
RSS No. 1	22102	10
RSS No. 2	278	—
Scrap Crepe No. 1	10519	04
Scrap Crepe No. 2	4181	02
Scrap Crepe No. 3	317	—
	238897	100

The estate continues to purchase latex from smallholders and the total purchase in 1987 is 35,667 kg against 26,205 kg in 1986 and the smallholders were paid an average price of Rs. 16/88.

The total crop manufactured during the season was 238,897 inclusive of 35,667 kg of bought latex.

22,000 kg of Crepe IX was supplied on forward contracts during the year.

Factory machinery

Machinery is in satisfactory condition, except the Brown's No. 1 Grooved Mill which is used for dry blanketing needs a complete overhaul.

Factory building

The repairs to the entire loft was completed. 200 G.I. sheets were replaced in the factory roof, and the general condition of the factory could be considered satisfactory.

Agricultural operations

The entire immature and mature areas, and the areas to be replanted in 1988 at Dartonfield and Gallewatta were weeded monthly and the cover crops were established. Nivitigalakele Division too was weeded monthly.

Roads

The road leading through field Nos. 1982 & 1983 was newly macadamized and completed within the year.

All motorable roads within the group were well maintained.

Pest & diseases

The incidence of *Corynespora* leaf disease spread to all areas planted with RRIC 103 from 1981 to 1985 replantings. All trees of RRIC 103 was uprooted and destroyed.

Fertiliser

Applications in all fields have been carried out.

Replanting

The 1987 – 32.61 ha clearing would be planted in 1988 S. W. monsoon.

The entire extent with RRIC 103 was uprooted and partly re-supplied at the latter part of the S. W. monsoon. Owing to non-availability of planting material the balance would have to be re-supplied in 1988 S. W. monsoon.

The clearings which are to be uprooted in 1988 is being tapped on a 400 % intensification.

Nurseries

120,000 seedlings were planted in a nursery at Nivitigalakele Division in an extent of 5 acres, the plants are gaining a satisfactory girth. These plants would be budded to be used in the fields on Dartonfield Group, which are coming under the accelerated replanting programme, and the balance to be desposed to smallholders.

Poly bagged nurseries

Poly bagged plants of the under mention 11 clones which total up to 11,700 plants has been established on Dartonfield Division to be planted during the 1988 S. W. monsoon in the 1987 clearings. All plants have been given the required fertiliser applications and protected against pest and diseases.

PB 86	—	1035
PB 28/59	—	650
PB 217	—	1000
RRIC 100	—	360
RRIC 102	—	650
RRIC 121	—	1667
RRIC 110	—	2109
RRIC 130	—	1430
RRIC 117	—	544
RRIM 600	—	1100
RRIM 623	—	1155
Total	—	11700

All nurseries were well maintained.

Field and factory experiments

The Research Departments were given the necessary assistance in carrying out their field and technological experiments.

Institute buildings

The general maintanance expected from the Estate Department was done and individual problems attended to when necessities arosed.

Labour & health

The casual labourers recruited in 1986 has worked for a period of one year without a break and now has to be treated as permanent workers.

All non working resident children over one year of age and below thirteen years continued to be issued with 1/4 lb bread p/day per head.

The health of the entire population was satisfactory during the year.

National tree planting campaign

Medicinal and herbal plants were planted in Dartonfield and Gallewatta Divisions on the 17 September 1987 to commomarate the 81st birth anniversary of His Excellency the President J. R. Jayawardena.

Accounts

Final accounts for 1987 is in progress.

Estimates

Estimates of Capital and Revenue expenditure for 1988 in respect of Dartonfield Group were submitted to the Rubber Research Board and awaits approval.