

**BIBLIOGRAPHY
OF
RUBBER RESEARCH
IN
SRI LANKA
1960 - 1980**

NA-31

Compiled by

N. A. W. A. T. Alwis

**SOCIAL SCIENCE RESEARCH CENTRE
NATIONAL SCIENCE COUNCIL OF SRI LANKA
47/5 Maitland Place
Colombo 7.**

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RUBBER RESEARCH IN SRI LANKA

A bibliography with abstracts

by

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PREFACE

The need for a bibliography of the literature on natural rubber pertaining to Sri Lanka had long been recognised by scientists engaged in research in the field of rubber industry, and this bibliography, which forms part of a series of studies covering the major agricultural crops in Sri Lanka, is confined to research and development in the economic, chemical, technological, biological and agricultural aspects of the rubber industry. It includes publications in the form of monographs, periodical articles, leaflets, theses, annual reports, abstracts, and published seminar papers. The literature collected begins with the year 1960 and concludes with 1980. The opportunity has been taken to include writings of local scientists on the research work carried out at the various foreign universities and research institutions for the greater benefit of the user. Sections and significant parts in articles which, though not dealing primarily with rubber, have a bearing on rubber have also been considered. Unpublished literature (except unpublished theses presented to local and foreign universities), book reviews and articles in newspapers have been omitted.

The entries have been checked up with the original as far as possible. This has been done to ensure the greatest possible accuracy of description. The titles have been organised under 11 groups followed by appropriate sub-groups. The details of classification are given in contents. All the entries have been serially numbered. Entries carry full bibliographic details. The name of the author is recorded as it appears in the publication. In the case of articles in journals, the title is followed by the name of the journal. This is followed by the volume, number, part (when available), year and pagination. A short descriptive annotation accompanies most titles. An author index is given for easy reference.

The major portion of the literature included has been consulted in the Library of the University of Peradeniya, Sri Lanka; Rubber Research Institute of Sri Lanka, Agalawatta, and Ratmalana; Colombo Museum Library; University of Sri Jayawardenapura, Nugegoda; Libraries of the Industrial Development Board of Sri Lanka; Ceylon Institute of Scientific and Industrial Research; Department of Agriculture, Gannoruwa; National Scientific and Technological Information Centre. And also major portion of material was collected through personal contacts with the Scientists active in rubber research mostly from the above mentioned institutions. The search for data has also been facilitated by use of relevant indexes, abstracts services and bibliographies. As the need arises regular supplement will be compiled, and any gaps and omissions in the bibliography will be remedied.

A special word of thanks is due to Mr. Richard Abrahams for typing the manuscript. I wish to thank Mrs. C.M. Fernando, Secretary, Social Science Research Centre, for her assistance in the production of this work.

N.A.W.A.T. Alwis

The Library,
University of Peradeniya,
Peradeniya.
SRI LANKA.

11th September 1981.

PART I

General

1. ALWIS, N.A.W.A.T.

Rubber. In: Bibliography of scientific literature on Sri Lanka and by Sri Lankan scientists relating to agriculture, forestry, veterinary sciences and fisheries, 1960-1978. Colombo, Social Science Research Centre, National Science Council of Sri Lanka, Volume I, 1979, pp. 268-326.

A list of 407 items on Sri Lanka and by Sri Lankan scientists relating to rubber research and published between 1960 and 1978. They are arranged under the following sub-headings: General; Rubber Research Institute, Annual Reports; physiology, biochemistry; morphology; agriculture; farming in general; soil science; selection, breeding; nurseries, replanting, rejuvenation, clones, planting material, tending and care of plants, grafting, budding, cover plants; harvesting, reaping, stacking, yields; treatment after harvesting, rubber technology, industry, manufacture; by- and co-products; fertilizers, manuring; geophysical influence (on climate); and plant injuries, diseases, plant protection, phytopathology, pest control. This includes publications in the form of monographs, periodical articles, leaflets, theses, annual reports, abstracts. The political, administrative and socio-economic aspects of the rubber industry are excluded except for few entries. Concluding each class of entries a cross reference is given to related materials classified under other headings. A broad alphabetical subject index to the terms used and an author index are given for easy reference.

2. ANON

Beginnings and growth of the industry. Economic Review (Sri Lanka) 6 (9) Dec. 1980 : 5, illus.

A brief article on the introduction of Hevea brasiliensis in 1876 at the Government's Heneratgoda Gardens, 17 miles from Colombo.

3. ANON

Research in Ceylon. New Commonwealth. 40 (4) 1962 : 256, photo.

A brief account of the research work carried out by the Ceylon Institute of Scientific and Industrial Research among other things CISIR has invented the all-rubber rainguard permitting the tapping of rubber trees during wet weather.

4. AUBERT, H.J.

[The development of the plantation sector of Sri Lanka within the agricultural sector after independence]. Die Entwicklung der Plantagenwirtschaft Sri Lankas im Rahmen der Agrarwirtschaft nach Erlangung der Unabhängigkeit. Dissertation, Köln Universität, German Federal Republic, 1974. 223 p.

In Part I the Sri Lanka plantation sector is described on the basis of a non-representative empirical survey. Part 2 deals with the factors determining economic changes and their importance without going into reasons. In 3, the main part, the plantation areas (tea, rubber, cocoa) are analysed under: structure; peasant farming; population; settlement and transport network. (World Agricultural Economics and Rural Sociology Abstracts. 18 (12) 1976 : No. 7296).

5. BAPTISTE, E.D.C.

Natural rubber - its position and prospects. Q. Jl. Rubb. Res. Inst. Ceylon. 37 (4) 1961 : 99-102.

The 2 new synthetic rubbers known as stereo-regular and stereo-specific rubbers, presents a serious threat to NR. It is expected, however, that for some time to come natural rubber may retain an advantage in cost of production. Subsidized replanting in Ceylon and Malaya aims at high productivity which is the most important contributory factor to low cost of production. From a technical point of view, the advantage still possessed by NR is that it has an overall superiority, to any synthetic rubber substitute, although it may be inferior to some in respect of some properties. The general trend is to regard SR and NR as complementary rather than competitive, and to suggest that there should be more co-operative research between NR producers and SR manufacturers. (Tropical Abstract). 17 (6) 1962 : No. J.1548).

6. BAPTISTE, E.D.C.

Properties and competitive prospects of natural and synthetic rubber. Q. Jl. Rubb. Res. Inst. Ceylon. 38 (3/4) 1962 : 35-39.

Two important international rubber conference were held in May 1962, one in Paris under the aegis of the International Rubber Research and Development Board and the other in Washington organized by the International Rubber Study Group. Papers presented at these conference covered all branches of elastomer production and of technical development. They brought up-to-date the comparisons between properties of natural rubber and synthetic rubbers and dealt with economic aspects and marketing organization. This article is based on the opinions expressed and conclusions reached at these Conferences.

7. BARLOW, Colin

Some improvements to the Ceylon rubber industry. R.R.I.C.

Bulletin (N.S.). 5 (1/2) 1970 : 1-14, 7 tables, 4 appendices, 11 refs.

Holding size in the Ceylon industry varies widely, one striking feature being the large number of small farms. Studies in W. Malaysia indicate that such units need not prevent effective resources use, provided adequate replanting takes place and satisfactory central processing facilities can be arranged. The conservative approach to exploitation in Ceylon is questioned, and examples are presented to demonstrate the advantage of more intensive tapping on both small-holdings and estates. These examples recognize the greater present value of profit earned today as against some future time. Present value assessment also highlights the advantage of shortening the immature period. The significance of special purpose rubbers to Ceylon is reviewed, and the conclusion reached that an immediate conversion from sheet to block rubber production is unlikely. The vital importance of establishing at least one block rubber plant, and the need for government assistance towards this end, is however emphasized. The desirable short-term policy is for efforts to improve sheet quality, and here there are undoubted national advantages in establishing a chain of rubber co-operatives to improve the small-holders' product. It is also crucial to remedy the unsatisfactory assembly and packing of sheet rubber. In regard to research the pressing need in Ceylon is for a short-term project-oriented bias. This should be associated with an effective working dialogue between rubber producers and research workers. (Author's summary).

8. BARLOW, C. and PERIES, O.S.

On some biases in the generation of technologies by rubber research institutes. Jl. Rubb. Res. Inst. Sri Lanka. 54, part I, No. 2 : 1977 : 445-459, 3 graphs, 3 tables, 35 refs.

This paper considers the distortion in economic use of resources flowing from the generation of partly inappropriate techniques and technologies. This distortion comes especially from the application of techniques essentially developed for estate conditions to the situation of small-holdings. As an introduction to the paper some pertinent economic concepts are discussed. A review is made of past research in the major rubber-producing countries, and highlights the almost exclusive concentration until recently on techniques and technologists suitable for estate conditions. Some specific examples of bias are reviewed in detail and desirable economic adjustments, in application to the circumstances of smallholdings, are suggested. The examples of major concern involve research on tapping systems, and on planting methods including the specific aspects of tree planting densities, intercropping and weeding. There is also the overall problem that the basic levels of input use on rubber research stations are usually inappropriate to realistic experimentation on the problems of small holders. It is believed that a better adaptation of available techniques and technologies to the situation of rubber small-holdings can produce substantial economic benefits.

9. CEYLON. Rubber Controller Department.

Administration report of the rubber controller. Part I -
Civil (K). Colombo, Govt. Printer, 1960- . Annual.

This report covers the activities of the Rubber Control Department during the year under review. The Rubber Control Department, which functions under the Rubber Control Act, No. 11 of 1956, is responsible for the collection of statistics of acreage, production, consumption and exports of rubber; for the issue of permits for the planting of new areas in rubber and the replanting of worn-out rubber areas; for the registration of rubber lands and the owners thereof; for the issue of licences to rubber dealers and for the performance of any other duties, in furtherance of the interests of the rubber industry. The Rubber Control Department is also responsible for the administration of the Rubber Replanting Subsidy Scheme, which is operated in terms of the Rubber Replanting Subsidy Act, No. 36 of 1953. Part I of each report deals principally with the activities of the Department under the Rubber Control Act, though a few other general matters relating to the rubber industry are also referred to in Part I. Part II of the report deals specifically with the Rubber Replanting Subsidy Scheme, operated under the Rubber Replanting Subsidy Act. Published separately in Sinhala, Tamil and English.

10. COMMONWEALTH DEVELOPMENT CORPORATION.

Government of Sri Lanka. Report on the rubber industry master plan study. In 12 vols. Prepared and published by the London Commonwealth Development Corporation in association with London Harrisons Fleming Advisory Services Ltd., Sept. 1979.

Volume I. Summary Report. This sets out the background to the rubber industry, summarises the specialists reports and recommendations, proposes a new organisational structure for the industry and consolidation of legislation and sets out the financial and economic conclusions.

Volume II, Part A. State Rubber Plantations. The Field Sector Report. The Estates Field Expert sets out the present position on the 198 estates of the Sri Lanka State Plantations Corporation (SLSPC) and the Janatha Estates Development Board (JEDB), examines and makes recommendations on technical considerations and sets out the proposed rubber replanting programme.

Part B. Rubber Processing and Factories. The Estates Factories Expert analyses the present product types and processing methods in estate factories. He recommends their consolidation into fewer central crepe and scrap factories, a great reduction in RSS factories and, after total production is restored to and exceeds present levels under the replanting programme, the development of up to three crumb rubber factories after 1992.

Volume III, Part C. State Rubber Plantations. Statistical Tables and Schedules. This comprises 16 Schedules analysing land use, rubber plantings, staff, labour, factories, housing, transport, power, water supplies, etc. on the 198 rubber estates by Corporations and their Regions.

Volume IV, Part A. Rubber Smallholdings and Private Estates Field Sector. The Smallholders Field Expert examines the present state of smallholder and private estate rubber plantings, technical planting and production considerations. He recommends an accelerated replanting programme and a strengthened Advisory Services Department (ASD). This will take over from the Rubber Controller, field inspection for the greatly expanded replanting and subsidy programme and for rubber registration, in addition to regular advisory visits to nurseries and growers with rubber in tapping.

Part B. Rubber Processing. The Smallholders, Processing Expert analyses present processing and marketing methods, recommends expansion of group processing centres (GPC) until, after a severe decline in production due to the backlog in replanting, output exceeds current levels when from about 1990 five crumb rubber factories would be developed. It is proposed that a strong processing supervisory service be set up and this function transferred to it from ASD.

Volume V. Parts A and B. Economic Studies. Sample Surveys and Social Studies. The Agricultural Economist analyses the results of a number of surveys initiated under the Study and previous social study reports in the rubber sector.

Volume VI. Economic Studies. To meet the range of information and analysis required, a second Agricultural Economist was brought in to amplify the economic studies.

Part C. Costs and Returns to Government.

Part D. Production Budgets.

Part E. Agricultural Credit.

Part F. Inter-Crops and Crop Diversification.

Part G. Land Tenure.

Volume VII-X. Rubber Control Office. Two Systems Analysts undertook a detailed study of the rubber registration and subsidy systems, their operation and organisation required, together with licensing requirements for dealers and manufacturers. Recommendations are made for establishing of a computer based system and staff training.

Volume XI. Rubber Research, Marketing and Manufacture.

Part A. Rubber Research. The Rubber Research Specialist studied research and staffing needs, including the Biological Chemistry, and Technology Departments. He has recommended that RRISL be re-established on a more suitable site for long-term rubber research nearer Colombo with some strengthening of staffing.

Part B. Rubber Marketing. The Rubber Marketing Expert advised that a strong and expanded market for natural rubber including Sri Lanka's two main product types, crepe rubber and RSS should extend for a considerable period ahead. Conversion of crepe into a blocked form might prove advantageous while diversification into crumb rubber should be considered once production exceeds present processing capacities.

Part C. Rubber Manufacture. The Rubber Manufacturing Specialist found that MPI had already licensed nine crumb rubber enterprises, all but one to process low grade RSS and scrap grades. The licensed capacity is well in excess of availability of such grades which will decline both as immature rubber areas increase and as standards of processing improve. Plans were outlined for the crumb rubber factories which the State estates and the private sector will require in a decade or two. These should be developed and run by a Rubber Manufacturing and Marketing Board. The local industry for manufacturing rubber was also analysed by the second Agricultural Economist.

Volume XII. Financial and Economic Analysis. Part A. Financial Analysis. This contains the detailed financial analysis undertaken by the Financial Analyst of a series of components of the recommended programme, including the State estates, and factories, the rubber smallholdings and private estates and processing, the Rubber Control Office, the RRISL and the restructured organisation of the rubber industry.

Part B. Economic Analysis. This contains the economic analysis of the proposals by the Agricultural Economist.

11. DE SILVA, C.A.

Review of the Institute's work. Q. Jl. Rubb. Res. Inst.

Ceylon. 41 (1/2) 1965 : 6-11.

A brief review of the work at the Rubber Research Institute of Ceylon, during the 11 year period since the last conference in 1953 by the Director.

12. FRANCISPILLAI, George-Cherubim

Les plantations d'hévéas à Ceylan et les petits producteurs. [French : The Hevea plantations in Ceylon and the small producers]. iv, 114 p. (These de Doctorate d' Université ès lettres. Paris, 1969).

A thesis in French language, and consists of four chapters in two parts. Contents: 1. Conditions physique de la culture de l'Heveas Brasiliensis. [Physical conditions of the rubber cultivation]. 2. Section I. Ordonnance Numere 1. [Ordinance No. 1]. Section II. Les observations critiques des membres du conseil et Lord Stanmore. [Critical observations of the members of the Council and Lord Stanmore]. 3. Section I. L'evolution des plantations. (L'histoire de l'heveaculture) depuis 1830. [Evolution of plantations. History of rubber cultivation since 1830]. Section II. Plan Stevenson [Stevenson plan], International Regulation Plan. 4. La periode du gouvernement democratique acot 1947. [Period of Democratic Government, August 1947]. (i) La politique que j'ai conseillé en 1949. [The policy that I advocated in 1949]. (ii) La politique du gouvernement et ses repercussions. [The policy of the Government and its repercussions]. (a) Sur les plantations de caoutchouc [on the rubber plantations]; (b) sur les petits producteurs [on the small holders]; (c) sur l'economie de Ceylan, [on the economy of Ceylon]. A copy is available at the Bibliotheque de la Sorbonne, Library catalogue no. W. Univ. 1969(58) - 4°.

13. GOONASEKERA, G.A.J.P.R. and PEIRIS, L.T.

An analysis of personnel and finances of the Rubber Research Institute of Sri Lanka from 1964 to 1975, with special reference to research departments. R.R.I.S.L. Bulletin. 11, 1976 : 4-15, 7 tables (one folded), charts, 3 refs.

It is only by analysis and self-examination that we can see at a glance the progress of an institute. This study reported in this article has covered the personnel and finances of the Rubber Research Institute of Sri Lanka over a period of 10 years with a special reference being made to the Research Departments. These facts and figures cannot paint a complete picture, it can never completely evaluate human resources - the complete dedication and devotion of the Scientific Staff to their work - still this article give a fair idea of the operational expenditure and what has been achieved with their limited resources.

14. GUNAWARDENA, K.J.

Country plans and programmes for rubber development and FAO assistance. Jl. Rubb. Res. Inst. Sri Lanka. 54, part 1, no. 2, 1977 : 417-421, 2 tables, 4 refs.

This paper provides information on rubber production, the national plans and programmes for rubber development and FAO assistance in the major rubber producing countries including Sri Lanka. A review and outlook for rubber are also included.

15. KARUNARATNE, S.W.

Report on a fortnight's visit to Malaysia (14th - 29th November 1967). R.R.I.C. Bulletin (N.S.). 3 (4) 1968 : 128-139.

16. KARUNARATNE, S.W.

A visit to Kerala State, the hub of the rubber plantations industry in India. Journal of the Plastics and Rubber Institute (Sri Lanka). 1, 1978/1979 : 22-24.

The author describes here the participation in the 9th conference conducted by the Indian Rubber Manufacturers Research Association (IRMRA) in Cochin, Kerala State and the experience he gained by the tour.

17. PERIES, O.S.

The impact of current research on the development of the NR industry. Q. Jl. Rubb. Res. Inst. Sri Lanka (Ceylon)

50 (3/4) 1973 : 256-260.

This paper summarises the highlights of the papers presented at the International Rubber Conference, 1973, held in Sri Lanka and drew the conclusions therefrom.

18. PERIES, O.S.

Prospects of the rubber industry. R.R.I.S.L. Bulletin (N.S.)
(Conference Supplement). 8 (3/4) 1973 : 13-14.

The price of rubber has been quite attractive recently, about double the price it was one year ago, when it reached the lowest level in 20 years. At present the price is the best it has been in 20 years. What are the reasons for this? For how long are good prices likely to last? What are the future prospects for the industry? On what lines should the industry develop? The author briefly answers for these questions.

19. SRI LANKA. Wages Boards.

Consolidated orders - decisions of Wages Boards, no. 4 of 1969 - The rubber growing and manufacturing trade (revised).
Ceylon Labour Gazette. 20 (4) 1969 : 246-253.

20. SRI LANKA. Wages Boards.

Consolidated orders - decisions of Wages Boards, no. 3 of 1972 - The rubber growing and manufacturing trade. (Reprint).
Ceylon Labour Gazette. 23 (3) 1972 : 175-182.

21. SRI LANKA. Wages Boards.

Consolidated orders - decisions of Wages Boards, no. 12 of 1973 - Tyre and tube manufacturing, tyre-rebuilding, rubber and plastic goods manufacturing trade (revised). Sri Lanka Labour Gazette. 24 (12) 1973 : 743-749.

22. WIJERATNE, M.S.

CISIR contribution to the rubber industry. In:
CISIR contribution to science and industry; proceedings
of the 21st anniversary seminar, May 4-6, 1976. Colombo,
Ceylon Institute of Scientific and Industrial Research, 1976.
pp. 39-43.

This article indicates the role of the Ceylon Institute of
Scientific and Industrial Research in the development of the
rubber industry in the 21 years of its existence. Discussion.

23. WIJERATNE, M.S.

Competition from synthetic rubber. R.R.I.C. Bulletin (N.S.)
2 (3/4) 1967 : 86-88.

A summary of a paper presented at the symposium on the
problems of rubber industry, Colombo, B.M.I.C.H. on 10th July,
1967.

24. WIJERATNE, M.S.

The consumer's angle on raw rubber. R.R.I.C. Bulletin (N.S.)
3 (3) 1968 : 53-58.

The author gave an insight into what the consumer requires
in raw rubber. He pointed out that basically different new
forms of synthetic rubber now on the horizon, notably liquid
polymers, are likely to pose a more formidable challenge to
both natural and to the present commercially marketed grades of
synthetics. They can be processed with much simpler and
cheaper equipment than the massive internal mixers and other
expensive equipment used for rubber processing today. The
author concluded by stressing that research work must be
initiated now to offer natural rubber in a form that makes
processing much simpler so that it can compete with tomorrow's
easy processing synthetics like liquid polymers.

25. WIJERATNE, M.S.

Industrial use of rubber in Ceylon and incentives for the
future utilisation of rubber with particular reference to export
of rubber goods. R.R.I.C. Bulletin (N.S.). 2 (3/4) 1967 :
89-90.

A summary of a paper presented at the symposium on the problems of the rubber industry, Colombo, B.M.I.C.H. on 10th July 1967. Author describes the industrial uses of rubber in Ceylon and reasons for the slow development of the local rubber manufacturing industry.

26. WIJEWANTHA, Ronald T.

Rubber research - the challenge of the 'seventies.

R.R.I.C. Bulletin (N.S.). 3 (1/2) 1968 : 8-14, 2 plates.

"R.I.M.S." spell out the future of natural rubber. Reduce cost of inputs; Increase outputs; Modernize production; See new uses. "RIMS" is the future of the RRI in the industry. The efforts made by the Rubber Research Institute to spell "RIMS" now and in the future are highlighted in this article.

PART 2

SOCIO-ECONOMICS AND STATISTICS

General

27. ABEYARATNE, B.K.

Incentives for increased rubber production. R.R.I.S.L.
Bulletin (N.S.). 12 (1) 1977 : 1-4.

It is by the intensive development of the existing plantations, the upgrading of the raw material produced and also by utilising a greater percentage of it in the manufacture of finished products that Sri Lanka can maximize the benefits that will derive from this raw material. The author writes in this paper on the various incentives given by the Government to achieve the objectives of developing the plantations and increasing the efficiency of processing the raw material.

28. ABEYNAYAKE, Chrishanthi

The competitive rubber market and prospects for Sri Lanka's rubber industry. Staff Studies of the Central Bank of Ceylon
5 (1) 1975 : 45-73, 11 tables, refs.

This paper attempts to deal with (1) some aspects of the competitive position of natural rubber vis-a-vis synthetic rubber, (2) the effects of the energy crisis on the present and future position of natural and synthetic rubber and (3) the review of Sri Lanka's rubber industry in the context of new developments.

29. ANANDA, Kodituwakku Arachchilage

An examination of the recent trends in the tea and rubber industries with special reference to Sri Lanka. (M.Sc. dissertation. University of Strathelyde, Glasgow, 1977. Unpublished typescript). pp. 81-139.

30. ANON

Can Ceylon survive intensified rubber competition?

Investor's Guardian. 204 (6349) 1964 : 1008-1009, tables.

Lower rubber prices expected for the second half of the 1960s constitute a serious threat to the rubber industry of Ceylon and especially to the larger company-owned estates, the area of which has already shrunk to 26 per cent of the total area under rubber of 270,000 ha. Despite better cultivation practices, many estates were sold to smallholders because they became uneconomic. An analysis of company expenses indicates that 92 per cent are estate expenses, of which 60 per cent consists of wages, with little scope for reduction because they are government-regulated. Smallholdings are much more flexible since they can avoid fixed wages by giving out work on contract or by working on a family basis. They may even stop operations completely for a considerable time without damage to the trees. Under these conditions, only estates able to restrain their production costs at the present level may hope to survive under conditions of increased competition. (Tropical abstracts : 20 (2) 1965 : no. n.394).

31. ANON

The rubber industry in Sri Lanka - Bleak 80's outlook;

Bright 90's prospects. Economic Review (Sri Lanka) 6 (9)

Dec. 1980 : 3-26, graph, 18 tables.

This study investigates the development of rubber industry in Sri Lanka and the various factors contributed to it are discussed. The various economic problems faced by the rubber plantations industry, in particular, are also discussed. This paper also discusses on the future prospects of the rubber industry, and the present position of NR. This study supplements the summaries and recommendations of the 'Rubber Industry Master Plan Study' commissioned by the Government of Sri Lanka in 1978, to study the organisation and performance of the industry and formulate proposals to improve its effectiveness.

32. ANON

Rubber's contribution to revenue. Economic Review (Sri

Lanka) 6 (9) Dec. 1980 : 7, table.

A brief review on the contribution to revenue in the Government of Sri Lanka. There is a table summarising the export duty over the last decade, and shows it as a percentage of annual rubber exports. Rubber contributed Rs. 1,239 million in a total of Rs. 4,168 million recovered as export duties by Government in 1979.

33. ANON

Sri Lanka rubber industry. Rubber Trends, no. 66, June

1975 : 2-13.

A survey of the rubber industry in Sri Lanka is given. Tabulated statistics show: (a) rubber acreage 1901-74; (b) rubber acreage by districts, 1974; (c) size of rubber holdings, 1974; (d) NR production, 1964-74; (e) rubber acreage replanted, 1964-74; (f) rubber production by grades, 1971-73; (g) rubber exports, 1970-74; (h) direction of rubber trade, 1973-74. (Rapra Abstract, 6th October 1975, no. 37434L). See also item no.34.

34. ANON

Sri Lanka rubber industry. Ceylon Commerce. 4 (126)

1975 : 1-4.

The special report of the June 1975 issue of the 'Economic Intelligence Unit', an International Business Research and Advisory Organisation in London is a study of the rubber industry of Sri Lanka as in 1974. This article publishes excerpts from this report. See also item no. 33.

35. CHANDRASIRI, G.R.

An econometric model for some factors affecting the rubber production in Sri Lanka. (M.Sc. dissertation. Wye College, University of London, 1972. Unpublished typescript).

This study is based on data gathered from a socio-economic survey conducted by the Economic Research Unit of the Rubber Research Institute of Ceylon under the guidance of Dr. C. Barlow - Australian National University and the Author. A broad objective of the current study is to establish the quantitative relationships among the major factors affecting the productivity of rubber lands operated by small farmers. There are over 180,000 farmers with less than 10 acres of land scattered in ten major rubber growing districts of the Island. About 55 per cent of the total R.S.S. (Ribbed Smoked Sheets) rubbers exported from Ceylon is produced by the smallholders. As a Cash Crop rubber has numerous advantages over many other

crops. For instance the tree could be tapped almost every day giving a continuous cash income. On the other hand tapping the tree is itself a very profitable form of self employment for many farmers. However, it was felt that to harness the full economic potentialities of this crop, particularly in the face of declining world market prices, more and more farm management and economic research studies have to be undertaken. Such studies could help to a great extent in future planning and implementation of development projects to uplift the individual farmer as well as the country's rubber industry in general. (Author's summary).

36. CHANDRASIRI, G.R.

Some economic aspects of rubber production in Sri Lanka.

(M. Phil. thesis. Wye College, University of London, 1974.

Unpublished typescript.

This study investigates some economic aspects of rubber production in Sri Lanka. The development of the Rubber Industry in the island and the various factors contributed to it are discussed. Attributes of the present day rubber industry with special reference to the plantation sector are dealt with. Also the cost of production and decision making in the plantations are investigated. The factors influencing the total production on small-holdings are identified in terms of a production function model estimated with cross sectional data collected from a field survey of the second largest rubber growing district (Kalutara) in the country in 1971. The various economic problems faced by the rubber plantation industry, in particular, are discussed. An economic analysis of the state aided replanting programme is undertaken employing an economic analytical model with social costs and benefits. The present policy of replanting in every 33 years is critically analysed and alternate replanting policies are suggested both in terms of a financial analytical model for the private entrepreneurs and incorporating yield stimulants along with the genetic improvement of the planting material. Four different investment strategies are discussed to improve the quality of the raw rubber produced in the country in terms of economic and financial analyses. (Author's summary).

37. CHANDRASIRI, G.R. and GUNASEKERA, H.D.B.H.

An economic evaluation of the state-aided fertilizer subsidy programme for rubber lands in Sri Lanka. Proc. Sri Lanka Ass.

Advmt. Sci. 33 (1) 1977 : 75.

An abstract.

38. CHANMUGAM, C.

Inter-Governmental consultation on tea and rubber.

Marza. 3 (2) 1976 : 69-81.

Pages 77-81 of this article discusses the approaches made by the rubber producing countries under the Association of Natural Rubber Producing Countries (ANRPC) on price stabilization and briefly reviews the events that have over-taken this commodity since the oil crisis.

39. CHANMUGAM, C.

Subsidies and incentives to the rubber producer.

R.R.I.S.L. Bulletin (N.S.). 9 (3/4) 1974 : 53-55.

The Rubber Factory Development Subsidy Scheme is briefly described. This scheme is intended to serve as an incentive to rubber producers to increase the manufacturing capacity of rubber factories producing premium grades of rubber.

40. DAHANAYAKE, A.

Agricultural extension. R.R.I.S.L. Bulletin (N.S.).

10, 1975 : 9-13.

Agricultural extension work aims at helping the rural population to recognise their agricultural problems to find the root cause of such problems and if possible to solve these problems as far as possible with their own resources, while not forgetting to capitalise on new innovations made in the technological field. The extension worker undertakes all this and more. This article has spot-lighted the work of the extension worker, and gives an insight into the day to day problems he meets during the course of his duties. Emphasis has been placed on the role of the extension worker as a Liaison Officer between the rural community and the research worker in the laboratory. He, is who brings the farmer's problems to the notice of the research worker, so that these problems can be solved as rapidly as possible.

41. DE SOYZA, T.C.A.

A common front by the natural rubber producing countries.

R.R.I.C. Bulletin (N.S.). 2 (3/4) 1967 : 79-80.

A summary of a paper presented at the symposium on the problems of the rubber industry, Colombo, B.M.I.C.H. on 10th July 1967. This paper discusses problems faced by the natural rubber producing countries as a result of synthetic rubber. It is suggested to replace all uneconomic areas in Ceylon with the best clonal rubber.

42. DISSANAYAKE, A.B.

An "agro-economic norm" for the natural rubber plantation industry of Sri Lanka. Proc. Ceylon Ass. Advmt. Sci. 30 (1) 1974 : 136.

An abstract.

43. DISSANAYAKE, A.B.

An analysis of production costs and profitability of rubber estates. In: Proceedings of the Conference on Agriculture in the Economic Development of Sri Lanka, August 1974; edited by Michael Roberts, S.W.R. de A. Samarasinghe, M. Sinnathamby, P. Wickramasekera. Peradeniya, Ceylon Studies Seminar, University of Sri Lanka, Peradeniya Campus, 1975. pp. 8-9.

An abstract.

44. DISSANAYAKE, A.B.

An analysis of the economic prospects of the rubber industry. Q. Jl. Rubb. Res. Inst. Ceylon. 48 (3/4) 1971 : 269-283, 3 graphs, 7 tables, 9 refs.

This paper discusses on the future prospects of the rubber industry, and the present position of NR. If NR, producers take full advantage of recent development, quality control and standardization, then future prospects appear to be good. Prospects of surplus production are discussed. Synthetics bridge the gap between total rubber requirements and production of NR. Strong and effective promotion campaigns are required.

45. DISSANAYAKE, A.B.

The Association of Natural Rubber Producing Countries (ANRPC). R.R.I.S.L. Bulletin (N.S.). (Conference Supplement). 8 (3/4) 1973 : 27-28.

Establishment of the ANRPC is briefly described.

46. DISSANAYAKE, A.B.

The development of the synthetic rubber industry. R.R.I.C. (Bulletin (N.S.)). 4 (1/2) 1969 : 6-10, 3 tables, 2 refs.

The increasing production of synthetic rubber (SR) calls for increased efforts on the natural rubber producing countries to meet the challenge in price competitiveness. A close study of the origin and development of the SR industry, therefore, helps us to assess the position of natural rubber (NR) in its true perspective. Within a space of about 12 years, the quantity of NR produced percentage of the total rubber production has dropped from 60 per cent in 1956 to 41.7 per cent in 1967. Much has been said and done on what the NR industry could do to face this challenge. This is a very informative article on the development of the SR industry.

47. DISSANAYAKE, A.B.

How viable is the NR industry of Sri Lanka. R.R.I.S.L. Bulletin (N.S.). (Conference Supplement). 8 (3/4) 1973 : 29-31.

This article projects a more accurate picture of viability of the NR industry, by looking at NR quality-wise; supply and demand for NR by comparing that with SR; future prices of SR; present economic condition of the NR industry; necessity to replant and the conditions that are favourable for replanting.

48. DISSANAYAKE, A.B.

Improving the viability of the natural rubber industry of Sri Lanka. Q. Jl. Rubb. Res. Inst. Sri Lanka (Ceylon). 50 (3/4) 1973 : 244-255, 7 tables, 8 refs.

The economics of rubber is discussed by the author and he shows that cost of production could be reduced. Factors affecting production efficiency of NR such as clones, manuring and other cultural practices, tapping, yield stimulation and other research findings are discussed. There is evidence to show that the price of SR will rise, and this in turn push up the price of NR. Considering the points discussed in the article, it is found that the NR industry is viable and that the viability could be greatly improved by replanting clones with higher yield.

49. DISSANAYAKE, A.B.

Review of the Estates Advisory Department, [R.R.I.C.].

For 1967 : Rubb. Res. Inst. Ceylon, Ann. Rev., 1967 (1968), pp. 72-74; For 1968 : ibid., 1968 (1969), pp. 64-69; For 1969 : ibid., 1969 (1970), pp. 90-93; For 1970 : ibid., 1970 (1971), pp. 79-82

50. DISSANAYAKE, A.B.

Review of the Estates Advisory Department and the Economic Research Unit, [R.R.I.C.]. For 1971 : Rubb. Res. Inst. Ceylon, Ann. Rev., 1971, pp. 110-113; For 1972 : ibid., 1972, pp. 99-106; For 1973 : Rubb. Res. Inst. Sri Lanka, Ann. Rev. 1973 (1974), pp. 86-89. For 1974 : ibid., 1974 (1975), 92-101; For 1975 : ibid., 1975 (1976), pp. 77-83; For 1976 : ibid., 1976 (1977), pp. 148-153; For 1977 : ibid., 1977 (1978), pp. 151-156; For 1978 : ibid., 1978 (1979), pp. 121-126. For 1979 : ibid., 1979 (1980), pp. 123-128.

51. DISSANAYAKE, A.B.

Some comments on the systems of accounting adopted in rubber plantations. R.R.I.S.L. (Bulletin (N.S.)). 12 (1) 1977 : 59-62, 3 diags.

The author discusses on the accounting systems adopted in rubber plantations under the following headings : the necessity to maintain accounts; the concept of the gross margin; profit; break-even point; and anomalies in accounting systems. He has avoided economic and accounting jargon in this article.

52. DISSANAYAKE, A.B.

A study of the future possibilities of the rubber industry.

Part I. Supply prospects. Q. Jl. Rubb. Res. Inst. Ceylon.

45 (3/4) 1969 : 33-40, 4 tables, 3 refs.; Part II. Demand prospects. ibid., 45 (3/4) 1969 : 41-48, 2 graphs, 4 tables, 3 refs.; Part III. Outlook. ibid., 45 (3/4) 1969 : 49-56, 2 tables, 3 refs.

This study was undertaken with a view to assessing the present position of the industry so that corrective measures could be taken. The many factors determining the supply and demand of both natural rubber (NR) and synthetic rubber (SR) are discussed. It is estimated that the supply of NR will be 2.70 million tons in 1970 and 3.05 million tons in 1975, whereas that of SR will be 4.32 million tons in 1970 and 5.62 million tons in 1975. Total rubber demand in 1970 and 1975 is estimated at 6.86 million tons and 8.67 million tons respectively. The world supply of rubber will thus exceed the total world demand for rubber, and the NR industry, if it is to survive, must be able to compete with the SR industry. Reduction in the cost of production is, among others, one of the steps to be taken. (Tropical Abstracts 26 (5) 1971 : no. U.1263).

53. DISSANAYAKE, A.B. and RANASINGHE, W.

The development of the rubber plantation industry in Ceylon.

R.R.I.C. Bulletin (N.S.). 3 (4) 1968 : 114-120, 4 tables, 3 refs.

This is a detailed article on history and growth of the rubber plantation industry in Ceylon. Annual exports of rubber from Ceylon since 1885 and rubber acreages since 1890 are listed.

54. GAMAGE, Cyril

An international rubber agreement : key to price stabilization. Economic Review (Sri Lanka). 4 (1) April 1978 : 31-33.

The need for price stabilization in the export commodities of the developing countries including Sri Lanka has been an important subject of discussion and international action over the last decade. Signs of major agreement for rubber now appears to be in sight, and the author discusses here the potential and connected issues in such an agreement.

55. GOONEWARDENE, Elaine

Natural rubber in bilateral agreements - II. R.R.I.C. Bulletin (N.S.). 2 (3/4) 1967 : 93-94, 2 tables.

A summary of a paper presented at the 'Symposium on the Problems of the Rubber Industry', Colombo, B.M.I.C.H. on 10th July 1967. This paper describes Bilateral Trade Agreements (BTA) and Bilateral Payments (BPA) made by Ceylon with other countries. Table I shows the trends in Ceylon's rubber exports between 1949 and 1966, and the Table II shows the proportion of rubber exports to countries having bilateral agreements with Ceylon. See also item No. 64.

56. GUNASEKERA, G.A.J.P.R.

Review of the Statistics Section, [R.R.I.C.]. For 1970 : Rubb. Res. Inst. Ceylon, Ann. Rev., 1970 (1971), pp. 78; For 1971 : ibid., 1971, pp. 96-109; For 1972 : ibid., 1972 : pp. 97-98; For 1973 : Rubb. Res. Inst. Sri Lanka, Ann. Rev. 1973 (1974), 136-137; For 1974 : ibid., 1974 (1975), pp. 90-91; For 1975 : ibid., 1975 (1976), pp. 75-76; For 1976 : ibid., 1976 (1977), pp. 144-147; For 1977 : ibid., 1977, pp. 148-150.

57. GUNASEKERA, Sena

Availability of foreign exchange and tax incentives for the establishment of new rubber industries. R.R.I.S.L. (Bulletin) (N.S.). 12 (2) 1977 : 67-68.

The author says that Sri Lanka consumes only a small fraction of the NR produced locally, and that the local market for rubber products is limited. He recommends that the industry should be developed by gearing it for export as that would earn immense foreign exchange. He also observes that the quality of rubber products manufactured locally has proved to be below international standards. He stresses the need to establish large scale export oriented industries with foreign collaboration.

58. GUNAWARDENA, A. de Vaas

Prospects for the manufacture of rubber goods in Sri Lanka.

Economic Review (Sri Lanka). 6 (9) Dec. 1980 : 16-17.

Of the Sri Lanka's total rubber production only 5 per cent is utilised locally for manufacture of rubber products. This article briefly discusses present local consumption, organisation and structure, and the marketing aspects of the manufacture of rubber goods in Sri Lanka. The quality and other aspects that require improvement in regard to product ranges are also briefly dealt.

59. JAYASURIYA, S.K.W.

The dynamic replacement problem in the rubber industry of Sri Lanka. (Thesis reproduction series : economics of agricultural development). Canberra, The Australian National University, Development Studies Centre, 1976. XI, 112 p., 7 graphs, 13 tables, 16 refs. 3 appendices. (M.Sc. thesis. Australian National University, 1973).

This study attempts to formulate the basic analytical techniques necessary for an economic evaluation of the optimum replacement cycle in rubber. The main determinants of the optimum replacement age, such as the tapping system, price of rubber, discount rate, rate of technological change are specified and discussed. Then the relationships between the optimum replacement age and these factors are investigated. A sensitivity analysis is carried out for a range of rubber prices, and discount rates. The optimum replacement age is evaluated from both the private and social point of view. On the basis of the relationships discerned between the optimum replacement age and these determining factors certain conclusions are drawn, which would be useful in formulating socially optimum replacement policies. The direction in which

further studies should be made is indicated. It is shown that a higher discount rate in general leads to a longer optimum replacement age. At higher prices more intensive systems are profitable, which at lower prices the less intensive systems are more profitable. Technological change substantially reduces the optimum replacement age. Appendices A : Computation of costs; B : Annual yield figures; C : Optimum replacement ages.

60. KANAGARETNAM, P.

The Incentive Scheme for R.S.S. No. 1 rubber. Ceylon Trade Journal. 34 (3) 1969 : 114-117.

This article is an attempt to assess the impact of the payment of the extra 2 cents over the Singapore daily price for R.S.S. No. 1 on the production of R.S.S. No. 1 during 1966 and 1967. The author investigates here whether this incentive scheme had achieved its desired results. On the basis of production analysis, this scheme shows no impact on the production of R.S.S. No. 1, and the author explains the possible reasons for the poor performance and suggestions to overcome.

61. MEEGAMA, S.A.

The influence of price factors in the competition between natural rubber and synthetic rubber in the U.S. market : an econometric analysis. Ceylon Journal of Historical and Social Studies. 6 (2) 1963 : 153-168, tables, 9 refs.

This article estimates the relative strength of the competition offered by the synthetic rubber industry to the natural rubber industry and this survey attempts to determine those factors which influenced the variations in the consumption respectively of synthetic, natural and reclaimed rubber in the U.S.A. during the years 1947-57.

62. NADARAJAH, M.

Economic considerations in introducing the new process rubbers in Ceylon. R.R.I.C. Bulletin (N.S.). 3 (3) 1968 : 59-62.

In considering the economics behind the introduction of new process rubbers into Ceylon, the author enumerated the factors that have militated against their introduction here. These are mainly the comparatively small size of our estates and the

quality of our scrap crepes. The new process rubbers are mainly suitable for large estates and our scrap crepes are generally of high quality and there is no advantage in processing them. The author advocates Government sponsored group processing centres producing new process rubbers for smallholders, who generally produce low quality RSS. He also recommended a scheme of Government assistance to pay the same premium over world price, which is now given to RSS Nos. 1 and 2 and 3, to be given to the new process rubbers, and when the latter is produced in large enough quantities, China may be persuaded to buy these rubbers on barter terms.

63. NADARAJAPILLAI, N.

Review of the Statistical Section, [R.R.I.C. for 1967].

Rubb. Res. Inst. Ceylon, Ann. Rev., 1967 (1968), pp. 65-71.

64. NAVARATNARAJAH, A.S.

Natural rubber in bilateral agreement - 1. R.R.I.C.

Bulletin (N.S.). 2 (3/4) 1967 : 91-92.

A summary of a paper presented at the 'Symposium on the Problems of the Rubber Industry', Colombo, B.M.I.C.H. on 10th July 1967. See also item no. 55.

65. PEIRIS, G.H.

Ceylon's prospects in the world rubber market. The Ceylon

Journal of Historical and Social Studies. 9 (2) 1966 :

155-171, 5 graphs (one folded) 5 tables, 2 statistical appendices, refs.

This paper deals with only the production and consumption of new rubber. Reclaimed rubber which on the average (1961-63) accounts for about 10 per cent of the total quantum of rubber consumed, has been excluded from the discussion. Two statistical appendices: Acreage, yields and costs of production of individual companies of the Rupee and the Sterling Company owned rubber estates of Ceylon.

66. PEIRIS, G.H.

Economic geography of rubber production in Ceylon. X, 381

leaves, figs., graphs, tables, maps, refs. (Ph.D. thesis.

University of Cambridge, 1965. Unpublished typescript).

This dissertation presents the results of a geographical study of the rubber industry of Ceylon. It is divided into 3 parts. The first part probes the circumstances which attracted the rubber industry to Ceylon and examines the economic milieu in which its initial development in the island took place. An attempt is made here to examine the problems faced by the rubber industry during its early phase of expansion and to trace the developments of those characteristics that are considered as lending it an individuality. The second part deals with the influence of the physical environment on rubber cultivation in Ceylon. The primary purpose of this section of the study is to recognize the advantages and disadvantages arising from variations in the physical setting, within Ceylon, and between Ceylon and the other rubber producing countries. Part 3 includes several inter-related aspects of production and marketing of rubber. It opens with a chapter outlining the main features of the economy of Ceylon relevant to the study and endeavours to place the rubber industry in the context of the economic and land-use setting of the country. This is followed by an investigation of the composition of the industry, in which size and ownership of the units of production of rubber in Ceylon are examined. Within the framework of a classification of the industry suggested on the basis of the study of its composition, such aspects as yield, cost of production, replanting and the response of the producers to price fluctuations are dealt with in the chapters that follow. The next chapter examines the position of the rubber industry of Ceylon in the world market, and reaches conclusions on the prospects of the rubber industry of Ceylon on the basis of a synthesis of certain findings of the earlier sections.

67. PEIRIS, G.H.

The effect of price fluctuations on rubber production in Ceylon : a study of the great depression and the Korean war boom. The Ceylon Journal of Historical and Social Studies (New Series). 2 (1) 1972 : 75-87, 2 graphs, 3 tables, refs.

A fresh empirical study of the response of rubber producers to price fluctuation, with reference to Ceylon, based on the two fold division of the industry into the 'estate sector' and the 'small-holdings sector'. This study discusses on the following topics : a review of price movements since 1909; views on relative flexibility of different classes of producers of rubber; rubber production on Ceylon's estates and small-holdings during the depression (1928-1934) and during the

Korean war boom and the aftermath (1949-1957); response of estates and small-holdings to price changes during this period. In regard to the relative flexibility of supply in different sectors, it is seen that distinctions lie not so much between the small-holdings and the estate sector, but rather between different classes of producers within each sector.

68. PEIRIS, G.H.

Plantation agriculture. In: Sri Lanka : a survey, edited by K.M. de Silva. London, C. Hurst & Co., 1977, Chap. 9, pp. 213-235, 14 refs.

A critical review of rubber plantation, among other plantation crops in Sri Lanka in the last two decades.

69. PERERA, Marshall; DE SILVA, Maxie and McCONNELL, D.J.

Economics of rubber production in Sri Lanka. (Farm Management Report, No. 9). Peradeniya, FAO Agricultural Diversification Project, 1974.

A survey on the economics of rubber production, collects the data relating to costs, labour and production, based on a survey of rubber estates for the year 1971-1972. Cost and production functions, returns and profits are listed.

70. RAJARATNAM, S.

History of plantation agriculture of Ceylon, 1886-1931, with special reference to tea and rubber. iv, viii, 351, xxxiii leaves. (M.Sc. thesis. University of London, 1961. Unpublished typescript).

71. RAJARATNAM, S.

Plantation rubber industry in Ceylon. University of Ceylon Review. 20 (1) 1962 : 96-124, tables, 96 refs.

A historical review of the plantation rubber industry in Ceylon covering the period from 1876 to 1932. The following points are discussed in this article: Price movement in the plantation rubber industry; supply and demand for rubber during the early stages of the industry; limitations to rubber cultivation in Ceylon; Supply and demand in latter stages of the industry; the post-war slump in rubber industry; the Ceylon's Stevenson Rubber Restriction Scheme; and some aspects of rubber restriction in Ceylon. Due to less favourable growing conditions and the government's landholding policy, Ceylon did not become a leading producer. The improvement in the industry, organization of producers and the rubber market are discussed with reference to Ceylon.

72. RAMACHANDRAN, Nadaraja

Foreign plantation investment in Ceylon, 1889-1958.

Colombo, Central Bank of Ceylon, (Colombo Apothecaries Co.

Ltd., printers), 1963. vii, 200 p. (Central Bank of

Ceylon Research Series).

The research of this study, which is a doctoral thesis accepted by London University (see no. 74). This study deals primarily with the financial experience from 1889 to 1958 of the Ceylon Sterling tea and rubber companies. Information on their operating results has been drawn from their files maintained by the Registrar of Companies, London, and from Stockbrokers' Manuals. Since it was not practicable to examine the records of the total of 229 companies, a 30 per cent sample was selected at random for this research. The floatation of the rubber companies and the raising of capital are first examined and then the tax burden. It is shown that the economic effects of taxation since the last war have principally been to erode tea companies' savings and rubber companies' capitals. The chapters on profits discuss the effects of the international restriction schemes, and it is demonstrated that the profits earned have been insufficient in relation to asset values in tea companies since 1939, and even more so in rubber companies since the late 1920s. In rubber economic profits have been partly capital payments. The investment of funds in acreage extensions are replacement of assets is analysed critically, and then finally the disinvestment of funds since 1939.

73. RAMACHANDRAN, Nadaraja

Outlook for Ceylon's rubber industry. Ceylon Trade Journal. 29 (7/12) 1964 : 704-712, 5 tables, 3 appendices.

Prospects for natural rubber are not considered depressing. The growth rate for world rubber consumption is analyzed and the demand forecast for 1970. A plan is outlined for the rehabilitation of Ceylon's areas. Cost of production are presented. The company-owned sector accounts for only 26 per cent of the total acreage. An analysis is given of total costs incurred by 21 rupee companies and by 14 sterling companies in 1942. (World Agricultural Economic and Rural Sociology Abstracts. 7 (3), 1965 : no.1520).

74. RAMACHANDRAN, Nadaraja

Sterling tea and rubber companies in Ceylon, 1889-1958.

Ph.D. thesis. University of London, London School of Economics, 1962. See item no. 72.

75. [RUBBER. A TABLE OF STATISTICS FROM 1970 UPTO THE END OF JUNE 1978].

Prepared by the Statistics Department of the Central Bank of Ceylon. Economic and Social Statistics of Sri Lanka. 1 (1) June 1978 . . . in progress.

Provides basic information and recent economic statistics on the rubber economy. Coverage : Current data with comparable data for recent past.

76. SOMERVILLE & CO. LTD.

Rubber and the national economy, 1979 : a brief statistical survey. Colombo, Somerville & Co. Ltd., [1980]. 4 p.

With official reports and statistics available of the performance, authors have attempted to gather all relevant data concerning the rubber trade in 1979. Authors have also tried to keep this survey as brief as possible, and the information is easily and conveniently presented. This survey is mainly intended for the benefit of those actively involved in the production of rubber.

77. SRI LANKA (CEYLON). Department of Census and Statistics.

Rubber acreage by districts. In: Statistical abstracts of Ceylon (Sri Lanka). Colombo, the Dept., 1949-annual.

This Table provides statistics of rubber acreage by districts in Sri Lanka. The first issue was designed mainly to cover the period 1937-1948. All statistics in succeeding issues are for the calendar year ending 31 December. From the 13th edition (1961) the abstract was published in English, Sinhala and Tamil in the same volume. Source of the Table: Rubber Control Department.

78. SRI LANKA. Ministry of Finance and Planning. Economic Affairs Division.

Bibliography on economic aspects of the rubber industry in Sri Lanka. Colombo, 1979. ii, 42 p.

About 220 titles in alphabetical order of author, and deals on the economic aspects of rubber industry in Sri Lanka. An attempt has been made in the document to give an indication of the sources where the documents are found. This has been compiled by Sujatha Sathkumara of the Economic Affairs Division of the Ministry of Finance and Planning under the supervision of the Library Committee.

79. SRI LANKA. Ministry of Plantation Industries.

Natural rubber statistics of Sri Lanka, No. 1. Colombo, Ministry of Plantation Industries. 31 p., 1973, 27 tables.

Reflects the over-all position of natural rubber industry for the period 1966 to 1971. Intended to be an annual publication.

80. WARUSAVITARNE, B.

The present agricultural problems in rubber production.

R.R.I.C. Bulletin (N.S.). 2 (3/4) 1967 : 77-78.

The following problems are discussed in this paper.
1. Recovering the estimated crop. 2. Obtaining the crop within the estimated cost of production. 3. Acquisition of the requisites of production, and 4. Transport of the finished product to the sales point.

81. WICKREMASINGHE, W.N.

Review of the Statistics Section, [R.R.I.C.]. For 1978 :
Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1978 (1979), pp. 118-120; For 1979 : ibid., 1979 (1980), pp. 114-116.

Production, Consumption and Marketing

82. BANKS, R.D.

Marketing aspects of new process rubber. R.R.I.C. Bulletin
(N.S.). 3 (3) 1968 : 82-90.

The author in his paper brought out a number of salient points for the consideration of the producer. He pointed out certain fundamental facts regarding the factors governing costs of marketing the new process rubbers, the freight rates compared to the traditional forms, the factors that dictate prices and the markets for the future. The underlying theme of the author's paper is the importance of changing over gradually to the new process rubbers as these are definitely the rubbers of the future.

83. CENTRAL BANK OF CEYLON

Rubber : exports, sales and prices. Central Bank of Ceylon Bulletin. Colombo, the Bank, Volume 1, 1951 : Monthly.

Factual and analytical data on rubber exports, sales and prices. The data cover monthly figures at the time the Bulletin goes to print, and the latest available information does not in every table relate to the same month. To enable comparison, monthly figures for recent year are given, and also the years since 1938.

84. CENTRAL BANK OF CEYLON.

Rubber-production and exports. Central Bank of Ceylon.

Annual Report. Colombo, the Bank, 1960 : Annual.

An annual review of the economy, which gives a detailed analysis of rubber production and exports in Sri Lanka, among other economic trends and development, formed a part of the Central Bank Annual Report, prior to 1975. Beginning 1975, it has been decided to publish the Review of the Economy as a separate document from the Central Bank Annual Report. Published separately in Sinhala, Tamil and English.

85. CEYLON. Department of Census and Statistics.

Cost of production of rubber per lb. In: Statistical abstracts of Ceylon [Sri Lanka]. Colombo, the Dept., 1949-Annual.

The cost of production of rubber are based on a survey carried out jointly by the Department of Census and Statistics and the Rubber Control Department. The costs figures given in the Table are all inclusive cost up to the point of the Colombo auctions and port of shipping. Source of this Table : Department of Census and Statistics.

86. CEYLON. Department of Census and Statistics.

Tea and rubber production. In: Statistical Abstracts of Ceylon (Sri Lanka). Colombo, the Dept., 1949- . Annual.

This Table provides statistics of rubber production in tons. Source of this Table: Rubber Control Department.

87. CEYLON. Department of Commerce.

Commodity markets - rubber. Ceylon Trade Journal.
Colombo, the Dept., Volume I, 1935- . Monthly.

Reviews monthly, production of rubber by type, world markets, Colombo auctions, and exports of rubber by destination. The data covers monthly figures at the time the Journal goes to print.

88. CEYLON. Department of Commerce.

Review of Ceylon's foreign trade. Ceylon Trade Journal.

Colombo, the Dept., Volume I, 1935- . Monthly.

These monthly issues reviews monthly and annual Ceylon's foreign trade of rubber.

89. CEYLON. Department of Commerce.

Statistics : export rubber. Ceylon Trade Journal.

Colombo, the Dept., 1, 1935- . Monthly.

A statistical table rubber exports with average prices. The data covers monthly figures at the time the Journal goes to print, and the latest available information does not every table relate to the same month. To enable comparison monthly figures for current year and previous year are given and also the annual figures of 3 previous years and 1938.

90. COLOMBO RUBBER TRADERS' ASSOCIATION.

Annual reports. In: Ceylon Chamber of Commerce. Annual report and accounts. Colombo, 1960- . Annual.

Periodical review of the output of rubber and the trade in ribbed smoked sheet, latex crepe, scrap crepe, sole crepe, liquid latex and technically specified rubber. This review is published as a separate chapter in the Annual Report and Accounts of the Ceylon Chamber of Commerce from 1964. The title of this report changed to Annual Review of Business and Trade from 1976.

91. GENERAL AGREEMENT OF TARIFFS AND TRADE. International

Trade Centre.

Market for selected manufactured rubber products from Sri Lanka. Geneva, UNCTAD/GATT, 1973. 103 p. (Restricted).

Report of the mission to the Persian Gulf, the United Kingdom, Nigeria and Kenya analysing and identifying potential markets for manufactured rubber products from Sri Lanka.

92. GUNAWARDENA, A. de Vaas

Transnational Corporations in the rubber industry.

Economic Review (Sri Lanka). 6 (9) Dec. 1980 : 20-21.

NR is a export-oriented commodity with less than 10 per cent of production being absorbed into manufacturing processes in the producing countries. World NR production is dominated by 4 Asian countries including Sri Lanka. This article describes transnational corporation (TNC) activity which are of significance and interest. In Sri Lanka two types of companies and Rupee Companies and by 1970 an estimated 27 per cent of national production, and 25 per cent of the acreage was handled between the Sterling and Rupee Companies. Under the Land Reform Laws of 1972 and 1975 Sri Lanka resulted in the expropriation of foreign rubber estates.

93. KUMARANAYAGAM, S.

The role of the broker. R.R.I.S.L. Bulletin (N.S.). 12

(1) 1977 : 24-28.

The author summarises in point form 14 items that would cover functions and services of a broker, and then highlights on the services to the two major components in the trade - the buying sector and the planting sector.

94. LEEELARATNE, T.P.G.N.

New incentives for rubber production and exports. Economic Review (Sri Lanka). 6 (9) Dec. 1980 : 10.

95. PERIES, O.S.

A study of the production strategy for the development of a marketing system for pale crepe. R.R.I.S.L. Bulletin (N.S.)

9 (3/4) 1974 : 61-65.

This article discusses technical specifications, availability, presentation, sales promotion, after-sales service, price of crepe, rubber and the manufacture of finished rubber products. The price of crepe rubber is governed by supply and demand. The current price is too high for the future of the product. Therefore it is recommended that production should increase by 5,000 tons in the next 2-3 years. This will help to reduce the price and stabilise it. It is thought there is a market for about 60,000 tons in the next 5 years if developed on the lines already indicated.

* were formed, namely Sterling and

96. ROMAINÉ, Grahame B. and GUNARATNE, Charles D.

If Sri Lanka is to get established as a rubber goods exporter. Karmantha. 3 (8) August 1976 : 6-7.

In 1973, the International Trade Centre (ITC) undertook a study in selected countries to find export markets for Sri Lanka's manufactured rubber products. The mission was carried out by the two authors. Prior to their overseas mission this team carried out a survey of the export capacity of local rubber goods manufacturers in order to identify the firms that could be considered likely exporters as well as the products which had immediate or further export potential. The team drew attention to several shortcomings in the production of manufactured rubber goods and the incorrect attitudes of several manufacturers who were hoping to cater to export markets. The authors say that a lack of planning, stemming from an unprofessional approach to marketing by management, that is at the root of the problems. The extracts published in this article are set out as pointers to those industrialists who intend entering export markets. This article focusses attention on the drawbacks in several of our rubber manufacturing units and makes suggestions.

97. SALGADO, S.J.

New trends in the production and marketing of crepe rubber : agency house views on crepe rubbers. R.R.I.S.L. Bulletin (N.S.) 9 (3/4) 1974 : 23-24.

Increased prices are now being paid for high crepe rubber. In order to increase production of crepe rubber in factories in Sri Lanka, more attention must be paid to electrification, replacement of old machinery, improved transport, availability of drying space, and availability of chemicals.

98. SILVA, P.A.

The role of the Colombo Rubber Traders' Association. R.R.I.S.L. Bulletin (N.S.). 12 (1) 1977 : 21-23.

This paper deals with the role played by the Colombo Rubber Traders' Association in getting the rubber produced in the estates into the hands of consumers overseas, and discusses on their major responsibility of the CRTA, i.e. the conducting of the Colombo rubber auctions. Its connection with international bodies such as the International Rubber Quality and Packing Conference (IRQPC), and the International Rubber Association are also described.

99. SILVA, P.A.

Some aspects of marketing crepes and problems of the rubber trade. R.R.I.S.L. Bulletin (N.S.) 9 (3/4) 1974 : 41-44.

Price stabilization so that foreign buyers can rely on realistic price movements is thought desirable. Licensing procedures need to be refined. The problem of liquidity is also noted. Export credits are needed. (World Agricultural Economics and Rural Sociology Abstracts. 19 (3) 1977 no. 1405).

100 SOYZA, D.

U.S. rubber disposal programme and its effects on natural rubber prices. R.R.I.C. Bulletin (N.S.) 2 (3/4) 1967 : 81-82.

A summary of a paper presented at the Symposium on the Problems of the Rubber Industry, Colombo, B.M.I.C.H. on 10th July 1967.

101. STRAARUP, E.L.

Present market arrangements for rubber. R.R.I.C. Bulletin (N.S.) 2 (3/4) 1967 : 84-85.

A summary of a paper presented at the Symposium on the Problems of the Rubber Industry, Colombo, B.M.I.C.H. on 10th July 1967. This paper represents the views of the Colombo Rubber Traders' Association and the Ceylon Brokers' Association, on the production and local disposal, grading and overseas marketing.

102. VARATHUNGARAJAN, G.

Role of the rubber technologist in natural rubber marketing. R.R.I.S.L. Bulletin (N.S.). 10, 1975 : 1-8, 2 diagrams, 3 refs.

The main functions of marketing are: (a) market research, (b) product development and design, (c) sales promotion, advertising and after-sales services. The rubber market is highly competitive and the seller should possess a high level of technological competence to achieve success in this field. One major disadvantage of the present system of NR marketing is its non-technological nature - it is more sales oriented rather than customer or product oriented. This paper describes how the existing system of marketing NR may be made more technologically oriented and discusses the importance of rubber technologist in the marketing of NR. Technological personnel could carry out the various marketing functions and improve the communication between the customer and the producer. Such communication and the flow of information could greatly help the various research organisations in carrying out more customer oriented research and tailor-making of rubbers to suit end-use requirements. Co-ordinated action by all producing countries in order to strengthen NR's competitive position vis-a-vis the synthetics is urged. It is proposed that a central market research and market intelligence organisation be set up under the aegis of the Association of Natural Rubber Producing Countries (ANRPC), as the first stage of co-ordinated action. Technical information from various customers through dealers and other market operators should be freely available to the research organizations and producers of member countries. (Author's summary).

103. WIJESINGHE, M.

Freight and shipping of rubber. R.R.I.C. Bulletin (N.S.)

2 (3/4) 1967 : 83.

A summary of a paper presented at the Symposium on the Problems of the Rubber Industry, Colombo, B.M.I.C.H. on 10th July 1967. Palletisation and freight rates of NR are briefed.

Socio-Economics of Smallholders' Management

and Group Processing

104. BARLOW, C.; PERIES, O.S.; DISSANAYAKE, A.B.
CHANDRASIRI, G.R. and CARRAD, B.

Some aspects of the economics of smallholding rubber in Sri Lanka. In: Proceedings of the International Rubber Conference, Kuala Lumpur, 1975. Kuala Lumpur, Rubber Research Institute of Malaysia, 1976. Vol. 3, pp. 385-407, 2 maps, graph, 13 tables, 13 refs.

This paper review on a 1971 study of 289 high-yielding rubber smallholdings in Sri Lanka. All major inputs, and the outputs of rubber secured from them, are recorded. The study showed that most resources, particularly trees and labour were used more intensively than on estates. More trees and labour per hectare were associated with higher yields. While farms below 0.4 ha were primarily operated by family labour, larger farms employed hired labour. Few holdings used weedicides or fertilizers, but pest and disease control materials were applied widely. Most farmers processed their rubber on contract, using privately owned facilities which seemed generally unsatisfactory. They sold their rubber about once a month, there being distinct advantages over selling more frequently in terms of higher prices received. The major item of cost in production and processing inputs for processing and for pest and disease control were also important. While family income per hectare showed no significant trend with increasing area of holdings, the average returns to labour were lowest on the smallest holdings. Very significant increases in family income occurred with increasing yield, these being accentuated by reduction in costs per kilogram.

105. CHANDRASIRI, G.R.; CARRAD, B.; TEO, C.K. and
WEERASINGHE, S.

The specification and estimation of a production function for smallholding rubber in Sri Lanka. Jl. Rubb. Res. Inst. Sri Lanka. 54, Part 1, No. 2, 1977 : 398-416, 10 tables, 13 refs.

An attempt is made to analyse the main input/output relationships in a cross-section of smallholdings growing high yielding rubber in the Matugama and Agalawatta areas of Sri Lanka. It follows from the results reported by Barlow et al (1975) of the 1971 survey of these holdings. The factors found to have most impact on output were tree age, planting density, area of mature rubber and tapping frequency. Specification problems associated with these variables and with rubber, as a perennial crop, are discussed. Two main types of clones TVIR 1, and PB 86 were grown on these holdings and a comparison of their performance was made. Similarly, the sample has been divided by the number and type (family or hired) of labour employed, in evaluating the performance of the various holdings in the sample. Throughout this paper the Cobb-Douglas production function approach was followed. (Authors' summary).

106. CHANDRASIRI, G.R.; GUNASEKERA, H.D.B.H. and WEERASINGHE, S.L.

Socio-economic aspects of group processing of smallholder's latex in Sri Lanka. Jl. Rubb. Res. Inst. Sri Lanka. 55, 1978 : 13-22, 10 tables, 7 refs.

There are 84 group processing centres (GPC) in operation and 24 are being constructed by the Government. The GPC scheme brings about socio-economic benefits; of which are primarily dependent on the price differentials between various grades of RSS; the quality of rubber produced at each GPC; the quantity of RSS produced per GPC; the maximum benefits achieved with an efficient system of transport, storage and handling could be provided to minimize the deterioration in quality before shipment; the GPCs should be given a fair deal by way of correct weighting and grading at the time of sales to maximize the benefits to the smallholders; emphasis by the extension worker towards improving the quality of rubber; and even if the loan of Rs. 12,000/= is not paid back by the GPC yet it is a profitable project as illustrated.

107. DE SILVA, Sumith

A report on the sample survey of the rubber smallholdings of Sri Lanka. Colombo, Ministry of Plantation Industries, Sri Lanka. [IV], 45 p., 1974, tables (mimeographed).

Report of a sample survey of rubber smallholdings and estates below 100 acres, conducted by the Ministry of Plantation Industries and the Rubber Research Institute of Sri Lanka. This survey aims at furnishing quantitative information on area under rubber, age of plantation, variety planted, replanting, processing facilities, awareness of market prices, percentage of production in various grades of sheet rubber and type of labour engaged in the industry.

108. DE ZOYSA, R.P.M.

The development and functioning of the Smallholdings Advisory Department of the Rubber Research Institute of Sri Lanka. In: Scientific Symposium, Part 1, Cochin, India 26-28, September 1974. Text of papers. Vol. I, Session D (36). London, International Rubber Research Development Board, 1975. 8 p., tables, 3 refs.

Origin, structure and function of the Advisory Department are indicated. Functions such as dissemination of information, practical and financial assistance, education of smallholders (demonstrations, training classes, film shows, smallholders' conference and Sinhala Bulletin) and inspection are discussed in more detail. (Abstracts on Tropical Agriculture. 2 (10) : no. 10867.

109. DE ZOYSA, R.P.M.

Group processing centres in Malaysia. R.R.I.S.L. Bulletin (N.S.). 8 (1) 1973 : 29-35, 1 plate (photo.)

Group processing centres are being established by the R.R.I.S.L. where adequate facilities for the processing of smallholders' latex are not available. In this article a study of Group Processing Centres in Malaysia is presented with a view to publicising the techniques adopted in that country, so as to enable us to compare the methods and make our Group Processing Centre Programme in Sri Lanka more effective. The administration, establishment cost, maintenance, and benefits to be derived from Group Processing Centres are discussed here, together with recommendations and suggestions for the improvement of our programme.

110. DE ZOYSA, R.P.M.

State sponsored group processing centres. R.R.I.S.L.
Bulletin (N.S.). (Conference Supplement). 8 (3/4) 1973 :
6-8.

A brief description on the group processing centres in Sri Lanka.

111. DISSANAYAKE, A.B.

An assessment of the training classes on rubber cultivation for smallholders. In: Report of the fourth seminar and workshop on progress and development of rubber smallholders, Colombo, 17-22 July 1980. Published by the Association of Natural Rubber Producing Countries, 1980. Appendix 9, pp. 96. (Summary).

The paper analyses a scheme of training classes for rubber smallholders which was started in 1963. It describes the progress made and the results obtained in terms of the usefulness of the training, its deficiencies and suggestions for improvement. Full text will be published in the Proceedings of the Fourth Seminar and Workshop on progress and development of rubber smallholders.

112. DISSANAYAKE, A.B.

The economic life span of the rubber tree in smallholdings.

Q. Jl. Rubb. Res. Inst. Ceylon. 44 (3/4) 1968 : 47-53,
2 tables, 2 refs.

Theoretically, the economic life span of a rubber tree is worked out at about 36 years on the standard system of tapping. A survey was carried out to ascertain how far this is true for replanted smallholdings. Due to deviations in the system of tapping in smallholdings, the average economic life span of a rubber tree has been observed to be very variable ranging from 24 years to about 40 years. A slightly higher rate of replanting therefore appears to be better for smallholdings. (Author's abstract).

113. DISSANAYAKE, A.B.

The group processing centre as a means of improving the quality of rubber produced by smallholders in Sri Lanka.

In: Scientific Symposium, Part 1, Cochin, India 26-28

Sept. 1974. Text of papers. Vol. 1, Session D (39).

London, International Rubber Research Development Board,

1975. 12 pp., 8 tables, 5 refs.; Reprinted in R.R.I.S.L.

Bulletin (N.S.) 10, 1975 : 22-30.

Since it is difficult to improve the skill of every smallholder to a sufficient degree to manufacture a high percentage of No. 1 smoked sheet, and further since it will be impracticable to make available to all, the necessary capital equipment, the next best thing is to bring a manageable number of smallholders together, and to provide them with the expertise and the necessary capital equipment to manufacture sheet of the highest possible quality. This is the thinking behind the establishment of Group Processing Centres (GPC) by the Rubber Research Institute of Sri Lanka. GPC were established as from 1970. Detailed information is provided on organization of GPC, financing and repayment of loans, advantages of a GPC over past methods, the economics of GPC, grades of RSS manufactured, the greater profitability of a GPC and return on capital. GPC can be recommended as a method of rapid improvement of smallholders' rubber.

114. DISSANAYAKE, A.B.

Review of the Smallholdings Department [R.R.I.C.]. For 1960 : Rubb. Res. Inst. Ceylon. Ann. Rev., 1960 (1961), pp.

75-81; For 1961 : ibid., 1961 (1962), pp. 89-99; For 1962 :

ibid., 1962 (1963), pp. 128-145; For 1963 : ibid., 1963 (1964),

pp. 96-114; For 1964 : ibid., 1964 (1965), pp. 99-122.

115. DISSANAYAKE, A.B.

A study of the rubber industry of Ceylon with special reference to smallholdings. . vii, 180 leaves, 3 graphs, (photos.), 45 tables, 32 refs. (M.Sc.(Agriculture) thesis. University of Ceylon, Peradeniya, 1969. Unpublished typescript).

This study assesses the present position and possibilities of natural rubber (NR) industry in the context of the world supply and demand for rubber. As 31 per cent of the acreage under rubber in Ceylon consists of smallholdings (under 10 acres) the position of smallholdings is studied in detail. In comparison to other categories of plantations small estates (10-100 acres) medium estates (100-500 acres) and large estates (500 acres) the viability of smallholdings is studied by working out the cost of production of smallholdings for comparisons with that of the other categories. The present policy of the Government with regard to smallholdings is also discussed and an attempt is made to recommend ways and means of improving the viability of the NR industry in general and the smallholdings in particular in the event of a further drop in the price of NR.

116. DISSANAYAKE, A.B.

Trends in extension methods for smallholders. Jl. Rubb.
Res. Inst. Sri Lanka. 55, 1978 : 1-4, 3 tables.

This article discusses the future trends in extension methods, specially for smallholders. This paper presented at the International Rubber Conference, Sri Lanka, 1976.

117. JAYASURIYA, S.K.W. and CARRAD, B.

Decision making in smallholding rubber : attitudes to replanting in Sri Lanka. Jl. Rubb. Res. Inst. Sri Lanka.
54, part 1, no. 2, 1977 : 381-397, 2 graphs, 12 tables, 5 refs.

The paper presents some early results of an enquiry into the major influence behind replanting decisions of the small rubber growers in Sri Lanka. It interprets farmers' responses within

the framework of multi-period profit maximization model and discusses the relevance of this type of approach for understanding smallholding investment behaviour. In 1975 a survey of 165 smallholdings was conducted in the Colombo, Kalutara and Ratnapura districts. The aim of the survey was to gain information about how smallholders made their decisions to replant rubber, the type of factors they saw as particularly relevant in influencing these decisions and what was their expected outcome. The responses gained showed a wide range of influences at work : the main ones encouraging farmers to replant were the promise of a steady flow of output and a reasonable income, low risk and a lack of viable alternative crops. Negative influences for replanting ranged from too great a need of current income (albeit very low) to cut down their trees, insufficiency of the replanting subsidy and the greater profitability of other perennials. The responses are presented in a cross tabular form with levels of income, size and other characteristics of holding and the expressed choice of investment policy. Concluding comments are made on several of the main factors influencing replanting attitudes. (Authors' summary).

118. PEIRIS, H.H.

Review of the Smallholdings Department, [R.R.I.C.]. For 1965 : Rubb. Res. Inst. Ceylon. Ann. Rev., 1965 (1966), pp. 78-98; For 1966 : ibid., 1966 (1967), pp. 147-159; For 1967 : ibid., 1967 (1968), pp. 75-86; For 1968 : ibid., 1968 (1969), pp. 70-80; For 1969 : ibid., 1969 (1970), pp. 94-104; For 1970 : ibid., 1970 (1971), pp. 83-89; For 1971 : ibid., 1971, pp. 114-120; For 1972 : ibid., 1972, pp. 107-114; For 1973 : Rubb. Res. Inst. Sri Lanka. Ann. Rev. For 1973 (1974), pp. 90-96.

119. PERIES, O.S.

Concern for rubber smallholders. Economic Review (Sri Lanka) 6 (9) Dec. 1980 : 24-25, table.

This is from a paper presented in connection with the Association of Natural Rubber Producing Countries (ANRPC) Seminar held in Colombo in July 1980. He summarises the several social, economic, marketing, institutional and other factors facing the smallholders. The author pointed out the problems of the rubber smallholder is basically one of lack of finance and the other resources available to the bigger producer.

120. SIVASUBRAMANIAM, V.

The economics of rubber smallholding in Ceylon.

Industrial Ceylon. 6 (4) Dec. 1966 : 363-367.

A brief survey of the economics of the smallholdings.

121. WAIDYANATHA, U.P. de S.; WIDANAPATHIRANA, A.S.
and DE ZOYSA, R.P.M.

Some observations on Sri Lankan rubber smallholder practices with special reference to tapping. In: Report of the fourth seminar and workshop on progress and development of rubber smallholders, Colombo, 17-22 July 1980. Published by the Association of Natural Rubber Producing Countries, 1980. Appendix 9, pp. 94.

An abstract.

122. WIDANAPATHIRANA, A.S.

Improved participation of rubber smallholders in extension activities. In: Report of the fourth seminar and workshop on progress and development of rubber smallholders, Colombo, 17-22 July, 1980. Published by the Association of Natural Rubber Producing Countries, 1980. Appendix 9, pp. 93.

An abstract.

123. WIDANAPATHIRANA, A.S.

Some problems associated with educating the rubber smallholders in Sri Lanka. Proc. Sri Lanka Ass. Advmt. Sci. 36 (1) 1980 : 84.

An abstract.

Economics of Replanting

124. ABEYSEKERA, C.M.

An evaluation of rubber replanting cycles in relation to productivity and profitability. Ceylon Management Accountant.

2 (3) 1974 : 37-40, 3 tables.

The object of this exercise is to stimulate inquiry and discussion on this matter and to provide a simple yet rational basis of evaluating three straight forward alternatives, viz.

1. alternative X - on a 33 year cycle with intensification during years 27 to 33.
2. Alternative Y - on a replanting cycle of 30 years with Ethrel stimulation during years 24 to 30.
3. Alternative Z - on a replanting cycle of 25 years with Ethrel stimulation during years 19-25.

125. ABEYSEKERA, H.E.R.

Ceylon's replanting scheme. Far Eastern Economic Review (Hong Kong). 34 (4) 1961 : 249.

The government has decided to extend the subsidized rubber replanting scheme. Up to now over 65,000 ha of Ceylon's total of 300,000 ha rubber have been replanted with high yielding material, and it is expected that by the end of 1962 the replanted area will be 90,000 ha. When this area is in bearing the production, now some 100,000 tons, will increase by about 60 per cent. The present rate of replanting is about 10,000 ha a year, at a cost of Rs. 20 million annually. Some details on subsidies and exports. (Tropical abstracts. 17 (2) 1962 : no. j.408).

126. DIAS, W.P.H.

The Rubber Replanting Subsidy Scheme. Ceylon Today. 9 (6) June 1960 : 22-26, 8 photos.

This paper identifies the functions and the progress made by the Ceylon's Rubber Replanting Subsidy Scheme which was inaugurated in 1953.

127. ETHERINGTON, D.M. and JAYASURIYA, S.K.W.

The economic analysis of rubber replanting cycles.

R.R.I.S.L. Bulletin. 13, 1978 : 1-6, 5 tables, 9 refs.

This paper has set out the basic decision rule for the optimal replacement of rubber trees with and without time preference. A key lesson to learn from the present exercise is that time is important in the economic analysis of perennial crops and, the more important it is (in terms of higher interest rates), the less significant are forms of technological change (e.g. stimulation) which influence yields only in later years.

128. ETHERINGTON, D.M. and JAYASURIYA, S.K.W.

The economics of rubber replanting cycles : an interpretive essay. Jl. Rubb. Res. Inst. Sri Lanka. 54, part 1, no. 2; 1977 : 460-477, 9 graphs, 10 tables, 15 refs.

This paper applies the economic principles of optimal replacement to the case of rubber trees. The principles are illustrated using a recent set of data from Sri Lanka. Various forms of embodied and disembodied technological change are investigated using a range of interest rates. The timing of the effects of the technological change is shown to be of critical importance. The main conclusion is that innovations which allow rubber to be tapped earlier and raise yields in the early (virgin bark) years are much more important to the long run viability of the rubber industry than effort to raise yields during the tapping of second renewal bark. A similar conclusion relates to the effects of intercropping. While the influence and importance of changes in prices and interest rates on the optimal replacement of Hevea trees producing latex is certain, the introduction of wood as an important by-product is likely to have confounding effects on optimal replacement dates.

129. HERATH, Herath Mudiyanseelage Gamini

A study of supply response of rubber in Sri Lanka. ix, 106 leaves, graphs, tables, 28 refs. (Degree of Master of Agricultural Development Economics. Thesis. Australian National University, 1975. Unpublished typescript).

The rubber industry occupies an important place in the Sri Lanka economy. The recent performance of the industry both in respect of replanting and processing and the deteriorating position of rubber in world trade has caused great concern. The

need to improve replanting, production and processing is recognised by the government. To this end a rubber replanting subsidy and some processing facilities are provided. The results have not been encouraging. This study attempts an estimate of the replanting and output response of rubber producers. The main determinants of replanting such as profitability and the replanting subsidy are specified and discussed. These are investigated for three different producer groups namely: smallholders, medium estates and large estates. The determinants of output are also investigated. Several hypothesis are formulated in respect of output response. It is seen that profitability as determined by costs and prices has been the only important determinant of replanting by all three producer groups. These groups are shown to have been efficient in an allocative sense. The recent decline in profitability is the reason for the decline of replanting of all groups despite the replanting subsidy. Price is not found to be an important determinant of output in this study. However, it is argued that price could be an important determinant of output. It is shown that the obscure role of price has been due to the high yielding varieties coming into production. (Author's summary).

130. RATNAPALA, N.L.

Revival of the rubber industry. Ceylon Today. 16 (6)

June 1967 : 10-11.

This article identifies the progress made by the Ceylon's Rubber Replanting Subsidy Scheme (RRSS) launched since 1953. At the end of 1967, more than 40 per cent of the cultivated acreage in rubber had been replanted under the RRSS.

131. RUBBER RESEARCH INSTITUTE OF CEYLON. Advisory Circular No.80.

A guide to the cost of replanting rubber. Agalawatta,

R.R.I.C. 1969. 5 p. R.R.I.C. Bulletin (N.S.) 4 (1/2)

1969 : 11-15.

Presents average costing figures, compiled in consultation with agency houses and the experienced planters in replanting. The figures refer to the costs of a high standard of agricultural practice to produce the best results from the recommended high-yielding planting material. This circular supersedes RRIC Advisory Circular No. 52.

132. WIJEPAIA, Geethanjali and SENANAYAKE, Y.D.A.

A study of Ceylon's rubber replanting subsidy scheme.

Journal of the National Agricultural Society of Ceylon.

7, 1970 : 69-91, 3 graphs, 11 tables, 7 refs.

The Rubber Replanting Subsidy Scheme (RRSS) has functioned for 17 years since its inception in 1953. As the government may support more subsidy schemes in the future, an examination of the RRSS should give information to the usefulness of subsidised agriculture in this country. This paper identifies the progress of the RRSS and the visible economic and social benefits that are directly attributed to the replanted rubber.

PART 3

Agricultural Research

Rubber Planting

General

133. CHANDRASEKERA, L.B.

Plantation research. R.R.I.S.L. Bulletin (N.S.).

(Conference Supplement). 8 (3/4) 1973 : 37-39.

Brief description on rubber plantation research carried out at the Botany Department, Rubber Research Institute of Sri Lanka, on yields, planting methods, tapping methods and yield stimulants.

134. CHANDRASEKERA, L.B.

Review of the Botany Section, [R.R.I.C. for 1965].

Rubb. Res. Inst. Ceylon. Ann. Rev., 1965 (1966) pp. 13-32.

As in previous years, advice was sought on the choice of new high-yielding clones for use in replanting programmes and on tapping problems connected with methods for obtaining increased yields from low-yielding seedling and budded areas with the aid of yield stimulation or intensive tapping systems. All previous yield stimulation experiments were discontinued as these areas were required for replanting. Two long-term experiments were set down in 1965 on two commercial estates to assess the effects of long-term stimulation in one case and to compare the yield responses from stimulation and tapping on the S/2, d/3, 67 per cent system as against the standard S/2, d/2, 100 per cent system without stimulation in the other. An experiment to evaluate the long-term effects of tapping during the wintering period as well as the effects of yield stimulation on virgin bark is in progress at Dartonfield. The list of planting materials recommended for use in Ceylon was completely revised during the course of the year and drastic changes have been made. According to the new list, only clones RRIC 45, PB 86, Wagga 6278 and GI 1 are recommended for general large scale planting. On the other hand, a large number of experimental clones are now recommended for small and medium-scale planting. To encourage such planting in the latter groups, RRIC clones 5, 36, 37, 88 and 89 have been declared 'free' clones within the island. Clone RRIC 45 continues to yield satisfactorily in the fourth year of tapping in a large-scale trial at Nivitigalakelle. It has

desirable vegetative characters and is relatively unsusceptible to leaf and panel diseases. Clone RRIC 44 planted in the same experiment had recorded higher yields than RRIC 45. This clone however has the unsuitable morphological character of a fluted trunk. The yields of clones RRIC 5, 7 and 41 continue to be promising. In the 1949 large-scale clone trial at Hedigalla, clone RRIC 86 recorded yields higher than that of the control clone PB 86. Clones RRIC 88 and 89 continue to maintain high yields in the 1946 replanted area at Nivitigalakelle Experimental Station. These two clones have now been included in a number of large-scale clone trials under commercial conditions. Clones RRIC 90 and 91, which are final selections from the 1962 small-scale clone trial at Hedigalla, will be included in further large-scale clone trials in 1966. Clone RRIC 36 had maintained high yields in all the Institute's experimental areas. This clone is however very susceptible to Bark Rot when planted in the wet districts. In a multi-clone trial in the Kalutara District clone RRIM 823 out-yielded all other clones during the first two years of tapping. In 1965 the average yield was 33.3 g. per tree per tapping as compared with 19.9 g per tapping in the control clone PB 86. A programme was drawn up for the setting down of yield trials of the more promising clones in commercial estates. These trials would give us data on the suitability of Hevea clones for particular districts as well as their performance under actual commercial conditions. One such trial is already in progress in the Avisawella District and arrangements have been made to set down similar trials in 1966 in the Ratnapura, Moneragala, Kalutara, Kelani Valley, Kegalle and Matale Districts. By the end of 1966 the clones RRIC 5, 36, 41, 45, 52, 75, 86, 88, 89, 91; RRIM 605, 701, Nab 15 and AVROS 427 are likely to be under test in these yield trials. The two trials set down to evaluate the feasibility of economically inter-cropping rubber with cocoa or coffee in marginal areas in the Koslanda and Kurunegala Districts respectively are progressing satisfactorily.

135. CHANDRASEKERA, L.B.

Review of the Botany Department, [R.R.I.C. for 1966].

Rubb. Res. Inst. Ceylon. Ann. Rev., 1966 (1967), pp. 44-71.

While general advisory work fell within the purview of the newly-formed Estates Advisory Department, special problems related to planting, tapping and yield stimulation continued to be attended to by this Department. Owing to the unavailability of suitable clonal materials at the Institute's estates, investigations on yield stimulation have been limited. Once again we appeal to estates to offer us 10-acre or larger

blocks in which to carry out trials. Results of a small-scale experiment at Dartonfield confirm the findings elsewhere that the response to stimulation of virgin bark is poor. A small-scale experiment commenced in August, 1966 on clone Tjir 1 has so far shown that the yield response to application of RRIC Mixture I was better than to injection of copper sulphate. Clone RRIC 45 continues to perform well in our yield trials. It is vigorous grower and although a few clones may out-yield RRIC 45, it offers a satisfactory combination of yield and growth as well as relative freedom from leaf and panel diseases. In trial plots under dry climatic conditions in the Kurunegala and Moneragala Districts, it has maintained its growth, vigour and relative freedom from leaf diseases. In the wet districts this clone should yield around 500 lb. per acre in the first year of tapping and exceed 1,000 lb. per acre in the 4th year of tapping. Among the RRIC clones under test, 86, 88, 89, 90 and 91 are performing well and at least one of these clones is expected to yield over 2,000 lb. per acre at maturity. RRIC 36 is a very high yielder with a predicted yield of over 3,000 lb. per acre but owing to its extreme susceptibility to Bark Rot, should be suitable only for the drier districts. A programme for the setting down of yield trials of the more promising clones on commercial estates was initiated in 1964. These yield trials are designed to assess the comparative performance of clones as well as to test their suitability for planting in the different districts in Ceylon. So far trials have been successfully set down at Hanwella, Matugama, Deraniyagala, Nivitigala, Yatiyantota, Kegalle, Matale and Moneragala. We await offers from estates in other planting districts to enable us to expand our clone evaluation trials.

136. CHANDRASEKERA, L.B.

Review of the Botany Department, [R.R.I.C. for 1967].

Rubb. Res. Inst. Ceylon. Ann. Rev. 1967 (1968), pp. 11-32.

Additional results on yield stimulation experiments using a R.R.I.C. mixture have confirmed the earlier findings that average annual yield increases of about 25 per cent could be achieved particularly in low-yielding rubber which is being tapped on the renewed bark. A small-scale experiment carried out on clone Tjir 1 indicates that while injection of copper sulphate pellets into holes bored in the stock has yield stimulation properties, the yield response was inferior to that obtained with the application of RRIC mixture which contains 2, 4, 5-T as the active ingredient. An experiment in which clone Tjir 16 was tapped on S/2, d/3, 67 per cent system with two applications of yield stimulants a year had given increased

yields in the second consecutive year. The yield per tapper per tapping averaged over 3 tapping tasks had been 18.5 lb. and 19.3 lb. during the first and second years respectively. The yields recorded for the controls were 10.1 lb. and 9.7 lb. per tapper per tapping respectively. No significant difference was evident in a small-scale experiment to determine the effect of tapping with and without rest during the 'wintering period' on yield and the rate of girdling. We regret once again that attempts to obtain suitable material in commercial estates for tapping experiments have so far been unsuccessful. Clone evaluation trials confirm that RRIC 45 continues to give good yields while maintaining its favourable secondary characteristics. The high-yielding RRIC 36 is recommended as an 'eco-clone' for drier districts. Among the clones that are recommended for moderate-scale planting in estates RRIC 5, 7, 37, 41, 86, 88, 89, RRIM 605 and 623 appear to be promising. Clone RRIC 37, like the clone RRIC 36 is very susceptible to Bark Rot in the wet districts. The clone RRIC 86 had been relatively free of panel diseases and should yield better than clone PB 86. AVROS 427 and 1734 : These two clones have been selected for moderate-scale planting in estates. In experimental areas their yields have been better than that of clones PB 86 and RRIC 36. The incidence of Bark Rot in these two clones has been negligible. Other recent selections for small-scale planting are the clones RRIC 40, 55, 61, 90, 91, 99, 100 and 101. The setting down of yield trials of the most promising clone selections was being continued. A part of the experimental area at Rosebury Estate, Koslanda, was inter-planted with cacao in 1967. The purpose of this trial is to assess the effects of inter-planting rubber with a subsidiary crop in the dry districts where the climatic conditions are not very favourable for high yields in rubber. Preliminary studies indicate no differences in the growth rate of PB 86 buddings when seedlings of Tjir 1, RRIC 7, 41, 52, 86, 88 and 89 were used as stocks. Experiments have shown that where bare root budded stumps are used for planting, ring-barking budded seedlings above the point at which they are cut back two weeks before uprooting could reduce the dormant period in the field. However, any undue delay in uprooting of ring-barked plants would result in scion buds sprouting in the nursery. In the dry districts, where the duration of rainfall during the planting season is relatively short, early sprouting would ensure better establishment before the onset of the dry inter-monsoon period. With suitable soil mixtures standard budded stumps could be raised in 400 gauge 12" x 27" lay-flat polythene bags for a period of up to 6 months. These should be suitable for use as supplies especially in the wet districts.

137. CHANDRASEKERA, L.B.

Review of the Botany Department, [R.R.I.C. for 1968].

Rubb. Res. Inst. Ceylon. Ann. Rev., 1968 (1969), pp. 10-32.

At the end of the third year, yield stimulation trials, using a R.R.I.C. mixture, have shown that increases in the region of 70 per cent can be achieved on renewed bark, tapped at 67 per cent intensity, as compared to unstimulated bark tapped at 100 per cent intensity. Arrangements are now being made to obtain patent rights over this stimulant mixture and to produce it on a commercial scale. Experimental studies have shown that yield responses to the application of stimulants on virgin bark are poor and also that the rate of girdling of trees tapped with and without a winter rest is not significantly different. The Institute does not recommend the application of yield stimulants on virgin bark, but is not opposed to the continuation of tapping during the wintering period. On the results of field experiments, clones IRCI 7, PB 28/59 and RRIC 90, 91 and 99 are now recommended for small-scale planting on estates. Many commercial plantings have now confirmed the high-yielding capacity of clone RRIC 36. This clone is now recommended for planting on a large scale in districts with an average annual rainfall of around 10 in. per year, as it is extremely susceptible to Bark Rot. Clones RRIC 13, 40, 41, 50 and 55 are not recommended for small-scale commercial planting. The high-yielding potential of AVROS 427 has been confirmed in field trials. However, this clone is a relatively poor grower with a tendency to develop Bark Rot in wet districts. Clones WR 101 and IRCI 2 are now recommended for small-scale commercial plantings. Experimental evidence to-date seems to indicate that clone GT 1 would not be a high-yielding clone under Ceylon conditions. Clone AVROS 1734 has good vegetative characters and should be suitable for planting, particularly in the wet districts.

138. CHANDRASEKERA, L.B.

Review of the Botany Department, [R.R.I.C. for 1969].

Rubb. Res. Inst. Ceylon. Ann. Rev., 1969 (1970), pp. 12-57.

The increase in per acre yield of rubber, by the use of improved clones and various techniques as correct methods of tapping and yield stimulants, is the most important area of research in the Botany Department. A problem that is closely related to the development of new high-yielding clones is the selection of a suitable stock plant, the root system of which would support the more vigorous new clones. The commercial

yields of clone RRIC 45 have continued to be promising and no serious outbreaks of diseases or wind damage have been recorded on this clone, which has surpassed most other clones in growth and establishment in the dry districts. Clone RRIC 36, which is very susceptible to Bark Rot, but has a very high yield potential is now recommended for planting in districts with an average rainfall of around 100 in. per year. The newer clones which have yielded better than PB 86 in large scale trials and at the same time have shown a fair degree of tolerance to diseases and AVROS 1734, WR 101, RRIC 13 and 55, PR 252, IRCI 2 and 9. RRIC 100 and 101, two clones which have given high yields in preliminary small-scale trials at the R.R.I.C. Sub-Station at Kuruwita, have a very high yield potential, and are recommended for small scale planting in estates. The S/2, d/2, 100 per cent is still the most acceptable tapping system for most Ceylon clones. Until further experimental data are available it is recommended that, for high-yielding clones the double-four tapping system be introduced, if necessary, only after the tenth year of tapping. The Institute has successfully formulated a yield stimulant mixture using locally available raw materials. The manufacturing rights for this mixture have been granted to a commercial firm in Colombo, and the product will be marketed shortly. Experimental results indicate that as far as growth is concerned the seed of most recommended clones, except PB 86, will give comparable results to Tjir 1 as stock plants.

139. CHANDRASEKERA, L.B.

Review of the Botany Department, [R.R.I.C. for 1970].

Rubb. Res. Inst. Ceylon. Ann. Rev., 1970 (1971), pp. 9-27.

On the basis of yields recorded in large scale trials, the local clones RRIC 13, 48, 50, 89 and 94 as well as the foreign clones AVROS 1734, PR 252, IRCI 2, 7 and 9 have yielded better than clone PB 86. The clones RRIC 100 and 101 are more recent selections from initial small scale trials and have yielded far in excess of clone PB 86. The clone RRIC 100 appears to be sensitive to high intensity tapping and may have to be tapped at 67 per cent intensity for the first few years. The clone RRIC 52, though a comparatively low yielder in the first year of tapping, has given high yields in later years, both in experimental and commercial plantings. The results of full spiral tapping on this clone have been inconclusive, both in yield and girthing of the trees. Results of stock-scion experiments, have shown that there is no significant difference in the growth of the scion in the immature phase when grafted on to seedling stocks of most clones. Trials on the inter-cropping of rubber with cacao have been started in Koslanda and Passara. Several species of bacteria, isolated

from different sources and cultural in pure coconut water have been tested for coagulating field latex. Some species have produced 99 per cent coagulation in four to five hours, and the technical properties of the bacterially-coagulated rubber are in no way inferior to that coagulated by conventional methods.

140. CHANDRASEKERA, L.B.

Review of the Botany Department, [R.R.I.C. for 1971].

Rubb. Res. Inst. Ceylon. Ann. Review. 1971 (1972), pp. 12-33.

Experiments on clone PB 86, with a 10 per cent solution of Ethrel in coconut oil, have given a 100 per cent increase in yield, with no ill-effects in the first year. This material has also given very encouraging results in combination with low tapping intensities. The wider use of this stimulant, with the appropriate cultural practices, on areas being tapped on panels C and D should be considered by all estates. There have been no adverse effects either on growth or yield during eight years of tapping of clones Nab 12 and PB 86, without the usual winter rest. These observations are applicable particularly to conditions that prevail in the wet low country districts. Daily tapping on a half spiral cut has given lower yields and DRCs in comparison with the usual S/2, d/2, 100 per cent system on clones RRIC 7, 45, 52 and PB 86. Tapping with the Jebong knife has given yields comparable with those of the Michie-Golledge knife on clone RRIC 52. Small scale trials carried out with a rainguard designed by the Botanist have given promising results. Experiments have indicated the feasibility of using dried bacterial cultures for field coagulation of latex. Callus culture developed from anthers of Hevea flowers have been grown successfully on solid agar media.

141. CHANDRASEKERA, L.B.

Review of the Botany Department, [R.R.I.C. for 1972].

Rubb. Res. Inst. Ceylon. Ann. Rev., 1972 (1973), pp. 11-38.

The more recent high yielding selections were included in the Institute's Planting Recommendations for 1972. It appears that tapping can be continued without the normal winter rest in the wet districts without adverse effects on yield or growth. Continuous tapping with the use of polythene rain-guards has depressed average yields per tapping in clones RRIC 7, 45, 52, and PB 86 in 1971. The yields improved in 1972 after the removal of rainguards. Tapping on the S/1,

d/4, 100 per cent system has depressed yields of clones RRIC 7, 45 and 52 in the second year. Clone PB 86 however has continued to maintain high yields during this period. Upward tapping on "V" cuts has given higher yields than tapping upwards on two quarter spiral cuts or ladder tapping at 100 in. above ground level. In preliminary small scale trials, the high yielding clones RRIC 13, 48, 50, IRCI 9 and PR 252 have failed to give an increased yield response to Ethrel stimulation on panel C. All large scale trials with Ethrel on panel C of clone PB 86 continue to show good yield responses in the second year. Early results of stock experiments indicate the possibility of using seeds of most recommended clones as stocks for budgrafting. The first year yields of clone PB 86 budgrafted on seedling stocks of clones RRIC 7, 41, 88 and 89 have been similar to those budded on selfed Rjir I stocks. In good weather, trials have given better budding successes with 1 in. polythene strips than the conventional budding tape. Preliminary results with a gutter type rubber rainguard developed at the Institute have been promising. This rainguard has two advantages over others in that it can be fixed on to the tree with field latex and it can be removed and refixed close to the tapping cut periodically. This rainguard is being tested on large scale trials on commercial estates at present. Studies on the bacterial coagulations of latex at initial concentration are being continued. This process has been found to be suitable for coagulation of latex for block rubber production. The specific strains of bacteria can be added to the latex as dried cells or as liquid cultures.

142. CHANDRASEKERA, L.B.

Review of the Botany Department, [R.R.I.S.L. for 1973].

Rubb. Res. Inst. Sri Lanka. Ann. Rev. 1973 (1974), pp. 43-76.

The first Ethrel experiments started in Sri Lanka are now three years old and the results so far have been very encouraging. On S/2, d/2, 100 per cent tapping, with six bi-monthly applications of a 10 per cent solution of Ethrel a year on Clone PB 86, the yields recorded up to the end of the third year have been well above those of the unstimulated control plots. This indicates that with either reduced tapping intensities or with a lower number of applications a year it should be possible to obtain yield increases over a longer period without adverse effects on trees. Ethrel stimulation carried out on S/4, d/2 and S/3, d/2 tapping systems with six applications a year have yielded better than the unstimulated plots tapped at the standard intensity of 100 per cent for the past two years. This is a trial which is likely to provide the necessary data for long term Ethrel

stimulation in commercial estates. A trial comparing tapping at 150 per cent intensity with tapping at 100 per cent intensity with Ethrel stimulation once every two months has indicated, during the two years 1972 and 1973, that higher yields could be obtained by tapping at 150 per cent intensity rather than by Ethrel stimulation. This indicates that Ethrel stimulation may not be an economic substitute for the present practice of progressively intensifying tapping before a replanting. This would mean that if Ethrel is to be used at all, it will have to be on a long term programme extending well beyond the last six years before replanting. Application of Ethrel above the tapping cut has given equally good results as applications below the tapping cut. No obvious deleterious effects on trees by applications above the cut has been observed so far. Trials have shown that, with the use of polythene rainguards, when tapping is possible every day of the year, the yields were depressed, indicating that enforced rest periods due to rain interference of tapping is beneficial. Investigations were next carried out on the use of a cheap rubber rainguard which permitted a reasonable increase in the number of tapping days, but where tapping was not possible during heavy rains. In Dartonfield 50 additional tapping days were possible in 1973, with the use of these rubber rainguards. Clone RRIC 36 has proved to be the outstanding yielder in the fairly dry districts such as Matale and Kegalle. Clone PB 86 has taken second place with regard to yield. In a trial at Polgahawela, the first year yields in 1973 of clone RRIC 36 has been equal to that of RRIM 600 which is planted in the same trial. Other newer clones which continue to show promise in the wet districts are: NAB 15, RRIC 13, 48, 50, 89, 100, 101, AVROS 1734, PR 252, IRCI 2, and IRCI 9. In two intercropping trials sited at Avissawella, where Passion fruit and Banana were inter-planted among young rubber, the growth of rubber in inter-planted plots shows an improvement over the control plots. The improved growth of rubber in the interplanted plots may possibly be due to the additional fertilizer used for the subsidiary crop. These results are in agreement with similar trials carried out in other countries.

143. CHANDRASEKERA, L.B.

Review of the Botany Department, [R.R.I.S.L. for 1974].

Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1974 (1975), pp. 13-47.

All long term Ethrel stimulation experiments which have been in progress for four years and where stimulation has been carried out at two months intervals with tapping in the S/2,

d/2, 100 per cent system, have shown a progressive decline in yield response with time. The yields at the end of the fourth year however remains above the unstimulated controls. It is of interest to note that where two applications of 100 per cent Ethrel are made per year and tapped at 100 per cent intensity, the plots where Ethrel was applied above the tapping cut have not shown a downward trend in yields in the third year as compared with below cut applications. Tapping at 150 per cent intensity has continued to give higher yields in the third year as compared with Ethrel stimulation at 100 per cent intensity. Clone RRIC 36 has continued to remain the best yielding clone in the dry districts. Clone RRIM 600 has yielded well in all trials tapped so far in Sri Lanka. The other selections with good performance in large scale trials and which may be considered for moderate scale commercial planting are clones RRIC 13, 48, 89, RRIC 600, AVROS 1734, PR 252, FB 28/59, RRIC 7 and 9. The use of rainguards in the wet districts has continued to give enhanced yields by increasing the number of annual tapping days. No deleterious effects have been observed so far, as a consequence of the increase in number of tapping days.

144. CHANDRASEKERA, L.B.

Review of the Botany Department, [R.R.I.S.L. for 1975].

Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1975 (1976), pp. 15-36.

Ethrel stimulation with tapping at reduced frequencies and reduced length of cut has maintained yield levels comparable with unstimulated control plots. These methods appear to offer better prospects for long term stimulation with a corresponding reduction in tapping costs and bark conservation. Experiments have also indicated the possibility of reducing the concentration of Ethrel without losing its effectiveness. Over a five year period no appreciable decline in yield per tapping was noted for the two clones RRIC 52 and FB 86 tapped daily on a half spiral cut. The incidence of dry cuts too have remained within acceptable limits. This observation would be of particular interest from the point of view of recovery tappings normally practised in the wet zone of Sri Lanka. RRIC 36 continues to be the best yielding clone in the dry districts, yielding on an average 45 per cent more than clone FB 86, during the first three years of tapping. It has responded well to opening of tapping cuts at 45 on girth and tapping for the first three years at a reduced intensity of 67 per cent. This could reduce by approximately one year the long period of immaturity under dry planting conditions. The clone RRIC 36 yields white latex that is suitable for crepe manufacture. Clonal seeds of all clones planted commercially

in Sri Lanka appear to be suitable for use as rootstocks. Preliminary experiments indicate that in seedling nurseries planted at normal spacings, there are no particular advantage to be gained by periodic thinning of the poorer growers as far as the percentage of plants that reach buddable size is concerned. The use of rubber rainguards in the wet zone has continued to give enhanced yields of reducing rain interference of tapping. In one trial at Dartonfield, the use of rainguards has increased tapping days by 13 per cent in 1975. Certain strains of Rhizobia which effectively fix nitrogen when inoculated on leguminous ground covers, Pueraria and Calapogonium, were isolated. Preliminary trials indicate the possibility of establishing Panicum maximum as a forage grass between rows of young rubber. Inter-planting rubber during the immature phase with perennial crops such as Bananas, Passion fruit and Pineapple has not adversely affected the growth of rubber. Perennials that do not require clean weeding, appear to be best suited to the hilly terrain in which most rubber is grown in Sri Lanka.

145. CHANDRASEKERA, L.B.

Review of the Botany Department, [R.R.I.S.L. for 1976].

Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1976 (1977) pp. 16-49.

Over a six year period, clone FB 86 has responded well to tapping daily on a half spiral cut, with the incidence of dry trees remaining within acceptable limits. This is of significance in relation to the smallholders' problems during periods following prolonged wet weather, when a majority of them tap daily in periods of fine weather. This also has a bearing on recovery tapping on estates in the wet zone. The clone FB 86, appears to be better adapted for daily tapping than any other popular clone grown in Sri Lanka at present. The recommended clones IRCI 2 and 9, PR 252, RRIC 36 and 48 and RRIM 600 continued to maintain high yields in all large scale trials. Clone RRIM 600 has recorded the highest yields in all trials sited in both the wet and dry planting districts. Among the clones of the RRIC 100 series, clone RRIC 101 has recorded a yield of over 1000 kg. dry rubber per hectare in the first year of tapping. All polyclone plantings have continued to maintain higher yields than mono-clone plantings. In a large scale planting, a yield of over 1000 kg. per hectare has been recorded in a polyclone planting in the second year of tapping. None has been recorded in a polyclone planting in the second year of tapping. None of the clones included in this trial has reached this yield level in mono-clone plantings. Clonal seed of all commercially planted clones in Sri Lanka appear to be suitable for use as rootstocks, in regard to both the growth and yield of the scion clones. There is no advantage in the

periodic thinning of poor growers in seedling nurseries, planted at normal spacing, from the viewpoint of increasing the percentage of plants reaching the buddable girth. However, thinning out improves the growth of seedlings remaining in the nursery. Interplanting rubber during the immature phase with perennial crops such as bananas, passion fruit, pineapples and forage grasses has not adversely affected the growth of rubber. On the contrary, where these subsidiary crops have been adequately fertilized, a distinct improvement in the growth of the rubber has been recorded.

146. CHANDRASEKERA, L.B.

Review of the Botany Department, [R.R.I.S.L. for 1977].

Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1977 (1978), pp. 11-49.

Ethrel trials, in which stimulation was carried out at two monthly intervals with tapping on the S/2, d/2, 100 per cent, continued to show declining yields with time, and in the fourth year bimonthly Ethrel applications, were generally uneconomic. Yield increase were maintained over 4 years only in one trial, where six stimulations were carried out and tapped on the S/2, d/3, 67 per cent systems. PB 86 has responded well to daily tapping over a period of 7 years and during this period, the average yield of the daily tapped area was 3161 kg/ha compared to 1720 kg/ha in the control plots, tapped alternate daily. Estates should now tap PB 86 areas daily, on a trial basis, keeping careful records of yield, the number of dry trees and the incidence of bark diseases. Clones RRIC 5, 13, 36 and 48, IRCI 2 and 9, PR 252 and RRIM 600 have maintained high yields on both virgin and renewed bark on all large scale trials. These clones should increase the average yields to around 2000 kg/ha. Clone RRIC 100 has given steady yield increases with time. All these clones should now be planted, at least in trial plots of 100 ha each on large estates. The presence of mycorrhizae enhanced the uptake of phosphorus from the soil by Pusararia spp., and Stylosanthes spp. Adding rock phosphate to the soil, increased uptake even further. The absorption of P from imported rock phosphate was superior to that from Eppawela apatite. There is evidence that mixing rock phosphate with small quantities of sulphur before application to the soil, increases the availability of P from rock phosphate. Interplanting rubber in its immature phase with perennial crops such as bananas, passion fruit and pineapple has not adversely affected the growth of rubber. The most profitable intercrop for rubber appears to be bananas, on the other hand growing passion fruit has been found to be uneconomic at present prices, mainly due to the expenditure on supports and the unsatisfactory marketing system for this crop.

147. CHANDRASEKERA, L.B.

Review of the Botany Department, [R.R.I.S.L. for 1978].

Rubb, Res. Inst. Sri Lanka. Ann. Rev., 1978 (1979), pp. 11-44.

It would be best to aim at yield increase in the order of 20 to 30 per cent per year with Ethrel stimulation. This could be achieved either by limiting applications of Ethrel to two or three a year during periods of good weather and tapping on the S/2, d/2, 100 per cent system or by reducing the tapping intensity to 67 per cent in the S/2, d/3, 67 per cent system with Ethrel applications below the tapping cut once every two months. Where applications are limited to twice or thrice a year, a better yield response was noted for applications above the cut. The two clones PB 86 and RRIC 52 have responded well to daily tapping on the S/2, d/1, 200 per cent system with the incidence of dry trees remaining below 10 per cent. Of the two clones PB 86 may therefore be suitable particularly for smallholders who tap their rubber daily. In another trial, recovery tapping of clone PB 86 (to bring up to 180 tappings per year) has resulted in appreciable yield increases without detrimental effects on trees. These observations can now be put into practical use on a limited scale on large estates. To begin with 180 tappings per year should be aimed at. If problems of Brown Bast arise, this Institute should be consulted immediately. Callus cultures, originating from stem explants were induced to differentiate roots when transferred to a root differentiating medium. Another important observation was the development of a plantlet with a distinct root and stem from callus obtained from endosperm tissue. This indicates that plantlet formation in *Hevea* callus cultures can be achieved. Trials involving the establishment of grasses and legumes among young rubber for cattle fodder were continued. In terms of herbage production, *Panicum maximum*, appears to do better when grown in combination with *Pueraria phaseoloides*, with high levels of Phosphorus. *Brachiaria brizantha* on the other hand was more productive when grown alone with high levels of Nitrogen. A combination of *P. maximum* and *Pueraria* appears to be an acceptable system for intercropping with immature *Hevea*. Among cash crops, intercropping with bananas has been popular among estates. It has been found to be less labour intensive and provides a quicker return with little or no problems in marketing. The cultivation of pineapple in the wet zone has not been popular due to high costs of weeding.

148. CHANDRASEKERA, L.B.

Review of the Botany Department, [R.R.I.S.L. for 1979].

Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1979 (1980), pp. 6-39.

There have been indications that the two clones RRIC 52 and PB 86 could be exploited more intensively than on the S/2, d/2, 100 per cent tapping system. In clone PB 86, tapping on the alternate daily half spiral system with additional recovery tappings to obtain in all 180 tappings for the year has resulted in high yields comparable with that for daily tapping (S/2, d/1, 200 per cent) and much higher than for S/2, d/2, 100 per cent system. From the point of view of dry cuts, recovery tappings spaced out so that not more than six additional tappings are carried out per month appear to be better than recovery of lost tapping days by daily tappings.

The yield response to puncture tapping appears to be a clonal character. Yields of over 2000 kg. per hectare have been recorded in large scale trials for the four clones RRIC 13, 48, 36 and RRIM 600. These four clones are therefore considered suitable for limited scale commercial planting with clone RRIC 36 confined only to the relatively dry districts. Of the two clones RRIC 100 and 101, the clone RRIC 101 has maintained higher average yields in all trials. Clonal seed of PB 86 has been found to be satisfactory for use as rootstocks. Inter-cropping rubber planted at spacings of 2.5 m x 9.0 with crops such as banana, passion fruit, pineapple and coffee has so far not had any adverse effects on the growth of rubber, when carried out according to this Institute's recommendations. Whether coffee would continue to thrive under mature rubber and yield adequately has still to be resolved. In pineapple cultivation where weeding costs are high, the pre-emergent weedicide Diuron has given promising results. Among forage crops, *Panicum* species produced more dry matter than the *Brachiaria* species tested both when growing alone or in combination with a legume. *B. brizantha* and *P. maximum* depressed growth of *Hevea* significantly when grown alone or in combination with a legume when compared with *Pueraria* or natural covers. In terms of both dry matter and availability of nitrogen, a mixed pasture of grass and legumes appears to be beneficial. Root differentiation was observed when *Hevea* calluses grown on a high auxin medium was transferred and grown on a low auxin medium with kinetin; low levels of cinnamic acid in the presence of kinetin also induced root differentiation. Crown budding experiments indicate that growth of the trunk could be significantly affected by the nature of the crown. Green buddings have been found to be suitable for large scale planting in the Kalutara District.

149. DE SILVA, C.A.

Planting and after-care of budded stumps and stumped
buddings. Q. Jl. Rubb. Res. Inst. Ceylon. 38 (1/2) 1962 :
18-22, 1 plate (2 photos.), 2 diagrams.

Recommendations in detail for planting rubber under Ceylon conditions including information on season for planting, size and age of stumps, method of up-rooting planting, care of the planted budded stump, cutting the stock snag, the use of stumped buddings for supplying vacant planting points or for planting certain small areas. This article is published separately as Rubber Research Institute of Ceylon. Advisory Circular No. 72 (superseding Advisory Circular No. 38).

150. DE SILVA, C.A.

Review of the Botany Department [R.R.I.C. for 1960]
Rubb. Res. Inst. Ceylon. Ann. Rev., 1960 (1961), pp. 13-36.

The advisory work of the Department has been mainly concerned with the choice of clones for particular localities and methods of obtaining increased yields by yield stimulation and the use of rainguards. A number of RRIC clones continue to show excellent yields in small-scale trials; clones RRIC 28, 41, 45, 57 and 76 have given yields over 50 lb. dry rubber per tree per year at 16 to 17 years of age, and about 70 per cent of the selected RRIC clones show yields of over 30 lb. dry rubber per tree per year at 13 to 19 years of age. Three of these clones in large-scale trials are commercial clones. Several promising local new clones yielding 50 to 60 grams dry rubber per tree per tapping in the third year of tapping on the half-spiral alternate day system (S/2, d/2, 100 per cent) will be selected for further trial on a large scale. Clone Nab 15 is out-yielding clone PB 86 in the first three years of tapping in a clone trial at Dartonfield. Yield stimulation experiments now in the second year, continue to show increased yields of 8 per cent to 40 per cent over the controls with seven proprietary yield stimulants on test. The poorer results have been obtained from stimulants prepared for application without scraping the bark. An RRIC yield stimulant based on 2, 4, 5-T with coconut oil as carrier has given promising results.

151. DE SILVA, C.A.

Review of the Botany Department, [R.R.I.C. for 1961].
Rubb. Res. Inst. Ceylon. Ann. Rev., 1961 (1962), pp. 13-37.

The advisory work of the Department has been mainly concerned with the choice of clones for use in replanting programmes and with methods of yield stimulation and of intensive tapping for increased yields. A number of selected RRIC clones continue to show excellent yields in test tapping and several of these clones, namely RRIC 7, 45, 52, 58 and 89, have been used in replantings carried out on Dartonfield Division during the South-West and North-East monsoons of 1961. The performance of clone Nab 15 has been excellent in all trials in which it is represented. A study of the morphological characters of most of the high-yielding RRIC clones was completed during the year. Preliminary yields have been recorded on old seedling rubber on the Kuruwita Sub-Station for the establishment in 1962 of a large-scale yield stimulation experiment on trees tapped on the double-four and double-three systems. A yield stimulation experiment on old rubber resulted in 45-50 per cent increased yields in 1961. Crown-budding experiments with clone LCB 870 continue to show an adverse effect of the LCB 870 crown on the yields of the centre section of a number of clones.

152. DE SILVA, C.A.

Review of the Botany Department, [R.R.I.C. for 1962].

Rubb. Res. Inst. Ceylon. Ann. Rev., 1962 (1963), pp. 18-41.

The advisory work as in former years has been mainly concentrated on the choice of new high-yielding clones for use in replanting programmes on commercial estates and on methods of obtaining increased yields with the use of yield stimulants, rainguards, and intensive tapping systems. The more promising clones RRIC 5, 7, 36, 37, 41, 45, 51, 52, 74, 86, 87, 88 and Nab 15 have been recommended for commercial planting. Clones RRIC 7, 41, 45, 52 and 86 have been declared "free" clones for multiplication and sale from registered budwood nurseries. In the 1953 large-scale clone trial, Hedigalla, with 800 to 900 trees of each clone, the more promising clones are RRIC 5 and 7, which yielded 32.6 and 34.4 grams per tree per tapping respectively in 1962 compared with a yield of 30.2 grams per tree per tapping of clone RRIM 501. In the 1954 large-scale clone trial, Hedigalla, with approximately 500 to 600 trees of each clone in tapping, clones RRIC 36 and 37 have yielded 33.0 and 28.8 grams per tree per tapping respectively in 1962 compared with a yield of 28.2 grams per tree per tapping of clone RRIM 501. In the 1955 large-scale clone trial, Hedigalla, with 500 trees in tapping from April 1962, clone RRIC 41 has yielded 30.3 grams per tree per tapping. Clone RRIC 45 budded in the field in 1955 has yielded 8.9 lb. per tree in 1962, with 477 trees in tapping.

In the 1949 clone trial, Hedigalla, clone RRIC 52 has yielded 15.6 lb. per tree in 1962. Clone PB 86 has given an equivalent yield of 15.6 lb. per tree per year in this clone trial. Yield stimulation experiments No. 3 and 4 were continued in 1962. Increased yields of 44 to 55 per cent over the control were obtained in old budded rubber while 19 to 37 per cent increased yields were obtained from old seedling rubber. A large-scale yield stimulation experiment, initiated in November 1962 in a 40-acre polyclone block of 30-year-old budded rubber, gave increased yields of 46 to 70 per cent in various treatments with stimulants in the first two months of experimental tapping. This experiment will be continued in 1963.

153. FERNANDO, D.M.

Problems of achieving agricultural production potentials in rubber. R.R.I.C. Bulletin (N.S.). 2 (3/4) 1967 : 62-65, 6 refs.

A brief resume is presented of the development of rubber industry in Ceylon and in other countries in the world on its different aspects of research, yields, tapping systems, soil management, growth, diseases and pests, vegetative and generative selection, natural vs. synthetic.

154. PERIES, O.S. comp and ed.

A handbook of rubber culture and processing. Agalawatta, Rubber Research Institute of Ceylon, 1970. [X], 188 p., plates (photos.), tables.

A handy manual, which contains information on all aspects of rubber production and processing. This has incorporated most of the information that is available in the advisory circulars of the R.R.I.C. bringing it up-to-date, and provided much new information on the culture of the crop and the manufacture of the products. The editor made every attempt to include as much of the information as possible on the usual queries put to the R.R.I.C. in their advisory capacity. This manual consists of the following 5 parts: 1. Nurseries and planting material; 2. Planting of rubber; 3. Plant nutrition and cultivation practices; 4. Diseases and pests; 5. Processing, manufacture and packing.

155. RUBBER RESEARCH INSTITUTE OF CEYLON. Advisory Circular No. 72.

Planting and after-care of budded stumps and stumped buddings. Agalawatta, R.R.I.C., 1962, 5 p., 1 plate (2 photos.), 2 diags.

This Circular supersedes Advisory Circular No. 38. See item No. 149.

156. WIDANAPATHIRANA, A.S.

Observations on farm practice adoption in a selected rubber growing area. Proc. Sri Lanka, Ass. Advmt. Sci. 36 (1) 1980 : 84-85. (abstract).

The adoption of 5 practices by smallholders in the early establishment of rubber was studied; (a) Selection of clones (b) establishment of budded plants (c) fertilizer practices (d) intercropping and (e) leguminous cover cropping. Most smallholders prefer to plant clone PB 86 as they believe it to be high yielding and disease resistant. The recommended practices connected with planting such as placement and orientation of bud patch, appear to be not followed by the majority of smallholders. Opinions on types of fertilizer and frequency of application were different among the growers, majority reporting incorrect information. Most grower's acceptance is for annual intercrops as against semi-perennial crops during the early period of rubber to be poor. (Author's summary).

157. WIDANAPATHIRANA, A.S.

Some aspects of adoption of innovations on rubber holdings in Sri Lanka. Proc. Sri Lanka Ass. Advmt. Sci. 35 (1) 1979 : 64. (Abstract).

The adoption of improved practices and materials on individual rubber holdings are of great significance in increasing the production of natural rubber. These innovations which showed a varying degree of adoption by private rubber growers are investigated. Among those analysed are the use of two material inputs namely planting materials and artificial fertilizers and several other practices such as the tapping of rubber, bark consumption and renewal density of planting, growing of cover crops and the rate of girdling of rubber trees in a

stand. The clone PB 86 has shown to be the widely adopted type of planting material by most rubber growers and the spread of other improved clones among the rubber growers is poor. This has been so because of the lack of knowledge of the growers on the merits of these clones. Only a minority of rubber farmers use fertilizers and its application reduces as rubber becomes older. Poor bark renewal associated with careless tapping was observed and this was more so on smaller rubber holdings. The tapping intensities were found to be higher than recommended mostly in rubber small holdings. The density of rubber trees in a plantation was found to be poor on smallholdings in the late years. Similarly the rate of girdling of rubber trees on a stand was poor under smaller units of management than on larger units. (Author's summary).

158. WILJEWANTHA, Ronald T.

Review of the Botany Division, [R.R.I.C. for 1963].

Rubb. Res. Inst. Ceylon. Ann. Rev., 1963 (1964), pp. 16-47.

The advisory work has been confined to recommendations on planting material, tapping problems, and the correct use of yield stimulants for obtaining increased economic yields. The local clones RRIC 7, 41, 45, 52 and 86, which have been declared 'free' clones have given promising yields during the year under review. The recommendations for planting these clones on a moderately large scale on commercial estates are favourably supported by the yield results as well as by secondary characters, especially with regard to disease susceptibility. Clone RRIC 7 was planted in two clone trials in 1945 and 1953. In the latter trial approximately 800 trees of the clone yielded 9.5 lb. per tree per year in the 4th year of tapping. Reliable methods of correcting the enzymatic discolouration of the latex of this clone have been recommended. In the 1955 large-scale clone trial at Hedigalla Station clone RRIC 41 has yielded 9.5 lb. per tree per year in 1963. The trees were first tapped in April 1962. Clone RRIC 45 was budded in the field in 1955 in a clone trial at the Nivitigalakele Station. 572 trees yielded 10.1 lb. per tree per year in the 2nd year of tapping. It is a vigorous grower and a promising high-yielding clone. Clone RRIC 52 was planted in a large-scale clone trial in 1949 with a spacing of 6' x 45'. This clone with 107 trees in tapping has given a yield of 14.9 lb. per tree per year in 1963. The control clone PB 86 yielded 15.7 lb. per tree per year with an equivalent number of trees. In the same trial 77 trees of clone RRIC 86 yielded 19.3 lb. per tree per year. Clone RRIC 52 is specially recommended for planting in smallholdings, with a spacing of 15' x 18' which is more suited to its spreading foliage canopy. Other local clones RRIC 5, 9, 13, 34, 35, 36, 37, 40, 50, 51, 59, 60, 74, 75, 88, 89 and clone Nab 15 have given promising yields in various clone trials. A number of these

clones has not been recommended for commercial planting pending a final assessment of their secondary characters. Among the foreign clones PB 28/59 planted in 1954 has given a yield of 14.2 lb. per tree per year with 143 trees in tapping. Clones RRIM 623 and 607, planted in large-scale clone trials on two commercial estates in 1957 and 1958 respectively, are above average in girth. In the 1958 trial clone RRIC 52 is the best grower with a girth of 20.8 inches in 1963. Clones RRIC 41 and 45 are above average girth in this same clone trial. The results of the early evaluations of planting material at the testing stations, located in Kepitigalla Group and Clodagh Estate in the Matale District for *Oidium* resistance and on Peenkande Group for *Phytophthora* resistance, will be reported in a Quarterly Journal. A site has been selected on Nakiadeniya Group in the Galle District for testing clones for resistance to *Gloeosporium*, which is now of economic importance to the industry. The general breeding stations, established on Nakkala and Moneragala Estates will help to extend the hand-pollination season to May and June each year, when trees in the Moneragala District are in flower. A better preservation of fruits which are set can be expected in the absence of *Phytophthora* in this District. Yield stimulation experiments were continued in the experimental stations. The increased yields obtained from budded rubber with good bark reserves, normally yielding 600 to 800 lb. per acre per year, have been encouraging. In the 4th stimulation experiment at Kuruwita the 'RRIC' mixture formulated with 2, 4, 5-T has given better results than "Stimulex" and "Dilatex" formulated with the same plant hormone. The Institute hopes to make arrangements for the production of the "RRIC" mixture on a commercial scale in 1964. A tapping experiment initiated in 1954 at Dartonfield for comparing tapping at heights of 42" and 50" in budded rubber does not show any significant differences in yield at the two heights of tapping. Some caution is required for good tapping at 50" in the first year of tapping.

159. WLJEWANTHA, Ronald T.

Review of the Botany Division, [R.R.I.C. for 1964].

Rubb. Res. Inst. Ceylon. Ann. Review., 1964 (1965), pp. 16-47.

The work of this Division as in previous years was concentrated on field experiments connected with breeding and selection work for the evolution of vigorous growing high-yielding clones with good secondary characters. Selected planting material was screened on Kepitigalla Estate in the Matale District for resistance to *Oidium heveae*, and for growth and yield under local conditions. None of the imported clones resistant to

Dothidella ulei was found to be resistant to Oidium; a few clones, however, showed a high degree of tolerance to Oidium. At the testing station for Phytophthora on Peenkande Group clones were evaluated for resistance to the disease and for yielding capacity. A testing station for Gloeosporium allorubrum was established on Nakiadeniya Group in the Galle District. A total of 38,470 hand pollinations were carried out during the 1964 flowering season. 1,631 seedlings were established in nurseries from this pollination programme. The budgrafts from a prematurely flowering mutant clone H 440 at Nivitigalakele commenced flowering as predicted one year after planting. A note on the further studies of this mutant will be prepared for publication. Preliminary studies on epiphytotic induction have given encouraging results. A successful method of inducing Phytophthora infection in nursery plants has been worked out. Girth measurements taken in 1964 in the 1962 large-scale clone trial at Kuruwita Sub-Station showed that under local conditions of growth in the Ratnapura District clones RRIM 701 and 623, RRIC 14, 41 and 52 ranged in girth from 5.6 to 6.7 inches, while clones RRIC 45 and 51, AVROS 529, WR 101 were just over 5 inches in girth. The average girth recorded in this trial was 4.7 inches. In a small-clone trial within the main clone trial recorded an average girth of 4.8 inches. In the 1954 clone trial, Nivitigalakele, where 25 trees each of clones RRIC 88 and 89 have been test-tapped in the 11th year of tapping, the clone RRIC 88 has yielded 24.1 lb. per tree per year, while clone RRIC 89 has yielded 22.1 lb. per tree per year. The two original budgrafts of clone RRIC 52 in the 1944 small-scale clone trial, Nivitigalakele, has given a yield of 43.1 lb. per tree per year in 1964, compared with a yield of 29.3 lb. per tree per year of the control clone Wagga 6278. In the 1945 clone trial, Hedigalla clones RRIC 5, and 7 have given yields of 23.6 and 21.5 lb. per tree per year respectively in 1964. In the 1955 large-scale clone trial, Hedigalla, clones RRIC 40, 41, 46 and 50 are among the best yielding clones with over 35.0 grams per tree per tapping in the 3rd year of tapping. In the 1953 large-scale clone trial at Nivitigalakele clone RRIC 45 with 588 trees in tapping has given 10.6 lb. per tree per year in the 3rd year of tapping; in the same clone trial 498 trees of clone RRIC 44 have yielded 11.7 lb. per tree per year. The latter clone has a fluted trunk which however has not unduly interfered with tapping. A selection of local and foreign clones PR 252, 253, RRIM 617 and 618, IRCI 9, RRIC 39, 48, 55, are among the better yielding clones yielding over 20 grams per tree per tapping in the first 10 months of tapping. In a clone trial at Dartonfield clones WR 101, GT 1, AVROS 385 and 427 planted in 300-tree monoclonal plots were first tapped in 1963. In a difficult rubber planting terrain with rocky outcrops, clone

AVROS 427 is the best yielder in 1964 with 32.9 grams per tree per tapping. Clone WR 101 has yielded 26.0 grams per tree per tapping while clone GT 1 and AVROS 385 yielded 19.9 and 17.9 grams per tree per tapping respectively. The annual girth measurements in immature areas have been taken in all the experimental stations as well as in clone trials planted in experimental areas on outside estates. The 1957 small-scale clone trial at Hedigalla including 171 ten-tree clones, which show marked differences in growing capacity in quick changing terrain, with inherent soil infertility. The annual girth increment for 1963-64 averaged 2.3" which is not up to required standards of good growth. In the 1961 large scale clone trial at Dartonfield, spread over 3 separate fields, clones RRIC 7, 52 and RRIC 513 as a North-East season replanting showed satisfactory increases in growth for 1963-64 ranging from 3.0 to 3.4 inches. Clones RRIC 45 and 88 have in a South-West season replanting shown increased girth figures of 3.4 and 3.6 inches respectively for 1963-64. The control clone PB 86 in the same field showed an increase of only 2.5 inches in girth. In an isolated and sheltered field of Dartonfield clones PB/28/59 and RRIC 89, planted in the North-East season were not up to standards of growth with girth increments of 2.4 and 2.1 inches respectively for 1963/64. In a clone trial planted on Estate A in the Kalutara District in 1957 on 300-tree plots clones TR 1406, AVROS 529, IRCI 2, IRCI 3 and RRIC 607 attached an average girth of over 20 inches. The control clone PB 86 was below the average growth of 21.9 inches with a girth of 19.8 inches. In the 1957 clone trial on Estate B, planted in 300-tree plots, clones TR 1548, RRIC 612, AVROS 2037 were above the average growth of 23.7 inches girth in 1964. AVROS 1734 was just below average growth while the girth of the control clone PB 86 was 20.8 inches. In the 1958 large-scale clone trial on Estate B, planted with foreign and local clones in 300-tree plots clone RRIC 52 was the best grower with an average girth of 22.8 inches. Clones RRIC 22, 36, 37, 39, 41, 54, RRIC 607 and PB 86 showed girth figures ranging from 20.0 to 22.9 inches. The average girth figures for clones RRIC 605 and RRIC 45 were 19.5 and 19.8 inches respectively. In a tapping experiment initiated in 1954, with 26 clones tapped at heights in the 10th year of tapping was not of any practical significance. The tapping at 50" can be carried out satisfactorily with some difficulty in the case of tapping during the first 5 to 6 months. This allows for approximately a 14-year tapping cycle on virgin bark. A small-scale replicated experiment was initiated in 1964 to investigate any differential response of clones to long-term stimulation with and without winter rest. Twelve-year old clones PB 86 and Nab 15, first tapped in 1958, were tapped under experimental conditions from

March 1964. The preliminary results are presented in Table III of the Head of the Botany Division's report. It would be premature to comment on these early results. The first three experiments on yield stimulation were discontinued. The 4th stimulation experiment in the series was initiated to test RRIC mixture I and II and Dilatex together with a control. The application were made once a year on old seedling rubber. RRIC mixture II gave the best results with an increased yield of 19 per cent over the control. In a 5th year stimulation experiment in a 30-year old polyclonal block at the Kuruwita Sub-Station with a single application per year of Stimulex, Dilatex, RRIC mixture I and II, the best results were obtained from RRIC mixture II on groomed bark with an increased yield of 12.3 per cent over the control. This experiment is in its second year of application. RRIC mixture II on ungroomed bark gave better results than either Stimulex or Dilatex under the conditions of this experiment.

Agricultural Meteorology. Climatic

Influences, and Crop Weather

Relations

160. DOMROS, Manfred

An agro-climatological land classification of Sri Lanka (Ceylon) for tea, rubber and coconut palms. Applied Sciences and Development (W. Germany). 7, 1976 : 39-65, 9 figs., maps.

In this article, an attempt is made to show the scope for agro-climatological research in Sri Lanka. The author has worked intensively on this on the basis both of published literature and field work in Sri Lanka.

161. GOONASEKERA, G.A.J.P.R. and PEIRIS, L.T.

The effect of weather on Hevea plant growth. Jl. Rubb. Res. Inst. Sri Lanka. 54, part 1, no. 2, 1977 : 299-305, 1 graph, 2 tables, 20 refs.

Girth and height measurements of a number of young rubber plants of several clones were recorded for a period of over 6 months. The effect of weather factors, rain, humidity, pressure, wind, sunshine, and temperature on the growth parameters were investigated using regression methods. Seasonal changes in girth and height were also studied.

162. SATCHUTHANANTHAVALA, R.

The influence of weather on crop harvesting of rubber in Sri Lanka. Rubber Board Bulletin (India). 12 (3) 1975 : 105-111, 2 diagrams, 2 graphs, 5 tables, 3 refs.

This paper discusses the effect of weather conditions, in a broad sense to include wet and dry weather conditions, on the yield potential and crop harvesting of rubber and also discusses some of the experiments conducted to minimise the effect of weather conditions especially wet weather, with a view to maximise crop production.

163. WIMALARATNA, S.D. and PATHIRATNA, L.S.S.

Observations on 'wintering' in Hevea. R.R.I.S.L. Bulletin (N.S.). 9 (1/2) 1974 : 5-9, 5 diagrams., 4 refs.

Hevea being a deciduous plant sheds leaves during the early part of the year, generally from January to March. It was observed that the clonal variation in leaf fall is characteristic. A detailed study of the process in wintering shows that yields decrease considerably during this period. This reduction is greatest at the commencement of bud break of the new flush, and returns to normal only with full establishment of the new foliage, which will be a considerable time after the new leaves mature, in certain clones. (Authors' summary).

Breeding and Selection

164. BAPTISTE, E.D.C.

Breeding for high yield and disease resistance in Hevea.

In: Proceedings of the Natural Rubber Research Conference,
Kuala Lumpur, 1960. Kuala Lumpur (Malaya), Rubber Research
Institute of Malaya, 1961. pp. 430-445, 10 photos, 4 tables,
17 refs.; Reprinted in Q. Jl. Rubb. Res. Inst. Ceylon.
36 (3/4) 1960 : 38-51.

The selection and breeding of Dothidella resistant Hevea clones in Brazil is reviewed in some detail. A complete list is presented of these clones imported into Ceylon for breeding work aimed at combining disease resistance with the high yield of Eastern clones, using the backcross method of breeding. An appraisal is made of the clones on their reaction to Dothidella and to Phytophthora. Examples are given of apparent breakdown of disease resistance and the importance is stressed of the need for diversification of highly resistant material for use as genotypes. Since tests of Dothidella resistance can be carried out only in the Western hemisphere, where the fungus is present, the situation of a testing station is discussed and Turrialba in Costa Rica is considered to be the best centre for the purpose. It is suggested that all natural rubber producing countries should take joint action to have the project implemented by an international body such as the F.A.O. of the U.N. A plea is made for international co-operation in the field of Hevea production research with a view to securing the future of the natural rubber industry. (Author's summary).

165. CHANDRASEKERA, L.B.

Review of the Genetics and Plant Breeding Department,

[R.R.I.S.L. for 1974]. Rubb. Res. Inst. Sri Lanka. Ann.Rev.
1974 (1975), pp. 48-60.

In the event of South American Leaf Blight (SALB) entry, rubber cultivation would move more into the dry zones and RRIC 103 showed suitability in growth and yields for these areas in trials sited at Moneragala and Bibile. RRIC 102 showed suitability for areas above 1000 feet. A new clone 4011 of RRIC 52 selfed percentage also showed suitability for upland areas. Progress was made in seed germination methods and in increasing the effectiveness of controlled pollinations.

166. FERNANDO, D.M.

Breeding for multiple characters of economic importance
in Hevea - preliminary assessment of recent selections.

Journal of Rubber Research Institute of Malaya. 21 (1)

1969 : 27-37, 10 illus. (photos.), 2 tables, 12 refs.;

Reprinted in Q. Jl. Rubb. Res. Inst. Ceylon. 46 (1/2) 1970 :
7-19.

The second stage of breeding of Hevea in Ceylon from 1957 is outlined. Selection of cultivars for multiple characters of economic importance has resulted in the evolution of some clones tolerant to Oidium leaf disease. Breeding for increased vigour resulted in a few more clones which had been successfully opened for tapping at 4½ years. Screening of 111 clones, found resistant to Dothidella ulei in Brazil, to Oidium leaf disease in Ceylon uncovered tolerance to Oidium in a few primary selections such as F 4542 and F 409, two first generation progeny and one third generation selection. The need for wide testing of the few favourable cultivars bred for multiple characters of economic importance is discussed. (Author's abstract).

167. FERNANDO, D.M.

Crop improvement. R.R.I.S.L. Bulletin (N.S.). (Conference supplement). 8 (3/4) 1973 : 48.

A short article on crop improvement in rubber.

168. FERNANDO, D.M.

An evaluation of recent Hevea selections. In: International Rubber Conference, Kottayam, 23-28, Nov. 1980. Abstracts of papers. Kottayam, Rubber Research Institute of India, 1980. Session 1, paper 5.

The early breeding work of the Rubber Research Institute of Sri Lanka is described. Yield of a few selected RRIC clones in large scale and small scale experiments is reported. Secondary characters such as vigour, girth, increment after tapping, suitability for upland and dry areas and resistance

to South American Leaf Blight have also been assessed. The reported susceptibility of clone RRIC 103 to Corynespora disease in Malaysia was not observed in Sri Lanka. Notwithstanding this fact, it is recommended that different clones may be planted in bigger estates to provide security against the failure of a particular clone. RRIC 101, RRIC 102 and RRIC 103 recorded higher yield in many large scale trials. Besides these clones, considering the desirable secondary characteristics, RRIC 117 and RRIC 121 are also recommended for large scale planting. (Author's summary).

169. FERNANDO, D.M.

Hevea planting material to 2000 A.D. Rubber Board Bulletin (India). 12 (2) 1975 : 38-40, 6 refs.

Hevea was introduced to Sri Lanka in 1875 and the planted acreage increased very rapidly with the advent of the age of the motor car. A seven fold increase of yield of rubber per ha. has also been achieved in a period of 40 years of breeding and selection. Price depression, leaf disease epiphytotics and competition from the synthetic product has so far been successfully combated by effective research and extension. The present energy crisis has revitalized the production sector but the problems of the developing countries of the East call for ever increasing effect impact. A methodology of breeding which combines quantitative genetics with major gene genetics as advocated by Knight, Watkins et al. for long term breeding of temperate fruit crops such as apples appears advisable in the case of rubber also. Early indices of yield and other important characters of economic importance, are necessary for this type of breeding. Such a wider methodology may be beyond the scope of a single national breeding unit in Hevea, in forming an International Registration Authority we have a possible basis for such an International effort. (Author's summary).

170. FERNANDO, D.M.

An outline of the breeding, selection and propagation of rubber. Q. Jl. Rubb. Res. Inst. Ceylon. 42 (1/2) 1968 : 9-12, 14 refs.

Successful experiments in budgrafting in 1918 opened the way to rapid improvement of this crop, which was introduced to Ceylon in 1876. Earlier breeding and selection work concentrated mainly on yield but later work incorporated

suitability of other characters such as growth habit, latex properties, bark characters and disease resistance. The biggest single threat to rubber is attack by the S. American leaf blight. In recent years appreciable work on the search for new material has been carried out in Brazil. Plant breeding incorporating this new material is going on in Brazil, Ceylon and Malaya. Breeding concentrated mainly on yield is also being carried out in Java, Sumatra, Indo-China and India. (Author's summary).

171. FERNANDO, D.M.

Report on consultancy in Hevea breeding and selection in Brazil (January 1980 to April 1980). Submitted to IICA/EMBRAPA, Brasilia, 1980.

Visits to rubber research centres, stock nurseries, multiplication nurseries and quarantine stations in Brazil are described. The possibility of selecting South American Leaf Blight resistant, vigorous, high yielding material from the acre area in Brazil is outlined. Observations are also made on the difficulty of controlling South American Leaf Blight unless a certain degree of resistance is already present in the tree. The resistance of polyploids of IAN 873 to SALB was also observed.

172. FERNANDO, D.M.

Review of the Plant Breeding section, [R.R.I.C. for 1960]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1960 (1961), pp. 37-46.

The Plant Breeding Section of the Botany Department carried out over 31,000 hand pollinations during the 1960 flowering season, which extended from February to April, an increase over the previous year's programme. Although the percentage of fruit set (5.5 per cent) showed an improvement over 1959 the losses of young fruit obtained by hand pollination continued to be high due to fungal attack, especially under the wet conditions obtaining on the Hedigalla Station, and by the end of June fruit loss was about 45 per cent of the total fruit set recorded in April. There is still considerable room for improvement of protective measures against fungal attack. A special nursery has been established to contain all the Dothidella-resistant FX and IAN clones introduced from the Western hemisphere, with 5 to 6 plants of each clone. Flower inducement experiments are in progress. Mature rubber trees of 1935 planting have been pollarded and the shoots produced have been budded with the imported Dothidella-resistant clones with the object of inducing

early flowering for breeding purposes. Nursery buddings, 2 to 3 years old, ring-barked a few inches above the union were induced to flower nine months after treatment. In all cases but one, fruiting was obtained on buddings of the Hevea benthamiana clone F 4542, a parent of all the Dothidella-resistant clones imported into Ceylon. An Oidium testing station established at 1,400 feet elevation on Kepitigalla Estate now contain 388 clones. Observation on Oidium tolerance will be made after the 1961 Oidium season. A Phytophthora testing station has been established on a Division of Peenkande Group in an area known to be very favourable to Phytophthora leaf fall. 152 clones are represented in this test. A Breeding Station has been established on Nakkala Estate, Moneragala. Ninety-five clones represented in this experiment, have been crown budded at 6 to 7 feet from the ground on to Tjir 1 seedlings of a 1956 replanting. The object of this breeding station is for breeding work to be carried out in May and June (as well as February and March in the South-West region) with little interference from rain and Phytophthora pod disease.

173. FERNANDO, D.M.

Review of the Plant Breeding Section [R.R.I.C. for 1961].

Rubb. Res. Inst. Ceylon. Ann. Rev., 1961 (1962), pp. 38-55.

The Plant Breeding Section of the Botany Department carried out 38,878 hand pollinations during the 1961 flowering season, a substantial increase over the previous year's programme, obtaining a fruit set of 1860 or 4.7 per cent pollination success. Individual clonal combinations ranged from complete failure to 22.1 per cent success. Disease control measures on flowers and fruit were more successful than in the previous year. An innovation was created by the introduction of imported Dothidella-resistant clones into the breeding programme with the aim of combining high yield and disease resistance. Eighty seven seedlings of various crosses were obtained. 579 legitimate (hand pollinated) seedlings of the 1956, 1957, 1958 and 1959 series of crosses were "cloned" at Karapincha nurseries and the clones were established as five-tree and ten-tree clones in a clone trial on Kuruwita Sub-Station during the South-West monsoon, along with 30 promising foreign clones and clone PB 86 as a control. 253 other clones were established in a further clone trial of 15 acres during the North-East monsoon planting season. Attempts have been made to induce early flowering for breeding purposes by budding imported clones on to shoots produced from pollarded mature rubber trees of a 1935 planting. To-date 92 clones have been successfully budded on to these trees. Nursery buddings of 7 Dothidella-resistant clones and 3 RRIC clones ring-barked in 1960

flowered according to plan, thus enabling these clones to be used in the 1961 breeding programme. The Oidium Testing Station, established in 1959 on Kepitigalla Group, was released from fungicidal control at the end of 1960. Screening for Oidium resistance of the 151 clones during the period under review showed that 15 per cent of the DR clones, 48 per cent of the clones made from LCB 870 crosses, 12 per cent of the clones made from RRIC 52 crosses and clone RRIC 52 itself possess varying degrees of resistance to the disease. Growth of the crown-budded clones at the Plant Breeding Station at Moneragala is progressing satisfactorily. 29 additional clones were added in late 1960 bringing the total to 106 clones. 211 new clones from the 1956-1960 crosses have been established in a neighbouring area along with 8 RRIC clones. Growth has been satisfactory at the Phytophthora Testing Station on Peenkande Group. 152 clones are represented in the test.

174. FERNANDO, D.M.

Review of the Plant Breeding Section, [R.R.I.C. for 1962].

Rubb. Res. Inst. Ceylon. Ann. Rev., 1962 (1963), pp. 42-56.

The Plant Breeding Section of the Botany Department carried out 60,571 hand-pollinations in 1962, which gave 1791 fruits, a 2.9 per cent success under difficult conditions of fruit preservation from Phytophthora and Gloeosporium infection. Clone RRIC 7, 10, 36, 45, 51, 52, 54, 62, 70 and Wagga 6278 and the foreign clones Ch 26, PB 86, PB 28/59 and Tjir 1, together with selected disease-resistant clones imported from Latin America, were used as female parents with a view of obtaining high-yielding, disease-resistant clones. Radiation studies in collaboration with the Radioisotope Centre in Colombo yielded favourable critical values for gamma radiation of germinating Hevea seeds. Methods for inducing early flowering were used extensively for hand-pollination work. Routine attention was given the crown-budded area on Moneragala Group and a new experimental area at Kumarawatta Group.

175. FERNANDO, D.M.

Review of the Plant Breeding Section, [R.R.I.C. for 1965].

Rubb. Res. Inst. Ceylon. Ann. Rev., 1965 (1966) pp. 33-43.

The first test tapping results from the Oidium and Phytophthora test areas at Keppitigala and Peenkande respectively have come to hand. Clone 451 (RRIC 52 and PB 86) was the highest yielder from among the Oidium-tolerant clones and clone 1461 (RRIC 52 and T 792) from among the Phytophthora-resistant clones.

Positive results of non-susceptibility to Gloeosporium leaf disease in the immature phase were obtained at Nakiadeniya Group. Of the large number of plants of the Oidium-tolerant clone 1108 (RRIC 52 and RRIC 7) that were planted in this experiment only one plant was infected, indicating a combination of Oidium and Gloeosporium-resistance. On the basis of early tapping tests and girth observations made towards the end of the previous year, the complete hand-pollination programme was shifted this year from Dartonfield Group to an outside estate where a selection of Dothidella resistant clones had been established in an experimental area in 1960. A satisfactory set of some important crosses was obtained. A difference in the flowering time of the IAN and local clones made it difficult to obtain the optimum number of pollinations in some crosses. Ineffective control of Gloeosporium and Phytophthora too contributed to the poor overall success of the pollination programme. Selections have been made on the basis of secondary characters, girth and Hamaker-Morris-Mann yield tests in the various plant breeding test clones. Those selected, will be further tested in small-scale trials.

176. FERNANDO, D.M.

Review of the Genetics and Plant Breeding Department,

[R.R.I.C. for 1966]. Rubb. Res. Inst. Ceylon. Ann. Rev.

1966 (1967), pp. 72-88.

A method for the rapid determination of the latex content of Hevea tissues as a possible means of assessing the potentialities of newly-bred varieties at an early stage in growth was evolved. Hand pollination programmes were carried out on a wider range of material than in previous years and with a reasonable degree of success. Twenty clones of hand-pollinated origin were selected for successful tapping at 4½ years of age at Kuruwita. These were especially bred for favourable secondary characters including vigour, to enable early exploitation. Girth measurements taken after one year's tapping at 67 per cent intensity confirmed that although the trees were brought into tapping at this early age, there was no appreciable set-back to growth. Most of these selected clones also showed high yields. Favourable yield indices in the Kalutara District were noted for clones previously found tolerant to Oidium at higher elevations in the Matale District.

177. FERNANDO, D.M.

Review of the Genetics and Plant Breeding Department,
[R.R.I.C. for 1967]. Rubb. Res. Inst. Ceylon. Ann. Rev.
1967 (1968), pp. 33-43.

The vigorous breeder's clones which were tapped initially at $4\frac{1}{2}$ years showed a sharp increase in yield in the 2nd year without adverse effects on their growth. Two of these clones, namely 663 (IRRIC 100) and 1174 (RRIC 101) were released for commercial planting in Group III. Two other early starter clones were also selected for further multiplication and large-scale trials. Several other trials of selections were under investigation. The evaluation of yield trends in clones possessing resistance to Oidium and Dothidella was also begun. Laboratory studies on cytogenetic investigations were initiated in 1967. Initial meiotic PMC studies of the early ever flowering clone H 440 suggest that the cytological behaviour of this clone is normal. A project was initiated to utilize the large seedling population of Egal-Oya nurseries in order to obtain genetical material for future cytological and breeding investigations. Routine examination of the latex content of Hevea petioles and estimation of the rubber seed oil content of the different clones were continued. Clone CH 26 was used over a very wide range of crosses of high-yielding, vigorous, and Oidium-resistant material in order to introduce even more vigour and yield. Over 18,000 hand pollinations were completed during the season and over 500 seedlings obtained. Over 100 seedlings were established of the cross Ch 26 x 815, and reciprocal and Ch 26 x 266. A few seedlings of parentage 1103 x Ch 26 and Ch 26 x 663 were also obtained.

178. FERNANDO, D.M.

Review of the Genetics and Plant Breeding Department,
[R.R.I.C. for 1968]. Rubb. Res. Inst. Ceylon. Ann. Rev.
1968 (1969), pp. 33-44.

The yields of RRIC 100 at Kuruwita Sub-Station have been remarkable, so much so that the Institute advocates tapping at lower intensities on large-scale planting, at least till the results of field experiments, now in progress, are available. The yields of RRIC 101 dropped when the intensity was increased

in 1968. More plants of RRIC 100 and 101 were established, in the Hedigalla nurseries, for distribution to estates. The Oidium-resistant clone 1103 showed favourable growth, yield and response to early tapping at both Nivitigalakele and Kuruwita. Populations of Tjir 1, which has been the principal source of seed for root-stocks, are decreasing rapidly, and the possibility of using seed from our recommended high-yielding clones is being investigated by the Institute. Plant Breeders have recognized the tendency for low seeding in vigorous high-yielding plants of all varieties. Low seeding can reduce the availability of seeds of certain clones in the future. Therefore, cytological studies on pollen production were undertaken to establish whether there were any abnormalities in some of our clones, which may lead to poor seeding. These studies have shown that there are meiotic abnormalities in three of our reputed low seed bearers viz. RRIC 41, 45 and 88, which may contribute to their poor seeding. Studies on the sex ratios of Hevea brasiliensis cultivars, have shown that there are obvious variations in the ratio of male and female flowers in inflorescences of 10 cultivars that have been studied so far. More extensive studies on this problem will be undertaken during the 1969 flowering season. Colchicine treatment of germinating seedlings of RRIC 52 gave a high frequency of polyploids. Swollen shoots, slow growth and abnormal foliage characteristics in the first set of leaves were common. However, beyond the first node growth was stabilized and the shoots appear to revert to the normal condition. This work is being continued. A survey of the seedling populations at Egal-Oya and Hedigalla nurseries was conducted in order to establish the frequency of natural mutations for chlorophyll abnormalities. The Hedigalla population and a fraction of the Egal-Oya population had an abnormally high frequency of chlorophyll deficient plants. This frequency should serve as a useful guide for differentiating poor seed sources, and this study is therefore being pursued.

179. FERNANDO, D.M.

Review of the Genetics and Plant Breeding Department,

[R.R.I.C. for 1969]. Rubb. Res. Inst. Ceylon. Ann. Rev.

1969 (1970), pp. 37-52.

The development of a clone that is high-yielding, disease-resistant and capable of growing under varied soil and climatic conditions is the goal of the Plant Breeder. It has been estimated that, with the available solar energy and photo-synthetic tissue, the potential yield of the rubber tree should be about 6,000 lb. per acre per annum. The results achieved in

Hevea breeding up-to-date, with about a seven-fold increase in yield from the original 3-400 lb. clonal seedlings, is quite impressive. The Institute is now studying various devices to induce mutations, so as to expedite the process of breeding high yielders. Studies initiated on the use of chemical mutagens such as ethyl methyl sulphonate have been continued and the toxicity levels of the latter determined. Statistically based seedling variability trials for six parent clones have been planted both at Kuruwita and Nivitigalakele. The hand pollination programme, which was directed towards the increase of yield and vigour and a study of heterosis, has yielded 416 seedlings, which have been established in nurseries. The yields of RRIC 100 and 101 have indicated that these clones are suitable for tapping at 67 per cent intensity during the first five years of tapping, when cuts are opened at 4½ years. The Oidium-resistant clone 1103 produced satisfactory foliage when planted above 1,000 ft. elevation; and gave very satisfactory yields at Kuruwita and Nivitigalakele. IAN 45-710, also an Oidium-resistant clone, has been found to be suitable for planting above 1,000 ft. elevation, producing good foliage and above average yields.

180. FERNANDO, D.M.

Review of the Genetics and Plant Breeding Department,
[R.R.I.C. for 1970]. Rubb. Res. Inst. Ceylon. Ann. Rev.
1970 (1971), pp. 26-42.

The oil content of cotyledons was examined and found to have high heritability, with an inverse relationship to growth and yield. This factor will therefore be used for early selection of clones. The analysis of a population of Tjir 1 seedlings revealed a strong correlation between germination period and growth characters such as height and diameter. This would facilitate selection of stocks on the basis of period of germination. RRIC 102 was evaluated as satisfactory for planting above 1000 ft. elevation. IAN 45-873 showed satisfactory yields in the Sabaragamuwa District, and is clearly tolerant to Oidium leaf disease. Seedlings from 30 clonal sources were examined individually for growth, latex yield and cotyledonary oil content. Selection was effected for initial nursery establishment and further study.

181. FERNANDO, D.M.

Review of the Genetics and Plant Breeding Department,
[R.R.I.C. for 1971]. Rubb. Res. Inst. Ceylon. Ann. Rev.
1971 (1972), pp. 34-50.

Large scale plots of RRIC 101 and RRIC 103 were brought into tapping at five years of age and showed very satisfactory yields and percentage of trees that could be tapped at a younger age than normal. A few seedlings were obtained with a combined source of SALB resistance. RRIC 102 yielded satisfactorily at Matale at an elevation of 1,400 ft. An inhibitor was isolated from rubber seed oil. A population of 3,000 seedlings from 31 different clonal sources was tested individually and 330 seedlings selected for further study.

182. FERNANDO, D.M.

Review of the Genetics and Plant Breeding Department.

[R.R.I.S.L. for 1972]. Rubb. Res. Inst. Sri Lanka. Ann.

1972 (1973), pp. 38-53.

More information was available on the large scale performance of RRIC 101, 102 and 105. A 169 tree plot of RRIC 101 at Kuruwita showed yields of over 1000 kg/ha = 1000 lb./ac.) in the first and second years of tapping when opened at five years. RRIC 102 and RRIC 103 were opened on a large scale on a commercial basis in an outside estate at four years and nine months, along with RRIM 623 as control; 700 kg/ha per year was recorded from RRIC 102; this was approximately equal to that obtained from earlier recordings for this clone in RRIC estates. The initial yields of RRIC 103 were lower on this estate but the growth was better than equivalent plots in the RRIC estates.

183. FERNANDO, D.M.

Review of the Genetics and Plant Breeding Department,

[R.R.I.S.L. for 1973]. Rubb. Res. Inst. Sri Lanka. Ann.Rev.

1973 (1974), pp. 25-42.

More experimental areas of the RRIC 100 series were opened on outside estates at five years of age. Yields above 700 (kg/ha/yr were recorded from large scale replicated plots of RRIC 100, 101, 102 and 103, compared to a yield of 600 kg/ha/yr from RRIC 45. Satisfactory growth and yield were also recorded from RRIC 103 at Moneragala and Matale. Preliminary results from the RRIM Unit at Trinidad indicated the possibility of South American Leaf Blight (SALB) resistance in some of the hybrids synthesized in Sri Lanka, some of which are in tapping here for three years.

184. FERNANDO, D.M.

Review of the Genetics and Plant Breeding Department,

[R.R.I.S.L. for 1976]. Rubb. Res. Inst. Sri Lanka. Ann. Rev.
1976 (1977), pp. 50-66.

The studies on 10 modern clones, to assess the effect of environment on genotype, have shown that there is a significant interaction between these two factors. Therefore, clones have to be selected on this basis for various districts, and this study is being pursued. The clone RRIC 110 was found to match RRIC 101 on the factor of early high yields. Clones, RRIC 100 and 102, showed later high yields and RRIC 103 was found to be resistant to drought and to develop a spreading canopy in areas such as Bibile and Moneragala. This makes it a suitable clone for planting on a large scale in these areas. One of the first small-holdings to plant clones of the RRIC 100 series was tapped and RRIC 103 was found to yield over 800 kg/hectare dry rubber in the first year of tapping.

185. FERNANDO, D.M.

Review of the Genetics and Plant Breeding Department,

[R.R.I.S.L. for 1977]. Rubb. Res. Inst. Sri Lanka. Ann. Rev.
1977 (1978), pp. 50-65.

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

186. FERNANDO, D.M.

Review of the Genetics and Plant Breeding Department,

[R.R.I.S.L. for 1978]. Rubb. Res. Inst. Sri Lanka. Ann. Rev.
1978 (1979), pp. 45-53.

The RRIC 100 series clones, particularly RRIC 100 and RRIC 103, were planted on a larger scale, especially on Estates. Individual plant preferences were also noted for RRIC 101 in view of its very high initial yields. Fifteen clones including RRIC 120, RRIC 123, RRIC 130 and RRIC 131 were sent to the RRIM Station at Trinidad for testing for resistance to South American Leaf Blight. A 4 x 4 Diallel Crossing Programme with RRIC 100, 101, 102 and 103 was successfully completed under the supervision of the Geneticist. Selections were made on the basis of yield and vigour from previous hand pollinated progeny. Two International Clone Trials were planted at Neboda and Hanwella. Yield and growth of clones such as RRIC 103, RRIC 118, RRIC 100 in the Bibile and Matale Districts indicate that the new clones could be profitably grown in the drier districts; the drought resistance characteristic of Hevea was an added advantage.

187. FERNANDO, D.M.

Review of the Plant Breeding Department, [R.R.I.S.L. for 1979].

Rubb. Res. Inst. Sri Lanka. Ann. Rev. 1979 (1980), pp. 40-53.

The main discovery for the year was the South American Leaf Blight (SALB) resistance of 3 clones viz. RRIC 121, RRIC 130 and 72-133. The yields of both RRIC 121 and RRIC 130 are satisfactory and the growth of RRIC 121 is above average. RRIC 103 and RRIC 118 showed satisfactory yields in the Matale District. RRIC 104 also showed suitability for larger scale planting in the Kalutara and Moneragala Districts. Budwood multiplied in 1978 was distributed in quantity in 1979 and requests towards the end of 1979 could not be met.

188. FERNANDO, D.M.

The selection of stocks in Hevea. International Symposium on Seed Processing. Bergen, Norway, 1973. International Union of Forest Research Organizations, Working Party S2 : 01.06.

Vol. 2, paper no. 9, 4 p.; Reprinted in Q. Jl. Rubb. Res. Inst.

Sri Lanka (Ceylon). 51 (1/2) 1974 : 28-39, 1 graph, 4 refs.

With the development of high yielding scions in Hevea the selection of improved stocks to support the higher yields has assumed importance. Seedlings of the cultivar Tjir I have proved to be the only suitable stock so far : the fluctuation of oil content of the cotyledons within a clonal seedling population has clarified the detection of other sources of seedling stocks. (Author's summary).

189. FERNANDO, D.M.

Some aspects of Hevea breeding and selection. Jl. Rubb. Res. Inst. Sri Lanka. 54, pt. 1 (1) 1977 : 17-32, 7 illus., 5 graphs, 1 table, 12 refs.

The performance of some cultivars of the RRIC 100 series is outlined with reference to yields, vigour, disease resistance, and agroclimatic suitability. Preliminary results on Hevea scions after exposure to gamma rays and neutrons are described. The possibility of utilizing mutation breeding methodology in improving South American Leaf Blight resistance of Hevea is mentioned. (Author's summary).

190. FERNANDO, D.M.

Trends in the improvement of rubber planting material with particular reference to Sri Lanka. Q. Jl. Rubb. Res. Inst. Sri Lanka. 50 (1/2) 1973 : 84-90, 1 graph, 2 tables, 6 refs.

The early Hevea selection and breeding programmes in Sri Lanka are described. The improvements achieved at the different stages are outlined. Selection is currently moving towards better secondary characters such as disease and wind resistance, and vigour. The possibility of selecting suitable seedlings of Hevea by utilizing the parameter of oil content, and thereby shortening the selection cycle of Hevea by nearly twenty years is discussed. (Author's summary).

191. FERNANDO, D.M.

The yields and secondary characters of clone RRIC 102. Q. Jl. Rubb. Res. Inst. Ceylon. 48 (1/2) 1971 : 56-65, 1 illus. (photo.), 4 fold. graphs, 6 refs.

The background of plant breeding in the Rubber Research Institute of Ceylon is briefly outlined. The selection of RRIC 102 for planting in successively larger replicated plots on the basis of early indices of yield, and resistance to Oidium leaf disease is discussed. The early information obtained thereby on the yields of this clone, and its success in Oidium-affected areas, is presented; its possible use in extending the limits of rubber replanting to areas above 1,000 ft. elevation is discussed. (Author's summary).

192. FERNANDO, D.M. and DE SILVA, M.S.C.

A new basis for the selection of Hevea seedlings.

Q. Jl. Rubb. Res. Inst. Ceylon. 48 (1/2) 1971 : 19-30,

5 illus. (2 fold. diagrms.), 3 tables, 9 refs.

Clonal seedlings from seven clones were germinated and periodically measured in height and diameter. The oil content of some seedlings was estimated by removing the cotyledons. The latex content was measured by a method of micro-tapping. A positive correlation was detected between latex content and growth. An inverse relationship was found between oil content and growth in some clones. Indications of an inverse correlation between latex and oil content were also detected. This assay of oil content therefore appears vital in the selection of seedlings and provides a link which considerably expands the possibilities of early selection of Hevea seedlings for growth and yield. (Author's summary).

193. FERNANDO, D.M. and LIYANAGE, A. de S.

Hevea breeding for leaf and panel disease resistance in Sri Lanka. In: Proceedings of the International Rubber Conference, Kuala Lumpur, 20-25 Oct. 1975. Kuala Lumpur, Rubber Research Institute of Malaysia, 1976. Vol. 3, pp. 236-246, fig., graph, 3 tables, 31 refs.

Hevea breeding in Sri Lanka for resistance to Oidium leaf is described and some resistance mechanisms that could be operative are discussed. The pedigree and yields of recent selections found resistant to Phytophthora panel disease and Colletotrichum leaf fall are also described. Preliminary studies on breeding and selection against South American Leaf Blight are reported. (Authors' summary).

194. JAYASEKERA, N.E.M.

Review of the Genetics and Plant Breeding Department,
[R.R.I.S.L. for 1975]. Rubb. Res. Inst. Sri Lanka. Ann. Rev.
1975 (1976), pp. 37-48.

Clones of the RRIC 100 series continued to give high yields in 1975. Seed samples were sent to Long Ashton Research Station, U.K. for irradiation. Irradiated pollen has been used in the hand pollination (HP) programme to induce mutants, RRIC 100 and 82 were self pollinated during the 1975 flowering season. An experiment was established in eight areas to study the environmental stability of ten clones. A tapping experiment was initiated at Sirikandura Estate to study the extent of variation between tappers and its influence on clone evaluation. The number of successful HP seed was low due to Oidium disease on flowers.

195. JAYASEKERA, N.E.M.; SAMARANAYAKE, P. and KARUNASEKARA, K.B.

Initial studies on the nature of genotype-environment interactions in some Hevea cultivars. Jl. Rubb. Res. Inst. Sri Lanka. 54, pt. 1, no. 1, 1977 : 33-42, 3 graphs, 6 tables, 5 refs.

Ten Hevea clones were grown in eight locations to study the nature of genotype-environment interactions. In this paper two early height measurements and the survival rate have been considered. The analysis of variance indicated the presence of significant genetic, environmental and genotype-environment interaction components of variation. Regression analysis has been used to study the nature of genotype-environment interactions. The clones which had significant linear interaction components have been grouped into three stability groups. Importance of this both in Hevea breeding and in recommending clones for commercial planting is discussed. (Authors' summary).

196. SAMARANAYAKE, Chandra

Selection of rootstocks. R.R.I.S.L. Bulletin (N.S.). 10, 1975 : 35.

A note. From the results of the experiments, the seedlings of clones RRIC 45, PB 86, RRIC 36, G 11 and RRIC 52 may be recommended for use as rootstocks in place of seedlings of clone Tjir I.

197. SAMARANAYAKE, P.; RUPATUNGA, K.W.; FERNANDO, D.M. and JAYASEKERA, N.E.M.

In vitro germination of pollen and pollen tube growth of Hevea brasiliensis in the presence of calcium and boron. Jl. Rubb. Res. Inst. Sri Lanka. 56, 1979 : 29-33, 2 tables, 14 refs.

The role of calcium and boron in Hevea pollen germination and pollen tube growth was investigated. Individual significant effects of both elements on germination of pollen grains were noted upto a maximum concentration of 0.03 per cent. When used in combination, boron appears to be more important than calcium in pollen germination. On the other hand, calcium has a clear positive effect on growth of pollen tubes in the presence of boron. (Authors' summary).

198. SATCHUTHANANTHAVALA, R.

Tissue culture technique in Hevea breeding. R.R.I.S.L.
Bulletin (N.S.). (Conference supplement). 8 (3/4) 1973 :
46-47.

This article is particularly intended for the laymen, to give an idea on the tissue culture technique in Hevea breeding.

199. SENANAYAKE, Y.D.A. and WIJEWANTHA, Ronald T.

Synthesis of Hevea cultivars : a new approach. Q. Jl. Rubb.
Res. Inst. Ceylon. 44 (1/2) 1968 : 16-26, 1 fold., chart,
1 table, 17 refs.

The stages of directed evolution of Hevea cultivars, from the time of hand pollination until they are recommended for large scale commercial plantings are described. The basis of selection is discussed in relation to the duration of different breeding pathways. A pathway of accelerated selection is outlined. The need to expand genetical investigations along different lines, to yield information which could help to develop cost competitive cultivars of the future is also stressed. (Authors' summary).

200. WIJEWANTHA, Ronald T.

Some breeding problems in Hevea brasiliensis. Q. Jl. Rubb.
Res. Inst. Ceylon. 41 (1/2) 1965 : 12-22, 2 plates (col.),
2 graphs, 4 tables, 10 refs.

Breeding work in Ceylon which was commenced about 4 decades ago, has led to an approximate six fold increase in the yield of rubber. Further increases are anticipated with the exploitation of heterotic vigour, prepotency and natural

variability in Hevea. For this latter purpose the importation of fresh materials of Hevea from tropical America is urged. Disease resistance breeding in Ceylon has brought to light the probable absence of major genes for resistance against Oidium in tested Eastern clones and in the 116 Dothidella-resistant clones imported in recent years. Here again, a plea is made for the importation of further breeding material with a broader genetic base. The picture in respect of Phytophthora resistance breeding is rosier, as several of the imported Dothidella-resistant clones are at the same time also resistant to Phytophthora. Back-crossing and out-crossing to high-yielding Eastern clones are expected to result in the evolution of acceptable clones with high yields and Phytophthora-cum-Dothidella resistance. Controlled induction of epiphytotics and the incorporation of an early flowering Hevea mutant gene, are expected to accelerate our breeding programmes, which nevertheless must of necessity be long-term ones. (Author's summary).

Planting Recommendation

201. ANON

Recommended planting material - 1966. R.R.I.C. Bulletin (N.S.)

1 (1) 1966 : 5-7.

The R.R.I.C. planting material list for 1966 shows a drastic change from recommendations made in previous years. In preparing this list, account is taken not only of results from trials conducted by the Institute but also of information obtained from commercial estates as well as Research Institutes elsewhere.

202. ANON

Recommended planting material - 1969. R.R.I.C. Bulletin (N.S.)

3 (4) 1968 : 144-150.

Brief notes on clones suitable for large scale planting, for estates up to 20 acres, up to 10 acres, and for small-scale experimental planting, with tabulated data on yields.

203. CHANDRASEKERA, L.B.

Developments in Hevea planting material in Ceylon.

Q. Jl. Rubb. Res. Inst. Ceylon. 48 (1/2) 1971 : 7-18,
12 illus. (col. photos.), 2 tables, 5 refs.

Descriptions of 8 local and 5 foreign clones selected for planting in Sri Lanka. Local : RRIC 45, 36, 89, 13 and 50, 48, 100, 101. Foreign : AVROS 1734, IRCI 2, 7 and 9, PR 252.

204. CHANDRASEKERA, L.B.

Hevea clones recommended for planting in Sri Lanka.

R.R.I.S.L. Bulletin (N.S.). 9 (1/2) 1974 : 1-4.

One of the major objectives of natural rubber producer is to increase yields by replanting old rubber areas with improved clonal varieties. In this article the merits and demerits of different Hevea clones have been discussed. It is recommended that clone PB 86, as it has done well consistently under all planting conditions in Sri Lanka, be planted over a major extent of all replanted areas, and other clones recommended by the RRI be planted over small extents as they are not yet fully proven. The adoption of correct cultural practices, as suggested by the RRI, and early tapping at reduced intensities would lead to the reduction of the immature unproductive, period of the rubber tree and thus increase the "profitability of rubber".

205. CHANDRASEKERA, L.B.

Performance of clones. R.R.I.C. Bulletin (N.S.). 3 (1/2)

1968 : 17-19, 4 tables.

Performance data of the rubber clones RRIC 52, GT 1, RRIC 36 and RRIM 623, grown in a number of small-scale plantings in Ceylon, are presented. In all areas, the yields of RRIC 36 have been outstanding, but owing to its susceptibility to bark rot, the clone is not recommended in the wet zone districts. RRIC 52 and RRIM 623 also give satisfactory yields; their susceptibility to wind damage is a disadvantage. As regards RRIC 52, however, no wind damage has so far been recorded from the 4th year onwards. The clone GT 1 is reported to be wind-resistant. (Tropical abstract. 24 (5) 1969, No. 1100).

206. CHANDRASEKERA, L.B.

Recommended clones and some factors that effect their performance in Ceylon. Q. Jl. Rubb. Res. Inst. Ceylon.

41 (1/2) 1965 : 55-62, 3 tables.

This paper discusses briefly some of the conditions that influence (rainfall, diseases and planting density) rubber production in Ceylon and the performance of clones that are recommended for commercial planting. For commercial planting, clones are classified into 3 groups, depending on the degree to which they have been tested for yield, degree of resistance to diseases and other secondary characters. The group recommended for large-scale planting comprises clones RRIC 45, 52, Wagga 6278, Glen 1, RRIM 513, Mil 3/2, FR 107, and PB 86. The yields obtained from these and other clones in large-scale and experimental plantings are listed and tabulated in detail. PB 86 had so far been the most popular clone, but owing to its susceptibility to Bark Rot, it is not recommended for planting in the wet districts.

207. CHANDRASEKERA, L.B.

Recommended planting material - 1972. R.R.I.C. Bulletin

(N.S.). 7 (1/2) 1972 : 39-47.

Brief notes on clones suitable for larger scale planting, for estates up to 20 acres, up to 10 acres, and for small-scale experimental planting, with tabulated data on yields.

208. CHANDRASEKERA, L.B.

Recommended planting material - 1973. R.R.I.C. Bulletin

(N.S.). 7 (3/4) 1972 : 85-93.

Brief notes on clones suitable for large-scale planting, for estates up to 20 acres, up to 10 acres, and for small-scale experimental planting, with tabulated data on yields.

209. DE SILVA, C.A.

The performance of "exchange" clones imported into Ceylon.

Q. Jl. Rubb. Res. Inst. Ceylon. 36 (1/2) 1960 : 1-16,

12 tables.

The performance of a selection of the 80 foreign clones imported into Ceylon in 1954 on an "exchange" basis is described and the yield and growth data from their countries of origin are summarized and discussed, with a view to popularise these clones in Ceylon. Recommendations are made for the early trial on a limited scale of a selection of these foreign clones under local conditions. A preliminary tentative selection of foreign clones, based on the performance of these clones in their countries of origin would be as follows: (1) From Malaya : Clones RRIM 605, 607, 610 and 623. (2) From Sumatra : Clones AVROS 385, 427, 529, 1328, 1734, 1851 and 2037. (3) From Java : Clones WR 101, GT 1, PR 226, 228, 231, 248, 250 and 261. From Indo-China : Clones IRCI 2, 3, 6, 7 and 9; TR 1486, 1548, 3645, 3072 and 3705.

210. DE SILVA, C.A.

The performance of RRIC clones under Ceylon conditions.

In: Proceedings of the Natural Rubber Research Conference, Kuala Lumpur, 1960. Kuala Lumpur (Malaysia), Rubber Research Institute of Malaya, 1961. pp. 378-391, 5 photos., 1 graph, 9 tables, 6 refs.; Reprinted in Q. Jl. Rubb. Res. Inst. Ceylon. 37 (1) 1961 : 1-12.

The earliest attempts to establish clonal rubber by budgrafting in Ceylon are briefly described with reference to the study of the inter-relationship of yield and growth factors for the selection of seedling mother trees as clone parents. The clones established from unselected, near-legitimate and legitimate seedlings are described and yield data and secondary characters of the selected clones are presented. The range of elevation and climatic conditions of rubber growing land, which favour the diseases caused by Oidium heveae and Phytophthora palmivora, are presented. As the cost of treatment of these diseases is an appreciable factor in the economics rubber production the question of making reliable recommendations to the rubber industry in Ceylon, during a transitional period of evaluation of selected clones, is briefly discussed. (Author's summary).

211. DE SILVA, C.A. and SATCHUTHANANTHAVALA, R.

History and description of promising RRIC clones. Q. Jl. Rubb. Res. Inst. Ceylon. 37 (4) 1961 : 112-128, 7 photos., 20 diagrams., 2 graphs, 2 tables.

This article provides a description of the vegetative characters of the clone RRIC 52, which are recommended for planting on a limited scale on commercial estates. Descriptive diagrams are given to illustrate the vegetative characters used in the description of this clone. Budwood of this clone will be multiplied in registered nurseries in order to meet the demand for planting material of this selected new clone. A brief description of this clone with the available growth and yield data will be given in this article.

212. DE SILVA, C.A. and SATCHUTHANANTHAVALA, R.

History and description of promising RRIC clones.

II - Clones RRIC 7, 41 and 45. Q. Jl. Rubb. Res. Inst. Ceylon.

38 (1/2) 1962 : 1-10, 4 plates (10 photos.), 3 diagrams,

4 graphs, 4 tables.

Item No. 211 is an article under the same title, which initiated the description of promising RRIC clones. This article is a continuation in the series and describes three more promising clones RRIC 7, 41 and 45, under the following headings : general description, identification characters such as stem, leaf storey, leaf stalk, leaflets and other characters. Yields per tree per year are tabled.

213. DE SILVA, C.A. and SATCHUTHANANTHAVALA, R.

History and description of promising RRIC clones.

III - Clones RRIC 86, 88 and 89. Q. Jl. Rubb. Res. Inst.

Ceylon. 38 (3/4) 1962 : 47-56, 3 plates (9 photos.), 3 diagrams.

4 graphs, 4 tables.

Item Nos. 211 and 212 are articles under the same title, which presented the description of promising RRIC clones. This article is a continuation in the series and describes three more promising clones RRIC 86, 88 and 89, under the following headings : general description, identification characters such as stem, leaf storey, leaf stalk, leaflets and other characters. Yields per tree per year are tabulated.

214. DE SILVA, C.A. and SATCHUTHANANTHAVALI, R.

History and description of promising R.R.I.C. Clones.

IV - Clones Nab 15 and RRIC 87. Q. Jl. Rubb. Res. Inst.

Ceylon. 39 (1/2) 1963 : 1-8, 2 plates (6 photos.), 2 illus.,
4 graphs, 4 tables.

Item Nos. 211, 212 and 213 are articles under the same title, which presented the description of promising RRIC clones. This article is a continuation in the series and describes two more promising clones Nab 15 and RRIC 87, under the following headings : general description, identification characters such as stem leaf storey, leaf stalk, leaflets and other characters. Yields per tree per year are tabulated. Clone Nab 15 has given better yields and is recommended for commercial planting on a moderate scale. Both clones Nab 15 and RRIC 87 have good growth and secondary characters.

215. FERNANDO, D.M.

Recent developments in rubber planting material. R.R.I.S.L.

Bulletin (N.S.). 12 (1) 1977 : 33-40, 4 charts, graph,

3 refs.; abstracted in Proc. Sri Lanka Ass. Advmt. Sci., 33 (1)
1977 : 27.

Details of the improved yields of rubber from the RRIC 100 series clones are given. The increased vigour enabling these clones to be opened earlier is described. Recent information on the possible origin of RRIC 52, which is one of the best parents for yield, vigour, and disease resistance, indicates a non-Wickham origin from a totally different region of Brazil : this may explain extensions of the genetic base leading to the expression of increased resistance to disease, more vigour and better yields. The utilization of improved material has usually been efficiently carried out by the managers of the larger holdings : this has been interrupted during the process of recent land reform. The formation of a new department for development may be necessary to maximise research benefits. The advisability of planting a number of clones instead of a single clone over a wide area is discussed. (Author's summary).

Vegetative Propagation

216. SAMARANAYAKE, Chandra

The use of polythene film in budgrafting Hevea seedlings.

R.R.I.S.L. Bulletin (N.S.). 8 (1) 1973 : 1-8, 5 plates.

From an economic viewpoint, the replacement of the commonly used adhesive tape by a stripe of polythene film in the budgrafting process is desirable. Materials and methods of the process is outlined here. The data are not comprehensive as would have liked them to be; the subject has to be studied further with a view to determining the performance of polythene film in wet weather.

217. SAMARANAYAKE, Chandra

Preparation and planting of stumped buddings. R.R.I.S.L.

Bulletin. 14, 1979 : 29-33, 4 photos.

A well illustrated note on the method of preparation, planting and aftercare of stumped buddings.

218. SAMARANAYAKE, Chandra

Propagation of Hevea. R.R.I.S.L. Bulletin (N.S.).

(Conference Supplement). 8 (3/4) 1973 : 11-12.

This article intended particularly for the laymen to give an idea on the propagation of Hevea.

219. SAMARANAYAKE, Chandra and GUNARATNE, R.B.

The use of 'leaf buds' and 'scale buds' in the vegetative propagation of Hevea. Jl. Rubb. Res. Inst. Sri Lanka. 54, part 1, no. 1, 1977 : 65-69, 1 graph, 3 tables, 12 refs.

Experiments were carried out to see whether the use of 'leaf buds' and 'scale buds' contributed to the intra-clonal variation which exists among budgrafts. Differences were observed in the time of emergence and in the early growth of the scions arising from them. The anatomical differences were compared and the levels of endogenous growth regulators of the two types of buds were studied. (Authors' summary).

220. YAHAMPATH, Chandra

Growth rate of FB 86 on different Hevea rootstocks.

(A research note). Q. Jl. Rubb. Res. Inst. Ceylon. 44 (1/2)

1968 : 27-30, 1 fold. graph, 2 refs.

The standard type of rootstock used for budgrafting different clones of Hevea brasiliensis is selfed Tjir I seedlings. Owing to an anticipated shortage of Tjir I seeds in the future, experiments are being conducted to investigate the suitability of other clones for use as rootstocks. A small-scale experiment where seedlings of 6 different clones of H. brasiliensis and seedlings of H. spruceana were used as rootstocks is discussed here.

Planting Techniques and Management

221. CHANDRASEKERA, L.B.

Sale of budwood. R.R.I.C. Bulletin (N.S.). 7 (1/2)

1972 : 29-30.

The author describes the Institute's (R.R.I.C.) scheme for the sale of budwood.

222. DE SILVA, C.A.

Pruning and pollarding of rubber trees. Q. Jl. Rubb. Res.

Inst. Ceylon. 38 (1/2) 1962 : 23-24.

223. JEEVARATNAM, A.J.

Improved system of planting rubber on the contour. R.R.I.C.

Bulletin (N.S.). 2 (1/2) 1967 : 2-7.

In planting rubber, some of the more common systems in vogue are rectangular, square, avenue and hedge planting. The popular practice of semi-contour planting is in keeping with the principles of soil conservation but this system does not allow every single tree to be provided with an equal growing area. With a view to minimising this draw-back, an improved system of planting rubber on the strict contour is suggested in this article.

224. LIYANAGE, A. de S. and FERNANDO, D.M.

Nursery methods for screening leaf and panel disease resistance in Hevea. In: International Rubber Research and Development Board Symposium, Kuala Lumpur, 15-18 May 1978; organised by

Rubber Research Institute of Malaya, Text of Papers.

[London], I.R.R.D.B., 1978. 6 p., fig., graph, 8 refs.;

(Preprint).

A number of Sri Lankan and foreign cultivars have been screened for resistance at nursery level to Oidium, Colletotrichum and Phytophthora diseases of Hevea. Some of these observations are confirmed by earlier field studies. The inheritance of resistance in some cultivars is discussed. The necessity for intensified work on clones originating from South American Leaf Blight (SALB) resistant parents is emphasised. (Authors' summary).

225. RUBBER RESEARCH INSTITUTE OF CEYLON. Advisory Circular No. 79.

Sale of budwood. Agalawatta, R.R.I.C. 3 p., 6 refs.

Describes Institute's (R.R.I.C.) scheme for the sale of budwood. This Circular supercedes R.R.I.C. Advisory Circular No. 74.

226. YAHAMPATH, A.C.I.

A comparison of nursery techniques. Q. Jl. Rubb. Res. Inst. Ceylon. 45 (3/4) 1969 : 57-62, 3 illus. (photos.), 1 graph, 2 tables, 4 refs.

The purpose of this investigation is to assess the suitability of different budgrafting techniques for planting conditions prevailing in Ceylon. Both green and brown buddings raised in polythene bags and brown buddings planted with bare roots were successful, with 100 per cent survival. Green buddings planted with bare roots were 88 per cent successful. The growth rate of buddings raised in polythene bags was better than the other treatments.

Plant Physiology

227. FERNANDO, D.M.; THAMBIAH, M.S.; ABEYWARDENA, V. and SAMARANAYAKE, P.

A study of the heritability of oil content in cotyledons of Hevea seedlings. Q. Jl. Rubb. Res. Inst. Ceylon. 47 (3/4) 1971 : 70-72, 1 table, 6 refs.

Appreciable heritability was discovered in the oil content of Hevea cotyledons. This oil content was also found to be significantly inversely correlated with height of the seedlings. The inverse relationship with growth suggested a hormonal mechanism and chromatographic analysis revealed an inhibitor as well as a stimulator in the oil. (Authors' summary).

228. FERNANDO, D.M. and WIJESINGHE, W.A.C.

Some features of the growth and yields of RRIC 100. Q. Jl. Rubb. Res. Inst. Ceylon. 46 (3/4) 1970 : 78-87, 2 photos., 4 graphs, 3 tables, 3 refs.; Abstracted in Proc. Ceylon Ass. Advmt. Sci. 25 (1) 1969 : 47.

The increases in yield obtained in natural rubber are reviewed. The significant increases in growth and yield obtained from RRIC 100, in comparison with PB 86, are analysed. Other favourable secondary characters such as partial wintering and satisfactory branching are described and the possible impact of this clone on the industry is described. (Authors' summary).

229. JAYASEKERA, N.E.M. and SENANAYAKE, Y.D.A.

A study of growth parameters in a population of nursery rootstock seedlings of Hevea brasiliensis, Tjir I. Part 1, Q. Jl. Rubb. Res. Inst. Ceylon. 48 (1/2) 1971 : 66-81, 5 graphs, 8 tables, 16 refs.

Growth measurements of a few characters were made on a population of seedlings of Hevea brasiliensis, cv. Tjir I in a rootstocks nursery. Preliminary data are presented on the rate of germination, height and diameter of seedlings and the

leaf area. Comparisons of the different growth parameters suggest that early germinators continued to maintain their superior vigour over the late germinators even 5 months after transplanting. The study also reveals that the diameter of rootstock seedlings can be used as a convenient parameter to separate vigorous and non-vigorous rootstock seedlings for future studies on the budded plants grown in the field. (Authors' summary).

230. SATCHUTHANANTHAVALA, R.

Hevea tissue culture. Q. Jl. Rubb. Res. Inst. Sri Lanka.
(Ceylon). 50 (1/2) 1973 : 91-97, 4 plates, 15 refs.

Reports are reviewed of callus induction from stem sections of young seedlings, root differentiation from callus obtained from plumule sections, and root and plantlet formation from cotyledons. A more detailed account is given of experiments on the continuous sub-culturing of callus tissue established from anthers. (From Horticultural Abstract. 45 (9) 1975 : abs. no. 6964).

231. SATCHUTHANANTHAVALA, R.

Hormonal control of organ formation in explants of Hevea stem sections. In: Scientific Symposium, Part 1, Cochin, India, 26-28 September 1974, Text of Papers. London, International Rubber Research and Development Board, 1975. Vol. I, Session A (II). 4 p., 8 refs.

Stem tissue subtending a flush in the copper brown stage of 6-9 months old rubber seedlings was used in rubber tissue culturing. Addition of 0.001 to 5 ppm kinetin (K) to the basic medium (BM) induced callus formation within one week at the surfaces. Callus development was slow and ceased after 6 weeks. 0.001-1 ppm K stimulated axillary bud development slightly. IAA or NAA caused little callus formation at 0.001-1 ppm. NAA 1-10 ppm '0.001 ppm K promoted root differentiation. NAA 0.01 ppm' K 0.01 - 2.5 ppm induced axillary bud development but stopped after 6 weeks. The failure in development after 6 weeks may be due to the possible presence of some unidentified endogenous cytokinins in the meristematic tissues.

232. SATCHUTHANANTHAVALI, R. and IRUGALBANDARA, Z.E.

Propagation of callus from Hevea anthers. Q. Jl. Rubb.

Res. Inst. Ceylon. 49 (3/4) 1972 : 65-68, 2 plate photos.,
table, 8 refs.

This paper describes the first successful in vitro culture of anthers of Hevea brasiliensis (Wild. ex. Adr. de Juss). Mull - Arg Anthers of H. brasiliensis, cv. RRIC 52 and KH 440, were excised at a stage when pollen grains were individualized and cultured successfully on a simple agar medium, containing modified Nitsch's medium with auxins, 2, 4-D and kinetin or coconut milk. Callus formation from tissues of the anther and pollen grains was observed after four to five weeks. Callus thus obtained has continued to maintain good growth on the same medium, through six sub-cultures over a period of six months. When auxin and kinetin were absent from the medium, the anthers and pollen grains became dark brown in colour and died off. The possibility is thus indicated for the development of haploid Hevea plants from callus tissue derived from pollen grains. (Authors' summary).

233. SENANAYAKE, Y.D.A.

Cytogenetics of Hevea, 1. a leaf squash technique from chromosome counts and its importance in Hevea breeding.

Ql. Jl. Rubb. Res. Inst. Ceylon. 44 (1/2) 1968 : 1-7,

3 plates, table, 15 refs.

A leaf squash technique is described which could be used to screen large nursery populations of Hevea seedlings cytologically. The advantages of the techniques are described and its importance for identifying euploids and aneuploids of Hevea species which could be valuable in cytogenetic and breeding investigations is discussed. (Author's summary).

234. SENANAYAKE, Y.D.A.

The growth of nursery rootstocks seedlings of plantation rubber Hevea brasiliensis. Muell. Arg. (Agricultural Research Seminar Series, paper no. 75-1). Peradeniya, University of Sri Lanka, Faculty of Agriculture, 1975. 14 p., 7 graphs, 4 tables, 14 refs.

The results of this paper were previously published in Q. Jl. Rubb. Res. Inst. Sri Lanka (Ceylon) and J. Nat. Sci. Coun. Sri Lanka. See items 229, 237 and 238.

235. SENANAYAKE, Y.D.A.

The natural chlorophyll mutation frequency and the occurrence of yellows in nursery seedling populations of Hevea brasiliensis. Muell. Arg. in Ceylon. Q. Jl. Rubb. Res. Inst. Ceylon. 45 (1/2) 1969 : 14-21, 6 illus. (photos.), 2 tables, 9 refs.

The natural chlorophyll mutation frequency of H. brasiliensis cv Tjir I seedlings in two rootstock populations in Ceylon is compared with the high frequency of 'yellows' observed in nursery seedlings of mixed origin. Lethal chlorophyll deficient mutants ranged from 5-7 per acre (0.405 hectare). Viable variegated seedlings ranged from 0-6 per acre. In contrast the frequency of 'yellows' in two mixed seedling populations were 100 and 658 per acre. The lethal chlorophyll mutants may be recessive homozygotes whereas the viable 'yellows' may be heterozygotes of different genetic constitution. Possible economic consequences of such seedlings are identified and the need to recognise the cause of yellowing is recommended so as to eliminate them from nurseries in future years. (Author's summary).

236. SENANAYAKE, Y.D.A.

Species specific abaxial foliar characteristics of Hevea benthamiana Muell. Arg. H. brasiliensis Muell. Arg. and H. spruceana (Benth.) Muell. Arg. and their expression in interspecific hybrids. Q. Jl. Rubb. Res. Inst. Ceylon. 45 (1/2) 1969 : 22-31, 11 illus. (photos.), 2 tables, 6 refs.

Abaxial foliar characteristics such as the outline of epidermal walls, appearance of epidermal cells, stomatal guard cells and veinlets and the presence of epidermal hairs were used to distinguish H. benthamiana, H. brasiliensis and H. spruceana. The transmission of dominant species specific characters to interspecific hybrids suggest that the characters may be useful for recognising hybrids early and also for identifying the parents in artificial and natural hybridizations.

Stomatal densities per unit area differed in the experimental plants. H. benthamiana (F 4542) and H. spruceana had 33.1 and 36.0 stomata respectively. Two H. brasiliensis cultivars RRIC 51 and PB 86 had densities of 25.8 and 37.4 respectively. The interspecific hybrids and stomatal densities intermediate to the parents. (Author's summary).

237. SENANAYAKE, Y.D.A.; JAYASEKERA, N.E.M. and SAMARANAYAKE, P.

Growth of nursery rootstock seedlings of Hevea brasiliensis

Muell. Arg. cv. Tjir I. Part two. Q. Jl. Rubb. Res. Inst.

Sri Lanka. 52, 1975 : 29-37, 5 graphs., 2 tables, 3 refs.

A study was initiated to examine the nature of variation in growth of an illegitimate population of nursery seedlings of rubber (Hevea brasiliensis Muell. Arg.) upto the time of removal from the nursery at 18 months. The stem diameter was used as the growth parameter. The seedlings which germinated early (12 to 22 days) always had a greater diameter at all stages of growth than those which germinated later (24 to 34 days). The diameter of the seedlings at the first measurement was correlated with the diameters at the later stages. The rate of growth of early germinators was higher than the late germinators. There was a high negative and significant correlation between the germination period and the rate of growth. The rates of growth during different intervals were high, low or intermediate and were associated with the rainfall pattern. The ability of the early germination to maintain their superiority in growth could be genetical. The results show that 30 - 35 per cent of seedlings could be culled in the germination bed itself so that only the more vigorous seedlings would be transferred to the rootstock nursery. (Authors' summary).

238. SENANAYAKE, Y.D.A. and SAMARANAYAKE, P.

Growth of nursery rootstock seedlings of Hevea brasiliensis

Muell. Arg. cv. Tjir I. Part III. Journal of the National Council

Science/ of Sri Lanka. 2 (2) 1974 : 157-160, 2 tables, 4 refs.

A trial was conducted to determine the nature of growth of seedlings of rubber (Hevea brasiliensis cv. Tjir I) a cultivar which has been widely used as a rootstock. At 32 months, a sample of seedlings which represented all the germination classes was removed from the nursery and the dry weights of their roots, stems and leaves were determined. Three parameters of growth namely, the plant height and stem diameter at first

measurement and root lengths showed a high positive correlation with the dry weights of the plants and their component parts. Root-growth even had an influence on the dry matter production of the leaves. It is suggested that the variation in the growth of the budlings could be caused by the genetic heterozygosity of the roots which would also cause differential growth of the serial parts of the plant. (Authors' summary)

239. SENANAYAKE, Y.D.A. and SAMARANAYAKE, P.

Intraspecific variation of stomatal density in Hevea brasiliensis Muell. Art. Q. Jl. Rubb. Res. Inst. Ceylon.
46 (3/4) 1970 : 61-68, 1 plate (4 photos.), 3 tables, 14 refs.

25 H. brasiliensis cultivars and 'breeders clones' which were originally selected for yielding ability showed unit leaf area. The mean stomatal density was 30.47 ± 3.8 . The frequency distribution of stomatal density in the population was a normal curve. There was no recognisable relationship between stomatal density and the known yielding ability of the experimental plants. The plants were classified into three density groups on the basis of stomata per unit leaf area as follows: Low (< 26.5), medium (26.6 - 34.5) and high (> 34.6). Before using this classification as an additional character to identify cultivars it is necessary to know if stomatal density of H. brasiliensis cultivars grown under different agroclimatic zones of Ceylon is a fixed or variable character. Variation in stomatal density may be related to drought resistance of cultivars and clones which are exposed to the different agroclimatic conditions. (Authors' summary).

Plant Anatomy - Leaves

240. WAIDYANATHA, U.P. de S. and GOONASEKERA, G.A.J.P.R.

Some methods for determining leaf areas in Hevea. Q. Jl. Rubb. Res. Inst. Sri Lanka. 52, 1975 : 10-19, 2 diags., 10 tables, 25 refs.

The 'punched disc' method described here gave accurate estimates of leaf areas of all cultivars of Hevea that were tested. Leaf length, maximum leaf width and the product of these dimensions were very highly correlated to leaf area. Highly significant correlations were also observed between area of the central leaflet or its length and the area of the entire trifoliate leaf. The two lateral leaflets of the trifoliate leaf were almost equal in area. The accuracy and use of these parameters for measuring leaf areas are examined. (Authors' summary).

Ground Covers and Inter-Crops

241. CHANDRASEKERA, L.B.

Intercropping of rubber replantings in the immature stages.

In: Report of the fourth seminar and workshop on progress and development of rubber small-holders, Colombo, 17-22, July 1980. Published by the Association of Natural Rubber Producing Countries, 1980. Appendix 9, pp. 95. (Summary).

The Rubber Research Institute of Sri Lanka has conducted experiments on the suitability of bananas, passion fruit, coffee and pineapple as intercrops in rubber smallholdings. The paper describes the planting densities and planting costs of these intercrops. Full text will be published in the proceedings of the seminar and workshop on progress and development of rubber smallholders.

242. CHANDRASEKERA, L.B.

Potential for intercropping rubber land in Sri Lanka.

R.R.I.S.L. Bulletin (N.S.). 12 (1) 1977 : 41-45.

Experiments carried out by the R.R.I.S.L. has indicated the suitability of the following crops for intercropping with rubber : cacao, coffee, banana, pineapple, passion fruit. An assessment is given of the relative adaptability of these fruits in the various climate zones of Ceylon. The main constraints against intercropping appears to be, 1. Lack of capital. 2. Difficulty in preventing thefts. 3. Lack of substantial returns from certain crops. Intercropping of banana is costly as an example and it appeared that for a plantation to be economically viable the minimum acreage required would be around 10 acres.

243. CHANDRASEKERA, L.B.

Treatment of cover crop seeds for improved germination.

Q. Jl. Rubb. Res. Inst. Ceylon. 40 (1/2) 1964 : 21-26, 1 plate, (3 photos.), 2 graphs, 3 tables, 3 refs.

It has been shown that the percentage germination of Pueraria and Desmodium seeds can be considerably improved by pre-treatment with conc. H_2SO_4 . Such acid treated seed, when properly washed and dried, could be stored for some time without unduly impairing their germination capacity. The

duration of treatment would depend on whether the seed is to be stored or used immediately after treatment. Hot water treatment is effective only with Pueraria seeds and seeds treated by this method cannot be stored. Due to their rapid germination, all treated seeds should be sown when weather conditions are favourable for germination and establishment. (Author's summary).

244. JEEVARATNAM, A.J.

Comparative studies of the chemical composition of some cover plants. In: Proceedings of the Natural Rubber Research Conference, Kuala Lumpur, 1960. Kuala Lumpur (Malaysia), Rubber Research Institute of Malaya, 1961, pp. 342-351, 5 tables, 4 refs.; Reprinted in Q. Jl. Rubb. Res. Inst. Ceylon. 37 (2) 1961, : 35-42.

Cover plants and mulching materials vary in their ability to improve the fertility of the soil, depending on the nature and amount of dry matter produced and on the chemical composition of the different plants. Results of comparative studies of the amount of dry matter produced and the chemical composition of 3 leguminous cover plants, Pueraria phaseoloides, Centrosema pubescens and Desmodium ovalifolium, and 2 non-leguminous cover plants, Mikania scandens and Tripsacum laxum (Guatemala grass) are reported. Guatemala grass was found to have the lowest content of N, P, Ca and Mg, but had the greatest total amount of plant nutrients N, P and K, by virtue of the relatively large quantities of dry matter which it produced. Two of the leguminous cover plants investigated, Pueraria phaseoloides and Centrosema pubescens, returned larger amounts of nitrogen than did Mikania scandens. The 3rd leguminous cover plant, Desmodium ovalifolium, was in fact poorer in chemical composition than Mikania. The non-leguminous cover plants contained large quantities of K but were low in Ca and Mg. These results indicate that the chemical composition of cover plants and mulching materials can exert considerable influence on the nutrition of Hevea. (Author's summary).

245. MARIKAR, Fuard

Potential alternate crops for marginal tea, rubber and coconut lands. Agriculture : Journal of the Ceylon University Agricultural Association. 8 (1) 1968 : 36-45, 10 refs.

The feasibility of alternate crops, depends on, topography, elevation, soil and climate conditions of the marginal lands. These lands are found in the low and mid-country wet zone areas, and wide variety of crops can be grown successfully under these conditions. Cultivation of the following alternate crops are considered in this article: Minor export crops (cacao, coffee, citronella, spice crops), fruit crops (pineapple, avocado, papaw, mangosteen, mango, banana, durian, sapodilla, passion fruit, rambutan and belin); other crops (oil palm, coconut, pastures). Export possibilities, current prices and demand, future trends in the world market, cost of production, processing facilities are considered with each of these crops.

246. RUBBER RESEARCH INSTITUTE OF CEYLON. Advisory Circular No. 77.

Cover crops. Agalawatta, R.R.I.C., 1967. 11 p.; R.R.I.C. Bulletin (N.S.). 2 (1/2) 1967 : 27-37.

Advice on the establishment, maintenance and protection of cover crops for Hevea plantations, with notes on desirable and undesirable species. This Circular supersedes R.R.I.C. Advisory Circular No. 56.

247. SENANAYAKE, Y.D.A.

Intercropping, supplementary cropping and crop substitution on rubber land - a viewpoint. R.R.I.C. Bulletin (N.S.). 3 (4) 1968 : 99-113, 5 tables, 20 refs.

The need to increase food production in the island, as a pre-requisite to the economic development, has been accepted for some time; therefore, all attempts to encourage the production of economically important crops in rubber plantation are investigated by the author. The types of crop likely to be suitable are listed and an assessment is given of the relative adaptability of a wide range of fruits in the various climatic zones of Ceylon.

248. WAIDYANATHA, U.P. de S. and ARIYARATNE, W.A.

Breaking dormancy in seeds of cover legumes. Jl. Rubb. Res. Inst. Sri Lanka. 53, 1976 : 8-16, graphs, tables, 4 refs.

The common methods of scarification of seeds to break dormancy : acid, hot water and heat treatments, were re-appraised. Treatment with conc. sulphuric acid was the most effective method. It was possible to break dormancy equally effectively, but using far less acid than has been used hitherto. In the hot water treatment, control of temperature and duration of treatment are important to achieve best results.

249. WAIDYANATHA, U.P. de S.; PATHIRATNE, L.S.S. and ARIYARATNE, W.A.

Studies on inoculation of cover legumes for improving nitrogen fixation. Jl. Rubb. Res. Inst. Sri Lanka. 54, part 1, no. 2, 1977 : 284-290, 4 tables, 12 refs.

Many rhizobial strains were screened for their nodulating ability against Pueraria, Centrosema, Calopogonium and Desmodium spp. using seedlings grown in nutrient agar. Pueraria and Calopogonium spp. formed effective nodules and fixed nitrogen in sterile sand culture with most of the strains that produced nodules on them in nutrient agar. Inoculation of seeds with some effective strains improved growth of Pueraria in pots but not in the field. This is probably due to natural populations of rhizobia in the soil which were able to successfully compete with the introduced strains in nodulating on the legume. There was evidence that indigenous rhizobia themselves formed effective nodules and fixed nitrogen. (Authors' summary).

250. YOGARATNAM, N.; SULAIMAN, H.; KARUNARATNA, A.D.M. and PEIRIS, K.S.A.C.

Management of covers under Hevea in Sri Lanka. Jl. Rubb. Res. Inst. Sri Lanka. 54, part 1, no. 2, 1977 : 291-298, 1 graph, 9 tables, 12 refs.

Results of two experiments, comparing the effects of leguminous creepers and naturals as ground covers on growth of immature rubber, are discussed. In one experiment the growth of rubber in plots under pure legume covers was better than that under naturals. Application of extra nitrogen to trees in plots with natural covers improved their growth but the latter was not comparable to that in legume plots. In the other experiment the increase in growth of rubber with higher levels of fertilizer nitrogen was observed irrespective of the type of cover. Application of phosphate to covers led to better tree girths

than where the phosphate was applied to the trees, irrespective of the type of cover grown. These results are discussed in relation to the N content of rubber leaves, green matter, litter and C/n ratio of the litter of covers. (Authors' summary).

251. YOUNG, John

Organic matter and cover crops - a viewpoint. R.R.I.C.

Bulletin (N.S.). 3 (1/2) 1968 : 15-16, 7 refs.

A leguminous cover crop in rubber replantings in Ceylon greatly accelerates the decay of felled or uprooted old rubber on stacking and so reduces the losses from root diseases. During its developing period, the cover crop competes with the young rubber for nutrients, but all it takes up from the soil will be returned with interest when it reaches maturity and finally dies back owing to shade. The leguminous cover should be established as early as possible, preferably before planting of the rubber. It is recommended not to dispose of the old rubber by burning or removal as the decaying trees will ultimately provide a reserve of humus and other chemical nutrients. (Tropical Abstract. 24 (5) 1969 : no. 1101).

Soils and Fertilisers

252. ANDRIESSE, J.P.

Mineralogical studies on major rubber soils of Sri Lanka.

(Interim Report 2). Part 1. Amsterdam, Soil Science and Agro-Chemistry Division, Royal Tropical Institute (Koninklijk Instituut Voor de Tropen), March 1980. 16 [V] p.

The study was carried out as part of a comprehensive investigation into the chemical, physical and mineralogical properties of major rubber soils of Sri Lanka aimed at assessing their origin, genesis and fertility status. The ultimate purpose is to arrive at a classification system at a low categorial level of practical use for the management of rubber growing. The complete study is carried out by the R.R.I.S.L. whereas laid down in a formal agreement with the Royal Tropical Institute (RTI), the mineralogical aspects of this study would be the responsibility of the RTI. Representative profiles of 7 main soil series were selected during a visit by the author

to Sri Lanka. As a result of anomalies in the soil series classification presently in use, two series were subdivided by the author into two phases for which the reasons were outlined in interim report (See item no. 253). Therefore in total 9 profiles were subsequently described and sampled by the R.R.I.S.L. and part of the air-dried samples forwarded to the RTI. The report contains the results of the investigations carried out by the RTI in fulfilment of her part of the agreement. The study is divided into 2 parts : that concerning the mineralogical studies on the sands, fractions (Part I) and that concerning the fine silt and clay fractions (Part II). This report concerns only Part I of the study. This is a internal report of the soil science and agrochemistry division of the RTI.

253. ANDRIESSE, J.P.

Notes concerning the classification of rubber soils in Sri Lanka. Amsterdam, Royal Tropical Institute (Koninklijk Institute Voor de Tropen), 1977. 7 p.

These notes are based on background information supplied by Mr. C.G. Silva, R.R.I.S.L., various documents on the subject and detailed observations made at the various selected soil sites, amplified by more general observations of road-cuttings passed during the field studies. The adapted soil series classification system is based mainly on parent material or derivation and gives little regard to profile morphology. Representative profiles of 7 main soil series were selected during a visit by the author to Sri Lanka. As a result of anomalies in the soil series classification presently in use, two series were subdivided by the author into two phases for which the reasons are outlined in this report. It is remarked that this is not a full definition of each series, but merely a guide for arriving at a complete definition. This is a internal report of the Soil Science and Agrochemistry Division of the Royal Tropical Institute.

254. JEEVARATNAM, A.J.

Innovations in cultivation and fertilizer practices. Q.Jl.
Rubb. Res. Inst. Ceylon. 41 (1/2) 1965 : 23-32. 4 plates
(photos.), 3 refs.

The best results in rubber production in Ceylon may be achieved by the adoption of rational fertilizing, proper disease prevention and control, and intelligent adoption of cultivation

practices, provided that adequate measures are taken for soil conservation, and allowing equal growing space for each tree at the time of replanting. The planting of system described by Violle (1962) and Frantsen (1964) in Malaya, i.e. planting on dead level contours while providing equal growing space for each tree by adjusting the planting distance in rows, is strongly recommended for Ceylon conditions. For the diagnosis of fertiliser requirements the combined use of soil and leaf analyses is suggested. The discussion on this paper was concerned in particular with ground cover problems. (Tropical Abstracts. 21 (3) 1968 : p. 640).

255. JEEVARATNAM, A.J.

Manuring and wind damage. Q. Jl. Rubb. Res. Inst. Ceylon.

38 (3/4) 1962 : 62-66, 9 refs.

Of the various factors that influence wind damage it would appear that manuring is the only factor that would lend itself to modification, particularly for areas that are already in production. This article examines critically the role of nutrition on wind damage. The excess nitrogen induces the development of heavier canopies of rubber trees in Ceylon, and that high applications of nitrogen and potassium may result in weaker wood. The omission of fertilizers significantly reduced wind damage when compared with applications of NPK + Mg mixtures with either high or low N/K ratios. However, adequate applications of nitrogen and phosphorus fertilizers resulted in increased girth and increased yields. Increased girth makes the Hevea tree less susceptible to wind damage. Adequate manuring is essential, but excess manuring should be avoided. Tentative recommendations are presented for immature rubber, for rubber trees in their first tapping cycle, and for older rubber trees.

256. JEEVARATNAM, A.J.

Relative importance of fertiliser application during pre- and post-tapping phases of Hevea. Journal of Rubber Research Institute of Malaya. 21 (2) 1969 : 175-180, 1 diagram., 8 tables; Reprinted in Q. Jl. Rubb. Res. Inst. Ceylon. 46 (1/2) 1970 : 52-60.

The paper reports the results of a long-term fertilizer trial to assess the response to continued application of fertilizer dressings (NPK) during the productive phase, as distinct from the response during the immature period. Growth and yield responses over seven years of immaturity and seven and half years of tapping are discussed. The results provide direct evidence of the beneficial effects of fertilizer dressings applied to the same stand of Hevea before and after commencement of tapping. Comparison of responses shows that the continued application of fertilizer during the first seven years of the productive phase could account for about two-fifths of the response in growth and for about half to three-fifths of the response in yield. However, in the light of the fact that responses of this order were realised only on material which had received adequate dressings of fertilizer during the immature period and in terms of the greater returns per unit input of fertilizer applied during the immature period, application of fertilizer dressings during the pre-tapping phase should be regarded as being of fundamental importance. (Author's summary).

257. JEEVARATNAM, A.J.

Review of the Soils Department, [R.R.I.C. for 1960].

Rubb. Res. Inst. Ceylon. Ann. Rev. 1960 (1961), pp. 55-64.

A major portion of the work of the Department was devoted to investigations in determining the validity and usefulness of the technique of 'Diagnostic Physiologique' (DP) and the applicability under Ceylon conditions of the "norm" established for South Vietnam where the technique originated. Another line of approach has been to determine in field experiments the response of rubber trees to fertilizer applications based on the results of leaf and latex analyses according to the "DP" technique. In this connection twenty six field experiments, seven of which with a statistical lay-out, have been laid down on collaborating estates and analyses of 555 leaf samples and of 255 latex samples have been carried out in the laboratory. An experiment to study the effect of high and low potash mixtures on six Hevea clones has given some indication that clones may vary in their response to potash applications. The accuracy of analytical methods used in this department has been confirmed by analysis of duplicate samples at the Rubber Research Institute of Malaya, the results obtained at both Institutes showing excellent agreement. The necessity for providing wind belts before replanting wind-swept exposed areas has been brought out in advisory correspondence. Centrally planted rows of Guatemala grass have been shown to serve as a useful wind break for the protection of young rubber during the early period of development

and belts of old rubber left on the windward side of a replanting provide protection during the early years of the replanted rubber. The effectiveness of dolomitic lime in preventing or curing magnesium deficiency is being investigated in a field experiments. The increase incidence of magnesium deficiency leaf symptoms in young replantings is being investigated by the experimental use in certain areas of NPK fertilizer mixtures with higher magnesium contents. Desmodium ovalifolium, because of its chemical composition and its susceptibility to attack by Synchytrium, is not considered a satisfactory cover plant under Ceylon conditions. Simazine 50 W, a pre-emergence weed killer, has been found effective in keeping planting rows in a clean weeded condition when applied at the rate of 2 lb. per acre at intervals of 2 to 3 months.

258. JEEVARATNAM, A.J.

Review of the Soils Department, [R.R.I.C. for 1961].

Rubb. Res. Inst. Ceylon. Ann. Rev. 1961 (1962), pp. 64-75.

Thirty field experiments to test under Ceylon conditions the value of the method of Physiological Diagnosis for the diagnosis of the fertilizer requirements of rubber plants are in progress on collaborating estates and the analyses of leaf and latex samples collected from these experimental areas form a major part of the work of the laboratory staff of the Department. Eight other manurial trials were in progress on Estates during the year and four new experiments, two on a collaborating Estate and two on the RRIC Kuruwita Sub-Station, have been laid in replantings during the South West Monsoon, of 1961. Applications of a NPK + Mg fertilizer mixture to the planting hole would seem to be more beneficial than that of rock phosphate or animal meal. An investigation into variations in the level of mineral content in a number of recommended clones is in progress. A nursery manurial trial has shown that it is possible by adopting a system of land rejuvenation and intensive manuring to bring nursery seedlings to buddable size in about 10 months from planting. The new herbicide, "Paraquat" has been found to be effective as a total weed killer at the concentrations recommended by the suppliers. A meteorological station has been installed at Dartonfield and regular records are being kept. In addition an automatic siphon rainfall recorder has been installed at ten different locations of the rubber growing areas.

259. JEEVARATNAM, A.J.

Review of the Soils Department, [R.R.I.C. for 1962].

Rubb. Res. Inst. Ceylon. Ann. Rev. 1962 (1963), pp. 94-112.

Based on early results from experiments and as a precautionary measure against heavy losses of trees due to wind damage, certain tentative changes have been introduced in the fertilizer recommendations for both immature and mature rubber. 1. A reduction in the amount of NPK or NPK + Mg from 3 to 4 lb. of the mixture per plant to 2 lb per plant during the first tapping cycle and to $1\frac{1}{2}$ lb. per plant subsequently. 2. A reduction in the level of nitrogen manuring for clones and areas (both immature and mature) definitely known to be susceptible to wind damage. It has been recommended that this could be effected by reducing the annual application of NPK mixture by half and supplying only the phosphate content of the other half in a separate application in order to avoid the introduction of new mixtures. The recommendation to apply dolomite as a source of magnesium has not been withdrawn from the Institute's recommendations since the results from experiments do not support the claim made that dolomite has a depressing effect on the growth of rubber plants and because it is a cheap and effective source of magnesium which is available locally. The technique of diagnosing nutrient requirements on the results of leaf or leaf and latex analysis, and the response obtained to fertilizer applications based on such diagnosis under field conditions has failed to give the striking and sudden response that was reported to have been obtained in Indo China. Investigations on this technique are being continued and a separate report will be submitted on this work during the course of 1963. Reports on field experiments in progress are grouped and reported according to age of planting material in this year's review, which is a deviation from previous procedure. Early observations maintained on experimental areas indicate that height measurement may not be a satisfactory criterion for evaluating growth response during the early stages of growth. The type of fertilizer added, and the method of application of fertilizer to the planting-hole could not be expected to have a long term effect on the growth of plants as subsequent treatments have been found to overshadow earlier effects. Nevertheless, it may be stated that application of a balanced fertilizer mixture like R 4 : 6 : 2 + Mg or Animal Meal (7 per cent N, 10 per cent P_2O_5 5 per cent K_2O) will be more beneficial than application of phosphate as rock phosphate in the planting-hole. Of two levels each of N, P and K tested on the growth of plants in the Moneragala District doubling the present level of nitrogen application was found to result in improved growth. The main drawback, however, seems to be one of inadequate moisture. Experiments carried out on different sources of nitrogenous fertilizers indicate that there is no significant difference between Urea and Sulphate of Ammonia as

sources of nitrogen for immature Hevea. Three brands of pelleted concentrated complete fertilizers under trial have not shown any advantage over inorganic fertilizer mixtures on the growth of young Hevea up to the second year of growth. Mulching with loppings of Pueraria showed a significant beneficial affect on growth over no mulching. Mulching with Guatemala loppings however, did not show this beneficial effect in one of the experimental areas. The response of mature Hevea in its fourth year of tapping has not yet shown any significant differences in yield due to fertilizer treatments, although different clones tested in the same experiment have responded differently to a significant degree from the time of commencement of tapping. The clones tested responded to fertilizer treatments in a similar manner. Since there is evidence that cover crop policies and cultivation practices could very often influence growth to a greater extent than even manuring, the importance of these practices are now emphasised in advisory work. Specific recommendations for eradication of weeds by the application of safe and effective herbicides can now be made on the results of investigations that have been carried out. With the appointment of a second graduate officer with postgraduate qualifications to the Soils Department in December 1962, it is hoped that the programme of soil survey of the rubber growing areas, which was initiated in 1957, and not continued due to lack of trained personnel, will get under way in 1963. Meteorological data for a full year have been recorded at Dartonfield in 1962 at the station set up and maintained by the Soils Department. The data are published at the end of the review of the Soils Department.

260. JEEVARATNAM, A.J.

Review of the Soils Chemistry Division, [R.R.I.C. for 1963].

Rubb, Res. Inst. Ceylon. Ann. Rev., 1963 (1964), pp. 70-81.

The satisfactory position of the staff enabled the Division to intensify the research programme on the manurial requirements of Hevea rubber. The field work includes a number of experiments to make accurate determination of the optimum doses of fertilizers for mature trees in production. The general fertilizer recommendations were revised to include increased rates of fertilizer applications in the early years of immaturity. The results of experiments on the effect of fertilizers on the growth of immature rubber indicate clearly the importance of applying potassium and magnesium at the correct levels for obtaining good growth. These nutrients when applied above certain levels can depress the growth of

young rubber plants in some areas. The application of magnesium as "Dolomite" or as magnesium sulphate has shown no differential response in growth during the first two years of development of young plants in the field. An organic fertilizer such as Animal Meal showed no advantage over inorganic fertilizer mixtures in applications made to nursery seedlings or planting holes. The results obtained during the period under review from a limited number of experiments, did not indicate the necessity for any revision of the reduced rates of application recommended in 1962 for mature clonal rubber. It has, however, been found necessary to qualify the recommendation with the stipulation that the reduced rate of 2 lb. per tree per year of the NPK mixture should be introduced after the third or fourth year of tapping. Areas under intensified treatment by a stimulation or tapping for increased yields during the 6-year period prior to uprooting, should preferably be supported by manuring at 2 lb. per tree per year with an NPK mixture up to three years before uprooting. Observations on a wind-damage losses on two estates in the Kalutara District in 1962 have shown that the major percentage of trees were damaged by uprooting rather than by trunk-snap. These observations indicate that wind-damage losses are connected more with the necessity for sound agronomic measures that favour a stable root system for anchorage and prevent large gaps in a planting, than with a modification of the composition or levels of fertilizer mixtures. Investigations on the possibility of preventing wind-damage by special manure mixtures will be feasible only in the case of clones which are known to be susceptible to wind-damage. Tentative recommendations on changes of fertilizer policy on one estate have been made for any possible effect of the nutrition of Hevea on the incidence of leaf-fall caused by Gloeosporium alborubrum. The results of this investigation will be of observational value only. The Soils Division does not recommend a general adoption of a revised fertilizer policy as a means of minimizing the incidence of Gloeosporium. Satisfactory progress has been made on the soil survey of rubber growing areas. A reconnaissance survey will be completed by the end of 1964. Special attention has been given to soil conservation methods in rubber in view the Government's intention to introduce regulations for the country as a whole. Observations on weed control have shown the necessity for making a distinction between importance in weed control procedure. Weed control procedure should, therefore, be adjusted to meet the conditions that prevail at different stages in the life of a rubber plantation. A weed is correctly defined as "a plant out of place".

261. JEEVARATNAM, A.J.

Review of the Soils Chemistry Division, [R.R.I.C. for 1964]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1964 (1965), pp. 75-86.

The Head of the Soils Chemistry Division represented the Institute on the Formulary Committee for Agro-Chemicals which was convened by the Ministry of Agriculture, Food and Fisheries. The Soils Chemist attended the International Training Course in Soil Biology held at the Indian Agricultural Research Institute, New Delhi, for a period of four weeks commencing from 20th December 1964. Two probationary Assistant Superintendents of Surveys from the Survey General's Department were trained in Soil Survey and Soil Classification by the Soils Chemist. The Division participated in the Inter-Institute parallel tests on leaf analyses, which were organized among members countries of the International Rubber Research and Development Board. The assay values obtained at the Institute's Laboratories compared favourably with those received subsequently from participating Institutes. An Advisory Service which will give more specific recommendations to a limited number of individual estates based on field and laboratory examinations on soil conditions, and tree nutrient status has been initiated. The problem of wind-damage in Hevea has been exclusively dealt with by the Head of the Soils Division. The role of nutrition in connection with the incidence of wind-damage in mature and immature areas has been particular interest to rubber producers. A considerable amount of time has been given to the study of this problem from a number of aspects which could be contributory factors to the incidence of heavy wind-damage experienced in recent years in certain clones and localities. Field experiments carried out for vigour of growth with seedlings of clones RRIC 45, 52, GL 1 and Tjir I have indicated that seed of clones RRIC 45 and 52 may prove to be better than those of the other clones. Foliar spraying with Urea or a complete liquid fertilizer like 'Fertil-Rei' has given very encouraging results as a means of accelerating the growth of plants in seedlings nurseries. Girth measurements taken at the end of the 6th year of growth indicating the effect of four levels of potassium with NPK mixtures on six clones showed no significant differences compared with the control R 4 : 6 : 2 mixture under the conditions of the experiment on Eladuwa Estate in the Kalutara District. Clone PB 86 was below average growth compared with Clone RRIC 45 which was above the average growth of 19.2 inches in this experiment. Clone PB 86

planted in 1961 manured with the major nutrients N, P, K in combination and singly showed no differential response in growth to magnesium applied as commercial Epsom Salts or Dolomite. Manurial experiments in the mature phase in the 5th year of tapping in 1964 indicated a positive response to manuring after the commencement of tapping. Yield trends in laterite soils from the commencement of tapping indicate that N and P are the more important nutrients at the immature phase, while the inclusion of K is essential only from the commencement of tapping. In one of the experiments with four clones the plots that received N and P during the immature period and N, P and K from the time of the commencement of tapping gave a mean yield of 33.1 grams per tree per tapping compared with 28.4 grams from plots that received the complete mixture in the immature and mature phase. Studies on the comparative merits of different cover crops in the past proved the Pueraria phaseoloides was by far the best. A well established ground cover of Pueraria before planting the rubber could however be more competitive to the rubber than the natural cover which it has replaced. The replacement of the natural vegetation with a beneficial ground cover is best effected gradually without clean weeding. The soil survey programme initiated in 1963 was continued. A programme of a more detailed nature than that adopted hitherto was initiated during the second half of the year and a semi-detail reconnaissance survey of the soils and land forms of the Alutgama, Panadura and Horana 1" maps was completed. Similar information on surveys of the Avissavella and Gampaha 1" maps is also available. With the completion of the Kandy and Kurunegala 1" maps the major rubber-growing areas would have been covered at the semi-detail reconnaissance level for soils and land forms.

262. JEEVARATNAM, A.J.

Review of the Soils Chemistry Division, [R.R.I.C. for 1965] 7. Rubb. Res. Inst. Ceylon. Ann. Rev., 1965 (1966)
pp. 59-69.

Every effort was made to execute the specialised advisory functions of this Division either by advisory visits or through correspondence. Twenty estates were visited by Divisional Officers. Of these eleven were concerned with instances of backward growth and/or unusual foliar symptoms. One case of unusual foliar symptoms turned out to be a case of Boron toxicity resulting from the incorporation of a

Boron compound in the fertilizer mixture applied to growing plants. While the surveying of soils in rubber-growing areas in Ceylon at a semi-detailed reconnaissance level was continued, a detailed soil survey of the area covered by the Ambalangoda one inch survey sheet was completed during the period under review. 114 soil samples were collected for laboratory investigations in connection with the different surveys. A study of the Potassium status of certain soils in the rubber-growing areas of Ceylon was undertaken, and information was obtained by determination of mechanical composition, certain exchange capacity, and total exchangeable bases on bulked samples from different sampling points. A trial area was planted at Dartonfield according to the new strict contour system of planting by way of an exploratory demonstration trial. Ground cover policies have been subject to re-appraisal in view of rising operational costs in maintaining pure stands of leguminous covers in replantings. Work on weed control has been restricted to the testing of some of the newer herbicides as and when they became available during the course of the year. Results from long-term field trials at Hedigalla have now provided evidence that clonal rubber which had been regularly fertilized during the immature phase does respond to continued fertilizer applications during the early years of the mature phase; whereas the response from trees that had not been fertilized during the immature phase was negligible. Results from fertilizer trials also indicate that fertilizer treatments that gave the highest response in terms of trunk girth increases were not necessarily the treatments that gave the highest yields during the early tapping years. There is also evidence that clone/fertilizer interaction has been found to be significant even with clones differing widely in growth and/or yield capacity. It must be emphasized that the above findings, while they cannot be regarded as being final, have been obtained under a specific set of conditions as obtains at Hedigalla. There were five experiments in progress to compare the response to fertilizers supplied as determined by foliar diagnosis with the response obtained to applications of fixed quantities of inorganic fertilizer mixtures. The fertilizer trials on mature areas continued to show no significant differences in yield due to treatments in spite of the fact that they have been in progress for periods ranging up to five years.

263. JEEVARATNAM, A.J.

Review of the Soils Chemistry Department, [R.R.I.C. for
1966]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1966 (1967)
pp. 110-131.

Results obtained from field trials now provide sufficient experimental evidence to indicate that application of NPK fertilizers at rates presently recommended by the Institute for clonal rubber during the immature as well as the early productive phase could result in increased yields that would economically be worthwhile even under conditions of an assumed unfavourable cost-price situation. There is now definite evidence that direct beneficial response to fertilizer application in the mature phase can be obtained only from rubber which as received balanced nutrition in NPK during the juvenile phase. A trial laid down in 1963 to determine whether the more vigorous clones that have been recommended for large-scale planting in recent years such as RRIC 45 and 52 would benefit from higher levels of fertilizer applications indicates that application of an NPK + Mg fertilizer mixture at higher rates than presently recommended in our standard mixtures will not increase the rate of growth of the more vigorous materials any more than that of the control PB 86. In an experiment laid down to study the effect of reduced levels of N, P and K on the incidence of wind-damage, there was no significant difference in wind losses due to treatment differences. The two new herbicides, Rordeon 22K and Tordon 101, tested for effectiveness in eradicating ferns such as Bracken and Nephrolepis and other pernicious weeds such as Illuk, Lantana and rogue rubber seedlings, have been found to be more effective than herbicides that have been tested in the past. This was found to be so even at the rate of 1.5 lb. per 30 gallons of water. The rubber-growing areas covered by the 1" topo sheets and covering a total area of about 2,300 sq. miles have now been soil-surveyed at a semi-detailed reconnaissance level. Instances of an unusual form of necrosis encountered in young replantings have been diagnosed as either boron toxicity and/or calcium deficiency. Since the remedial measure for boron toxicity as well as calcium deficiency is the application of lime and since no dolomite had been applied in all instances where the symptoms were observed, application of dolomite was recommended as the remedial measure. In a trial set down on Clone PB 86, to evaluate the response to application of fertilizers from the time of planting as estimated by foliar analysis when compared with the response to application of standard NPK + Mg fertilizer mixture, an increased girth of 0.5" per tree was recorded in the foliar analysis treatment. This is not statistically significant yet worthy of note as this response was recorded with lesser expenditure on fertilizers. Pelletized compounded fertilizers are in common use in most western countries. In a preliminary trial set down to evaluate the response of 3 granular compounded fertilizers against the standard NPK mixture, the treatments

receiving for 3 brands of granulated compound fertilizers continued to show an additional girth of 1" per tree. Although the response was significant it should be borne in mind that the treatments are not strictly comparable in that the NPK proportions were not exactly the same in all 4 cases.

264. JEEVARATNAM, A.J.

Role of fertilizers in the production of natural rubber.

Tropical Agriculturist (Ceylon). 119 (3/4) 1963 : 145-153,

10 refs.

This paper outlines briefly the stages in which fertilizer use has developed in Ceylon from the 1930s to the present day and assesses the economic significance of fertilizer application. In doing so it points out certain features which are peculiar to the crop under discussion. In comparison to any other crop of economic importance in Ceylon, these peculiar features make it difficult to assess accurately the influence any particular factor on production levels.

265. JOHN, R.S.

The potassium status of some soils in the rubber growing areas of Ceylon. Q. Jl. Rubb. Res. Inst. Ceylon. 43 (1/2) 1967 : 19-33, 10 tables, 17 refs.

Amounts of different forms of K present at various depths were determined in 5 soil types occurring on rubber estates in Ceylon; total K. contents in the top soil ranged from 709 to 7,669 p.p.m. With the exception of unchangeable K, which was most abundant in the top soil, K contents did not change much in depth. The reliability of the analytical data was computed and sampling procedures are discussed in the light of the findings. Soil K data from 5 fertilizer trials indicated a high correlation of responses of rubber to K fertilizer with total K content, no correlation with contents of water-soluble, exchangeable, and difficulty exchangeable K. Significant responses were obtained on soils with total K contents of 752 and 2,279 p.p.m., no responses on soils with 3,711 and 4,631 p.p.m. total K, a depressing effect on a soil with 7,983 p.p.m. total K. (Tropical Abstract. 23 (2) 1968 : no. 361).

266. KALPAGE, F.S.C.P.

[Manuring of rubber]. In: Soils and fertilizers with special reference to Ceylon. Colombo, The Freedom from Hunger Foundation, Ceylon, 1967. Chap. 9, pp. 113-118.

267. KALPAGE, F.S.C.P. and SILVA, C.G.

Studies of the manganese status of the rubber soils of Ceylon. Q. Jl. Rubb. Res. Inst. Ceylon. 44 (1/2) 1968 : 8-15, 2 tables, 13 refs.

The total available and exchangeable manganese of twenty one soil profiles have been determined. The varieties in soil manganese between each soil series has been explained in terms of the nature of the parent material and the degree of precipitation. Reasons for the absence of manganese deficiencies and toxicities and why they will not occur are also given. (Authors' abstract).

268. KARUNARATNE, S.W.; JOHN, R.S. and PIYADASA, K.A.

Use of natural rubber latex to improve seepage resistance of soils. Q. Jl. Rubb. Res. Inst. Ceylon. 47 (3/4) 1971 : 51-58, 3 graphs, 1 table, 1 ref.; Abstracted in Proc. Ceylon Ass. Advmt. Sci. 26 (1) 1970 : 110-111.

Use of natural rubber latex to stabilise soils against seepage and erosion offers great potentialities in the numerous irrigation schemes operated in Ceylon. Small scale trials carried out with natural rubber latex at field dry rubber content stabilised with anticoagulants and other additions are discussed in this paper. The results of permeability studies on soils of varying mechanical composition following different soil treatments are reported and discussed. (Authors' abstract).

269. PAVANASASIVAM, V. and KALPAGE, F.S.C.P.

Dithizone extractable zinc in rubber soils in Ceylon.

Tropical Agriculturist, Ceylon. 125 (1/2) 1969 : 15-20,

2 tables, 13 refs.

Zinc is an essential micro-nutrient whose deficiency in Malayan rubber soils has been considered to predispose rubber seedlings to Oidium hevea attack. Results of preliminary investigation on dithizone extractable zinc in surface soils of the main rubber growing districts of Ceylon are reported. The extractable zinc content varies from 2 p.p.m. to 56.4 p.p.m. with an average value of 16 p.p.m. Soils of the Deniya series have the highest values (40 p.p.m.) and those of the Ratnapura series the lowest (9.5 p.p.m.). Results indicate that zinc deficiency is not likely to limit growth of rubber or be a predisposing factor in the incidence of Oidium hevea in acid soils with high dithizone extractable zinc contents. Low availability due to high soil pH is compensated by high amounts of extractable zinc. Excessive uptake of zinc is possible in acid, ill-drained Deniya soils. (Authors' summary).

270. PAVANASASIVAM, V. and KALPAGE, F.S.C.P.

Studies on the organic phosphorous fraction of rubber soils in Ceylon. Journal of the Indian Society of Soil

Science. 18 (2) 1970 : 133-140, 3 tables, 9 refs.;

Abstracted in Proc. Ceylon Ass. Advmt. Sci. 25 (1) 1969 : 39-40.

Total, organic, inorganic and Truog's available phosphorous are reported for surface soils from the main rubber growing districts of Ceylon. More organic phosphorous was mineralized with increase in incubation time except in the limed samples of the Matale and Parambe series. In all samples, there was more mineralization at 40°C. than at 30°C. During the first 10 days at 40°C more mineralization took place than during 50 days at 30°C. Both increased temperature and liming promote mineralization but three of the soils studied showed a drop in extractable phosphorous at 40°C and liming. 40°C most of the mineralizable organic phosphorous seems to have been converted into extractable forms during the first ten days. (Authors' summary).

271. PERIES, O.S.

Review of the Soils Chemistry Department, [R.R.I.C. for
1971]. Rubb. Res. Inst. Ceylon. Ann. Rev. 1971 (1972),
pp. 62-75.

A detailed soil survey of the Panadura-Horana one inch to a mile topographic map was started and more than half the area has been mapped. The studies on volatalization of urea showed that it was controlled by the moisture status and the texture of the surface soil. Field experiments have indicated that variation in fertilizer practices in the mature phase does not affect yields. In two experiments high levels of fertilizer have given significant responses over the control. Two separate experiments have shown that potassium has a significant effect on yield and girth increment and a third that phosphorus has a linear effect on yield. Studies on cover crops have shown that rubber plants grow better in areas planted with leguminous covers than those where volunteer plants are allowed to grow. Nursery experiments have confirmed that the current policy of applying a complete NPK + Mg mixture to young seedlings is correct and that the normal soil application of fertilizers is generally better than foliar applications.

272. RUBBER RESEARCH INSTITUTE OF CEYLON.

Diagnostic physiologique. The Planters' Chronicle (India).
55 (10) 1960 : 265-266.

Diagnostic physiologique (DP), is the method of physiological diagnosis for determining the fertilizer requirements of Hevea. DP covers leaf analysis and the analysis of corresponding latex, and there are several advantages in favour of this method.

273. RUBBER RESEARCH INSTITUTE OF SRI LANKA. Smallholdings
Advisory Leaflet No. 14.

Conserve your soil. Ratmalana, R.R.I.S.L. Advisory Services
Department. 7 p., photo, 2 diagrms.

This leaflet of the Advisory Services Department of the R.R.I.S.L. discusses as simply as possible what causes soil to erode and the conservation of soil. Two main agents of soil erosion are rain and wind.

274. SILVA, C.G.

Discriminatory fertilizer recommendations for rubber in Sri Lanka. In: Proceedings of the International Rubber Conference, Kuala Lumpur, 20-25 Oct. 1975. Kuala Lumpur, Rubber Research Institute of Malaya, 1976. Vol. 3, pp. 132-141, graphs, 5 tables, 11 refs.

This paper discusses the fertilizer requirements of Hevea in Sri Lanka from leaf and soil nutrient status. The variation of leaf nutrient status with age has been established. The tree-to-tree variation in leaf nutrient status was used to determine the size of a sampling unit. Analysis of leaves with the midrib was confirmed to be a satisfactory method for evaluating the nutrient status of leaves. Soil and foliar surveys of a limited area of mature rubber predominantly on Boralu series soil showed that the soil and leaf nitrogen and potassium levels were sub-optimal while the phosphorus and magnesium levels were adequate. (Author's summary).

275. SILVA, C.G.

An evaluation of the nutrient status of the rubber soils of Ceylon. Q. Jl. Rubb. Res. Inst. Ceylon. 48 (3/4) 1971 : 147-159, 8 graphs, 3 tables, 6 refs.

Data are presented on the nutrient status of 5 soil series in South-Western Sri Lanka, together with some mean leaf nutrient values. Modifications to the current rubber fertilizer recommendations are suggested. (Horticultural Abstracts. 43 (8) 1973 : no. 5644).

276. SILVA, C.G.

Fertilizer recommendations for the rubber soils. Journal of the Soil Science Society of Ceylon. 1, 1970 : 89-96.

A paper read at the "Symposium on Recent Developments in the Use of Fertilizers in Ceylon", held on 2nd April 1970 in Colombo. The author approached the problem of regional differentiation of the rubber growing areas, by using the soil region as a basis for its fertilizer-use recommendations.

277. SILVA, C.G.

The fertilizer requirements of smallholdings in Sri Lanka. R.R.I.S.L. Bulletin (N.S.). 10, 1975 : 31-34, 4 tables, 5 refs.

The use of fertilizer in the cultivation of rubber results in better growth and higher yields. But the lack of finances and the high cost of fertilizers are barriers to the use of fertilizers in the required quantity. Experiments carried out to find inexpensive local fertilizer substitutes are reported in this article. Paddy straw ash and local apatite have been found to be valuable sources of potassium and phosphorus. It should however be remembered that the locally available substitutes for potash and nitrogen fertilizer will not necessarily supply the total requirements of these nutrients, and therefore it is necessary to supplement with inorganic fertilizer.

278. SILVA, C.G.

Management of the rubber soils for maximum yields. Q. Jl. Rubb. Res. Inst. Sri Lanka (Ceylon). 30 (1/2) 1973 : 60-67, 8 graphs, 5 refs.

This study has attempted to evaluate a few of the factors which contributes to low yields and also to formulate the yield potentials of PB 86 grown under conditions of different climate, rainfall and on different soils. This data is available from various districts in Sri Lanka. It has been shown that in the high yielding class of estates the yields from the coastal area are better while in the lower yielding class the yields from the Ratnapura district are better. The yield capacity of the 4 soils studied are quite similar and that significant differences between the yield potentials do not exist. Most of the low yields which have been recorded by estates could very easily be attributed to, low stand and rain interference.

279. SILVA, C.G.

Phosphorus nutrition in rubber. In: Soil Science Society of Sri Lanka. 4th annual sessions, July. Proceedings, 1975 : 58-62.

280. SILVA, C.G.

Provisional classification of rubber soils of Ceylon and their relationships to Malayan soils. Journal of Rubber Research Institute of Malaya. 21 (2) 1969 : 217-224, 1 map, 21 refs.; Reprinted in Q. Jl. Rubb. Res. Inst. Ceylon. 46 (1/2) 1970 : 20-29.

Earlier work on the studies of Ceylon soils did not stress the importance of the soil parent material. Based on the differences in parent materials, the rubber soils of Ceylon respond differently to fertilizer application. Comparisons of Ceylon soils with Malayan rubber-growing soils have shown that some of their properties are similar; manuring requirements for rubber on these soils have also followed a similar pattern. (Author's summary).

281. SILVA, C.G.

Review of the Soils Chemistry Department, R.R.I.C. for 1967. Rubb. Res. Inst. Ceylon. Ann. Rev. 1967 (1968), pp. 50-59.

The reconnaissance survey of the rubber growing areas which was completed in 1967 has recognized the existence of 8 soil series. Laboratory investigations were confined to the analysis of leaf samples in order to determine the mineral status of the plant and also to the analysis of soil samples to determine their chemical status. Investigations to find a substitute for sodium have revealed that in immature areas Gramoxone with 2, d-D and disodium methane arsonate could be used in keeping natural ground covers under control in the inter-row areas. A residual herbicide like Diuron was found to be useful in keeping the planting rows in a clean weeded condition. Amino triazole alone and mixed with 2, 4-D was found to check Mikania and some grasses. DSMA with 2, 4-D was also observed to kill the natural vegetation effectively. Mixtures of sodium chlorate and 2, 4-D did not give very favourable results. The cost of these various weedicides has not been worked out. Observations on areas where weed control experiments were conducted indicate that natural vegetation

should be controlled to the point of eradication only when such vegetation could be replaced with a leguminous ground cover. Under all other circumstances the natural vegetation should be kept only under control. The large number of long-term fertilizer experiments are now in the process of being analysed and studied, with a view to changing our manurial recommendations where such changes cost-wise have become necessary. A foliar analysis cum soils analysis service as a tool for making more precise and useful fertilizer recommendations for particular 'fields' was accepted in principle by the Board of Management, but lack of staff prevented its implementation during the year under review. Results of investigations carried out in the course of advisory work brought to light the incidence of high boron contents in two instances. In another estate even though the leaves showed marginal scorch and other typical symptoms of boron toxicity leaf analysis did not show any appreciable increase in leaf boron in the affected leaves.

282. SILVA, C.G.

Review of the Soils Chemistry Department, [R.R.I.C. for 1968]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1968 (1969), pp. 49-58.

On the basis of the present methods of analysis, it has been found that long-term experiments have not clearly indicated the benefits of fertilization in the early mature phase. However, it appears that more critical analyses of data with more realistic corrections, made for residual effects of fertilizer application in the immature phase, are necessary before this is accepted unequivocally. A trial laid down in 1961 has indicated that the optimum level of nitrogen and phosphorus for Hevea is approximately 21 oz. of sulphate of ammonia and 21 oz. of saphos phosphate per plant, per annum, in the presence of a basal dosage of potassium and magnesium. In areas where nitrogen and phosphorus are basal, there is no response to potassium but magnesium showed a depressant effect. A comparison of the more vigorous clones RRIC 7, 45, 52 and PB 86, has shown that PB 86 will respond on par with the others to the application of NPK + Mg mixtures at higher rates, than those recommended at present by the Institute. Therefore, the vigour of the clone does not appear to enhance its capacity to utilize fertilizers. The trials on the application of one or more fertilizer elements on the basis of foliar

analyses, as compared to standard NPK + Mg mixtures, have so far indicated that partial mixtures are more beneficial. Studies on this subject are in progress. The results of the trial on the use of different forms of nitrogenous fertilizers have shown that urea is superior to the other two forms tested. However, these results must be considered inconclusive until it is established whether there is a response to nitrogen in the experimental area. Studies with granular fertilizers have shown their superiority over standard fertilizer mixtures. A provisional soil map of the rubber lands is now available. This will be supplemented with detailed surveys of each area and will form the basis of the envisaged soil and foliar survey programme.

283. SILVA, C.G.

Review of the Soils Chemistry Department, [R.R.I.C. for 1969]. Rubb. Res. Inst. Ceylon. Ann. Rev. 1969 (1970), pp. 63-79.

The increasing yields of the newer clones made it necessary to assess their optimum nutritional requirements. Therefore, a soil and leaf nutrient survey is being organised for rubber growing areas, with a view to the lowering of the cost of production but maintaining the yields that are to be expected of the high-yielding clones. As an essential pre-requisite to this programme the soil resources of the rubber growing areas and the leaf nutrient status of the experimental areas are being determined. The growth rate of the more vigorous clones like RRIC 7, 45 and 52 presently indicate that they do not require extra doses of manure for their better growth. The optimum times and methods of fertilizer application and the most effective and cheap methods of controlling weeds are being studied. Herbicide mixtures based on MSMA appear to be effective in the control of the common weeds in rubber plantations. The concentration of sodium arsenite and the total cost of control with this weedicide can be reduced, if control measures are adopted early. The soil surveys have been continued, with more detailed studies in selected areas. Refinements of the Aluthgama 1 in. map have shown that there are other soil types, not already identified, in this area. A study of wind-damage in rubber has shown that while uprooting depends on the environment, trunk snap and branch breakage are clonal characteristics.

284. SILVA, C.G.

Review of the Soils Chemistry Department, [R.R.I.C. for 1970]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1970 (1971), pp. 56-66.

A detailed soil map was prepared of the Alutgama 1 in. map and the chemical properties of five important soil series were also determined. Soil surveys were carried out for planting oil palm at Nakiadeniya Group, Nakiadeniya. Six new field experiments were initiated during the year to test the effect of fertilization in relation to covers, frequency of fertilizer application in the immature phase and the fertilizer requirements of nursery plants. Herbicide mixtures based on mono sodium methane arsonate (MSMA) have been found to be as effective as sodium arsenite in controlling most weed populations commonly found under rubber. The economics of the use of these mixtures will have to be studied in detail. There has been a great deal of interest recently in intercropping rubber with various cash crops. Trials have been initiated on the cultivation of pineapples as an intercrop.

285. SILVA, C.G.

Review of the Soils Chemistry Department, [R.R.I.S.L. for 1972]. Rubb. Res. Inst. Sri Lanka. Ann. Rev. 1972 (1973), pp. 67-78.

A study on commercial rubber productivity in relation to soils, weather, management etc., was initiated in 1972. The data collected from this study is expected to be the frame work on which, a programme of fertilizer recommendations based on soil and foliar analysis is to be implemented. A study of the variation in leaf nutrient content throughout the year and the position of the leaf on the tree, was also carried out for the same purpose. More field experiments were started to find out the suitability of substituting urea as a source of nitrogen in rubber fertilizer mixtures. Pot experiments were initiated to test the suitability of using the locally available Eppawela Apatite as the source of phosphorus in rubber fertilizer mixtures.

286. SILVA, C.G.

Review of the Soils Chemistry Department, [R.R.I.S.L. for 1973]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1973 (1974), pp. 77-85.

Thirty estates were selected for a study of the relationship between commercial production and soil, weather, management and other factors. Only seven of these estates were studied in detail this year, because the large acreage involved requires heavy investment in staff and other inputs. A programme for the recommendation of fertilizers, based on soil and foliar analyses, was initiated over an extent of 2000 acres of mature rubber in the Kalutara District. The work on this project was completed on schedule and it has been decided to increase the acreage under this programme to 30,000 acres in 1974. A polybag experiment to test the possibility of using apatite as a source of phosphorus, showed that the local apatite may not be as suitable as the imported rock-phosphate for this purpose.

287. SILVA, C.G.

Review of the Soils Chemistry Department, [R.R.I.S.L. for 1974]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1974 (1975), pp. 66-75.

Discriminatory fertilizer recommendations based on soil and leaf analysis, were made for 2000 acres of mature PB 86 in the Kalutara District in 1974. About 11,000 acres of mature rubber were also surveyed and fertilizer recommendations will be made to these areas in 1975. A shortage of phosphatic fertilizer and a price increase of all fertilizers was experienced. However, the discriminatory approach to fertilizer recommendation helped to reduce the harmful effects of the above two factors and the fertilizer consumption of the estate sector has not been adversely affected. Leaf nutrient studies have indicated that the present methods of fertilization do not ensure the maximum utilization of fertilizer. The importance of a legume cover during the non-productive phase has been demonstrated. Urea appears to be as good as sulphate of ammonia as a source of nitrogen. The importance of nitrogen and potassium in the nutrition of Hevea has been shown. However, there are some rubber growing areas in Sri Lanka, e.g. Kelani Valley, where phosphorus too is required.

288. SILVA, C.G.

Review of the Soils Chemistry Department, [R.R.I.S.L.
for 1975]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1975
(1976), pp. 57-63.

There were many requests during the year for fertilizer recommendations on the basis of soil and foliar analyses. It has been established that the variation in leaf nutrient content during the year in Sri Lanka is similar to that in India and Liberia. Soil phosphorous studies have indicated the beneficial effects of incorporating fertilizers into the soil. Soil and leaf nutrient surveys have shown that most PB 86 areas require extra nitrogen and potassium. An Atomic Absorption Spectrophotometer was gifted to the Institute by the Australian Government. This instrument has made possible the analysis of a large number of leaf and soil samples. It would now be possible for the Institute to undertake the analytical work necessary to recommend fertilizers on a discriminatory basis to the whole rubber growing area in Sri Lanka. The importance of potassium in the nutrition of mature rubber has been confirmed. The establishment of a leguminous cover during the immature phase has again been shown to be beneficial to growth. Urea has been found to be just as good as sulphate of ammonia as a source of nitrogen for mature rubber, growing on Boralu series soils.

289. SILVA, C.G.

Review of the Soils Chemistry Department, [R.R.I.S.L.
for 1976]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1976
(1977), pp. 114-123.

Studies on the uptake of soil phosphorus have shown that rubber trees absorb phosphatic fertilizers more efficiently when crushed rock phosphate is placed in bands and a good ground cover is grown in the area concerned. Incubation studies and pot and nursery experiments have shown that local apatite may be substituted for imported saphos phosphate. Forking rock phosphate into the soil has been found to ensure a uniform distribution of the fertilizer in the soil. A field experiment has confirmed that the growth and yield of rubber trees planted in Boralu soils can be improved by the addition of potassium. It has been shown experimentally that rubber trees, grown in areas previously planted in tea, can

produce good growth on lower dosages of fertilizer than those recommended by the Institute in areas where the former crop was also rubber. Studies on ground cover have shown that: (a) Mimosa invisa does not fix nitrogen effectively, (b) the practice of applying rock phosphate to covers is very beneficial, and (c) it is most important to grow a suitable legume cover in all replanted areas. In its absence about thrice the normal quantity of nitrogen fertilizer must be applied to the rubber for comparable growth during its immature period. It has been shown that there is a direct relationship between the uptake aluminium and phosphorus in Pueraria plants. The significance of this in the nutrition of Hevea is being investigated. The area sampled for soil and foliar analyses is twice that done in 1975. It is expected that the total area under rubber in Sri Lanka will come under this survey by 1980.

290. SILVA, C.G.

Review of the Soils Chemistry Department, R.R.I.S.L. for 1978/. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1978 (1979), pp. 88-100.

291. SILVA, C.G. and BELLIS, E.

Manuring of rubber. R.R.I.C. Bulletin (N.S.). 7 (3/4) 1972 : 62-70, 4 tables.

Discriminating application of fertilizers in order to counter balance the loss of various essential elements from soil, is necessary for healthy growth of plants. Topographical, climatic and ecological conditions of a particular area are major factors that govern the soil status and its suitability for plant growth. The Rubber Research Institute of Sri Lanka has introduced a new terminology for fertilizer mixtures in place of that designated by the 'R' terminology. It describes the appropriate method, time, sequence and dosage of application with respect to various soil series located in different rubber growing areas. A brief description of 7 important soil series which have been identified has been included. This information would facilitate the selection of the proper fertilizer mixtures for the various soils. Published separately as a Advisory Circular. (R.R.I.C. Advisory Circular No. 84, 1976).

292. SILVA, C.G.; KUMARAKULASURIYAR, S. and WICKREMASINGHE, L.J.

The efficient use of phosphatic fertilizer in relation to the phosphorus fixing capacities of the rubber soils.

Jl. Rubb. Res. Inst. Sri Lanka. 54, part 1, no. 2, 1977 :

263-269, 4 graphs, 3 tables, 9 refs.

Rubber is grown extensively in the South-Western part of Sri Lanka. The soils of this region have a pH range of 4.5 to 5.5 and contain appreciable amount of Fe and Al as Oxides. These rubber lands have received large quantities of fertilizer over the years. The source of fertilizer P has been exclusively the import rock phosphate. About 150 kg. per ha. is recommended for use annually. The phosphorus fixing capacities of these soils have been estimated to be high. The present study attempts a quantitative evaluation of the phosphorus fixing capacities of the important soil series and their relationships with a few significant physical and chemical properties, in order that meaningful recommendations may be made on the use of rock phosphate in supplying the phosphorus requirements of Hevea. The significance of this work to the rubber industry has been increased, as a result of the availability in Sri Lanka of a large deposit of apatite. The use of apatite as a source of P for the nutrition of rubber is also discussed.

293. SILVA, C.G. and PERERA, A.M.A.

A study of the urease activity in the rubber soils of

Ceylon. Q. Jl. Rubb. Res. Inst. Ceylon. 47 (1/2) 1971 :

30-36, 1 map, 5 tables, 8 refs.

The urease activity of the rubber soils of Ceylon has been determined, along with the organic carbon, pH and soil moisture. The Metals and Parambe soil series, belonging to reddish brown lateritic great soil group have a significantly higher urease activity than the other soil series, belonging to the red-yellow podzolic great soil group. In all the six soil series pH shows a significant positive influence on urease activity. Organic carbon has a direct relationship to urease activity only in four soil series while in the other two soil series, organic carbon does not seem to have any influence. It is suggested that urea can be used as the source of nitrogen under most situations in the rubber areas, except in the soils of the Matale series, where it could be used with caution for the present, until further studies are made on this subject. (Authors' summary).

294. SILVA, C.G.; PERERA, A.M.A. and PEIRIS, D.R.

Loss of ammonia by volatalisation from surface dressings
of urea containing rubber fertilizer mixtures. Proc. Ceylon
Ass. Advmt. Sci., 28 (1) 1972 : 46.

An abstract.

295. YOGARATNAM, N.

The molybdenum status of some rubber soils of Sri Lanka.
Proc. Sri Lanka Ass. Advmt. Sci., 33 (1) 1977 : 30.

An abstract.

296. YOGARATNAM, N.

Review of the Soils Chemistry Department, [R.R.I.S.L. for
1977]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1977 (1978),
pp. 99-128.

Although some of the RRIC 100 series clones grow more vigorously than PB 86, during the first year of planting, their requirements for major elements were similar to those of PB 86. Sulphate of ammonia can be broadcast applied, but sub-surface application is best for urea. The efficiency of nutrient uptake can be enhanced by the application of nitrogen and potassium either at the time defoliation, depending on weather conditions at the time. Rock phosphate has been found to be a more effective source of phosphorus than Eppawela Apatite. However, due to the importance of the Eppawela source to the economy of the country, further studies are being conducted to devise means of improving the availability of P from this material. The trace element studies of the rubber growing soils appear to be satisfactory, especially with regard to Molybdenum, Zinc, Manganese, Copper and Iron. The availability of some trace elements e.g. Molybdenum can be improved by increasing the organic matter content and the pH of the soil. Application of high levels of magnesium has depressed yields, and this is a factor to be noted on many estates, where magnesium has been used regularly, over several years. A low intensity detached soil of the Aluthgama topographical sheet has shown the existence of several hitherto unidentified soil series in the rubber growing areas in Sri Lanka.

297. YOGARATNAM, N.

Review of the Soils and Plant Nutrition Department,
[R.R.I.S.L. for 1979]. Rubb. Res. Inst. Sri Lanka. Ann.
Rev., 1979 (1980), pp. 77-90.

The main concern of the Department is the study of the response of the rubber tree to the supply of nutrients. It appears that the amount of some nutrients in particular potassium, required by the rubber trees (PB 86) in replantings is higher than what is recommended currently to Boralu soils. Moreover, the potassium requirements of the RRIC 100 series clones appear to be still higher than that of the PB 86. There are also indications in general of higher yields with applications of N, P and K. Yield increases ranging from 5 to 32 per cent over no fertilizer plots, have been recorded. Yield data obtained from an experiment that has been in progress for the last 7 years indicated that urea is as effective as sulphate of ammonia as a source of nitrogen for mature rubber growing in Boralu soils. Other experiments also showed similar tendencies. With regard to sources of phosphate, imported rock phosphate appeared to be more efficient than Appawela Apatite as a source of phosphate for immature rubber. Increasing the concentration of P with Eppawela apatite as the source is not likely to increase its efficiency. Among the three sources of magnesium viz. commercial epsom salt, kieserite and dolomite, it seems that even a sparingly soluble form of Mg. such as dolomite could be used in replantings. Based on these findings, fertilizer recommendations to rubber are being revised in order to accommodate dolomite, the cheapest source of Mg. available in the country, in the fertilizer schedule. It has been observed that from an economic as well as agronomic point of view, all fertilizers to mature rubber should be applied within one month after refoliation if only a single application is envisaged, within one and three months after refoliation if two applications are given and when three applications are made within one, two and three months after refoliation. This would however depend on weather conditions at the time. Some cover management practices such as establishment of legumes and fertilizing them with phosphate continued to show their long term beneficial effects on growth and yield of mature rubber. But, with regard to potassium fertilizers, its application direct to the rubber tree appears to be a more efficient method at least during the early stages of a replanting, than its application to the ground covers, especially in K deficient soils. Investigations on soil conservation practices showed

that until the establishment of a good leguminous cover in a new or replanting, use of mulch is a good agronomic practice. Attempts should also be made to establish good legume covers with resorting to clean weeding. Spraying with latex alone or compounded latex is not likely to be beneficial under our conditions.

298. YOGARATNAM, N. and KARUNARATNE, A.D.M.

Fertilizer responses in Hevea brasiliensis seedlings grown in the field nursery. Q. Jl. Rubb. Res. Inst. Ceylon. 49 (1/2) 1972 : 28-36, 2 diagrams., 6 tables, 24 refs.

The results of 2 experiments with Tjir I seedlings are reported. Treatments included all possible combinations of N, P, K and Mg. at rates from 1-4 oz./plant/year and at various frequencies. N increased growth by up to 30 per cent, P by up to 8 per cent and K by up to 5 per cent. The mean plant diameter with the N₁ and N₂ rates were 2.349 and 2.344 cm. respectively, compared with 1.811 cm. for the controls. The optimum fertilizer application was 6 oz./plant/year of a mixture of N₁ P₂ O₅, K₂ O₂ and Mg O in the ratio 4 : 6 : 5 : 2. (Horticultural Abstract. 44 (5) 1974 : No. 3591).

299. YOGARATNAM, N.; NADARAJAH, M. and DAYARATNE, W.C.

Soil erosion and run-off studies in rubber plantations. Proc. Sri Lanka Ass. Advmt. Sci. 34 (1) 1978 : 25-26.

An abstract.

300. YOGARATNAM, N. and SILVA, F.P.W.

Standardization and improvement of soil testing methods for rubber soil of Sri Lanka with emphasis on soil phosphate.

Proc. Sri Lanka Ass. Advmt. Sci. 34 (1) 1978 : 17.

An abstract.

301. YOGARATNAM, N. and SILVA, Percy

Use of leaf analysis as a guide to manuring of rubber.

R.R.I.S.L. Bulletin (N.S.). 12 (1) 1977 : 46-50, 1 graph,

6 tables.

The leaf nutrient status, which is one of the aspects of soil/plant investigations for efficient diagnosis of specific fertilizer requirements for any one site, is discussed in this paper.

DISEASES AND PESTS

302. ANON

Brown root disease. R.R.I.C. Bulletin (N.S.). 2 (1/2)

1967 : 24-26.

A short description of brown root disease caused by the fungus Fomes lignosus and F. noxius, including symptoms, spread of infection and their control. The early symptoms should not be overlooked. When an infected tree is observed it should be uprooted, and all infected roots, the stump and other pieces of dead wood burnt on the site. The tree should be treated just as a white root disease, if infection is observed.

303. ANON

Phytophthora diseases of rubber in Ceylon and India.

Planters' Bulletin of the Rubber Research Institute of Malaya.

95, 1968 : 49-51.

An account of the field observations in India and Ceylon, to study the occurrence of and control of the rubber disease caused by Phytophthora-leaf fall, pod rot and black stripe is presented in this paper. In Ceylon the disease occurs only sporadically as a secondary effect of pod infection; treatment is generally uneconomic but dusting with copper fungicides is recommended where leaf fall habitually occurs. The situation in Ceylon is similar to that in Malaya. On the other hand, black stripe is more severe in Ceylon than in Malaya, though its incidence has been reduced since it is recommended not to tap wet-trees. Infected panel parts are excised; prophylactic use of mercury fungicides is recommended as it is in India

304. ANON

Rubber mildew. World Crops (London). 12 (1) 1960 : 40.

A note on the use of a special activated product called 'Palmetto', during the mildew season, to control rubber mildew disease caused by Oidium heveae which attacks young foliage and causes great damage, by repeated defoliations.

305. ANON

A severe case of pink disease. Q. Jl. Rubb. Res. Inst.

Ceylon. 36 (1/2) 1960 : 29-30, 1 photo.

306. BAPTISTE, E.D.C.

Phytophthora palmivora. Q. Jl. Rubb. Res. Inst. Ceylon.

37 (1) 1961 : 22-23.

A note on the incidence and control of Phytophthora disease in Hevea, based on a discussion.

307. DANTANARAYANA, D.M.

The incidence and control of Bark rot. R.R.I.S.L. Bulletin

(N.S.). (Conference Supplement). 8 (3/4) 1973 : 40-41.

DE

308. JONG, P.

Phytophthora on rubber in Ceylon. Planters' Chronicle. (India).

56 (15) 1961 : 267.

A report by the author on Phytophthora leaf-fall in Ceylon and its experimental control. Weekly rounds of dusting are carried out, and 7 lbs. of a 4 per cent copper dust are applied per acre/round. The dusting costs about Rs. 25 an acre for seven rounds. Low volume spraying with copper-oil fungicides will be investigated, but it seems unlikely that this method will prove to be more economical than the system of dusting. More attention is given to dressing the tapping panel with suitable fungicides for the control of the bark rot, and organo-mercury fungicides are used for this control.

309. DE SILVA, C.A.

Brown bast disease of Hevea. Q. Jl. Rubb. Res. Inst.

Ceylon. 37 (4) 1961 : 129-130.

A short description of brown bast, a physiological disease of rubber, including symptoms, prevention and control. In Ceylon it is recommended that the tapping intensity be reduced if an incidence of more than 10 per cent of the brown bast occurs. The early symptoms should not be overlooked. Since prevention is better than cure, every effort should be made to obtain high yields from the modern high-yielding clonal material in the early years of tapping without unduly straining the trees.

310. DE SILVA, C.A.

Wind damage in rubber plantations. Q. Jl. Rubb. Res.

Inst. Ceylon. 37 (3) 1961 : 91-92.

This note summarizes some of the important factors that influence wind damage. Clones Mil 3/2, RRIC 52, Glen 1 and PB 86, have shown tolerance to wind damage in Ceylon.

311. DISSANAYAKE, A.B.

Report on the sulphur dusting of smallholdings in 1961.

Q. Jl. Rubb. Res. Inst. Ceylon. 37 (3) 1961 : 83-90, 3 charts, 1 map, 2 graphs, 3 diagrams, 2 tables.

A state-aided co-operative sulphur dusting scheme is organized every year by the Smallholdings Department of the R.R.I.C. for the purpose of controlling Oidium leaf disease on smallholdings which advces and guides the smallholders and organizes the dusting groups. In 1961, the scheme gave satisfactory results and the most of the smallholders who took part, have expressed their willingness to participate in the following years. Annex 1 - Total acreage accepted for sulphur dusting in 1959, 1960, 1961; Annex 2 - Distribution of sulphur dusting groups according to districts; Annex 3 - Progress of sulphur dusting of smallholdings; Annex 4 - Rubber acreage sulphur dusted classified according to kind of rubber.

312. DISSANAYAKE, A.B.

Report on the sulphur dusting of smallholdings in 1962.

Q. Jl. Rubb. Res. Inst. Ceylon. 38 (3/4) 1962 : 75-82,

3 charts, 1 map, 2 graphs, 3 diagrms., 2 tables.

The abstract is similar to the abstract of item no. 311.

313. DISSANAYAKE, A.B.

Report on the sulphur dusting of smallholdings in 1963.

Q. Jl. Rubb. Res. Inst. Ceylon. 39 (3/4) 1963 : 95-104,

4 diagrms., 1 map, 1 graph, 2 charts, 2 tables.

The abstract is similar to the abstract of item no. 311.

314. FERNANDO, D.M. and LIYANAGE, A. de S.

South American leaf blight resistance studies in Sri Lanka.

In: Report of the Third Meeting of the ANRPC technical committee on SALB, Kuala Lumpur, 12-13 October 1979. Kuala Lumpur, the Association of Natural Rubber Producing Countries, 1979. Appendix XIV, 8 p., 2 figs. (graphs), 2 tables, 10 refs.

Two consignments of rubber plants have been sent from Sri Lanka to the RRIC Unit at Trinidad for SALB screening. Although clones RRIC 119, RRIC 115, RRIC 117 and 6004 showed a high degree of resistance, only RRIC 117 showed favourable yields. Resistant plants from the second consignment, sent in 1978, showed much better combination of yields and disease resistance in RRIC 121 and RRIC 130. The combination of different sources of resistance in clone 72-133 is also discussed. The necessity for including SALB resistant clones in at least small scale planting programmes is mentioned. (Authors' summary).

315. FERNANDO, D.M. and PERIES, O.S.

The increased use of SALB resistant material in eastern rubber planting. In: Scientific Symposium, Part I, Cochin, India, 26-28 September 1974, Text of Papers. London, International Rubber Research and Development Board, 1975, Vol. I, Session A(13) 8 p., tables, 11 refs.

SALB means South American Leaf Blight caused by Dothidella ulei. Ford and Goodyear Companies searched for SALB resistant varieties in South America during the 1940's. The IAN series 45, 2000 and 6000 developed at Turrialba in Costa Rica resulted from this work and were SALB tested 873 (FB 86 x FA 1717) yields in Malaysia up to the level of RRIM 600 for the first 3 years of tapping. First and second back-crosses to Far Eastern material did not do so well in general. New backcrosses are tested on SALB resistance in Trinidad and show signs of resistance to SALB and Oidium. Release and modest multiplication of productive SALB resistant parentage is proposed to safeguard the industry. (Abstracts on Tropical Agriculture 2 (9) 1976 : no. 10353).

316. FERNANDO, T. Marcus

The control of three important diseases of Hevea brasiliensis in Sri Lanka. R.R.I.S.L. Bulletin (N.S.). (Conference Supplement). 8 (3/4) 1973 : 25-26.

The three major disease of rubber in Sri Lanka are the White Root disease caused by the fungus Fomes lignosus, Oidium leaf disease caused by the fungus Oidium heveae and Bark Rot or Black Stripe caused by a species of Phytophthora. Newly developed methods of control involving less wasteful use of fungicides are described for planters.

317. FERNANDO, T.M.

Oidium leaf disease - the effect of environment and control measures on incidence of disease and atmospheric spore concentration. Q. Jl. Rubb. Res. Inst. Ceylon. 48 (1/2) 1971 : 100-111, 6 graphs (1 fold.), 2 tables, 8 refs.

Oidium heveae being a fungus disseminated mainly by an air-borne spore the production of which is influenced to a great extent by weather conditions. This paper outlines the results of a study, and discusses the significance of the findings in relation to the incidence of the disease and the outcome of the control measures adopted. The results of this study shows that the propagation of the causal fungus (O. heveae) is encouraged by high humidities and low temperatures accompanied by mist during the night. These conditions are always followed by high catches of spores in the trap. On the other hand, hot dry periods being followed by poor catches of spores. Therefore Oidium control in susceptible clones should be confined to periods of dull, cool, humid weather. Sulphur dusting is not warranted during periods of bright sunny weather and dusting rounds falling due in such periods should be skipped.

318. HEINISCH, K.F.; NADARAJAH, M. and VEERABANGSA, M.T.

Investigations of the effects of copper dusts used to control Phytophthora leaf disease, Part I. Copper contamination of latex and scraps. Q. Jl. Rubb. Res. Inst. Ceylon. 37 (3) 1961 : 61-74, 16 tables, 27 refs.

It has been found that despite the prevention in the field of direct contamination of the latex by copper dusting the natural copper content of the rubber may increase, indicating that the copper may enter the tree either through the leaves or through the roots. The panel scrap often shows a much higher copper content than the latex and it is suggested that this is caused by a higher content of phenol oxidase in the scrap, the enzyme being excreted from the bark tissue wounded by the tapping operation. The contamination of rubber due to copper dusting is mainly a problem of the scrap grades, and it would appear that the use of skirt-type polythene rainguards covering the tapping panel, may considerably reduce the risk and degree of copper contamination. A high degree of contamination of commercial lower grade rubbers is mainly due to insufficient care in the field and to non-compliance with the recommendations for minimizing the risk of contamination. With the implementation of the recommended precautions and treatments no serious copper contamination should occur. (Authors' summary).

319. HEINISCH, K.F.; NADARAJAH, M. and VEERABANGSA, M.T.

. Investigations on the effects of copper dusts used to control Phytophthora. leaf disease. Part II. Removal of copper from scraps. Q. Jl. Rubb. Res. Inst. Ceylon. 37 (4) 1961 : 103-111, 1 plate, 7 tables, 17 refs.

Research carried out in Ceylon shows that panel scrap may have a high natural copper content. It is recommended to apply a treatment for the reduction of this Cu content as a normal procedure throughout the year and not only during the relatively short period of dusting against Phytophthora. It is recommended, therefore, to soak all panel scraps and earth scraps and preferably also the cup scraps for two days in five to ten times the volume of fresh serum to which 0.1 per cent "Detergent 4OE" may be added. In case of oxalic acid serum alone the soaking period should only be 1 day unless Detergent is added. Another procedure ensuring a better removal of mechanical dirt, would be to soak the scraps for two days in serum, followed by a 2 days soaking in a solution of 0.2 per cent Detergent 4OE and 0.1 per cent Trisodium phosphate.

320. JEEVARATNAM, A.J.

A note on boron toxicity in young replantings. R.R.I.C.

Bulletin (N.S.). 2 (1/2) 1967 : 22-23.

Marginal necrosis of other wise healthy green leaves was observed in rubber estates and was ascribed, after foliar analyses, to Boron toxicity and/or Calcium deficiency. Liming was recommended for control. It will be noted that the remedial treatment for both boron toxicity and calcium deficiency is the same. Published separately as a Advisory Circular. (R.R.I.C. Advisory Circular No. 78, 1967).

321. JEEVARATNAM, A.J.

Tree damage caused by wind in rubber plantations. Q. Jl.

Rubb. Res. Inst. Ceylon. 40 (3/4) 1964 : 64-73, 1 table.

There is increasing evidence to indicate that losses due to tree damage caused by wind in mature rubber plantations is becoming a serious problem to contend with. It would appear that, though in the past certain suggestions have been made on ways and means of alleviating the extent of damage, the doubts expressed on the possibilities of effecting any real improvement in mature plantations in this respect were not altogether unfounded. As envisaged earlier, the possibilities of effecting a marked improvement would, therefore, appear to be greater in future replantings and new plantings. In view of the above considerations an attempt has been made to present the problem of wind damage in its correct perspective, in order to emphasize the necessity for the early adoption of measures and would lead to a reduction of wind damage in the future. Observations and statistics, on the nature and extent of tree damage caused by wind at the experimental stations of the Rubber Research Institute and on a few commercial estates are reported to focus attention on the importance of adopting measures that would lead to better anchorage of trees, and prevention of gaps within plantations. Some of the measures that may be adopted to achieve these objectives are discussed. (Author's summary).

322. JEEVARATNAM, A.J. and KANTHASAMY, T.

Use of herbicides for weed control in seedling nurseries :

Preliminary Report. Q. Jl. Rubb. Res. Inst. Ceylon. 38

(1/2) 1962 : 11-12, 1 plate (5 photos.).

323. LIYANAGE, A. de S.

Control of white root disease caused by Rigidoporus (fomes)

lignosus. R.R.I.S.L. Bulletin (N.S.). 11, 1976 : 24-29,

3 photos.

A description on the identification and control of white root disease caused by the fungus Rigidoporus lignosus in rubber. Sulphur dusting is recommended only at planting and during the first year after planting. At a later stage a collar protectant should be used.

324. LIYANAGE, A. de S.

Economics of white root disease control. R.R.I.S.L.

Bulletin (n.s.). 12 (1) 1977 : 51-57, 2 tables, 7 refs.

A description of a survey and a estimation of the damage caused by the fungus Rigidoporus lignosus (fomes) lignosus), including economics of control measures.

325. LIYANAGE, A. de S.

Influence of some factors on the pattern of wintering and on the incidence of Oidium leaf fall in clone PB 86.

Jl. Rubb. Res. Inst. Sri Lanka. 53, 1976 : 31-39, 6 tables, 9 refs.

Data are presented on the wintering pattern of rubber trees (clone PB 86) of different ages and planting densities and on the incidence of leaf fall due to Oidium heveae in several low- and mid-country districts in Sri Lanka. (Horticultural abstract 48 (7) 1978 : abs. no. 6927).

326. LIYANAGE, A. de S.

Review of the Plant Pathology Department, [R.R.I.S.L. for 1976] 7. Rubb. Res. Inst. Sri Lanka. Ann. Rev. 1976 (1977), pp. 67-113.

The wintering pattern, host phenology and the incidence of secondary leaf-fall due to infection by Oidium heveae was recorded on four cultivars. Rod traps were successfully used for the first time in Sri Lanka, to trap Oidium spores. The pre- and post-penetration behaviour of O. heveae on several cultivars were examined. Scanning electron microscopy of leaves, naturally infected by O. heveae, showed several interesting morphological features. A useful technique was developed to examine the structural details of Phytophthora species, by growing the fungus on a smear of Lima Bean Agar (LBA) on a microscope slide. Biochemical investigations on resistance to Phytophthora spp. showed that there were differences in the phenolic compounds present in different Hevea clones. Some of those compounds inhibited spore germination in the Phytophthoras isolated from rubber. Clone RRIC 101 had the highest phenolic content in pods. The content of phenolics was significantly higher in healthy bark of clone PB 86 than in bark infected by Bark Rpt, caused by Phytophthora spp. The clones which are known to be susceptible to Bark Rot had a higher bark moisture content than from resistant clones. It was found that there was a significant difference in the number of latex vessel rings in

virgin and callused bark. Therefore, the excision of Bark Rot infected bark in the curative treatment of this disease is not likely to result in a reduction in yield, if there is a direct relationship between the number of latex vessel rings in the bark and yield. There were no significant differences between several proprietary and local formulations on the rate of bark renewal. Therefore, the use of expensive proprietary formulations to encourage bark renewal, after surgical treatment for Bark Rot control, is not warranted. It was observed however that bark of Clones RRIC 52 and RRIM 513 callused over more rapidly and evenly after injury, than that of clone PB 86. The use of preserved latex as an adjuvant with fungicides has given promising results in controlling Bark Rot. Clonal susceptibility to Oidium, Phytophthora and Gloeosporium leaf diseases, Bark Rot and White Root disease were determined under laboratory and field conditions. Most of the high yielding Eastern clones were susceptible to Oidium and Gloeosporium leaf diseases, but clones of F, FX and IAN origin were resistant. It was found that clones could be screened for Bark Rot control at an early age. Varying degrees of clonal resistance was noted for Bark Rot. Studies on the effect of temperature, pH, light and dark and relative humidity on the growth of several isolates of Rigidoporus (Fomes) lignosus have shown that there are differences in the rate of growth, morphology and pathogenicity of different isolates of this fungus. Its growth pattern in different soil types is also different. The development of the sporophore and the pattern of basidiospore release of R. lignosus showed that there are a bimodal pattern of spore release in the fungus, with peaks between 0400 h and 0800 h and 1900 h and 2100 h. Spores were abundant during the period 0400 to 0800 h. A seedling technique has been successfully developed to evaluate clones against infection by R. lignosus. RRIC 52 appears to be resistant to infection by this fungus.

327. LIYANAGE, A. de S.

Review of the Plant Pathology Department, [R.R.I.S.L.
for 1977]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1977
(1978), pp. 66-98.

White Root disease caused by Rigidoporus lignosus is the most serious disease problem on Hevea in Sri Lanka. It has been shown that about 8 - 9 per cent of the total area cultivated in the wet rubber growing districts is affected by

this disease. Laboratory studies have shown that there is tremendous variation in the pathogen and differences were also observed in the nature of its spread in different soil types. A number of experiments have been initiated to examine the most effective method for its control. This involves studies on different methods of clearing the land prior to replanting, and soil amendment, particularly with sulphur, to develop a biological method of control. Black Root disease, caused by Xylaria spp. was detected in a number of Estates in the Kegalle District. The application of Fomac on the healthy roots after removal of infected laterals has given good control of the disease. It was observed that virgin bark is more susceptible to Bark Rot infection than renewed bark and also that the spread of the lesion appears to be better during wet than in dry weather periods. Although there were clonal differences in the rate of callusing of bark, application of various chemicals did not improve the rate of bark renewal. Bark Rot was effectively controlled by incorporating a wetting agent to low ammonia centrifugal latex containing phenyl mercuric acetate. The phenolics produced in response to infection of rubber pods of RRIC 100 by Phytophthora spp. appear to be released from pre-formed conjugates. Susceptibility to Bark Rot at the nursery stage could be evaluated when the lesion area is measured. It was shown that some clonal seedlings were more resistant to R. lignosus than others.

328. LIYANAGE, A. de S.

Review of the Plant Pathology Department, [R.R.I.S.L. for 1978]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1978 (1979), pp. 54-87.

White Root disease caused by Rigidoporus lignosus is the most serious disease of rubber in Sri Lanka and about 8 - 10 per cent of the total area cultivated with rubber is affected by this disease. Immediate steps should be taken by all concerned, to take adequate action to eradicate infected roots at the time of uprooting for replanting. A new root disease caused by Fusarium salani f. sp. heveae was detected, for the first time and there was clear evidence that the fungus has gained entry into the host through the wounds caused by severe pruning of roots. Field investigations on epidemiology of Oidium heveae revealed that RRIC 7 and 52 were the most susceptible and resistant clones, respectively. There were two peaks of secondary leaf fall on susceptible clones and two peaks of spore production were also evident. "Bayleton" was as effective as sulphur in controlling Oidium under field conditions. Some of the local and introduced clones were more

resistant to Bark Rot than the other clones. The susceptibility to Bark Rot varied when grown at different locations. The use of different knives, tapping systems and zoospore concentrations, affected the susceptibility and spread of Bark Rot in the clone PB 86. PB 86 was more susceptible to Colletotrichum gloeosporioides than RRIC 100 and 103 but less than RRIC 52. Appressoria were commonly found along the junctions of epidermal cells. Well developed acervuli were formed within 72 h of inoculation. Leachates of different clones also affected the germination and growth of this fungus. Sporocarps of Rigidoporus lignosus show a bimodal pattern of spore release and viable spores were released from early stages of development. There were several critical conditions for basidiospore germination. Basidiospores successfully colonised rubber wood under laboratory conditions but failed to do so under field conditions. Stock plants of clones RRIC 45, 101, LCB 1320 and IRCI 9 appear to be more resistant to Rigidoporus than a number of other root stocks. Contamination of rubber sheets with various species of fungi significantly affected the Plasticity Retention Index, Volatile Matter, Dirt Content and Plasticity.

329. LIYANAGE, A. de S.; GUNARATNE, W.D.L.; MUNASINGHE, G.
and BANDARA, J.M.R.S.

Studies on a new disease of rubber (Hevea brasiliensis)
caused by Fusarium solani f. sp. Hevea. Proc. Sri Lanka Ass.
Advmt Sci., 34 (1) 1978 : 21.

An abstract.

330. LIYANAGE, A. de S.; NADARAJAH, M.; LIYANAGE, G.W.
and DANTANARAYANA, D.M.

Investigations on new fungicidal systems for control of bark
rot on Hevea brasiliensis. Jl. Rubb. Res. Inst. Sri Lanka.
54, part 1, no. 2, 1977 : 316-328, 3 illus. (photos.), 6 tables,
6 refs.

The efficacy of Bark Rot fungicides is significantly impaired by frequent rains. The present investigation was therefore undertaken to examine the possibility of increasing the efficacy

of panel fungicides by incorporating them in rubber latex. Several dithiocarbamates containing metal ions, chemicals such as zinc oxide and formaldehyde and fungicides recommended for Bark Rot control were used singly or in combination, in invitro trials. Zinc oxide and Zinc dithiocarbamates were of limited use, while others gave satisfactory results. The influence of rubber serum, on the activity of the chemicals and fungicides was then examined. It was shown that all the materials tested except Ziram inhibited the growth of the fungus. Pre-vulcanised latex was not found to be suitable as an adjuvant under laboratory conditions. However, satisfactory results were obtained when fungicides were incorporated into high ammonia field latex and high and low-ammonia centrifuged latex. The use of preserved latex as an adjuvant with Antimucin and Thiram (TMTD), singly or in combination, was investigated under field conditions. Infection occurred on tapping panels which were inoculated after removal of scrap, although fungicides were applied prior to inoculation. Disease also occurred on panels, when the inoculum was removed a week after inoculation, but its spread was arrested when fungicides were applied, indicating that continued application of fungicides could limit the spread of the disease. Panels which were tapped and protected with Antimucin at the time of collection of latex, when inoculated 4 hours later, without removal of scrap, showed less infection. The significance of these findings, in relation to the control of Bark Rot and the influence of these fungicides on the yield are discussed. (Authors' summary).

331. LIYANAGE, A. de S.; PERIES, O.S.; DANTANARAYANA, D.M. and LIYANAGE, N.I.S.

Studies on some factors influencing the growth and sporulation of Phytophthora palmivora from rubber, cacao and coconuts. Proc. Sri Lanka. Ass. Advmt. Sci., **33** (1) 1977 : 33.

An abstract.

332. LIYANAGE, A. de S.; PERIES, O.S. and SEBASTIAN, R.D.

Assessment of the incidence of Oidium leaf fall and economics of its control in the smallholdings. Q. Jl. Rubb. Res. Inst. Ceylon. **48** (1/2) 1971 : 112-124, 14 tables, 15 refs.

The main purpose of this survey was to assess the degree, and distribution of the incidence of Oidium in the smallholdings, the efficacy of control measures currently adopted and determine whether routine control of the disease in all rubber growing districts of Ceylon is warranted, with due emphasis placed on economic considerations. It has been found that Tjir 1 clonal seedlings succumb to Oidium infection more readily than PB 86 in the entire rubber growing area; Oidium control can be dispensed with, in all the smallholdings and estates situated below 300 ft. above mean sea level, in Colombo, Galle, Kalutara, Kegalle, Matara and Ratnapura districts. The virulence of the fungus increases at higher altitudes causing greater leaf fall and the efficacy of sulphur dusting is unlikely to cause appreciable economic losses, through yield depression, to warrant routine control on the more popular rubber clones planted recently.

333. LIYANAGE, A. de S.; WETTASINGHE, S. and DHARMARATNA, A.

The distribution, spread and control of Black Root disease in Sri Lanka. Proc. Sri Lanka Ass. Advmt. Sci., 33 (1) 1977 : 31.

An abstract.

334. LIYANAGE, G.W.; HALANGODA, L. and FERNANDO, N.

Studies on the spread of White Root disease in rubber. Proc. Sri Lanka Ass. Advmt. Sci., 33 (1) 1977 : 22.

An abstract.

335. LIYANAGE, G.W.; LIYANAGE, A. de S.; PERIES, O.S. and HALANGODA, L.

Studies on the variability and pathogenicity of Rigidoporus lignosus. Jl. Rubb. Res. Inst. Sri Lanka., 54, part 1, no. 2, 1977 : 363-372, 3 illus. (photos.), 2 graphs, 7 tables, 14 refs.

White root disease in Hevea, caused by the fungus Rigidoporus lignosus (Fomes lignosus) occurs widely in Sri Lanka. In recent years, the severity of the disease has increased alarmingly. One of the factors that could be attributed to the increased incidence of the disease is the

virulence of the pathogen. This paper reports the results of laboratory experiments on the effects of pH, temperature, light and dark, and relative humidity on a number of isolates, obtained from sites located in different rubber growing areas. The fungus is able to grow over a wide range of temperature with maximum growth being reported at 30°C. All the isolates grew better when kept in continuous darkness except one isolate which grew equally well under both light and dark conditions. There was wide variability in the pH requirements for the growth of the fungus. The virulence of the different isolates was examined using healthy rubber roots under laboratory conditions and rubber seedlings in pot culture. The results show that there are differences in virulence and pathogenicity. (Authors' summary).

336. LIYANAGE, G.W. and PERIES, O.S.

The control of white root disease in Sri Lanka. Q. Jl.

Rubb. Res. Inst. Sri Lanka (Ceylon). 50 (3/4), 1973 :

201-207, 3 tables, 24 refs.

This paper reviews the control of Fomes lignosus in rubber in Sri Lanka. The current recommendations include the destruction of infected material when uprooting the old stand; sulphur treatment of the immediate area; the use of PCNB-based collar protectants. The isolation of diseased trees by means of trenches is not recommended.

337. LIYANAGE, N.I.S.; YAPA, P.A.J.; PERIES, O.S. and
LIYANAGE, A. de S.

Production of phytoalexins in Hevea pods in response to infection by Phytophthora spp. Proc. Sri Lanka. Ass. Advmt.

Sci. 33 (1) 1977 : 24-25.

An abstract.

338. LLOYD, J.H.

The control of abnormal leaf-fall disease
(Phytophthora palmivora Butler) of Hevea in Ceylon.
Agalawatta, Rubber Research Institute, 1963, [iv], 54 p.,
11 plates, 46 tables, 76 refs. (Bulletin No. 57).

The author examines in this bulletin, the control, application and economy as well as details of methods, and this involved the following investigations:
1. Laboratory and field assessments of application characteristics of spray and dust formulations of copper fungicides. 2. Assessments of application performance of spraying and dusting machinery. 3. Field trials and operational assessments of spraying and dusting for the control of Leaf-Fall and on the incidence of Bark Rot. 4. An appraisal of the epidemiology and economics of Phytophthora disease of rubber in Ceylon. In view of their diversity, these investigations have described in this bulletin in four separate parts, and a summary of each investigation has been given. The main conclusion reached from these investigations has been that Phytophthora Leaf-Fall is not economically important enough to warrant control on any scale, and certainly not to warrant helicopter-spraying or pump-spraying. Moreover, in view of various important limitations of spraying and dusting by available ground machines it was speculative whether their use for attempts at control would result in a worthwhile effectiveness even when applied only in the restricted areas where Phytophthora Leaf-Fall occurs seriously enough to warrant control in most years. Finally, the prospects of even obtaining hand-portable machinery powerful enough to spray mature Hevea rubber appeared to be very remote.

339. LLOYD, J.H.

Les problèmes posés par le traitement des maladies du feuillage des Hévéas adultes. (Problems of the control of leaf diseases in mature rubber trees.) Machinisme Agricole Tropical (France), 12, 1965 : 19-27, photos., tables.

Fungicidal control of Hevea leaf diseases is discussed with special reference to Ceylon and India. The canopy of mature trees is often beyond the reach of ground sprayers except the heaviest types which generally cannot be used in rubber fields. Consequently, Oidium is controlled by dusting with sulphur using portable machines although it has been shown that spraying could be more effective. Late attacks cannot be satisfactorily controlled because the developing foliage slows down the air stream from the duster. This factor is even more important in wet-season spraying with copper against Phytophthora. One pre-monsoon spraying with a copper fungicide in oil would suffice if suitable equipment for its application were available. A portable yet powerful sprayer is badly wanted. English Summary. (Tropical Abstracts. 21 (7) 1966 : p. 1549).

340. LLOYD, J.H.

Problems of applying sprays and dusts to mature Hevea rubber in Ceylon. Journal of Agricultural Engineering Research (England). 8 (3) 1963 : 240-251, tables, photos., 20 refs.

Spraying and dusting for the control of leaf diseases in mature rubber in Ceylon require air-flow machines that are powerful enough to have a vertical range of 75-85 ft. and yet sufficiently small and light to be portable. Physical assessments showed that, under canopy-free conditions, sprays and dusts were deposited in comparable amounts at all heights up to 85 ft. In rubber plantations sprays and dusts seemed to be affected equally by canopy to the extent that there was hardly any spray or dust deposited beyond a height of 30 ft. under conditions where the understorey was low and the canopy was dense and continuous. Prospects of developing the required type of portable sprayer were considered to be remote. However, there is an important need for such a machine not only for use in rubber, but also for other tall crops such as coconut, oil palms, and for forestry. (Author's summary).

341. MUNASINGHE, H.L.

Algal spot of Hevea leaves in Ceylon. Q. Jl. Rubb. Res. Inst. Ceylon. 37 (2) 1961 : 49-50, 4 plates, 4 refs.

This short article is only meant as a record of the algal spot condition in Ceylon. No attempt is made to deal with it in detail. Two algae were found to cause the condition. Phycopeltis sp., as an epiphyte and Cephaleuros mycoidea as a mild parasite. This condition is of no economic importance and does not warrant any control measures. (Author's summary).

342. MUNASINGHE, H.L.

Black root disease of Hevea caused by Xylaria thwaitesii.

Q. Jl. Rubb. Res. Inst. Ceylon. 48 (1/2) 1971 : 92-99,

6 illus. (photos.).

The symptoms and control of the fungus disease caused by Xylaria thwaitesii are described. In a pilot survey on the control, satisfactory control was achieved by excavation of root system, excision of diseased roots, removal of food base from the soil and refilling with the same soil. The treatment of control with PCNB grease appeared to enhance root regeneration appreciably.

343. NEWSAM, A.

Root diseases of Hevea. Q. Jl. Rubb. Inst. Ceylon.

42 (3/4) 1966 : 48-52.

Scientists from various Asian and African countries met in Colombo on November 25, 1965, to exchange information on Hevea diseases. A summary of the discussion is reviewed in these pages. Dr. O.S. Peries, speaking of root disease in Ceylon, referred to: The restricted role of fungicides in treatment - removal of the food base being the essential feature; indications that a useful degree of biological control can be achieved by adding sulphur to the soil to alter the microflora; the possibility of excluding root disease fungi from tree stumps by encouraging their colonisation by saprophytes; the changed economic situation in Ceylon, making it imperative to cut down labour requirements.

344. PEIRIS, H.H.

Sulphur dusting of smallholdings in 1967. R.R.I.C.

Bulletin (N.S.). 3 (1/2) 1968 : 20-24, 1 graph, 2 tables.

A state-aided co-operative sulphur dusting scheme is organised every year by the Smallholdings Department of the Rubber Research Institute of Ceylon (RRIC) for the purpose of controlling Oidium leaf disease on smallholdings, which advises and guides the smallholders and organizes the dusting groups. In 1967, the scheme gave satisfactory results and the most of the smallholders who took part, have expressed their willingness to participate in the following years.

345. PERIES, O.S.

An assessment of the significance of the food base in relation to infection of Hevea roots by Fomes lignosus.

Plant Disease Reporter (U.S.A.) 58 (4) April 1974 : 295-297, table, 7 refs.

All timber and stumps of an old stand of Hevea are now burned or removed from the site when preparing land for replanting rubber. This organic material can be retained on the site without significant effect on root disease incidence in the replanted area. This practice can improve soil conditions, but should be confined to areas where the incidence of root diseases in the senile stand is low. (Author's summary).

346. PERIES, O.S.

The control of Oidium leaf disease of Hevea on the basis of experimental data. The Planter (Kuala Lumpur) 49, 1973 : 452-455.

This paper is written in order to assist the planter to obtain the maximum benefits from the sulphur dusts, by adopting methods developed over a number of years at the Rubber Research Institute of Ceylon, on the basis of yield experiments. Sulphur dusting is a very simple though

effective method of controlling Oidium. If these methods are followed, adequate control of the disease can be achieved with 3 to 4 mounds of dusting.

347. PERIES, O.S.

A critical study of the use of weather data for the economic control of Hevea diseases. Q. Jl. Rubb. Res.

Inst. Sri Lanka (Ceylon). 50 (3/4) 1973 : 208-217,

2 graphs, 3 tables, 22 refs.

The correlation between weather and incidence of Hevea diseases is analysed in this paper and the importance of the study of the biology of the fungus in effecting economic disease control is discussed. Laboratory studies on the effects of temperature, humidity, light and air movement on Oidium hevea, Colletotrichum gloeosporioides and Phytophthora sp. are reported, which confirm the validity of weather data as a basis for predicting the incidence of leaf and stem disease of Hevea, and how they can be used to economise on disease control costs.

348. PERIES, O.S.

The disease of Hevea, problems and progress by 2000 A.D.

Rubber Board Bulletin (India) 12 (4) 1975 : 125-128,

21 refs.

The author attempts to analyse how the diseases of Hevea are likely to be controlled in A.D. 2000 at minimum cost, on the basis of the studies now being conducted in various Rubber Research Institute in the world. Research and development has reduced the average cost to 0.5 cents per pound now in Sri Lanka. Developments in the near future, which have been described in this paper, are likely to reduce the cost of disease control to negligible amounts in the next 2 decades. Developments of new clones and various biological control methods, future identification and control of virus diseases should further reduce the cost.

349. PERIES, O.S.

The ecology of Phytophthora meadii McRae, the causal agent of bark rot and mature leaf fall of Hevea. Proc. Ceylon Ass.

Advmt. Sci., 29 (1) 1973 : 68-69.

An abstract.

350. PERIES, O.S.

Economics of control of the white root disease
(Fomes lignosus) of Hevea brasiliensis in Ceylon. In:
Root disease and soil-borne pathogens : Second
International Symposium on Factors Determining the
Behaviour of Plant Pathogens in Soil; held at Imperial
College, London, July 11-28, 1968; edited by T.A.
Toussoun, Robert V. Bega and Paul E. Nelson. Berkeley,
University of California Press, 1970. pp. 191-193,
4 tables, 11 refs.

This paper discusses the results of a series of experiments conducted specifically to assess the cost of controlling the disease. The most economic procedure is to eradicate all roots of infested trees at the time of uprooting, and to plant at a slightly higher density than normal. Detection is best done by the method of foliar inspection. Collar protection of trees adjacent to those infected is economical. The writer is of the opinion that the spread of Fomes is more rapid in Ceylon than in Malaysia because of the higher rainfall recorded in Ceylon.

351. PERIES, O.S.

The economics of disease control in Hevea. R.R.I.C.
Bulletin (N.S.). 1 (2) 1966 : 27-33. / In Q. J1. Rubb.
Res. Inst. Ceylon. 42 (3/4) 1966]

A description of the fungus diseases Oidium (O. heveae), Phytophthora (P. meadii), and Gloeosporium (Glomerella cingulata) leaf diseases; bark rot (Phytophthora sp.) and white root disease (Fomes spp.).

352. PERIES, O.S.

Epidemiology of Oidium. Q. Jl. Rubb. Res. Inst. Ceylon.

38 (3/4) 1962 : 83.

A note on the epidemiology of Oidium leaf disease of Hevea.

353. PERIES, O.S.

The etiology of "bark cracking" disease of Hevea

brasiliensis. Plant Disease Reporter (USA). 61 (11) 1977 :

946-948, figs., table, 4 refs.

Bark cracking, accompanied by the exudation of latex in rubber trees was first recorded in 1930. The disease retards the growth of immature trees and delays their coming into production by 12-18 months. Experiments from Sri Lanka confirm that the disease is caused by a graft-transmissible agent. Available information indicates that a vector does not play a part in the transmission of the disease. Eradication of the disease appears to be feasible by ensuring that budwood for grafting is never taken from areas that have a history of bark cracking. (Author's summary).

354. PERIES, O.S.

Factors affecting infection of Hevea bark by Phytophthora

species with special reference to disease control. In:

Proceedings of the International Rubber Conference, Kuala

Lumpur, 20-25 October 1975. Kuala Lumpur, Rubber Research

Institute of Malaya, 1976. Vol. 3, pp. 199-212, 3 photos.,

3 graphs, 2 tables, 18 refs.

A detailed study was made of the infection of Hevea bark by Phytophthora species, with special reference to the environment, in order to provide data for the most economic control of the disease. Critical studies were also made on the use of fungicides for the prevention and control of the disease. (Author's summary).

355. PERIES, O.S.

Incidence and control of bark rot in Hevea brasiliensis. Planter (Malaysia) 51 (596) 1975 : 491-498, photos., tables, 11 refs.

Bark rot, Black Tread or Stripe Canker is an endemic bark disease of the rubber tree in Sri Lanka. Studies showed that a spore suspension containing 10 zoospores per ml. equivalent to 1 zoospore per drop, can cause infection of injured bark. Tapping of wet trees is therefore dissuaded when the inoculum is present, i.e. during the occurrence of infected pods or leaves. The recommended curative treatment of the disease consists of removing all infected bark. There is no necessity to chisel out discoloured wood as the studies also have shown that the fungus does not penetrate deeply into the wood. (Abstract on Tropical Agriculture. 2 (8) 1976 : 09890).

356. PERIES, O.S.

Methods for the biological control of white root disease (Fomes lignosus) of Hevea. Proc. Ceylon Ass. Advmt. Sci. 29 (1) 1973 : 68.

An abstract.

357. PERIES, O.S.

The nomenclature of the Phytophthora spp. causing bark, leaf, pod and twig diseases of the rubber tree in Ceylon. Q. Jl. Rubb. Res. Inst. Ceylon. 42 (1/2) 1966 : 1-8, 5 photos., 5 tables, 21 refs.

Four diseases of the Hevea rubber tree : abnormal leaf fall, bark rot, die-back of green twigs and pod rot, are caused by one or more species of Phytophthora. There has been a great deal of controversy regarding the species of this fungus affecting Hevea in this country. The purpose of this paper is to present a review of the relevant literature on the nomenclature of the Phytophthoras affecting tropical crops, to summarize the studies carried out on the different forms of the fungus isolated from Hevea in Ceylon, and to give a full

description of the most common form of it found in this country. The author is of the opinion that the correct name for the causal fungus of the four diseases mentioned above is P. meadii.

358. PERIES, O.S.

Oidium heveae Steinm. In: Diseases, Pests and Weeds in Tropical Crops, edited by Jürgen Kranz and others. Berlin, Verlag, Paul Parey, 1977, pp. 220-222, 2 illus., 4 refs.

Brief description on Geographical distribution, host plants, symptoms, morphology, physiological specialization, epidemiology and control.

359. PERIES, O.S.

The perennations of Oidium heveae the causal agent of Oidium leaf disease of rubber. Proc. Ceylon Ass. Advmt. Sci. 29 (1) 1973 : 65-66.

An abstract.

360. PERIES, O.S.

Phytophthora spp. on Hevea brasilliensis. In: Diseases, Pests and Weeds in Tropical Crops, edited by Jürgen Kranz and others. Berlin, Verlag, Paul Parey, 1977, pp. 86-89, 3 illus., 3 refs.

A brief description on geographical distribution, host plants, symptoms, morphology, physiological specialization, epidomology and control.

361. PERIES, O.S.

Present status and methods of control of leaf and panel diseases of Hevea in South East Asian and African countries.

Q. Jl. Rubb. Res. Inst. Ceylon. 42 (3/4) 1966 : 35-47,

9 refs.

This paper presents a summary of proceedings of a liaison meeting sponsored by the International Rubber Research and Development Board, held in Colombo on 25th November 1965, pertaining to the discussions on leaf and panel diseases. The diseases discussed in this summary are: Oidium leaf disease, Phytophthora, leaf disease Glomerella cingulata, Helminthosporium leaf disease, Dothidella leaf disease, Phytophthora bark disease, moldy rot Cerotocystis fimbriata and pink disease Corticium salmonicolor.

362. PERIES, O.S.

Recent developments in the control of the diseases of the Hevea rubber tree. Q. Jl. Rubb. Res. Inst. Ceylon. 41 (1/2) 1965 : 33-43, 5 tables, 13 refs.

This paper discusses the control of Oidium and Phytophthora leaf diseases, Bark Rot and White Root disease. Recent studies on the biology of Oidium heveae have shown that this fungus thrives under conditions of comparatively low temperatures and high humidities. Intense sunlight and free water on the leaf surface are injurious to the fungus. Therefore, control measures are most likely to be necessary during periods of dull weather with little rain, especially when there is excess dew in the night and early mornings. Clone PB 86 has been found to be relatively resistant to Oidium leaf disease and a restricted dusting programme has been recommended for this clone. Experimental evidence has shown that there is a direct correlation between pod-set and Phytophthora leaf fall, the pods being infected first and providing the spores for leaf infection. It is now considered that the general control of secondary leaf on all estates is not warranted. A method of forecasting Phytophthora leaf disease epidemics has been proposed here, together with a scheme of dusting small acreage which become affected by the disease every year. Field experiments have shown that Fylomac (90) is the most effective fungicide for Bark Rot control of PB 86, whereas a number of fungicides, including phenolics like Brunolinum plantarium and Izal, can control this disease on the less susceptible Clones

like Glen 1, RRIC 45 and 52, Tjir 1 and Wagga 6278. It is suggested that the planters carry out field trials on small acreages with the appropriate materials on the respective clones, until further experiments now being carried out by the R.R.I.C. on this subject are concluded.

363. PERIES, O.S.

Review of the Plant Pathology Department [R.R.I.C. for 1961] 7. Rubb. Res. Inst. Ceylon. Ann. Rev. 1961 (1962), pp. 56-63.

Incidence of Oidium leaf disease was mild in most districts, the weather conditions during the refoliation period being not conducive to the development of the fungus. The comparative effectiveness of spraying and of dusting for the control of the disease was investigated in 5 field experiments covering an area of 118 acres and confirmed the previous year's findings that, provided adequate coverage of the foliage is obtained, better control is obtained by spraying than by dusting. Incorporations of certain chemicals in the wettable sulphur preparations, used as sprays for Oidium control, caused a fairly high incidence of flower drop but it is doubtful whether this method of indirect control of Phytophthora by reducing fruit set would be either practical, or economic on a commercial scale. The incidence of Phytophthora leaf fall was relatively low during the early part of the South West monsoon season but showed a marked increase during the abnormally wet months of August and September. The most effective method of control would appear to be by spraying rather than by dusting and a water suspension of copper oxychloride to which is added a new low volume formulation has given the best results in our field experiments. Black Stripe disease caused by Phytophthora palmivora was not much in evidence until the later stages of the monsoon when a heavy incidence was reported from some districts. The incidence of Gleosporium leaf disease has not been serious during the first half of the year although some damage to young shoots and leaves was recorded in a number of young replanted areas. No serious cases of Pink disease were reported to the Institute during the period under review. The incidence of White Root disease in young replanted areas remained within normal limits. A questionnaire on the effect of Tillex treatment, returned by 84 estates revealed the high effectiveness of Tillex in the control of White Root disease, early treatment with the chemical resulting in 75 to 80 per cent of cures.

364. PERIES, O.S.

Review of the Plant Pathology Department, [R.R.I.C. for
1962]. Rubb. Res. Inst. Ceylon. Ann. Rev. 1962 (1963),
pp. 57-70.

The incidence of Oidium leaf disease was light in all rubber districts. Heavy leaf fall was, however, experienced in late wintering areas. The foliage of most clones in 1962 was about the best seen for many years. The results of two field experiments confirmed that spraying with sulphur-based fungicides can be as effective as sulphur dusting against Oidium infection. The incidence of secondary leaf-fall caused by Phytophthora palmivora and Black Stripe (Bark Rot), caused by the same fungus was very light during the year under review. Field experiments, dealing with the control of Phytophthora Leaf-Fall was carried out by the Agricultural Engineering on the physical and biological efficiency of the spraying and dusting methods adopted in this country. A separate report has been submitted by him on this findings. A preliminary selection of seven fungicides suitable for the control of Bark Rot has been made, based on the results of detailed laboratory and small-scale field experiments. The further testing of the selected fungicides under field conditions was carried out in the latter half of 1962. The application of a selected fungicide for the control of Bark Rot has shown that the treatment at the time of latex collection is significantly better than the treatment before the commencement of tapping. An assessment of the incidence of Gloeosporium and the economic importance of Gloeosporium leaf disease in Ceylon has been made. The results of a number of field experiments on the control of Fomes lignosus have indicated that the use of organo-mercuric compounds for the control of White Root disease in Ceylon under field conditions may not be justified and the position will have to be reviewed in the light of results obtained from further experiments carried out by the Pathology Department. Three long-term experiments have been initiated at Dartonfield to compare the effectiveness of the different methods of identifying and treating Fomes infected plants. A simple method of inoculating Hevea roots with the fungus Fomes lignosus was perfected during the year. The Agricultural Engineer in his report has provisionally drawn our attention to the serious doubts he has on the biological efficiency of the intensified use of copper fungicides in Ceylon for the control of Phytophthora Leaf-Fall. His report on the ineffectiveness of the dusting and spraying machines to deposit the copper fungicides efficiently on the leaves and on the better 'fainfastness' qualities of selected copper sprays compared

with colloidal dusts is based on factual data obtained in the field and laboratory. The findings of the Agricultural Engineer indicate that the economic importance attributed to Phytophthora Leaf-Fall is not justified and that a considerable saving can be effected by less intensive dusting and spraying in the future. Laboratory work under the guidance of the Plant Pathologist has been concentrated on the biological studies and the host-parasite relationships of the two leaf disease fungi, Oidium and Phytophthora with special emphasis on the methods of perennation of these fungi. Studies on the methods by which Phytophthora tides over periods unsuitable for its growth, on bark, pods, fallen twigs and branches of Hevea have given results, which could lead to a more economic use of fungicides in the future. Recent studies have indicated that mummified pods act as a source of primary inoculum of the fungus for the new season.

365. PERIES, O.S.

Review of the Plant Pathology Department, ✓ R.R.I.C. for 1963 7. Rubb. Res. Inst. Ceylon. Ann. Rev. 1963 (1964), pp. 48-69.

The Head of the Division was appointed to co-ordinate research work carried on leaf and bark diseases in Hevea rubber between member countries of the International Rubber Research and Development Board in the United Kingdom. The Advisory Services of this Division have considerably increased in connection with the methods of disease control on estates. A number of field experiments have been initiated by the Division on commercial estates, which require the personal supervision of the Head of the Division and his technical staff. A total of 788 estate visits have been made during the year under review. The wintering season in 1963 was abnormally long and certain clones defoliated up to the first week in May. The late wintering clones suffered heavy attacks of Oidium, causing considerable leaf-fall. The foliage in general was not up to the standards of luxuriance observed in 1962. Prolonged rainfall causing wetness on leaves for a long period (2-3 days) militates against the rapid spread of the Oidium fungus. The incidence of Phytophthora leaf disease was comparatively mild in spite of the heavy rainfall recorded in 1963. Six Phytophthora-control field experiments were carried out during the year; five of these for comparing dusting and spraying methods and one for demonstrating relationship between pod-set and the incidence of Phytophthora leaf disease. In general, the incidence of

the disease was too mild for results of any practical value. Studies on the biology of Phytophthora spp. have been completed and papers on sexuality and perennation of the fungus have been prepared for publication. The time taken by the parasite to infect pods, petioles and leaf blades has been clearly established. It has been found that the petiole of the leaf is much more susceptible to Phytophthora infection than the lamina; in fact, it is very rarely that the lamina is infected under field conditions in Ceylon. The time taken for lesion production on petioles of rubber leaves at various temperatures is summarized in Table I of the Divisional Review. It has been established quite definitely that the Phytophthora spp. grow and sporulate best on pods and that the major part of the inoculum of this fungus for leaf-fall epidemics is produced on these fruit bodies. The Phytophthora fungus can penetrate the pod and produce a lesion within 2 hours of inoculation and incubation under optimum conditions. The incidence of Bark Rot was low for a major part of the year, but severe infection was recorded on certain estates in the last three months of the year. Field experiments have shown that the routine application of fungicides is best done after tapping. A considerable amount of work has been done on the biology of spore germination in Gloeosporium alborubrum. The fungus is now of economic importance in this country as indicated by our experience of the incidence of this disease in 1963. Preliminary studies on the susceptibility of different clones to Gloeosporium leaf disease have been completed. Studies on the mode of penetration of Fomes lignosus into Hevea roots indicate that the fungus can enter more readily through surface injuries than by the penetration of the undamaged surface. It was found that sulphur or copper sulphate added to the soil increased the acidity and caused a fundamental alteration in the composition of the microflora of the soil. These studies could lead to a method of biological control of White Root disease. The incidence of "Physiological Yellows" was very high in May/June and again in October-November 1963. This phenomenon could have been caused by abnormal and protracted wet-weather conditions. Excessive shady conditions during this year contributed to an abnormal leaf-fall, which was not associated with a pathogen.

366. PERIES, O.S.

Review of the Plant Pathology Division, [R.R.I.C. for
1964]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1964 (1965)
pp. 48-74.

Dr. O.S. Peries continued his duties as co-ordinator of research work carried out on leaf and bark diseases at all the Rubber Research Institutes affiliated to the International Rubber Research and Development Board. The wintering commenced early this year and was even in most districts, and together with the hot sunny weather prevented the development of Oidium heveae. The refoliation without a high incidence of Oidium presented a luxuriant foliage canopy in all the rubber-growing districts. No significant results were obtained from six field experiments carried out on Oidium control during the susceptible period in 1964 due to the low incidence of the disease in all experimental areas. The incidence of Phytophthora leaf disease was comparatively heavy in 1964 following the mild attack of Oidium, which favoured a heavy pod-set. The favourable weather in July for the propagation of the fungus (Phytophthora) was a contributory cause to the spread of the disease. Pot experiments for the assessment of the value of copper sulphate and sulphur for the biological control of Fomes have been concluded. The results indicated that there was a possibility for the biological control of Fomes in newly replanted areas with the use of small quantities of sulphur in each planting hole. Field experiments on Fomes for detection of the root disease were carried out. The results have indicated that the disease is best identified by leaf symptoms. The incidence of Bark Rot was above average during 1964. A field trial for the selection of the best fungicide showed that Fylomac '90' was significantly better than all other fungicide on test, at the correct concentration for the required toxicity on the causative fungus for effective control. Studies on the biology of the diseases of rubber of economic importance in Ceylon were continued. The effect of sunlight and ultra-violet light on the germination of spores indicated that both treatments were injurious to the conidia. A short period of less than an hour of exposure to sunlight or ultra-violet light was sufficient to kill the conidia. Detached spores (conidia) succumbed more quickly than spores attached to the mycelium on leaves; the latter were killed after 3 to 4 hours of exposure to sunlight. It has been found that more than one species of Phytophthora are pathogenic to Hevea rubber. Some of these can be considered as physiologic races of Phytophthora meadii. Further studies on this subject are being carried out with the help of the Commonwealth Mycological Institute, England. Studies on the perennation of Phytophthora palmivora have shown that the fungus can survive for approximately six weeks on detached dry twigs stored in the laboratory and for about 3 weeks on infected twigs in the field. The minimum time taken for the appearance of Phytophthora lesions after artificial inoculation with a

zoospore suspension on leaf petioles in 28 hours; the pods are, however, infected with a single inoculation. It has been established that infected pods provide the inoculum for petiole infection entirely by wet splash dispersal; wind dispersal plays a very minor role. A tentative method of forecasting severe leaf fall has been worked out, which generally occurs following certain weather conditions, with regard to temperature, relative humidity, rainfall, and sunshine prevailing for four consecutive days in the presence of infected pods. Such periods are most likely to occur during the mid-monsoon months of June and July in rubber-growing districts of Ceylon. The results are obtained when control measures are adopted as soon as possible after the observation of such a period. The studies on the biology of spore germination of Gloeosporium alborubrum have been concluded. The concentration of spores in the suspension used for germination studies has an overall effect on spore germination. Germination takes place most rapidly at optimum temperature; both lower and higher temperatures having a retarding effect. Germination takes place below a relative humidity of 85 per cent. A field survey of clonal susceptibility of Gloeosporium indicates that clones PB 86 and IRCI 7 are highly susceptible. Clones RRIC 7, 52 and RRIM 513 are of average susceptibility while clones RRIC 45, Wagga 6278, Mil 3/2, PR 107, RRIC 605 are below average susceptibility. One locally prepared fungicide was tested by the Institute as a control for Bark Rot. It was found to be non-toxic at 100 per cent strength. New fungicides should not be used on a commercial scale unless they have been tested by the Institute. A nominal charge of Rs. 300/= is made for testing new fungicides by this Institute. Detailed studies were carried out on the use of organo-mercurial fungicides on rubber plants. It was found that mercury is very rapidly absorbed and readily translocated from mature to immature leaves of Hevea. A spray containing 0.01 per cent Hg W/V will be the threshold phytotoxic limit to young Hevea leaves. Basic investigations on the quantitative evaluation of soil micro-organisms in rubber-growing soils were continued. Soil moisture apparently plays an important role in determining the type and distribution of soil fungi at any particular time. A total of 135 species of fungi representing 102 genera has so far been isolated from the soils and rhizospheres. This work will be continued to cover a full cycle of seasonal variations. The fungi in the rhizosphere will be of particular value in studies on the control of Fomes with the use of sulphur and copper sulphate as soil applications.

367. PERIES, O.S.

Review of the Plant Pathology Division, [R.R.I.C. for 1965] 7. Rubb. Res. Inst. Ceylon. Ann. Rev., 1965 (1966), pp. 44-58.

Thirty one diseases specimens sent to the Institute in connection with advisory work were identified by this Division. Dr. O.S. Peries continued his duties as co-ordinator of the International Rubber Research and Development Board on research on leaf and bark diseases. The highlight of this work as the successful liaison meetings held in Colombo on the "Diseases of Hevea" in November 1965. Studies on the nutrition of Phytophthora meadii and P. palmivora were continued. The work on the rate of growth on various sugars have been completed, and the studies on nitrogen and vitamin requirements are now in progress. Studies on physiologic specialization of P. meadii are also in progress, and the preliminary indications are that there are at least five physiologic races of this fungus on Hevea in Ceylon. Wintering was very uneven during the Oidium leaf disease season with the result that during March and April, heavy Oidium control, 4 experiments gave no significant results while the results in respect of the other 3 experiments were significant at the 5 per cent level. In the absence of Peries Periods the incidence of Phytophthora leaf disease in 1965 was negligible. There was confirmatory evidence once again that it is the rubber pod which provides the inoculum for the leaf-fall phase of this disease. The absence of Peries Periods also resulted in none of the field experiments on Phytophthora leaf disease control reaching the level of statistical significance. The incidence of Gloeosporium leaf disease was also comparatively low in 1965. Observations were continued throughout the year on clonal susceptibility to Gloeosporium, distribution of the disease in various districts, virulence of the pathogen during different periods of the year and the relationship between foliar flush and incidence of the disease. Bark Rot was generally low during the year, except in isolated cases where the disease had got out of hand, because of failure to eradicate it in its early stages. If the disease is detected in its early stages, and remedial action is taken immediately, there is evidence now, that this disease can be kept under control even in bad years. An important precautionary measure which should be taken to ensure that the incidence of this disease is kept low is to avoid at all times the tapping of wet trees. The moisture, the nitrogen, the phenol and the amino contents of the bark of seven clones were carefully determined and compared to

ascertain whether there is correlation between any of these factors and the susceptibility of those clones to Bark Rot. The histological characteristics of the bark of these clones were also examined and compared with one another for the same reason. Two new fungicides were tested in the laboratory for bark disease control, one of them a mercury based paint, showed promise as a water-proof panel dressing. Pure culture experiments with Fomes lignosus, to assess the role of the bark in the infection of dead wood by the fungus, were initiated. Studies on the distribution of soil fungi under Hevea in various conditions are being continued. Culture of selected Rhizobia spp. for the inoculation of Pueraria seeds have been maintained in the division and issued free to estates on request. Three new spraying machines were tested and helpful suggestions for the improvements of the machines were made to the firms supplying them. Field experiments have helped to confirm the earlier belief that a certain degree of biological control of Fomes could be achieved by introducing small quantities of sulphur (about 1/4 lb.) to the planting hole. Care must, however, be taken to ensure that no more than 4 ozs. of sulphur is used per planting hole. A high dosage of sulphur can be toxic to rubber roots. Laboratory studies on the biology of spore germination and host parasite relationships of Gloeosporium, Oidium and Phytophthora as well as studies on the epidemiology of these diseases have been continued. The bark cracking phenomenon in young trees of certain clones as studied by the Head of the Plant Pathology Division indicated a virus as the causal agent. Further confirmatory evidence is being sought with the aid of electron microscopic studies.

368. PERIES, O.S.

Review of the Plant Pathology Department, [R.R.I.C. for 1966]. Q. Jl. Rubb. Res. Inst. Ceylon, 43 (3/4) 1967 : 89.

The incidence of Oidium leaf disease was the lowest on record for a number of years. Some Oidium spores became available in April which enabled further studies on germination. It was observed that direct sunlight and ultra-violet light are not quite as lethal to the conidia of Oidium heveae as to the zoospores of Phytophthora meadii. Studies on the growth of Phytophthora on media of known composition were continued with the assessment of the requirements of this fungus for nitrogen and vitamins. It has been found that Vitamin B₁ is essential for Phytophthora meadii, to grow profusely on basic synthetic media. Studies on physiologic specialization of this fungus, have shown that there are at least 5 races of this fungus in

Ceylon. In investigations on the epidemiology of Phytophthora leaf disease, critical studies have shown that pods become infected readily in the presence of little inoculum and that leaves are generally infected by the inoculum splashed from infected sporulating pods. It was also found that the sporangia can be produced on pods for periods of up to 14 days from first sporulation. The effect of temperature and relative humidity on the sporulation of Gloeosporium alborubrum on immature rubber leaves were studied to establish the correlation between weather and the incidence and spread of this disease. Gloeosporium alborubrum was found to sporulate most profusely at high humidity and relatively low temperatures. Laboratory studies on clonal susceptibility to Gloeosporium leaf disease have confirmed that PB 86 is the most susceptible while RRIC 45, 52 and 86, as well as GL 1, Mil 3/2 and Wagga 6278 are the most tolerant to Gloeosporium leaf disease. Two new fungicides 'Cerano N' and 'Pantox' were tested for their efficiency as panel fungicides. The former was found to be toxic to P. meadii as well as the bark of the rubber tree while the latter proved to be non-toxic to P. meadii. Histological studies of Bark Rot-infected tissue revealed that fungal hyphae are almost exclusively intracellular and could readily pass through cell walls. Pot experiments have confirmed that sulphur is effective in suppressing the incidence of Fomes when introduced to the soil. It appears that the mode of action of sulphur in the soil is that it suppresses the growth of all fungi other than Trichoderma viride and this fungus on the distribution of fungi in rubber-growing soils were continued and the fungi associated with healthy and Fomes-infected rubber roots are being studied.

369. PERIES, O.S.

Review of the Plant Pathology Department, [R.R.I.C. For 1971]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1971 (1972), pp. 51-61.

The incidence of Oidium leaf disease was very heavy during the re-leafing season, but those of Phytophthora and Gloeosporium leaf diseases were negligible during the S.W. monsoon season. The results of field experiments on Fomes control have shown that the use of small quantities of sulphur in the planting holes, is not likely to have any retarding effect on growth of young trees. The indications are that the timber from the old stand can be kept back in replanted areas, where the incidence of Fomes in the old stand was low, as long as certain precautions are taken.

Two more effective species of bacteria were isolated from cup coagula for the coagulation of latex. Bacterial cultures, dried over silica gel and stored in polythene vials for varying periods of time, have been found to be effective for latex coagulation.

370. PERIES, O.S.

Review of the Plant Pathology Department, [R.R.I.C. for 1972]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1972 (1973) pp. 54-66.

Studies on the production of Phytoalexins (plant antibodies) were continued whenever rubber pods were available. It is known that phytoalexins are produced as a result of the interaction of the host and the parasite. There appears to be a correlation between the amount of phytoalexin produced and the resistance of the host to the pathogen concerned. Intensive studies are being carried out on the biological control of White Root disease, including investigations on the action of sulphur, the rate of decay of rubber wood, selection of fungi causing rapid wood decay and testing their ability to act as antagonists to the pathogen. A survey of the soil fungi present in the different rubber growing soils of Sri Lanka has also been completed, to assist in the studies on the biological control of White Root disease.

371. PERIES, O.S.

Review of the Plant Pathology Department, [R.R.I.S.L. for 1973]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1973 (1974), pp. 16-24.

A new method of testing clones, at an early age, for resistance to Bark Rot has been developed. A number of clones have been screened. It has been found that clone RRIC 52 and clones bred from it show a certain degree of resistance to Bark Rot, whereas clone RRIC 45 appears to be susceptible to this disease, under the conditions of this test. Preliminary studies on wound healing following Bark Rot, have shown that the method of treatment advocated by the irregular and uneven when the lesions are left untreated. Considerable progress was made in the studies on the survival of Fomes lignosus in the soil and the effect of sulphur on Fomes control. Studies are now being conducted to assess the

the lowest dosage of sulphur required to control Fomes. The soil fungi present in the various rubber growing soils of Sri Lanka have been isolated, and many of these fungi have been identified by the Commonwealth Mycological Institute, U.K. It has been found that certain fungi, naturally present in the soil, causes more rapid decay of rubber wood than others. We are now trying to find out whether it is possible to encourage the growth of the rapid decay causing fungi under field conditions. Three types of fungi have been isolated from decaying rubber wood. Fomes grows over the first type, the second type stops the growth of Fomes and the third type not only stops the growth of the pathogen, but grows over it, producing thick hyphae. It is now necessary to find out whether the fungi antagonistic to Fomes can be encouraged to grow on rubber stumps and other wood, thereby preventing Fomes from colonising them.

372. PERIES, O.S.

Review of the Plant Pathology Department, [R.R.I.S.L. for 1974]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1974 (1975), pp. 61-65.

Observations made during the year showed that the incidence of leaf diseases of Hevea had been mild. Laboratory and field experiments carried out in the control of different root diseases have given promising results and these methods are being further investigated. Detailed investigations on Black Root disease of rubber caused by Xylaria spp., to determine the symptomatology, nature of spread of the fungus and its control, have been undertaken on several outside estates. Screening clones to test for resistance against Oidium spp., Gloeosporium spp., and Phytophthora spp., and also to determine the basis of inheritance of disease resistance characters are being carried out.

373. PERIES, O.S.

Review of the Plant Pathology Department, [R.R.I.S.L. for 1975]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1975 (1976), pp. 49-56.

The incidence of Oidium leaf disease was heavy during the 1975 refoliation season; perhaps, the heaviest it has been for several years. Generally, when wintering occurs early, as it did in 1975, the weather conditions are not conducive for heavy infection. However, during the 1975 refoliation season, the weather conditions were ideal for the propagation of the fungus, with short evening showers and high humidities maintained through out the night. This resulted in there being at least two defoliations, due to Oidium infection, in most areas and sparse canopies over all. The poor pod set consequent to Oidium infection of flowers helped to reduce Phytophthora leaf-fall and Black Stripe. The incidence of Gloeosporium leaf disease was negligible during the South West Monsoon season. There appears to be a general increase in the incidence of Fomes in replanted areas. Therefore, greater emphasis should be laid on clearing and estate sanitation prior to replanting, for the eradication of this disease.

374. PERIES, O.S.

Review of the Plant Pathology Department, [R.R.I.S.L. for 1979]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1979 (1980), pp. 54-76.

The incidence of leaf diseases was mild in 1979. White and Black Root disease are now the important diseases in the wet and dry districts respectively. F, FX and IAN, foreign clones were more resistant to Oidium leaf disease than local ones, of which the RRIC 100 series clones, particularly RRIC 103, were the best. Up to 25 per cent artificial defoliation does not affect yields but over 50 per cent does. The maximum amount of phenolic compounds were released 6 h after inoculation of pods with Phytophthora zoospores. The pathogenicity of Phytophthora isolates varies with both clone and location. Panels tapped on the d/1 and d/2 systems are more susceptible than those tapped on the d/3, and those on d/4 are not affected. Susceptibility to Bark Rot decreases with age of trees. Germinating Gloeosporium spores produce more appressoria on leaves of resistant clones than on susceptible ones, which encourage mycelial growth. One anti-fungal substance was isolated from PB 86 and RRIC 100 in chromatographic studies. The release and viability of R. lignosus basidiospores are correlated with high humidity. Detached sporocarps stop release of spores 96 h after storage at all humidities. The size of the foodbase is

important in the initiation and spread of White Root disease. Only a few plants were infected when even large food bases were buried near plants; but even small pieces of inoculum caused infection when placed in contact with roots. Therefore, soil conditions and environment are closely linked with the spread of the disease. Infected material remains viable for more than 30 months in the soil. Roots grow out of planting holes after about 6 months. Tap roots grow deep; infection too spreads deep and has been recorded at 186 cm depth. Infection of laterals was mostly confined to the top 50 cm of soil. The soil pH, lowered by the addition of sulphur, remains so for over 18 months. Several fungi antagonistic to Rigidoporus have been isolated. Mikania cordata contains a compound which inhibits Rigidoporus. The rate of decay of rubber stamps is increased by treatment with 2, 4, 5-T Xylaria (Black Root) infection can be controlled by the same methods of treatment as White Root disease.

375. PERIES, O.S.

Rigidoporus lignosus (Klotzsch) Imazeki. In: Disease, pests and weeds in tropical crops, edited by Jürgen Kranz and others. Berlin, Verlag Paul Parey, 1977, pp. 171-173, 2 plates, 4 refs.

376. PERIES, O.S.

A study of the factors affecting spore germination in Oidium heveae. Proc. Ceylon Ass. Advmt. Sci. 29 (1) 1973 : 64-65.

An abstract.

377. PERIES, O.S.

Studies on epidemiology of Phytophthora leaf disease in Hevea brasiliensis in Ceylon. Journal of Rubber Research Institute of Malaya. 21 (1) 1969 : 73-78, 1 table, 11 refs; Reprinted in Q. Jl. Rubb. Res. Inst. Ceylon. 46 (1/2) 1970 : 1-6.

The paper describes laboratory and field experiments to study the mode of infection and spread of Phytophthora leaf disease of the Hevea rubber tree. Data are provided on the rate of infection of the pods and leaf stalks at different stages of growth and under various environmental conditions; also on the intensity of sporulation of the causal fungus on various organs of the rubber tree. Green pods were found to be most susceptible to infection; sporulation was also most prolific on them. This accounts for a close relationship between pod set and Phytophthora leaf fall, the pods being infected first and providing the inoculum for leaf infection. Experimental evidence shows that Phytophthora leaf disease is spread almost exclusively by rain splash, wind having very little effect. The importance of suitable weather conditions for the propagation and dissemination of the fungus is discussed. A method of forecasting epidemics of the disease is also suggested. (Author's summary).

378. PERIES, O.S.

Studies on the liberation of spores of Oidium heveae, the causal fungus of Oidium leaf disease of rubber. Proc. Ceylon Ass. Advmt. Sci., 29 (1) 1973 : 64.

An abstract.

379. PERIES, O.S.

Studies on the relationship between weather and incidence of leaf diseases of Hevea. Planter (Malaysia). 55 (637) 1979 : 158-169, graph, photo., tables, 40 refs.

The rubber tree (Hevea brasiliensis) is susceptible to 3 important leaf diseases in Sri Lanka. These are caused by the fungi Colletotrichum gloeosporioides, Oidium heveae and Phytophthora meadii. This study evaluates the importance of the weather, as interaction between temperature, humidity including rainfall, sunlight and air movement (i.e. wind), in the development of these diseases. This knowledge can help in forecasting the intensity of leaf disease incidence, which again can assist in economising on control measures.

380. PERIES, O.S. and BROHIER, Yvette E.M.

A virus as the causal agent of bark cracking in
Hevea brasiliensis. Nature (London) 205 (4971) Feb.
1965 : 624-625, photo., 5 refs; Reprinted in Q. Jl. Rubb.
Res. Inst. Ceylon. 41 (3/4) 1965 : 102-103.

Bark cracking accompanied by the exudation of latex in young trees of certain clones of Hevea brasiliensis Müll.-Arg. has been observed in the eastern rubber growing countries for a number of years. This is a brief note on the aetiology of the disease. The serological examinations revealed that this is caused by a virus infection and not by wind damage. Planters are advised not to use budwood from nurseries in which bark cracking has been observed.

381. PERIES, O.S. and DANTANARAYANA, D.M.

Compatibility and variation in Phytophthora cultures isolated from Hevea brasiliensis in Ceylon. Transactions of the British Mycological Society (England). 48 (4) 1965 : 631-637, 3 tables, 16 refs.

Phytophthora meadii, which is generally homothallic, has recently been re-established as a species and a common pathogen of Hevea in Ceylon. Therefore, the sexual features of the Phytophthora isolates studied in these laboratories were re-examined. All were separable into two groups on the basis of sexual compatibility, and all the cultures identified as P. meadii fall into one of these groups. The isolates in the two groups can also be separated on cultural characters alone. P. meadii produces oospores in pure culture after $2\frac{1}{2}$ - $8\frac{1}{2}$ weeks of incubation, and is compatible only with the 'rubber' strains of P. palmivora. It is suggested that these factors be considered diagnostic characters of this fungus. There was considerable variation between the isolates in each group and some of them could not be identified with reference to known species of Phytophthora. (Authors' summary).

382. PERIES, O.S. and DANTANARAYANA, D.M.

The distribution of different sexual compatibility types of Phytophthora species affecting Hevea in Ceylon.

Q. Jl. Rubb. Res. Inst. Ceylon. 42 (1/2) 1966 : 29-33,

4 tables, 5 refs; Abstracted in Proc. Ceylon Ass. Advmt.

Sci. 21 (1) 1965 : 25.

There are two sexual compatible types of Phytophthora affecting Hevea rubber in Ceylon. In most cases only one type of the fungus is present in any particular rubber estate, but in certain cases both sexual compatibility types are found, and in one instance both types were isolated from the same tree. The significance of these factors in the possible variation of the fungus and the consequences thereof on breeding Hevea clones resistant to infection by this fungus are discussed.

383. PERIES, O.S. and DANTANARAYANA, D.M.

Physiologic specialization of Phytophthora meadii affecting Hevea in Sri Lanka. Plant Disease Reporter (USA) 59 (3) 1975 : 252-254, photo., table, 8 refs.

The morphological characters of Phytophthora meadii, affecting Hevea rubber in Sri Lanka vary widely. Studies on physiologic specialization in this fungus revealed five races in a total of 8 isolates tested. This is the first record of race differentiation in a Phytophthora sp. isolated from Hevea. The existence of different races of the fungus may complicate the breeding of Hevea clones resistant to Phytophthora diseases.

384. PERIES, O.S. and DAYARATNE, W.C.

Studies on copper fungicides. 1. Biological efficacy of copper spray deposits containing various 'stickers'. Q. Jl. Rubb. Res. Inst. Ceylon. 42 (3/4) 1966 : 53-57, 6 plates, 3 fold. graphs, 1 table, 11 refs.

In laboratory experiments to compare the fungicidal efficacy of copper sulphate with that of 3 copper-based fungicides incorporating a sticker or oil to improve their rain resistance, fresh young hevea leaves were sprayed different concentrations of the fungicides and inoculated with Phytophthora meadii zoospores. With copper sulphate there was a direct correlation between the amount of copper on the leaf surface and the percentage germination of zoospores, the lethal dose being approx. 1.35 Cu per sq. cm. of leaf surface. With the other fungicides, however, fungicidal efficacy was impaired by the additives. Zoospore germination was erratic and was observed in the presence of 7 Cu per sq. cm. of Perenox-sprayed leaves and 15 and 20 Cu on leaves sprayed with Fycol and Lovo copper, respectively. (Horticultural Abstract. 38 (1) 1968 : Abs. no. 2178).

385. PERIES, O.S. and FERNANDO, T.M.

Studies on the biology of Phytophthora meadii.

Transactions of the British Mycological Society. 49, 1966 :

311-325; Reprinted in Q. Jl. Rubb. Res. Inst. Ceylon.

49 (1/2) 1972 : 13-27, diagrms., tables, 37 refs.

The Cardinal temperatures for growth of P. meadii McRae in vitro were 5, 28-30 and 36°C. The fungus remained viable for 96 hr at 36°. The optimum for the production of sporangia was 28°, and zoospores were liberated readily between 20 and 28°, the maximum zoospore liberation being recorded at temperatures about 2° below those at which the sporangia were produced. Sporangia took longer to germinate and lost viability as they aged, becoming completely non-viable after 16 days incubation at 28°. Zoospores came to rest within 1 hr at 28°, but remained motile for 9 hr at 15 to 20°. Very few sporangia formed germ-tubes directly, and chlamydospores were produced rarely by this fungus; both occurred only above 30°. Sporangia liberated zoospores only in the presence of free water and lost viability rapidly on exposure to lower humidity, being rendered completely inactive after 4 hr at 75 per cent RH. Zoospores germinated poorly and produced little germ-tube growth on dry surfaces even under highly humid conditions (approaching 100 per cent RH). The optimum pH for growth and sporulation of the fungus was 6. Exposure to direct sunlight and uv radiation for 5-20 min. completely inactivated both sporangia and zoospores. Zoospores were produced only at low temperatures (20°), and all attempts to germinate them failed. The significance of

the available data on the biology of the fungus in formulating a scheme for forecasting Phytophthora leaf disease epidemics on Hevea is discussed. (Authors' abstract).

386. PERIES, O.S.; FERNANDO, T.M. and SAMARAWEERA, S.K.

Control of White Root disease (Fomes lignosus) of Hevea brasiliensis. Q. Jl. Rubb. Res. Inst. Ceylon. 41 (3/4) 1965 : 81-89, 4 tables, 19 refs.

The results of detailed experiments carried out during 1963-64 have proved conclusively that the eradication of the good base is the essential step in root disease control according to the method originally suggested by Napper now generally adopted by all rubber-growing countries in the eastern hemisphere. 60-80 per cent of Fomes infected trees can be saved merely by the removal of the food base alone, early detection of the disease leading to better results. Fungicides do not play a significant role in this method of treatment, and need not be used. Care in the process of clearing the old rubber stand prior to replanting is a useful method of reducing the incidence of Fomes in replanted areas. Special attention should be given to Fomes infected trees in the old stand, and every effort must be made to eradicate all sources of inoculum from such infected patches. (Authors' summary).

387. PERIES, O.S.; FERNANDO, T.M. and SAMARAWEERA, S.K.

Field evaluations of methods for the control of White Root disease (Fomes lignosus) of Hevea. Q. Jl. Rubb. Res. Inst. Ceylon. 39 (1/2) 1963 : 9-15, 4 tables, 16 refs.

This paper describes experiments that were carried by the R.R.I.C. during 1962 to review the control of White Root disease of Hevea. The main purpose of these experiments was to assess the necessity for fungicide to supplement root surgery in the method recommended earlier for this treatment. Available evidence suggests that there is little justification for the use of Tillex for White Root disease control and that the removal of the food base is the essential part of the treatment of the infected trees.

388. PERIES, O.S. and IRUGALBANDARA, Z.E.

Histology of Hevea roots infected by Fomes lignosus.

Annals of Applied Biology (England). 73 (1) 1973 : 1-7,

2 plates (9 photos.), 35 refs.

Inspection of naturally or artificially infected Hevea roots showed that Fomes lignosus can penetrate undamaged roots directly, but does so more readily through wounds or natural openings like lenticels, or through bases of lateral roots and bark scales. Therefore, Fomes-infected trees should be identified by leaf symptoms rather than by uncovering and inspecting roots, as this generally leads to root injury, which facilitates fungal penetration. Initial fungal entry into host tissue appears to be by mechanical pressure alone, but deeper penetration is through the action of extracellular enzymes. The fungus remains intercellular in the cortex but is intracellular in the woody tissue. Ray cell walls are penetrated mechanically, but the xylem through pits. The time taken for various stages of infection to occur is assessed. The amount of damage done by the fungus to roots and the blocking of xylem vessels by tyloses suggest that yellowing, curling and buckling of leaves on infected trees are drought symptoms and not a reaction to fungal toxins. The host reacts to the invasion of the cortex by forming a cork cambium and to the invasion of the woody tissue by blocking individual cells when phenols and resins, which could be important when breeding disease resistant Hevea root stocks. (Authors' summary).

389. PERIES, O.S.; LIYANAGE, A. de S. and DANTANARAYANA, D.M.

A comparative study of the nutrition of Phytophthora meadii

and P. palmivora. Jl. Rubb. Res. Inst. Sri Lanka. 56, 1979 :

1-8, 3 tables, 23 refs.

The growth of Phytophthora meadii and P. palmivora was compared in defined media with different carbon and organic-N sources and vitamins. P. meadii grew much better than P. palmivora on maltose. Of the organic-N compounds tested L-glycine, L(-)histidine, L(+) isoleucine, L(-)phenylalanine and peptone were better for P. meadii and alpha alanine for P. palmivora. No significant growth differences were recorded on any of the vitamins tested. These results are discussed in relation to those of other workers. It is suggested that only comparative studies with several isolates of each species are likely to be of value to differentiate related Phytophthora species. (Authors' summary).

390. PERIES, O.S.; LIYANAGE, A. de S. and LIYANAGE, N.I.S.

Fungi associated with rubber growing soils in Sri Lanka. Jl. Rubb. Res. Inst. Sri Lanka. 56, 1979 : 9-20, 2 tables, 32 refs.; Abstracted in Proc. Sri Lanka Ass. Advmt. Sci. 33 (1) 1977 : 19.

The fungal content of the rubber growing soils of Sri Lanka (RGS) was studied, by the dilution plate technique. A terminal modification of this method, which can be used to increase the range of fungi isolated, was developed during these studies. 129 apparently different fungi were isolated from the RGS. Many of these fungi are new records for Sri Lanka. The isolation of a species of Phytophthora in this study was unique in studies of this type. 3 species of Basidiomycetes were also isolated; these fungi too are rarely isolated from soils by the dilution plate method. It was found that, apart from the absence of Trichoderma and the paucity of Aspergillus and Penicillium species in the Malate soils, there was no marked difference in the distribution of fungi in the RGS, which is very similar to that found elsewhere in the world. (Authors' summary).

391. PERIES, O.S. and LIYANAGE, N.I.S.

Observations on the spore production release, biology and colonization of Hevea by basidiospores of Rigidoporus lignosus, the causal organism of White Root disease. Proc. Sri Lanka Ass. Advmt. Sci. 34 (1) 1978 : 18.

An abstract.

392. PERIES, O.S. and LIYANAGE, N.I.S.

The use of sulphur for the control of White root disease caused by Rigidoporus lignosus. In: International Rubber Conference, Kottayam, 23-28 Nov. 1980. Abstracts of papers. Kottayam, Rubber Research Institute of India, 1980. Session 4, paper 1.

The Rubber Research Institute of Sri Lanka recommends the use of sulphur as a soil amendment for the control of white root disease caused by Rigidoporus lignosus. In the present study, the basis of action of sulphur in controlling white root disease was investigated. Amendment of soil with sulphur resulted in decrease in pH to a depth of 40 cm. The pH at 15 and 30 cm depth recorded the lowest value by about 6 weeks after addition of sulphur. Trichoderma spp. was the prominent fungus at the surface layers after amendment with sulphur, while in deeper layers a sharp increase in the number of colonies of Penicillium spp. was observed. Under laboratory conditions isolates of Penicillium and Trichoderma caused lysis of Rigidoporus hyphae. The optimum pH for isolation of Rigidoporus lignosus was found to be at 8. At pH 4, the colony was less than half and at pH 3, the growth was significantly reduced. It is thus concluded that amendment of soil with sulphur, by reducing the soil pH controls Rigidoporus spp. significantly. It was also showed that the effective action of sulphur would remain for approximately a year. (Authors' summary).

393. PERIES, O.S.; MENDIS, E.G.; FERNANDO, T.M.;
SAMARAWEEERA, S.K. and DAYARATNE, W.C.

Field experiments for the control of Oidium leaf disease of Hevea. Q. Jl. Rubb. Res. Inst. Ceylon. 39 (3/4) 1963 :
73-80, 4 tables, 14 refs.

A series of experiments were started by the R.R.I.C. in 1963 for the purpose of reviewing this problem, establishing the economic value of Oidium control by dusting and by spraying. The results obtained during the 1963 Oidium season are reported in this paper. The only conclusive result of the first year was the confirmation of former observations that sulphur dusting was more effective and more economical than spraying.

394. PERIES, O.S. and SAMARAWEEERA, S.K.

Pure culture inoculation of Hevea roots with Fomes
Lignosus. Q. Jl. Rubb. Res. Inst. Ceylon. 39 (1/2) 1963 :
16-17, 1 plate, 4 refs.

A highly successful method developed at the R.R.I.C. for the inoculation of Hevea roots with Fomes lignosus, pure cultures of this fungus is described in this paper. The method

described here has given almost 100 per cent success in inoculations carried out on roots of 10 year old budded Hevea trees which are pollarded every year to keep them at a reasonable height for investigations on leaf diseases.

395. PERIES, O.S. and SATCHUTHANANTHAVALA, R.

Incidence, symptoms and histology of bark cracking in Hevea brasiliensis Müll. - Arg. Tropical Agriculture (Trinidad). 41 (4) 1964 : 265-276, 9 illus., 16 refs.

Reprinted in Q. Jl. Rubb. Res. Inst. Ceylon. 41 (3/4) 1965 : 90-101.

Bark cracking accompanied by the exudation of latex in certain Hevea clones has been recognized since 1930 as a fairly common clonal characteristic which has been attributed to wind damage. These studies have shown that this disorder originates as an abnormal proliferation of the xylem and ray parenchyma cells, and that the bark cracks are due to the resulting nodulation of the wood. A bacterium, Bacterium subtilis, has been consistently isolated from the abnormal tissue, but inoculations with this organism have so far failed to produce the typical symptoms of the disorder. There is a close similarity between the anatomy of abnormal tissue associated with the bark cracking symptom in Hevea and that produced as a result of virus infection in other woody plants. Studies are now in progress to establish the cause of this disorder. (Authors' summary).

396. PERIES, O.S.; SIVAPALAN, Vimaladevi and DANTANARAYANA, D.M.

Methods used by the Rubber Research Institute of Ceylon for testing water-miscible fungicides for the control of Bark rot of Hevea. 1. In vitro and phytotoxicity tests. Q. Jl. Rubb. Res. Inst. Ceylon. 38 (3/4) 1962 : 57-61, 1 plate (2 photos.), 1 table, 2 refs.

This tapping panel disease, caused by the fungus Phytophthora palmivora (Butl.), can be controlled by the application of suitable water-miscible fungicide which is usually followed by the protective coating of the tapping panel

with a water-repellent material. This paper describes the methods which the Institute proposes to adopt for the routine testing of fungicides for the protection of the tapping panel.

397. PERIES, O.S. and SOLOMON, V.B.

The incidence, control and economic importance of Oidium leaf disease on Ceylon rubber, based on planters' assessments, 1963. Q. Jl. Rubb. Res. Inst. Ceylon. 39 (3/4) 1963 : 65-72, 4 tables, 1 ref.

This article summarises the information obtained from a questionnaire which were sent to planters in 1963 to assess the regional distributional and the clonal susceptibility of Hevea to Oidium leaf disease and the efficacy and economics of the control measures adopted against it in Ceylon. The following conclusions arrived at are: 1. On the basis of the present survey it appears that the incidence of Oidium is higher in the Colombo, Kegalle, Kurunegala and Matale districts. 2. Clone Tjir 1 appears to be more susceptibility of Oidium than FB 86. 3. The wintering season was spread over a long period in 1963. 4. Approximately 40 per cent of the estates rest the areas in tapping during the wintering period. 5. All estates, except in the Ratnapura district, have expressed complete satisfaction in sulphur dusting for Oidium control. 6. There appears to be a certain defect in one of the more popular machines used for sulphur dusting. 7. A complete analysis of the estimated costs of Oidium control in Ceylon has been given, and the economics of control have been discussed.

398. PERIES, O.S. and WIMALAJEWA, D.L.S.

The control of Gloeosporium leaf disease of Hevea in Ceylon. Tropical Agriculture, (Trinidad). 47 (3) 1970 : 221-228, 6 tables, 24 refs.

The quantity of mercury retained by Hevea leaves on the application of phenylmercuric acetate increases with the concentration of the spray formulation used, but the relationship may not be linear. The fungicide is phytotoxic at concentrations above 0.01 per cent Hg on Hevea, but can be sprayed repeatedly, over long periods, at a concentration of 0.005 per cent Hg without damage to the plant. Mercury is translocated in small quantities from sprayed to unsprayed leaves of Hevea. Unsprayed leaves cannot be expected to be

protected from Gloeosporium infection entirely by translocated mercury after one or two applications of the fungicides. Mercury accumulates in both sprayed mature and unsprayed mature leaves on regular application of the fungicide, and the young leaves may be protected from infection on repeated application to the mature leaves. Mercury is rapidly absorbed by the rubber leaf, more than 4 ppm being retained in leaves washed soon after the application of a solution of phenylmercuric acetate containing 0.005 per cent Hg. The low incidence of Gloeosporium on some one- to two-year old rubber trees is not correlated with the natural mercury content of the immature leaves of those trees. (Authors' summary).

399. RATNAYAKE, C.M.B.

An assay of growth inhibitors in seed oil and normal and diseased (Brown Bast) bark of Hevea. Q. Jl. Rubb. Res. Inst. Sri Lanka (Ceylon). 50 (1/2) 1973 : 19-27, 7 graphs, 16 refs.

This paper clarifies whether the diseased condition is associated with growth substances present in the tissues of Hevea. These studies show that there is a significantly higher content of growth inhibitors in diseased than in healthy bark.

400. RIGGENBACH, A.

On the control of the White Root disease of the Para-rubber tree, Hevea brasiliensis Muell. Arg. Phytopathologische Zeitschrift. 49 (3) 1964 [1965]; Reprinted in Q. Jl. Rubb. Res. Inst. Ceylon. 40 (3/4) 1964 : 35-55, 2 plates, 9 tables, 57 refs.

The paper presents a review of the methods used for the control of the White Root disease of the Para rubber tree, Hevea brasiliensis Muell. Arg. caused by the fungus Fomes lignosus (Klotzsch) Bres. and an investigation into the effectiveness of different inorganic, metallo-organic and organic fungicides for the control of this disease in vitro under laboratory conditions and in vivo in practical application. 1. Copper sulphate, $\text{CuSO}_4 \cdot 5 \text{H}_2\text{O}$, has, at concentrations, no or only insignificant fungicidal effects on Fomes lignosus. 2. Organo-mercurial

fungicides, such as Ceresan, Panogen, Tillex and Verdasan have the greatest fungicidal effects on Fomes lignosus. These preparations are of practical value. 3. A survey of the results of practical treatments - using organo-mercurial fungicides - carried out in Ceylon in the years 1959 and 1960 on large estates reveals that it is possible to save an average of 70 per cent and more of the Fomes infected rubber trees (of 3-6 years of age) provided that the appropriate measures are taken in time. (Authors' summary).

401. RIGGENBACH, A.

Recent progress in the control of the White Root disease of Hevea. In: Proceedings of the Natural Rubber Research Conference, Kuala Lumpur, 1960. Kuala Lumpur (Malaysia), Rubber Research Institute of Malaya, 1961, pp. 468-472, table, 5 refs.; Reprinted in Q. Jl. Rubb. Res. Inst. Ceylon. 37 (1) 1961 : 18-21.

The method of control of the white root disease of the rubber tree Hevea brasiliensis, Muell. Arg. caused by the fungus Fomes lignosus (Klot.) Heim, consisting of the surface application to infected roots of a copper sulphate solution after scraping off the fungus mycelium, gave disappointing results. Consequently laboratory tests and field experiments with a wide range of fungicides were carried out at the Rubber Research Institute of Ceylon (R.R.I.C.). As a result of these experiments and of the successful use in commercial areas replanted with rubber, Tillex, an organo-mercurial fungicide, is now recommended by the R.R.I.C. instead of copper sulphate, for the control of the White Root disease of Hevea. (Author's summary).

402. RIGGENBACH, Alfred

Review of the Plant Pathology Department, [R.R.I.C. for 1960]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1960 (1961), pp. 47-54.

The incidence of Oidium heveae, Gloeosporium alborubrum and Corticium salmonicolor was higher in 1960 than in the previous few years whilst that of Phytophthora palmivora was negligible. The increased incidence of Oidium was due to the higher rainfall during the refoliation period (14.4" in February at Dartonfield compared with 3.2" for February 1959) and the low incidence of Phytophthora was due to the relatively dry conditions experienced in June and to the intervening dry periods during the wet month of July. Six field experiments to compare the effectiveness of dusting and of spraying for Oidium control have shown that under certain conditions better control is obtained by spraying. Addition of certain chemicals to the wettable sulphur preparation used in spraying experiments for Oidium control has resulted in appreciable flower drop. These experiments showed, however, that it is practically impossible to achieve a total destruction of flowers, and thus a complete elimination of fruiting, as the flowering season is often protracted and flowers produced late in the season was protected from the spray by the young developing foliage. It remains to be seen, therefore, whether this method of indirect control of Phytophthora diseases is a practical one. Reports from commercial estates show that about 80 per cent of 2 to 4-year-old budded plants showing early signs of infection by Fomes lignosus can be saved by treatment with Tillex, provided the treatment is carried out at the first signs of infection. The field experiments on the control of Phytophthora were in 1960 greatly handicapped by the relatively low incidence of the disease. From the results obtained, however, it was concluded that early dusting rounds made well in advance of the actual outbreak of the leaf phase of the disease are a waste of money as they can but have little effect in the absence of climatic factors (rainfall and temperature) favouring the disease. It would seem that dusting at the first signs of infection of the young fruit may be as effective as dusting at the onset of the monsoonal rains. The experiments with shorter intervals between dusting rounds and with different quantities of copper dust failed to give conclusive results because of the low incidence of Phytophthora. The most promising results were obtained with fungicidal oil sprays, i.e. the application of a copper-based fungicide in an oil carrier. Oil sprays stick better to the leaves and, as they are not as easily washed off by rain as are dusts or water sprays, adequate control may be obtained with considerably fewer rounds, with greatly reduced incidence of copper contamination of scrap rubber. A disadvantage is that the spray may not reach the full height of tall trees to ensure a complete leaf coverage. Routine applications of Antimucin 1 : 120, according to the Institute's recommendations, have given a satisfactory measure of control of Bark Rot, and the effect of polythene rainguards in keeping the tapping panel dry may be expected to reduce the incidence of bark infection.

403. RUBBER RESEARCH INSTITUTE OF CEYLON. Advisory Circular
No. 68.

Minor pests of rubber plantations. Agalawatta, R.R.I.C.

1960, 7 p.

Minor pests are grouped into two: animal pests caused by elephants, deer, pigs, cattle, monkeys, hares, porcupines, handicoats, rats, squirrels, bats, flying foxes, snails, slugs, mites; and insect pests caused by termites, scale insects, mealy bugs, cockchafer and borers. The recommendations contained in this Circular have been selected from various sources as control measures which practical experience shown to give the best results under average conditions. They should be taken as a general guide only and may be altered to suit particular conditions.

404. RUBBER RESEARCH INSTITUTE OF CEYLON. Advisory Circular
No. 70.

Oidium leaf disease. Agalawatta, R.R.I.C. 1962. 4 p.

Oidium leaf disease caused by the fungus Oidium heveae occurs in all the rubber growing districts of Ceylon, the incidence increases with increasing ground elevation. Tjir 1 is one of the most susceptible of the clones planted in Ceylon, PB 86 and PR 107 are less susceptible, while LCB 870 is usually tolerant to the disease. It has been found that temperatures below average during the wintering season, and high air humidity favour the spread of the fungus. Sulphur dusting is the most effective and economic method of this disease. Information is presented in this Circular on the rate of dusting, method of dusting. Experiments carried out by the R.R.I.C. have shown that Oidium leaf disease can be controlled effectively by spraying with various wettable sulphur preparations and that under certain conditions spraying can give better control of the disease than dusting. This Circular supercedes R.R.I.C. Advisory Circular No. 43.

405. RUBBER RESEARCH INSTITUTE OF CEYLON. Advisory Circular
No. 76.

Brown root disease. Agalawatta, R.R.I.C. 1967. 3 p.

A short description of brown root disease caused by the fungus Fomes noxius, including symptoms and cultural control measures.

406. RUBBER RESEARCH INSTITUTE OF CEYLON. Advisory Circular
No. 78.

A note on boron toxicity in young replantings.

Agalawatta, R.R.I.C. 1967. 2 p.

See No. 320

407. RUBBER RESEARCH INSTITUTE OF SRI LANKA. Advisory Circular
No. 81.

South American Leaf Blight of rubber. Agalawatta, R.R.I.S.L.

1975. 4 p., 5 col. photos., map.

This leaflet help the planter to make familiar with the appearance of this disease, caused by a fungus, Microcyclus ulei. There are two stages to this disease and the form they take is illustrated and described.

408. RUBBER RESEARCH INSTITUTE OF SRI LANKA. Smallholdings
Advisory Leaflets No. 15.

White root disease. Ratmalana, R.R.I.S.L. Advisory

Services Dept., 1976. 4 p., photo.

The purpose of this leaflet is to explain the smallholders as simply as possible on the White Root disease caused by the fungus Fomes lignosus; its nature of the fungus; method of attack; symptoms; control measures; and after care.

409. RUBBER RESEARCH INSTITUTE OF SRI LANKA. Smallholdings
Advisory Leaflets No. 16.

Bark rot and canker. Ratmalana, R.R.I.S.L., 1976.

Advisory Services Dept., 5 p., 3 photos.

The purpose of this leaflet is to explain the smallholders as simply as possible the Bark Rot or Black Stripe disease caused by Phytophthora, and describes its symptoms and control measures. Uncontrolled Bark Rot will later lead to Canker.

410. RUBBER RESEARCH INSTITUTE OF SRI LANKA. Smallholdings
Advisory Leaflets No. 17.

Sulphur dusting controls Oidium. Agalawatta, R.R.I.S.L.
Advisory Services Department, 1977. 3 p. (In Sinhala and
English).

The purpose of this leaflet is to explain the smallholder
as simply as possible that sulphur dusting controls leaf
disease caused by the fungus Oidium. This leaflet describes
its symptoms and its control.

411. RUBBER RESEARCH INSTITUTE OF SRI LANKA. Smallholdings
Advisory Folder, No. 7.

Phytophthora leaf fall, by R.T. Wijewantha. Colombo,
R.R.I.C. Smallholdings Dept., 1960. 5 p., 1 illus.

The purpose of this folder is to explain the smallholder as
simply as possible the symptoms and the control measures of
the fungal leaf disease caused by the Phytophthora palmivora,
which often occurs in the wake of the South West Monsoon.

412. SATCHUTHANANTHAVALA, V.

Black stripe or bark rot of Hevea. Q. Jl. Rubb. Res. Inst.
Ceylon. 48 (1/2) 1971 : 125-135, 6 illus. (col. photos.), 13 refs.

A review on the epidemiology and control of black stripe
caused by fungus Phytophthora palmivora. Avoiding the tapping
of wet trees, adopting proper cultural practices and the
judicious use of fungicides at the proper time will reduce the
incidence of Black stripe. Prevention is better than cure is
truly applicable to Bark rot. He stressed that the fungicide
application during wet weather should suffice, as inoculum for
infection of panels is present only during this period.

413. SATCHUTHANANTHAVALA, V.

Compatibility strains of Phytophthora palmivora from Ceylon
rubber. (Note). Phytopathology (U.S.A.). 53, 1963 : 729,
table, 2 refs.

Studies were first carried out on the 16 Phytophthora isolates from Hevea examined by the author, and he gives in this note, the details of their origin. The sexual spores of P. palmivora are produced abundantly at low temperatures. All the isolates tested fell into 2 groups, on the basis of their compatibility with their cultures 60 and 62. Fungal adaptation must be carefully considered in the breeding of Hevea clones resistant to infection by P. palmivora in Ceylon. The compatibility of certain strains of P. palmivora increases the chances of physiologic specialization of the fungus in Ceylon.

414. SATCHUTHANANTHAVALA, V.

Hevea diseases of economic importance. R.R.I.S.L. Bulletin (N.S.). (Conference Supplement). 8 (3/4) 1973 : 15-17.

Hevea rubber in Sri Lanka suffers from three fungal diseases, the immature leaf fall caused by Oidium heveae, the panel disease, black stripe or Bart Rot, caused by Phytophthora and the White root disease caused by Fomes lignosus which are of economic importance. This article is intended particularly for the laymen, to give an idea of the causes, symptoms and the control of these diseases.

415. SATCHUTHANANTHAVALA, V.

Review of the Plant Pathology Department, R.R.I.C. for 1967/7. Rubb. Res. Inst. Ceylon. Ann. Rev. 1967 (1968), pp. 44-49.

Only one staff officer was on duty throughout the year. Consequently the work on this department was orientated to pursue the experiments which were already in progress. Advisory work was mainly confined to special pathological problems of Hevea. Twenty specimens with aberrant symptoms were received for diagnosis and advice on their control measures. The majority of specimens were diseases due to fungal attack while the remaining specimens had symptoms caused by pest attack, physiological disorders or mechanical damage. Studies on the occurrence of the two sexually compatible groups of Phytophthora on Hevea were continued. 142 isolates were recovered from 7 estates. The majority (86.6 per cent) were identified as Group I Phytophthora spp. and the remainder were P. meadii. The former were isolated from the petiole, pod, stem and leaf blade and the latter was isolated from the petiole and pod. Since the inception of these studies,

P. meadii has not been removed from the stem and the leaf blade. The predominance of Group I Phytophthora spp. indicates that this species plays a major role in leaf and panel diseases of Hevea. Laboratory studies revealed that Group I Phytophthora spp. produce only chlamydospores where P. meadii produce only oospores. This suggests that the former species could over-winter in nature in mummified pods, infected shoots and old bark lesions. In general the incidence of Oidium leaf-fall was mild except for a few isolated cases. The incidence of secondary leaf-fall caused by Phytophthora was also mild in 1967. A few estates which reported heavy leaf-fall also reported heavy pod-set. The incidence of Black Stripe was also light. Three commercial estates carrying fungicidal trials had a low incidence of Black Stripe. In an experiment to confirm the suitability of sulphur as a soil amendment for the control of White Root disease caused by Fomes lignosus, the incidence of the disease declined in all the treatments. During the first two vulnerable years the control plots showed a high incidence in comparison to the treated soil. The setting down of an experiment designed to assess the effect of retaining the timber from the previous stand, on the incidence of Fomes in the replanted area was completed. Assessments of the incidence of the disease on the treatments as well as the effect of the treatments on the growth and performance of Hevea will now be made at 6-month intervals.

416. SATCHUTHANANTHAVALI, V.

Review of the Plant Pathology Department, [R.R.I.C. for 1968]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1968 (1969), pp. 45-48.

The Plant Pathology Department functioned without any graduate staff officers throughout a major part of 1968. The incidence of Oidium and Phytophthora leaf diseases was generally light during 1968. The indications are that 5-6 lb. of sulphur per acre per round may not be effective during heavy leaf-fall. However, a majority of the clones currently recommended by the Institute are tolerant to this disease and can be adequately protected with about 30 lb. of sulphur. The incidence of Bark Rot was so low in the experimental areas that no useful conclusions could be drawn from the results of these experiments. It appears now that no useful purpose is served by the application of waterproof fungicides to the tapping panel. Theoretically too, the protection of callused bark with fungicides appears to be futile. On the basis of

these observations a review of the treatment of Bark Rot, both preventive and curative, is necessary. Ten species of fungi were isolated from sheet rubber stored at the Torbay Stores belonging to the Department of Commodity Purchase. Species of Aspergillus and Penicillium were the most common contaminants, and the moisture and temperature requirements of these fungi are being studied in order to establish whether their growth can be retarded in these stores, by controlling these factors.

417. SATCHUTHANANTHAVALA, V.

Review of the Plant Pathology Department, [R.R.I.C. for 1969]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1969 (1970), pp. 53-62.

As the immediate pathological problems of Hevea have been satisfactorily resolved to a large extent, the Plant Pathology Department is carrying out certain fundamental studies on the physiology of disease resistance. The results of these studies will ultimately assist in the more economical control of the diseases of the rubber tree. Preliminary investigations on the physiology of disease resistance have indicated that clones resistant to Bark Rot disease appear to possess certain 'factors' responsible for disease resistance. In resistant clones "phytoalexins" are produced in quantities toxic to zoospores of Phytophthora species. Work is being continued to isolate and identify these "phytoalexins". It has been found that the cork layer of the bark of clone PB 86 is resistant to Phytophthora infection; any injury to this layer would make all the underlying layers of bark susceptible to Bark Rot. The fungus sporulates well on rotted bark indicating that it may survive on the trunk for at least a limited period. The tapping cut has been found to be susceptible to infection up to about five days from the time the cut is opened. Studies on survival of Fomes lignosus and decomposition of rubber wood have shown that there are a number of cellulose decomposing fungi, antagonistic to Fomes, which can grow on decomposing wood. Field observations on Xylaria root disease have confirmed the relation of the food base to infection of Hevea roots by Xylaria. Studies on mould species contaminating prepared rubber have shown that relative humidities above 95 per cent and temperatures between 25° - 35° are optimum for germination of spores and growth of mould. Observations made in rubber factories have established that

contamination is high during rainy weather and practically nil during dry weather. Humid conditions prevailing during wet weather have been found to be ideal for growth of moulds.

418. SATCHUTHANANTHAVALA, V.

Review of the Plant Pathology Department, [R.R.I.C. for 1970]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1970 (1971), pp. 43-55).

It has been found that the causal fungus of White Rot disease Fomes lignosus will survive for longer periods in dry soils than in moist. Treatment of dry or moist soils with sulphur would eliminate the fungus from wood pieces of small volume. Studies on mould contamination of rubber have shown that sheet rubber can be stored at 60 per cent relative humidity, at room temperature, for long periods without contamination. The conditions of storage at most buyers' depots at present promote mould growth. An assessment of the incidence of Oidium leaf disease in small-holdings showed that incidence is low to negligible in areas than 300 ft. above mean sea level, and that control measures are not warranted in such areas. Incidence increases with increasing elevation and sulphur dusting of clones PB 86 in such areas reduces leaf fall significantly. It has also been found that hot, dry periods with bright sunny days as well as continuous rains militate against the propagation of the fungus, and control measures against the disease should be adopted only during periods of dull, cool, humid weather.

419. SATCHUTHANANTHAVALA, V. and DANTANARAYANA, D.M.

Observations on Phytophthora diseases of Hevea. Q. Jl.
Rubb. Res. Inst. Sri Lanka (Ceylon). 50 (3/4) 1973 :
228-243, 6 plates (col.), 1 graph, 8 tables, 7 refs.

The authors made observations on rainfall in relation to disease incidence, and on the availability of pods during the season, to determine how helpful these factors would be in following the course of disease, development for the season, and whether the period for application of fungicides recommended by the R.R.I.S.L. holds good for all

years, and also whether the application is necessary during the wet season in all years. In addition, this study screened clones for disease reaction to black stripe disease, for selecting planting material for the wet zone. Facts that emerged from these observations are: (i) factors affecting pod set influence the duration and intensity of leaf-fall, (ii) rainfall coinciding with the presence of mature pods in the field is the major climatic factor which affects the onset and severity of the disease, (iii) pod set and rainfall are both essential for disease incidence - in the absence of either one of these factors leaf-fall does not occur on an appreciable scale.

420. SATCHUTHANANTHAVALA, Vimaladevi and HALANGODA, L.

Sulphur in the control of white root disease. Q. Jl.

Rubb. Res. Inst. Ceylon. 48 (1/2) 1971 : 82-91, 4 illus.

(Photos.), 2 tables, 12 refs.

Observations made in the laboratory and in the field on the effects of sulphur on the control of Fomes lignosus are presented in this paper. Sulphur is toxic to Fomes lignosus in pure culture and even in soil it appears to have a fungicidal effect on the fungus.

421. SATCHUTHANANTHAVALA, V.; SATCHUTHANANTHAVALA, R. and DANTANARAYANA, D.M.

The evaluation of inherent resistance/susceptibility of Hevea cultivars to black stripe disease. In: Scientific Symposium, Part I, Cochin, India, 26-28 September 1974.

Text of Papers. London, International Rubber Research and Development Board, 1975. Vol. I, Session A (14), 5 p.,

3 refs.

An inoculation technique to evaluate Black Stripe Disease (Phytophthora palmivora) in rubber has been described. A bark plug of 2.5 cm diameter is removed at 150-170 cm and a cotton plug saturated with 2 ml. inoculum with 125,000 - 200,000 spores/ml. is placed. The wound is sealed with budding tape allowing aeration. Inoculation should take

place 30-45 min. after preparation of the inoculum. Evaluation is 8 weeks later and compared with a susceptible tester clone such as PB 86. Lesions spread readily above and below tester clone such as PB 86. Lesions spread readily above and below the wound in susceptible clones. Clone RRIC 45, said to be resistant, was susceptible. This is in agreement with the plantation experience in wet areas. The test results agree well with the known resistance of clones. (Abstracts on Tropical Agriculture. 2 (1) 1976 : no. 10354).

422. SATCHUTHANANTHAVALA, V.; SATCHUTHANANTHAVALA, R. and DANTANARAYANA, D.M.

Screening of clones for black stripe disease in Hevea.

Rubber Research Bulletin (India). 12 (2) 1975 : 50-53,

4 photos., table, 2 refs.

In Sri Lanka, the major rubber growing districts are in the South West monsoon belt with climatic conditions suitable for the development of the Phytophthora palmivora fungus. In selecting clones for planting in these districts, their susceptibility to black stripe disease must be considered. In this paper, a method is described to screen promising clones for resistance to black stripe at the selection stage. (Abstracts on Tropical Agriculture. 2 (3) 1976 : no. 07391).

423. SILVA, C.G. and DE SILVA, M.U.J.

A survey of wind damage in rubber plantations. R.R.I.C.

Bulletin (N.S.). 6 (1/2) 1971 : 1-11, 10 tables.

The problem of wind damage in rubber plantations is extremely important and the incidence of this was increasing rapidly in the 1960s. It was therefore decided to conduct a survey, to assess the extent of damage and also to ascertain the influence of various factors both plant specific and environmental on wind damage. This survey indicates that uprooting is the most common form of wind damage, branch breakage and trunk snap being next importance in that order. The incidence of uprooting is highest near gaps and in hilly areas. It is less common in closed plantings and lowest alongside roads. The incidence of trunk snap is highest in closed plantings and almost the same near gaps and alongside roads. In respect of both uprooting

and trunk snap, there is a marked increase in susceptibility as the trees reach the mid-age group and a sharp decrease in susceptibility, as the trees age further. Of the clones studied, RRIC 7 appears to be the least susceptible, with PB 86 coming next. LCB 1320 is fairly resistant from the point of view of uprooting and poor in respect of trunk snap.

424. SIVAPALAN, Vimaladevi

Diseases of Hevea caused by non-parasitic agents. Q. Jl.

Rubb. Res. Inst. Ceylon. 38 (1/2) 1962 : 13-17.

Deficiency of water or of nutrients, excess of these, intense heat or light and injury by tools, wind, fire, lightning or chemicals can also upset the normal functions of, or induce abnormal growth, in plants. These are classified under physiological disorders (Brown Bast, cracking of bark, nutrients, nodules, malformation); damages due to meteorological conditions (sun-scorch, wind damage, lightning, fire damage); or chemical injury (application of herbicides). The symptoms of each disorder or damage, its prevention and its treatment are considered in this article.

425. WIJEWANTHA, R.T.

Influence of environment on incidence of Fomes lignosus in rubber replantations in Ceylon. Tropical Agriculture (Trinidad). 41 (1) 1964 : 69-75, 4 graphs, 7 tables, 11 refs.; Reprinted in Q. Jl. Rubb. Res. Inst. Ceylon. 40 (3/4) 1964 : 56-53.

The success of state-aided replanting programme for the rehabilitation of rubber replantings in Ceylon threatened by a root disease caused by Fomes lignosus (K.) Heim ex Pat. A survey was therefore made to assess the extent of infection and to determine the influence of environmental factors on the occurrence of this disease. The survey showed a correlation between disease and planting density, topography, and rainfall respectively. Statistically significant results were obtained with respect to disease and the type or source of planting material used. The highest amount of infection was observed to occur during

the first three years from replanting, the peak being reached in the second year. The significance of the results obtained is discussed. (Author's summary).

426. WIJEWANTHA, Ronald T.

Report on the sulphur dusting of smallholdings in 1959/60.

Q. Jl. Rubb. Res. Inst. Ceylon. 36 (3/4) 1960 : 56-62,

3 diagrms., 1 map, 1 graph, 3 fold. charts, 2 tables.

The abstract is similar to the abstract of item no. 311.

427. WIJEWANTHA, R.T.

A survey on the incidence of Fomes Lignosus in rubber plantations. M.Sc. thesis. University of London, 1960.

(Unpublished typescript).

A state-aided replanting scheme for the rehabilitation of rubber plantations which had been severely damaged during the last World War as a result of slaughter tapping as Ceylon's contribution to the War effort, was commenced in 1953. Fomes lignosus (Klotzoh) Heim ex Pat., or White Root Disease was found to be a serious problem in these replantations. A survey on the incidence of this disease in replantations in Ceylon was commenced in 1956 to obtain detailed information on the extent of damage caused by Fomes lignosus, and to determine the factors which influence the occurrence of the disease so that effective control methods could be adopted. This survey of all rubber replantations below 10 acres each in extent, and planted in 1953-1956 was continued in 1957, 1958 and 1959 so that trends in infection could be followed in these holdings over a period of three to four years. Smallholdings planted since 1955 were also placed under similar observation. It was found that replantations were most susceptible to attack during the first three years of growth. It was observed that the average annual rainfall, influences Fomes lignosus infection. Replantations in the highest average rainfall regions showed the greatest amount of infection. Smallholdings replanted with Budded stumps were more susceptible to infection than those replanted with Clonal seedlings. Replantations on flat land were more liable to infection.

than those on hilly slopes. The degree of infection by Fomes lignosus also varied with differences in soil pH. The acid soils carried more infection than soils with a pH closer to neutrality. Experimental results indicate the limited use of available fungicides for the control of this disease. On the basis of this survey and field observations, the author suggests control methods. (Author's summary).

428. WIMALAJEewa, D.L.S.

The incidence and economic importance of the Gloeosporium leaf disease of Hevea in Ceylon. Part II. A survey on the incidence of Gloeosporium. Q. Jl. Rubb. Res. Inst. Ceylon. 39 (3/4) 1963 : 81-84, 1 table, ref.

The main purpose of this survey was to assess the degree of incidence of this disease in the various rubber planting districts in Ceylon, and to find out the probable causes contributing to the present level of incidence. Data were gathered on the regional distribution of the disease in relation to climatic conditions (chiefly rainfall), topography of the land, age of planting and clonal variety. At the same time an assessment was made on the efficacy of control measures currently adopted against the disease. The views expressed by planters, summarized in a previous article (Wimalajeewa and Lloyd, 1963) have been confirmed by the observations made during this survey, thus indicating the immediate necessity for detailed research on the subject.

429. WIMALAJEewa, D.L.S.

The significance of the factors affecting spore germination in the spread of Gloeosporium leaf disease in Hevea. Q. Jl. Rubb. Res. Inst. Ceylon. 41 (1/2) 1965 : 63-68, 5 plates, 4 tables, 6 refs.

Laboratory investigations carried out on the effect of the following physical factors on the germination of Gloeosporium spores are reported (a) spore concentration (b) moisture (c) temperature (d) reaction of medium (e) visible light (f) ultra-violet light. Very high spore concentrations such as those which occur in the spore fructification inhibit

germination of the spores without affecting their viability and thus aid the spread of the disease by ensuring the dispersal of ungerminated but viable spores. The presence of free water promotes germination, but it is not essential if the relative humidity of the ambient atmosphere is high and approaching the dew point. This enables Gloeosporium, unlike Oidium and Phytophthora, to cause infections almost throughout the year in the wet low country districts. The optimum temperature range for germination is 25 - 28°C, with inhibition of this process at 40°C. Dry spores, however, could withstand temperatures between 40°C and 50°C without any appreciable losses in viability. Thus, according to these studies the diurnal shade temperatures, encountered in the rubber growing districts in this country, which are generally below 35°C, are favourable for germination. There is complete inhibition of germination of wet spores in direct sunlight due to high temperatures (above 40°C) and ultra-violet radiation effects. Dry spores lose viability in direct sunlight mainly due to lethal effects of ultra-violet radiations. These are contributory factors for the low incidence of Gloeosporium in the 1 to 3 year old plantings, where a larger proportion of the foliage is exposed to direct sunlight than in the older plantings. It is concluding from these studies that the most favourable conditions for the spread of Gloeosporium leaf disease are prevalent, particularly at night, in the wet low country districts, and elsewhere during damp gloomy weather. (Author's summary).

430. WIMALAJEewa, D.L.S.

Studies on the physiology of spore germination in
Gloeosporium alborubrum. Q. Jl. Rubb. Res. Inst. Ceylon.

43 (1/2) 1967 : 4-12, 7 plates, 8 tables, 19 refs.

Studies on spore germination of Gloeosporium alborubrum were conducted in Ceylon with an isolate from rubber clone PB 86. Germination was found to require oxygen and a high atmospheric humidity while free water is not necessary; the optimum temperature is 28°C. Sunlight is deleterious on account of its ultra-violet radiation. This explains why Gloeosporium leaf disease is most prevalent in fields over 3 years old and may remain prevalent even during periods of low rainfall, whereas its much lower incidence in young fields is due to more sunlight and high temperatures. Non-germinated spores remain viable for several hours at temperatures up to 50°C; longevity increases as the relative humidity of the ambient air decreases. The optimum pH is around 6. (Tropical Abstract. 23 (2) 1968 : no. 367).

431. WIMALAJEewa, D.L.S. and LLOYD, J.H.

The incidence and economic importance of the
Gloeosporium leaf disease of Hevea in Ceylon. Part 1.
Planters' assessment. Q. Jl. Rubb. Res. Inst. Ceylon.
39 (1/2) 1963 : 18-24, 9 tables, ref.

This article summarises the information obtained and the conclusions reached, by sending a questionnaire to the planters, to get their views in order to determine whether detailed research on this disease was warranted, especially with reference to control measures. Estate returns showed that Gloeosporium has been controlled on an ever-increasing scale since 1957 in all the planting districts except Matale and Kurunegala; The incidence of the disease seemed to be more widespread between April and May. Gloeosporium was reported to be worse in plantings of 1 and 4 years of age and clone PB 86 seemed to be the most affected. The total area treated in 1961 was estimated to be approximately 13,000 acres, by control measures costing the industry about Rs. 20/= per acre. The general trend of the incidence of Gloeosporium in more recent years indicates that the disease may become economically important in the future. The belief amongst planters that the disease is becoming serious there was clearly an important need for further research on the biology of the causal fungus and on the economics of the control of this disease.

432. WIMALAJEewa, D.L.S. and SHANMUGANATHAN, T.

A preliminary report of physical assessments of products
for Gloeosporium control trials. Q. Jl. Rubb. Res. Inst.
Ceylon. 39 (1/2) 1963 : 25-26, table, ref.

The use of fungicides with good wetting characteristics and with good rainfastness properties are important, as the immature leaves attacked by Gloeosporium are not readily wettable. Assessments of the characteristics were made on 14 fungicides and the results and conclusions are reported in this article. Bordeaux Mixture with Lissapol, Bordeaux Mixture, Aerial Perenox and Cuman showed satisfactory results.

433. YOGARATNAM, N.

Weed control under Hevea in Ceylon with herbicide mixtures based on MSMA. Q. Jl. Rubb. Res. Inst. Ceylon.

48 (3/4) 1971 : 168-181, 10 tables, 10 refs.

Results of 7 experiments where the effects of MSMA when used singly and in mixtures with Amitrole, 2, 4-D-amine, sodium chlorate and Dalapon on *Paspalum conjugatum*, *Mikania scandens* and a few other weeds under mature rubber in Ceylon are reported. High rates of MSMA were required to obtain a good control of *P. conjugatum*. Under mature rubber, mixtures of 0.825 lb. MSMA + 0.188 to 0.375 lb. Amitrole were found to effectively control *P. conjugatum*. Mixtures of 0.825 to 1.65 lb MSMA + 0.6 to 0.9 lb 2, 4-D-amine were very effective on a mixed growth of *P. conjugatum* and *M. scandens*. In areas with a mixed growth of *P. conjugatum*, *M. scandens*, *Axonopus affinis*, *Borreria hispida*, *Borreria ocymoides* and *Hedyotis auricularia*, mixtures of 0.825 to 1.65 lb MSMA + 0.6 to 0.9 lb 2, 4-D-amine + 4 to 5 lb sodium chlorate or 1 to 2 lb Dalapon were found to control the weeds effectively. (Author's summary).

Exploitation

General

434. DE SILVA, C.A.

Tapping of Hevea rubber. Q. Jl. Rubb. Res. Inst.

Ceylon. 37 (3) 1961 : 75-82, 4 diagrms.

A discussion of the problems related to the tapping of Hevea rubber in Ceylon, including subjects such as: the standard of tappability, the choice of tapping systems, bark consumption, height of opening and slope of the cuts, depth of tapping, tapping knives. (The Michie-Golledge knife is used in Ceylon), size of tapping task and various tapping systems.

435. RUBBER RESEARCH INSTITUTE OF SRI LANKA. Advisory Leaflet No. 2.

Tapping. Ratmalana, R.R.I.S.L. Advisory Services Dept.,

1976. 12 p., 3 photos., 5 diagrms. (In Sinhala and English).

Explains to smallholders' as simply as possible on tapping of Hevea and discusses on the following: commencement of tapping, tapping systems, opening of tapping cuts, marking for tapping, depth of tapping, change-over systems of tapping, time of tapping, spouts and cup hangers, pre-coagulation of latex, diseases of the tapping panel.

436. SENANAYAKE, Y.D.A.

The influence of rainfall on yield of rubber (Hevea brasiliensis Muell. Arg.). Journal of Plantation Crops

(India). 6 (1) 1978 : 21-23, graph, table, 5 refs.

The influence of fluctuations of rainfall on the test tapped dry rubber content (DRC) yields of three clones, RRIC 36, RRIC 45 and PB 5/51 was studied. The yields were high during the months of high rainfall and depressed rainfall decreased. Rainfall and yield were positively but non-significantly correlated. (Author's summary).

437. SENANAYAKE, Y.D.A.

Yield variability in clonal rubber (Hevea brasiliensis)

Muell.Arg. Journal of Plantation Crops (India). 3 (2)

1975 : 73-76, graphs, table, 11 refs.

Coefficients of variability were determined in the clone RRIC 88 budded on seedlings for yield (27.02 per cent), length of tapping cut at commencement and termination (respectively 12.09 and 12.85 per cent), change of length tapping cut (51.03 per cent) and increase in tree girth (50.64 per cent). Yield fluctuations were closely related in rainfall. More attention should be given to rootstock selection to eliminate low yielders and in this way to increase production of existing clones. (Author's summary).

Tapping Systems and Rainguards

438. ANON

All rubber rainguards. Planters' Chronicle (India).

55 (1) 1960 : 12, diagsr.

This article describes the outstanding success of an all rubber rainguard developed by the Ceylon Institute of Scientific and Industrial Research. It is cheap, easy to install, harmless to the trees, fits any size trunk without waste, and lasts several years before needing replacement. Under large scale long-term trials, high-yielding rubber has benefitted by a 20 per cent yield decrease. Potentially, the device can make a sizeable contribution to new national wealth. It has also been of primary assistance in controlling bark rot disease of the tapping panel and as an accessory in control measures against Phytophthora leaf blight.

439. DE SILVA, C.A.

Tapping for increased yields with the use of rainguards.

Q. Jl. Rubb. Res. Inst. Ceylon. 36 (3/4) 1960 : 63-64,

1 plate (4 photos.), 1 table.

A well illustrated description of the use of rainguards, which used in order to protect the rubber tapping panels from wetness during the monsoon periods, and to reduce bark diseases caused by Phytophthora palmivora. The types of rainguards made of 'polythene' film or of rubber are illustrated.

440. SATCHUTHANANTHAVAL, R.

Use of rainguard for rubber trees. Q. Jl. Rubb. Res.

Inst. Sri Lanka (Ceylon). 50 (1/2) 1973 : 28-39,

3 diagrms., 2 photos., 7 tables, 4 refs.

The benefits to be gained by the use of rainguards for normalizing late tapping days and minimizing loss os tapping days, especially in high yielding and Ethrel stimulated fields are evident. A description is given of a cheap gutter-type of rainguard, which has proved its suitability in various field trials. Its main components are a thin rubber band about 6 cm. thick. The guard is fixed effectively to the tree with ordinary field latex.

The chief advantage of this rainguard is that it is re-usable. The expected service life of 3 years could be extended with improved compounding during manufacture.

441. WAIDYANATHA, U.P. de S. and FERNANDO, D.M.

Studies on a technique of micro-tapping for the estimation of yields in nursery seedlings of Hevea brasiliensis.

Q. Jl. Rubb. Res. Inst. Ceylon. 49 (1/2) 1972 : 6-12,

2 illus., (photos.), 3 tables, 12 refs.

A new method is described for estimating the rubber content of young Hevea brasiliensis seedlings by the collection of latex resulting from needle pricks. An evaluation is made of the repeatability of the results; a comparison is made of rubber yields from different systems of extraction for the purpose of estimating yielding capacity. The technique described is rapid and simple. It would be of value because selection for yield capacity could be made at an early stage. (Authors' summary).

442. WIMALARATNA, S.D.

The development of tapping systems for rubber.

R.R.I.S.L. Bulletin (N.S.). (Conference Supplement).

8 (3/4) 1973 : 3-5.

This article intended for the laymen, to give an idea of historical development of tapping systems with a special reference to tapping experiments carried out by the Rubber Research Institute in Sri Lanka.

443. WIMALARATNE, S.D.

Economic evaluation of tapping systems. Q. Jl. Rubb. Res.

Inst. Sri Lanka (Ceylon). 50 (1/2) 1973 : 40-54, 1 graph,

3 diagrms., 7 tables, 11 refs.

This paper discusses the early results of some of the tapping systems, which have been of topical interest to the rubber planting in Sri Lanka. The tapping experiments were carried out only for 2 years. Data of these 2 years indicate that the standard half spiral alternate daily tapping system at 100 per cent intensity is still the best for most local commercial plantings. High panel tapping experiments have shown that V cuts tapped upwards to have given a better yield than two quarter spiral cuts tapped upwards or ladder tapping downwards from a half spiral.

Tapping Economics

444. DISSANAYAKE, A.B.

A survey of tapping in smallholdings planted under the rubber replanting subsidy scheme. Q. Jl. Rubb. Res. Inst.

Ceylon. 39 (1/2) 1963 : 38-49, 4 photos., 5 tables, 1 annex.

The results of a survey of tapping in smallholdings and also of the standard maintenance in subsidy smallholdings in Ceylon dating from 1953-56, carried out in 1962 by the author are reported here. The number of holdings visited was 2,253, representing 20 per cent of replanting permits granted during 1953-56; their total area was about 1,500 ha. Of these, only 816 holdings were being tapped; in 471 cases tapping had been started at the correct stage (i.e. when 60 per cent of the trees had attained a girth of 51 cm at 90 cm above the ground), on 218 holdings tapping was begun when only 40 - 50 per cent of the trees had reached tappable age, whereas 127 holdings had been irreparably damaged by tapping when the majority of the trees was below tappable age. Of the total number of holdings, 27 per cent were not properly maintained; among the tapped holdings, 37 per cent showed tapping cuts at a wrong height or at an incorrect angle. A training scheme for smallholders has been launched. Annex 1 - Survey of tapping in subsidy replanted smallholdings, 1953-1956.

Yield Stimulation

445. ABEYSEKERA, C.M.

Cost effectiveness of ethrel stimulation : a point of view. R.R.I.C. Bulletin (N.S.). 7 (1/2) 1972 : 31-38, graph, table; Reprinted in Ceylon Management Accountant. 1 (1) 1972 : 27-31.

One of the major objectives of the NR producer is to raise the yield by replanting with improved clonal varieties; in the meantime it is necessary to obtain better yields per unit area already planted and per unit labour input at lower cost. In this respect the stimulation of latex flow by auxin-type yield stimulants such as 2,4, 5 - trichlorophenoxy acetic acid has long been a subject of interest and importance. The introduction of Ethrel (2, chloroethyl phosphonic acid) as a stimulant has provoked great interest and research into its capacity as an effective yield stimulant. Ethrel has been used on a fairly large scale in Malaysia, but the long term advisability of using Ethrel has been viewed with reservation in Sri Lanka because of the possible long term effects of this material on the tree.

This article, discusses the cost effectiveness of Ethrel stimulation under Sri Lanka conditions, on the basis of findings already available. No attempt has been made to deal with the interactions between clones, stimulation and tapping systems. The costing techniques used for this exercise are very basic, the primary intention being to make the findings simple and these workings and findings must therefore be accepted with caution. Conclusion in respect of particular estates/area should be arrived at only on the basis of an analysis yield/cost etc., in each case.

446. ANON

Yield stimulation and stimulants. R.R.I.C. Bulletin (N.S.).

1 (1) 1966 : 2-5.

Rubber growers in Ceylon are advised to restrict stimulation of the tapping panel to old stands with a declining yield not exceeding 900 kg/ha per year. However, some clones respond poorly to stimulation, and bark less than 6 cm thick should not be scraped. The R.R.I.C. is experimenting with 2 stimulant mixtures; R.R.I.C. Mixture 1, which is of a fairly thick consistency and is meant to be applied on scraped bark below the tapping cut, will soon be commercially produced. It should be applied with a 2½ cm brush over 3.8 cm of a 5 cm high scraped area 1 or 2 times annually depending on the growth conditions; a 2nd application should not be made before the treated bark has been completely tapped away. The S/2, d/2, 100 per cent tapping system is best suited for long-term yield stimulation. (Tropical Abstracts. 22 (4) 1967 : 9748).

447. CHANDRASEKERA, L.B.

A critical evaluation of the currently available results of some Ethrel trials in Sri Lanka. Q. Jl. Rubb. Res. Inst.

Sri Lanka (Ceylon). 50 (1/2) 1973 : 12-18, 11 tables, ref.

A number of trials carried out in Sri Lanka on Ethrel stimulation have confirmed the findings in other countries that Ethrel is by far the most effective yield stimulant for rubber yet known. It has given large yield increases on panels C and D of clone PB 86. Due to the relatively short duration of the trials, it appears too early to arrive at firm conclusions of the long term effects of Ethrel

stimulation. There is still an uncertainty as to the point at which Ethrel safely be introduced during the economic life of a plantation.

448. CHANDRASEKERA, L.B.

The effects of the replanting cycle, tapping intensity, shortening the immature period and yield stimulation on production of natural rubber. Jl. Rubb. Res. Inst. Sri Lanka. 54, part 1, no. 1, 1977 : 125-130, 4 tables, 3 refs.

In a given plantation, the highest output of rubber will be recorded for the longest replanting cycle. By reducing the period of immaturity by one year, there can be a 3 to 4 per cent increase in annual productivity for a given replanting cycle. In Sri Lanka, a progressive intensification of tapping six years before replanting would be more profitable than Ethrel stimulation. At it's best, Ethrel stimulation may increase production by about 13 per cent on a 30-year replanting cycle. (Author's summary).

449. SATCHUTHANANTHAVALA, R. and WEERASINGHE, T.C.

Ethrel stimulation of Hevea under conditions in Sri Lanka. Jl. Rubb. Res. Inst. Sri Lanka. 54, part 1, no. 1, 1977 : 150-162, 1 map, 8 graphs, 7 tables, 6 refs.

The results are given of trials extending over 4 to 5 years in which ethephon (as Ethrel) at 5 or 10 per cent, or proprietary preparations containing a penetrant, were applied by different methods to clone PB 86 tapped at different intensities. Two stimulation cycles/year during the best cropping months (August - September and late November - January) resulted in enhanced yields, with little difference between the effects of different ethephon concentrations. Six applications of ethephon/year were detrimental. Ethrel applied on the tapping panel (above the cut) for 5 years had no adverse effects, and reduced costs by obviating the necessity of bark scraping for below-cut applications). Data are also presented on the percentages of partially and completely dry trees and on the dry rubber content of the latex. (Horticultural Abstracts 49 (6) 1979 : no. 4602).

Latex Physiology

450. FERNANDO, D.M. and SAMARANAYAKE, P.

The deterioration of rubber in samples of Hevea tissues.

Q. Jl. Rubb. Res. Inst. Ceylon. 44 (1/2) 1968 : 31-33,

1 graph, 1 table, 2 refs.

Hevea petioles are used. Petioles are ground up in a Waring Blender; samples are then extracted in a Goldfish apparatus, first with acetone to remove chlorophyll and non-rubber constituents, is followed by benzene extraction in order to extract rubber. About 5 gms dry weight of the sample and 30 ml each of the solvent are used. The rate of deterioration of latex is most probably due to oxidation, and is shown to deteriorate more when air-dried than when vacuum dried; data are presented showing the percentage of latex present up to 10 days after sample collection compared with that found at collection.

451. FERNANDO, D.M. and SAMARANAYAKE, P.

A method for the rapid determination of rubber in Hevea species. Q. Jl. Rubb. Res. Inst. Ceylon. 43 (1/2) 1967 : 1-5, 4 refs.

Determination of the rubber content of petioles is regarded as the best method of screening young Hevea seedlings for high yield. A relatively rapid technique for its estimation was worked out in Ceylon. Petioles are ground up in a Waring Blender; 5-g samples are then extracted in a Goldfish apparatus, first with acetone to remove chlorophyll and other non-rubber constituents and subsequently with benzene to extract the rubber, each phase taking 3 hours. Rubber contents of the petioles of 8 clones were found to range from 18.10 mg/g dry weight in RRIC 52 to 25.14 mg/g in PB 86. Petioles have to be extracted soon after collection : extractable rubber in clone RRIC 86 fell from 22.9 to 20.3 mg/g within 2 weeks. (Tropical Abstracts 23 (2) 1968 : no. 370).

452. FERNANDO, D.M. and TAMBIAH, M.S.

Sieve tube diameters and yields in Hevea spp. : a preliminary study. Q. Jl. Rubb. Res. Inst. Ceylon.

46 (3/4) 1970 : 88-92, 3 diags., table, 7 refs.; Abstracted in Proc. Ceylon Ass. Advmt. Sci. 25 (1) 1969 : 65.

The diameters of the sieve tubes of recently evolved cultivars of Hevea were measured : a grouped representation showed more of the sieve tubes with larger diameters in high-yielding clones. It would appear that such a grouped representation would materially assist in the selection of high-yielding cultivars at an early stage of growth. (Authors' summary).

452.a FERNANDO, D.M. and TAMBIAH, M.S.

A study of the significance of latex in Hevea spp.

Q. Jl. Rubb. Res. Inst. Ceylon. 46 (3/4) 1970 : 69-77, 1 diagram., 5 tables, 8 refs.; Abstracted in Proc. Ceylon Ass. Advmt. Sci. 25 (1) 1969 : 64.

The different theories for the function of latex are discussed. The favourable growth of recently evolved high-yielding cultivars in areas marginal for agriculture is described. An analysis is made of the yields, dry rubber content and growth of a single popular clone PB 86, from different districts in Ceylon : correlations made with rainfall and temperature incline towards the view that latex functions as an internal system regulating water within the plant. The ability of the plant to survive and grow satisfactorily under drought conditions appear to improve with increased capacity for latex production. The breeding and selection of Hevea for yield would also result in extending the cultivable range of the crop. The possibility of thus moving Hevea cultivation to areas considered marginal for profitable growth of other crops appears definite. (Authors' summary).

453. WAIDYANATHA, U.P. de S. and PATHIRATNE, L.S.S.

Studies on latex flow patterns and plugging indices of clones. Q. Jl. Rubb. Res. Inst. Ceylon. 48 (1/2)

1971 : 47-55, 4 graphs, 4 tables, 16 refs.

This paper embodies studies on (a) flow patterns and plugging indices of some of the more important clones and the relationship of these with the other important clonal characters, (b) plugging indices of clones as influenced by breeding and genetic selection. This study needs only a measuring cylinder. Awareness of the plugging behaviour of clones and the fact that this largely determines the response to tapping systems and yield stimulants would enable the planter to extract the maximum economic return from the rubber trees.

454. WIMALARATNA, S.D.

A staining procedure for latex vessels of Hevea Stain Technology (U.S.A.). 48 (5) 1973 : 219-221, photo., 3 refs.

It is difficult to stain Hevea latex vessels and other bark parenchyma cells differentially. A method to identify the latex vessels by staining the coagulated latex in them is described here. Hevea bark, on removal, was immediately fixed in formal-acetic-alcohol for 24-36 h., then dehydrated in tertiary butyl alcohol and embedded in parafix wax, mp 58°C. A few drops of oleic acid were added to the wax to retain the coagulated latex. The wax ribbons and absolute ethyl alcohol at 60°C for 1½ h. The sections were then rinsed in 95 per cent ethyl alcohol and stained with the following solutions, all made up in absolute ethyl alcohol: (a) Old bark : 2 ml 2 per cent oil red 4B, 3 ml 1 percent methyl green, 3 ml 2 per cent light green and 2 ml 10 per cent safranin, 1 ml 2 per cent sulfate. (b) Young bark : 6 ml 2 per cent oil red 4B, 4 ml 2 per cent light green, 2 ml 10 per cent safranin, 1 ml 2 per cent aniline sulfate. (Author's summary).

PART 4

CHEMICAL AND TECHNOLOGICAL RESEARCH

Chemistry and Technology of Latex

General

455. CHANDRASIRI, E.L.

Natural rubber and latex production. Karmantha.

9 (6) June 1980 : 11-12.

Industrial Development Board of Sri Lanka have had numerous requests from time to time for information on natural rubber and this article has incorporated all the information that had been called.

456. GUNAWARDHANA, Calyanatissa A.

Technology of latex : studies and observations. Colombo, M.D. Gunasena (Printers), 1968. 16 p., figs., 4 refs.

This paper deals with some aspects of cellular rubber manufacture from Hevea latex and is based on observations made by the author at the Institut Francais du Cacutchouc in Paris. The discussions are placed in the following order: Introduction; natural rubber latex; preservation; concentration; foaming; gelification; cellular rubber; and developments.

457. MENDIS, E.G. and NADARAJAH, M.

The use of coconut shells as latex collection cups in Ceylon. R.R.I.C. Bulletin (N.S.). 6 (1/2) 1971 : 24-28, 3 tables, 6 refs.

A cheap plastic coating for coconut shells would be of great value in sole crepe, pale crepe, centrifused latex and new process rubber manufacture. The plastic coating would not only reduce pre-coagulation but will also contribute to greater cleanliness. The use of a resin paint has been found to be satisfactory. The use of a synthetic rubber (SR) latex, which is a co-polymer of acrylate and polyvinyl acetate, has also been found to be satisfactory. Investigations are being carried out to make this SR latex cheaper by mixing with methyl methacrylate-grafted (MG) natural rubber (NR) latex. (Authors' summary).

Structure, Composition and Biochemistry

458. HEINISCH, K.F.

Copper, manganese and iron content of lower grade estate rubbers. Q. Jl. Rubb. Res. Inst. Ceylon. 38 (3/4) 1962 : 67-74, 3 graphs, 5 tables.

Copper, manganese and iron content of commercial rubbers and unprocessed panel scrap, sampled during one year on 5 estates in Ceylon is summarized and figures for latex are also given for comparison. A fractionation of the latex during the flow from the tree shows an increase of metal content towards the end of the latex flow. It is suggested that the present limits of 8 p.p.m. and 10 p.p.m. for copper and manganese respectively should be specified for first grades only, manufactured from fresh field latex. Higher values should be tolerated for the lower grades.

459. KARUNARATNE, S.W.

Polyphenol oxidase in Hevea latex. Q. Jl. Rubb. Res. Inst. Ceylon. 40 (3/4) 1964 : 74-77, graph, 3 refs.

This paper describes a method for the isolation of the enzyme from rubber latex free of rubber particles and confirming the purity of the protein fraction by means of electrophoresis; its assay by a colorimetric method and its inhibition by sodium bisulphate (which is the chemical used in the process of rubber manufacture to inhibit enzymatic discolouration) as compared with the inhibition by copper complexing agents.

460. KASINATHAN, S.; NADARAJAH, M. and TIRIMANNE, A.S.L.

A study of the free amino acids in the latex of natural rubber. R.R.I.C. Bulletin (N.S.). 6 (1/2) 1971 : 29-33, 4 tables, 12 refs.; Abstracted in Proc. Ceylon Ass. Advmt. Sci. 26 (1) 1970 : 101-102, 2 refs.

Some of the free amino acids present in natural rubber latex are potent antioxidants and play an important role in the ageing of natural rubber. The method of extraction used in this study was mainly that of in which chemical and enzymic hydrolysis and proteins were reduced to a minimum. More than twelve free amino acids were separated by paper chromatography. The variations in the amino acid pattern of the five clones RRIC 54, Wagga 6278, G1 1, PB 86 and RRIC 36 recommended for large-scale planting in Ceylon and of the four promising clones RRIC 7, Nab 15, RRIC 100 and RRIC 101 and the importance of these amino acids in the ageing of natural rubber latex is discussed.

461. NADARAJAH, M. and KARUNARATNE, S.W.

Some observations on the non-rubber constituents of Hevea latex. Part I. Q. Jl. Rubb. Res. Inst. Ceylon. 39 (1/2) 1963 : 27-31, 1 plate (3 photos.), 2 graphs, 4 tables, 5 refs.

Latex contains spherical non-rubber particles which are known as Frey-Wyssling occur singly, in clusters or in an ordered arrangement. This article describes observations made on these particles, present in latex of various clones from chemical investigations.

462. NADARAJAH, M. and KARUNARATNE, S.W.

Some observations on the non-rubber constituents of Hevea latex. Part II - Discolouration of latex and of rubber. Q. Jl. Rubb. Res. Inst. Ceylon. 40 (1/2) 1964 : 1-12, 2 plates, 7 tables, 20 refs.

The relationship between the copper, iron and phenol contents and enzymatic discolouration of the bottom fraction of field latex has been investigated. The role of naturally occurring inhibitors in latex as well as that of commonly used rubber chemicals such as oxalic acid, oxalic acid, RPA 3 and sodium bisulphite in inhibiting discolouration is discussed.

463. PERERA, Chulanganie and DE SILVA, Tuley

Extraction of bromelin and its use in the reduction of the nitrogen content of rubber latex. In: Proceedings, Institute of Chemistry, Sri Lanka, 7th annual sessions, 1978, pp. 61-65, 3 tables, 5 refs.

Bromelin is a proteolytic enzyme system found in the fruit, leaves and stem of the pineapple plant. Since similarities of the bromelin to papain have been reported, this article investigates the use of bromelin in the manufacture of rubber with a low nitrogen content. It is found that time taken for coagulation decreased with increasing concentrations of the bromelin. The reduction in nitrogen content, is caused by the proteolytic enzyme by acting upon the latex proteins the nitrogen content is reduced by about 50 per cent and 20 per cent when field latex and deammoniated latex respectively, is used. These preliminary results show that pure bromelin is more effective in reducing the nitrogen content of rubber latex, particularly of field latex.

464. PIYADASA, K.A. and KARUNARATNE, S.W.

A quick method for the determination of ammonia content in natural rubber latex : a modification of the B.S. Method.

R.R.I.C. Bulletin (N.S.). 6 (1/2) 1971 : 19-23, 3 tables, ref.

A modification of the British Standard Method for the determination of ammonia content in latex is described in these pages. This method is recommended for use in collection centres, bulk storage tanks and in the factory. The method is easy, rapid and requires a minimum of apparatus. It uses bromothymol blue solution impregnated into filler paper as an external indicator and measures the latex instead of weighting it.

465. SENTHESHANMUGANATHAN, S.; YAPA, P.A.J.; NADARAJAH, M.
and KASINATHAN, S.

Some aspects of lipid chemistry of natural rubber. In:
Proceedings of the International Rubber Conference, Kuala
Lumpur, 20-25 October 1975. Kuala Lumpur, Rubber Research
Institute of Malaya, 1976. Volume 2, pp. 457-469,
4 figs., 3 tables, 36 refs.

Sodium fluoride has been found to be a satisfactory
inhibitor of phospholipase D and phosphatase enzymic
activity in a natural rubber latex and was used at a
concentration of 1 per cent on latex for the collection of
latex samples. Hot alcohol was used to coagulate latex and
digest the coagula obtained. This enabled the qualitative
separation and detection of sphingolipids in latex.
Sphingolipids unlike other lipids are not hydrolysed by mild
alkali and this factor was used in their further separation
from other lipids. Sphingolipids have a long chain base in
them may be the compounds responsible for improved heat
build-up properties of natural rubber. (Authors' summary).

466. YAPA, P.A.J.

Biosynthesis of latex. R.R.I.S.L. Bulletin (N.S.)
(Conference Supplement). 8 (3/4) 1973 : 9-10.

This article is intended particularly for the laymen to
give an idea on the biosynthesis of latex of the rubber tree,
methods to control or stimulate rubber production in Hevea
plant, and the uses of the rubber latex.

467. YAPA, P.A.J.

Some aspects of phenolic discolouration in natural rubber.
Jl. Rubb. Res. Inst. Sri Lanka. 53, 1976 : 22-30, 3 graphs,
4 tables, 24 refs. Abstracted in Proc. Sri Lanka Ass. Advmt.
Sci. 32 (1) 1976 : 91.

Quantitative and qualitative studies were made on the phenolic compounds in the latex of two clones: PB 86 and RRIC 7. Five phenolics were detected in RRIC 7 and three in PB 86 by paper chromatography. In both clones two of these compounds were found to be predominant. One of them was a phenolic, identified as tyrosine and the other is probably an indole compound. A slight increase in the phenolic content was observed after Ethrel stimulation. Clonal variation of thiol content in latex was also studied. Addition of thiols to latex improved the colour and the oxidative resistance of rubber. (Author's summary).

468. YAPA, P.A.J.

Enzyme deproteinization of Hevea latex, 1. Preparation and properties of DPNR and viscosity stabilized DPNR.

Jl. Rubb. Res. Inst. Sri Lanka. 54, Part 2, 1977 : 508-519

12 tables, 14 refs.

Methods for the preparation of deproteinized natural rubber (DPNR) and the viscosity stabilized version of DPNR (CV-DPNR) from field latex are described. The processes basically involve the treatment of papain-coagulated rubber in crumb form with an alkali. For CV-DPNR, the aldehyde condensing reagent, hydroxylamine hydrochloride or sulphate is added to latex simultaneously with the enzymic coagulant. Alkali treated rubber is then washed sufficiently overnight, and finally soaked in a mixture of phosphoric/oxalic acid prior to drying. The possibility of using several other commercially available proteolytic enzymes was also investigated. Two proteases of bacterial origin Bacterial Protease Novo (BPN) and Superase were found to be satisfactory. Raw rubber properties of DPNR and CV-DPNR are reported, papain, BPN and superase all gave satisfactory results and the oxidative resistance (PRI) is markedly affected by trypsin-coagulation. (Author's summary).

469. YAPA, P.A.J.; GOONASEKARA, G.A.J.P.R. and KASINATHAN, S.

A biochemical basis for characterization of Hevea clones. Proc. Sri Lanka. Ass. Advmt. Sci. 33 (1) 1977 : 25-26.

An abstract.

470. YAPA, P.A.J. and LIONEL, W.A.

Enzyme deproteinization of Hevea latex. II. The use of papain in RSS manufacture. Jl. Rubb. Res. Inst. Sri Lanka. 56, 1979 : 34-40, 6 tables, 5 refs.

The use of papain treatment in RSS manufacture was investigated. The problem of prolonged drying time associated with enzyme coagulation was alleviated by using acid as part coagulant. Milling into a thinner sheet also reduced drying time. Papain treated sheet were found to be resistant to mould growth. Both papain treated rubber and papain/acid treated rubber were found to be suitable for cyclization with p-toluene sulphonic acid, using auto- and heat-initiation of the cyclization reaction, respectively. Raw rubber and technological properties of papain-treated sheet were satisfactory. Technological properties were adversely affected by the use of raw papain milk. (Authors' summary).

471. YAPA, P.A.J. and LIONEL, W.A.

Enzyme deproteinization of Hevea latex. III. Clonal suitability for papain treatment. (Short communications). Jl. Rubb. Res. Inst. Sri Lanka. 56, 1979 : 41-47, 2 graphs, 3 tables, 4 refs.

The latices of 24 Hevea clones were tested for their suitability for papain treatment. Four of them namely RRIC 39, RRIC 52, RRIC 101 and PB 86, produced latices that were superior for this purpose, with more consistent technological properties and low protein contents together

with less seasonal variations in both these characteristics. Clone RRIC 39 was found to be the best all-round clone for enzyme deproteinization with papain. (Authors' summary).

472. YAPA, P.A.J. and BALASINGHAM, C.G.

The proteolytic action of papain on proteins in Hevea latex. Q. Jl. Rubb. Res. Inst. Sri Lanka. 51 (1/2) 1974, 1-12, 2 graphs, 10 tables, 14 refs.

Treatment of natural rubber latex with papain serves two purposes. First it acts as a coagulant, second it reduces the nitrogen content of the final product substantially, the reduction generally being in the range of 30 - 50 per cent. Papain breaks down Hevea proteins to the amino acids, this is reflected in the increase in the quantities of several amino acids namely glutamic acid, serine, α -alanine, tryptophan, phenylalanine, valine and leucines present in the serum after enzymic action. Papain appears to be more effective at a neutral than at an alkaline pH though the latter gave a rubber of a better colour. Temperatures higher than the ambient temperature were relatively favourable for the proteolytic effect. Of the chemical activators examined only cysteine and thiourea appeared to have any desirable effect on deproteinization. Inhibitory effect of hydroxylamine hydrochloride was so small that it can be used in combination with papain in the manufacture of CV rubber with a low nitrogen content. The slight increase in the ash content is, apparently, the only disadvantage of the papain treatment which may be of some consequence.

473. YAPA, P.A.J.; PREMATHILAKE, S.P. and LIONEL, W.A.

Proteolytic action of bromelain on Hevea latex. In: International Rubber Conference, Kottayam, 23-28 November 1980. Abstracts of papers. Kottayam, Rubber Research Institute of India, 1980. Session 2, paper. 3.

The proteolytic action of purified bromelain and unfractionated juice of pineapple (Ananas cosmosus) on Hevea proteins was studied. Both were found to be

effective in hydrolysing Hevea proteins resulting in a low protein rubber which satisfies the specifications for deproteinized natural rubber (DPNR). It showed a temperature optimum around 45°C and a broad pH max near 8.0. The highest deproteinization (63.15 per cent) was observed at 0.08 per cent W/V bromelain on latex. The low protein rubber obtained from bromelain or pineapple juice (PAJ) treatment can be cyclized readily and completely by the p-toluene sulphonic acid method. PAJ treatment of Heveas latex is simple and economically feasible and therefore is of obvious commercial importance. (Authors' summary).

Physical and Chemical Properties

474. MENBIS, L.P.; ABEYAGUNAWARDENE, Susima; PEMAWANSA, K.P.W.; WIJERATNE, M.S. and HETTIARACHCHI, S.

Developments in electrochemical aspects of natural rubber latex. In: CISIR contribution to science and industry; proceedings of the 21st anniversary seminar, May 4-6, 1976, at the B.M.I.C.H. Colombo. Colombo, Ceylon Institute of Scientific and Industrial Research, 1976. pp. 77-80, 4 tables, 12 refs.

The CISIR Rubber Technology Section has initiated a programme of research on electrochemical aspects of NR latex. Some of the research in progress on 3 aspects of NR latex, viz. (a) electrodeposition (b) electronic deposition (c) electrochemical synthesis, are briefly outlined.

475. NADARAJAH, M. and MUTHUKUDA, D.S.

The determination of the dry rubber content of natural rubber latex by the use of the metrolac. Q. Jl. Rubb. Res. Inst. Ceylon. 39 (3/4) 1963 : 85-94, 2 graphs, 6 tables, 6 refs.

The use of the metrolac for the determination of the rubber content of latex is based on the assumption that the relation between the specific gravity and the dry rubber content of the latex is constant. The authors explain why this assumption is not generally valid, discuss several factors which effect the metrolac readings, and indicate the correct use of the instrument. The O'Brien Ceylon scale glass metrolac, the type commonly used in Ceylon, is based on the tapping system. Since the tapping system has generally been changed to s/2, d/2, 100 per cent and monoclonal plantings of clones with latices of different compositions have been introduced, calibration of the metrolac readings against trial coagulations are necessary for each separate estate; seasonal variations and clonal effects should be taken into account. (Tropical Abstracts. 19 (9) 1964 : M 2132).

476. NADARAJAH, M.; SIVABALASUNDERAM, J. and DEKUMPITIYA, A.S.

Further factors affecting the plasticity retention index of natural rubber. Q. Jl. Rubb. Res. Inst. Ceylon.

43 (1/2) 1967 : 13-18, 9 tables, 5 refs.

Studies conducted in Ceylon showed the Hoekstra and Wallace plastimeters to be equally suitable for determining the plasticity retention index (PRI) of natural rubber coagulation with oxalic acid resulted in higher (better) PRI values than did coagulation with formic or phosphoric acid at pH values of 3.4, 4.0 and 4.6; the effect of pH was small. Exposure to ultraviolet light for 30 minutes did not lower the PRI. The deleterious effect of sunlight was found to be caused mainly by violet light, whereas green light had the smallest effect. The PRI panel scrap decreased as collection was delayed, even during the night. Pyrogallol proved to be the best antioxidant to counteract the effect of exposure to sunlight. (Tropical Abstract. 23 (2) 1968 : No. 375).

477. SIVABALASUNDERAM, J. and NADARAJAH, M.

Factors affecting the plasticity retention index of natural rubber. Q. Jl. Rubb. Res. Inst. Ceylon. 42 (1/2) 1966 : 13-28, 17 tables, 11 refs.; Abstracted in Proc. Ceylon Ass. Advmt. Sci. 21 (1) 1965 : 53.

* of seedlings with a S/2, d/3, 67 per cent tapping

The PRI of panel scrap and cup lump have a much lower value than that of the total solids of the corresponding latex. An explanation for this could be that they have been exposed to sunlight and to atmospheric conditions for about 2 days. Another explanation is that there is an increase in Calcium content towards the end of latex flow and during spontaneous coagulation the phosphatides in latex get degraded by the enzyme phospholipase D activated by Ca ions. Another explanation is the high copper, manganese and iron content. Cup lump should not be soaked in water for long periods as there is the possibility of the antioxidants getting leached out. Excessive milling should be avoided. The quality of the scrap could be improved by soaking in a solution of oxalic acid. In the manufacture of latex crepe it would be better if the latex is coagulated without dilution thus retaining most of the antioxidants, and oxalic acid is the best coagulating agent. Use of RPA 3, excessive milling and drying over 100°C should be avoided. The quality of the latex crepe could be improved by adding EDTA or very low concentrations of Antimucin before acid coagulation. (Authors' summary).

478. THARMALINGAM, R. and DISSANAYAKE, A.B.

Implications of the use of the Metrolac in weighing smallholders' latex. In: Report of the fourth seminar and workshop on progress and development of rubber smallholders, Colombo, 17-22 July 1980. Published by the Association of Natural Rubber Producing Countries, 1980. Appendix 9, pp. 97. (Summary).

An abstract.

479. YAPA, P.A.J.; FERNANDO, D.M. and PEIRIS, B.M.S.G.

Heritability of raw rubber properties in a Hevea population. Proc. Sri Lanka Ass. Advmt. Sci. 36 (1) 1980 : 23-24.

An abstract.

Bacteriology

480. JOHN, C.K.; NADARAJAH, M. and LAU, C.M.

Microbiological degradation of Hevea latex and its control. Journal of the Rubber Research Institute of Malaysia. 24 (5) 1976 : 261-271, 10 tables, 25 refs.

This paper reports the results of a series of investigations of promising chemicals which include bactericides, enzyme poisons and substrate-complexing materials. Chemicals which are able to react with carbohydrates, enzyme poisons and bactericides and which can be used as secondary preservatives for field and concentrated latices were investigated. Good control of bacterial proliferation and volatile fatty acids (VFA) build-up in field latex were obtained for two or three days, in the presence of 0.2 per cent ammonia and a secondary preservative such as hydrazine hydrate, 1-(3-chlorallyl), 3, 5, 7 triazy-1-azoniadamantane chloride hydroxylamine neutral sulphate, 1, 2-benzisothiazoline-3-one, tetramethyl thiuram disulphide and 2, 2 methylene bis(4-chlorophenol). Ammoniated latex treated with a small amount of hydrazine, hydrate, or hydroxylamine neutral sulphate, or tetramethyl thiruram disulphide prior to and immediately after centrifugation gave concentrates with better properties than those obtained by a single treatment of the same chemical at higher concentrations after centrifucation. Early addition of the secondary preservative also helps to give clean concentrates even from field latex containing a high level of biochemically degradable substrates and/or ammonia-resistant bacteria. (Authors' summary).

481. NADARAJAH, M.

Preliminary studies on the effect of the mercury fungicide, antimucin WB on rubber yield. Q. Jl. Rubb. Res. Inst. Ceylon. 41 (1/2) 1965 : 47-54, 6 tables, 10 refs.

Phenolic and mercury fungicides are applied on the tapping cut to prevent Bark Rot. Their bactericidal action on acid producing bacteria present in the tapping cut should give increased yields. But both these types of fungicides are latex coagulants and this property may result in an adverse effect on yield. It is known that the enzymes which play an important part in rubber biosynthesis contain thiol groups. Organo-mercuric compounds are known to react with thiol groups. Hence this interaction of the enzymes with the organo-mercuric compounds can adversely affect yield. Our preliminary investigation shows that this could occur when Antimucin is applied: (1) to trees of certain clones just before tapping but after removing the panel scrap; (2) to slaughter tapped trees; and (3) to high-yielding trees. (Author's summary).

Preservation and Storage

482. DHARMASENA, W.

Preservation and concentration of natural rubber latex.

Karmantha. 3 (9) September 1976 : 20-21, 2 diags.,

2 tables.

In order to preserve rubber latex from coagulating, the action of the carbonic acids and metal ions presence in the latex should be suppressed. For this purpose an anti-coagulant like ammonium hydroxide is used. 'Creaming process' used for reducing the percentage in rubber latex from 65 per cent to 40 per cent is also briefly described. This process does not require large machinery and the implements may be manufactured locally.

483. JOHN, C.K.; NADARAJAH, M.; RAD, P.S. Rama; LAU, C.M.
and NG, C.S.

A composite preservation system for Hevea latex. In:
Proceedings of the International Rubber Conference, Kuala Lumpur, 1975. Kuala Lumpur, Rubber Research Institute of Malaysia. Vol. 4, 1976, pp. 339-357, 2 figs., 13 tables, 23 refs.

A number of composite systems have been investigated as secondary preservatives for field and concentrated latices, and are consisting of low levels of ammonia, tetramethyl-thiuram disulphide (TMD) and Zinc oxide has been found to preserve field latex for many days. There is no apparent difficulty in processing the stored latex either into concentrate or dry rubber. The system is efficient and enable the processing of latex from small holdings into good quality concentrate or dry rubber. It helps to reduce the day-to-day variation in the quality of latex received in large centralised processing factories. The dry rubber or concentrate derived from this latex has satisfactory technological properties. The new system costs only about half as much as with the conventional methods. (Authors' summary).

Creaming and Concentration

484. AMARAPATHY, A.M.A.

Feasibility of creaming natural rubber latex in Sri Lanka.

Proc. Sri Lanka Ass. Advmt. Sci. 35 (1) 1979 : 49.

An abstract.

485. AMARAPATHY, A.M.A.

Preparation of concentrated latex by the creaming technique.

R.R.I.S.L. Bulletin. 14, 1979, 13-19, 3 figs., 2 tables.

Although centrifuging is the most popular method of concentrating natural rubber latex, centrifuges are very expensive. This article discusses the possibility of using tamarind seed powder as a creaming agent and compares it with sodium alginate with respect to efficiency and concentrate properties. The main advantages of the creaming process are its simplicity, ease of operation, low labour cost, and low capital cost of installation.

486. KARUNARATNE, S.W. and MENDIS, B.P.H.R.

Electrodecantation of natural rubber latex. Proc.Sri Lanka Ass. Advmt. Sci. 35 (1) 1979 : 44.

An abstract.

Coagulation

487. COOMARASAMY, A.; YAPA, P.A.J. and KASINATHAN, S.

Use of palmyrah seed distillate as a coagulant for natural rubber latex. Proc. Sri Lanka Ass. Advmt. Sci. 34 (1) 1978 : 22.

An abstract.

488. KARUNARATNE, S.W. and PIYADASA, K.A.

Coagulation of natural rubber latex with hydrochloric acid (HCl). Q. Jl. Rubb. Res. Inst. Sri Lanka (Ceylon). 50 (3/4) 1973 : 151-156, 4 tables, 2 refs.

Natural rubber derived from HCl coagulation was tested for any deleterious effects, principally ageing, and it was found that under controlled conditions HCl coagulated rubber after shelf ageing as well as accelerated ageing. (Authors' summary).

489. MUTHUKUDA, D.S. and NADARAJAH, M.

Latex coagulating tanks. R.R.I.C. Bulletin (N.S.) 6 (3/4) 1971 : 79-85, 3 diagrs., 3 tables.

In the manufacture of raw rubber from latex, whether it is smoked sheet, pale crepe or new process rubber, the latex has to be bulked and coagulated in tanks. Various types of

coagulating tanks used in Ceylon are described in this article. The cheapest lining material for these tanks in Ceylon has been found to be Epikote resin. However, porcelain tiles, which can be considered to be the next cheapest material, not only give a cleaner appearance to the tanks, but also involve less expenditure to the country in terms of much needed foreign exchange. From the point of view of performance, both kinds of lining material have proved to be equally satisfactory.

490. NADARAJAH, M.; YAPA, P.A.J.; BALASINGHAM, C.G. and KASINATHAN, S.

The use of papain as a biological coagulant for natural rubber latex. Q. Jl. Rubb. Res. Inst. Sri Lanka (Ceylon)

50 (3/4) 1973 : 134-142, graph, 7 tables, 13 refs.

The use of papain as a general coagulant for natural rubber latex in conjunction with formic acid for raw rubber manufacture should give a superior rubber as it will have a lower nitrogen content. This method of coagulation would be of value in the manufacture of partially purified crepe and in coagulating of skim latex to get rubber of acceptable quality. Papain fetches a high price but rubber estates could produce it for their own use at reasonable prices by inter-cropping papaya between immature rubber trees. This can be conveniently done as the period during which papain can be commercially exploited (3 to 4 year) coincides with the period during which it can be successfully grown as an inter-crop. (Authors' summary).

491. RUBBER RESEARCH INSTITUTE OF CEYLON. Advisory Circular No. 73.

Prevention of coagulation in the field. Agalawatta, R.R.I.C. 1963, 4 p., table.

Latex from young trees and from trees of certain clones, shows a tendency to pre-coagulation prior to arrival at the factory and manifests itself in lumps in the latex cup, clots in the latex, coagulation during transportation and fermentation bubbles in the coagulum. This is minimised by the addition of latex anticoagulants, and this Circular describes, choice, method of application, preparation and dosage of anticoagulants. For sheet manufacture ammonia is considered the best anticoagulant, except for latex from high cuts for

which formalin is recommended. For crepe manufacture sodium sulphite should be used because ammonia and formalin may cause discolouration in the crepe.

492. SATCHUTHANANTHAVALA, R. and SATCHUTHANANTHAVALA, Vimaladevi

Bacterial coagulation of latex. Q. Jl. Rubb. Res. Inst.

Ceylon. 48 (3/4) 1971 : 182-192, 5 col., plates, 3 tables,
14 refs.

This paper gives some preliminary observations and results of experiments directed towards the coagulation of latex by the aid of suitable strains of bacteria, after they were cultured in a coconut water medium. The experimental work is divided into 2 parts: (1) The isolation and selection of bacteria on their ability to coagulate latex; (2) the physical and technological properties of rubber obtained by bacterial treatment. If the conventional acid coagulation method is adopted, the cost of acids, and anticoagulants will amount to Rs. 1,350,000 or more in foreign exchange, for 135 million pounds of sheet rubber produces annually. Bacterial coagulation involves no foreign exchange expenditure.

493. SATCHUTHANANTHAVALA, R.; SATCHUTHANANTHAVALA, Vimaladevi;
NADARAJAH, M. and AMARASINGHE, I.

Possibilities of bacterial coagulation in raw rubber
manufacture. Q. Jl. Rubb. Res. Inst. Ceylon. 48 (3/4)

1971 : 193-201, 3 col. plates, 3 tables, 6 refs.

Item No.492 have demonstrated that controlled coagulation of field latex could be effected by seeding field latex with suitable strains of bacteria. This paper examines the possibilities of this method of coagulation as applied in the field and also its applicability for latex skim coagulation. The controlled bacterial coagulation is a useful process in enabling smallholders' latex to be converted into new process rubber by coagulation in the cup. It can also be used for coagulation in the factory. It is also of value in coagulation of skim latex to give a rubber with superior properties than acid coagulation with no attendant problems of odour nuisance.

Skim Latex

494. YAPA, P.A.J.; NADARAJAH, M. and LIONEL, W.A.

High quality low protein rubber from skim latex.

In: International Rubber Research and Development Board
Symposium, Kuala Lumpur, 15-18 May 1978, organized by the
Rubber Research Institute of Malaya, Text of Papers.

[London], IRRDB, 1978. 5 p., 3 tables, 7 refs.

(Preprint).

A new method based on enzyme deproteinisation, for the production of high quality rubber from skim latex is described. The process is fairly simple, involving a creaming step followed by mixing of creamed skim with fresh field latex and overnight treatment - coagulation with papain. It gives a rubber with a considerably low nitrogen content (0.15 per cent) and a satisfactory PRI (62), the best values obtained for skim rubber, by any method reported so far. Preliminary results on technological and dynamic properties are also satisfactory. (Author's summary).

RUBBER CHEMISTRY AND TECHNOLOGY

General

495. ABRAHAM, A.V.

Adapting rubber goods for the export market. Karmantha.

4 (2) February 1977 : 18-19.

This article contains a few general extracts of recommendation from a report by the author as a UNIDO Product Adaptation Advisor who was in Sri Lanka on a 6 months assignment in 1976, assisting the Ministry of Industries on a project for adapting rubber products for the export market.

496. ANON

Incentives for the production of new forms of natural rubber. Ceylon Trade Journal. 33 (7) July 1968 : 213-214.

The Government of Ceylon decided on 5th July 1968, to offer certain incentives to firms which undertakes the manufacture of new forms of rubber such as Hevea Crumb, Dynat Natcom., and these are briefly outlined in this paper.

497. ANON

Rubber products - manufactured and processed. In:
Ceylon Investment Guide - the rubber, leather, wood and non-metallic mineral products industries, prepared for the Ministry of Industries and Fisheries of Ceylon by the Economist Intelligence Unit, London, 1968. Chap. 1, pp. 8-30, 9 tables.

This guide presents the detailed results of a survey of the rubber of Ceylon which was carried out by the Economist Intelligence Unit for the Industrial Development Board of Ceylon in mid-1967. The purpose of the guide is to give existing and potential industrial developers comprehensive information on rubber industry with a view to encouraging new industrial

development or an expansion of existing development wherever all the necessary conditions are considered appropriate. The following items are considered in this guide: Primary rubber; various rubber products e.g. mattresses, cushions, seats, car accessories, piping and hose, buckets, toys, etc.; Rubber seed oil.

498. AMARAPATHY, A.M.A.

Possibility of expansion of the latex based industry in Sri Lanka. R.R.I.S.L. Bulletin (N.S.). 12 (1) 1977 : 83-86.

Rubber products manufactured by the latex and by dry rubber are costed, and found that, it is profitable to invest money on manufacturing latex based products. Possibilities of manufacturing various types of products for export are also discussed.

499. BANDARANAYAKE, Lalitha Dias

A select bibliography on pollution in the rubber industry. (Covers the period 1941-1978). Colombo, Ceylon Institute of Scientific and Industrial Research, Technical Library and Information Service, 1978. (Bibliographical series 11/78). [ii], 4 p. (Mimeographed).

A select list of 27 items, some of them are abstracted, and they have no relevance to Sri Lanka

500. DE SARAM, C.S.

The need for education in the rubber products manufacturing industry in Sri Lanka. R.R.I.S.L. Bulletin (N.S.). 12 (2) 1977 : 72-74.

501. DE SOYSA, W.C.R.

Bounce to rubber industry. Karmantha. 6 (10) October

1979 : 11-13, 1 photo.

The local rubber goods manufacturing industry in Sri Lanka has not made any notable progress, for the following reasons, even though the industry has been carried on for a number of years; lack of technical know-how, financial problems to improve technologically, non-availability or high cost of the raw materials (local and foreign), non-availability of better marketing set-up, poor quality of rubber products by the small-scale manufacturers, high prices of machinery and equipments. This article is concluded with few recommendations to overcome and improve this industry.

502. DE SOYSA, W.C.R.

The rubber goods industry in Sri Lanka. Katubedde,

Moratuwa, Industrial Development Board of Sri Lanka, 1979.

V, 44 p., 8 appendices.

This report in rubber goods manufacture with special reference to small-scale industry is the third of the series. This report deals with all aspects of the rubber goods industry in Sri Lanka during the period 1966-1977 and highlights a number of important problems relating mainly to technological aspects. The manufacture of tyres and tubes has been left out in this study as it is being done only on a large. Specific references have been made to the problems with regard to the essential raw materials, quality, the prices of products and lack of essential testing and laboratory facilities for the industry. The main objectives of the study are: (a) To assess the state of technology of the rubber goods industry in Sri Lanka; (b) to identify the general problems where assistance is needed, (c) to identify critical problem areas in which technical assistance is needed, (d) to suggest guidelines for development possibilities. This report will provide an overall picture of the rubber goods industry in Sri Lanka.

503. DHARMASENA, W.

Boost for rubber industrialists. Karmantha. 6 (6)

June 1979 : 17-18, 1 photo.

Various types of technological assistance, management assistance and financial incentives provided by the Rubber Industries Unit of the Industrial Development Board of Sri Lanka to the small and medium scale rubber industrialists are briefly described in this article.

504. HEINISCH, K.F.

Review of the Chemistry Department, [R.R.I.C. for 1960].

Rubb. Res. Inst. Ceylon. Ann. Rev. 1960 (1961), pp. 65-74.

The work of the Department has been largely concerned with determination of dirt content of Ceylon rubbers and of the copper content of latex and scrap from copper-dusted areas. It has been found that the high dirt content of scrap rubber may be substantially reduced by soaking the rubber prior to milling in solutions of surface active substances, such as "Detergent 4OE". Experiments on copper contamination of rubber have shown a residual effect of copper on rubber obtained from trees which had been previously dusted with copper compounds, the copper being removed from the bark of the trees by rain water and contaminating the bark scrap. The degree of copper contamination may be reduced by the use of polythene film rainguards fixed over the tapping panel, by blending the scrap from dusted and non-dusted areas and by soaking it for 24 hours in a weak solution of oxalic acid. Experiments on latex coagulation have resulted in a simple method of controlling coagulation by the use of bromo cresol green indicator paper which is highly effective for controlling coagulation by formic or acetic acid but not nearly as effective when oxalic acid is used as the latex coagulant. Investigations into the prevention of mould growth on smoked sheet have shown that three of the fungicides, tested for their effectiveness on the four species of mould most commonly found in Ceylon sheet rubber, may prove to be excellent substitutes for paranitrophenol.

505. HEINISCH, K.F.

Review of the Chemistry Department, [R.R.I.C. for 1961].

Rubb. Res. Inst. Ceylon. Ann. Rev., 1961 (1962), pp. 76-88.

A systematic study of the latex and rubber of 20 clones is in progress. Monthly samples of the latex are tested for dry rubber content, total solids, percentage of yellow fraction and viscosity at 30°C and the total solids are tested for ash, nitrogen, water extract, acetone extract, caustic potash extract, copper, iron, manganese, magnesium, phosphorus, calcium and potassium. The crepe made from the latex of each clone has been tested for colour and plasticity. Considerable interest has been shown by estates regarding the use of "Detergent 40E" and trisodium phosphate in reducing the dirt content of scrap rubber. It has been found that Robin Blue used at concentration of $2\frac{1}{2}$ to 3 per cent in diluted Antimucin WB solution acts as a good indicator without staining the scrap crepe. Crepe rubber manufactured on five estates has been sampled weekly and tested for dirt, copper, manganese, iron and ash. Treatment of scrap rubber for the reduction of copper and manganese content has been successfully carried. Investigations on carotenoids and enzymes in clonal latices are in progress. A microscopic study of the non-rubber particles present in fresh latices of a number of clones has shown differences in the amount and type of these particles.

506. KARUNARATNE, S.W.

Rejuvenation of the natural rubber industry in Ceylon.

R.R.I.C. Bulletin (N.S.). 3 (3) 1968 : 46-52.

The author put his finger on the crux of the problem by pointing out that although on the balance of properties and value for money, the natural rubber (NR) may be unrivalled, it would be foolish to expect this position to to on for ever. NR must move with the times and he pointed out that technically specified NR has removed the special advantage hitherto enjoyed by synthetic rubber, and he advocated the vigorous exploitation of this factor together with replanting with high-yielding clones as the two most important goals to aim at for the future prosperity of NR. The author also made the very important point that all new process rubbers are basically the same - the principle behind them is the breaking up of the coagulum into small particles, which are cleared of dirt, rapidly dried and packed in small bales, of convenient size, and sold to technical specifications. Therefore, terms such as crumbling, granulation, comminution, pelletisation and shredding are merely technical terms - jargon, as the author says. The choice of processes must be governed primarily by the cost of the machinery required and will be favoured where existing machinery can be adopted.

507. KARUNARATNE, S.W.

Review of the Rubber Chemistry Department, $\angle$ R.R.I.C.
for 1967 $\angle$. Rubb. Res. Inst. Ceylon. Ann. Rev., 1967
(1968), pp. 60-68.

In order to formulate a technical specification scheme for Ceylon rubbers large-scale sampling and testing of sheet and crepe were undertaken. The results have been encouraging. Heveacrumb, one of the newer forms of rubber is now being manufactured at the Institute's pilot plant on Peenkande Estate. Heveacrumb from fraction, cup lump, tree laces as well as mixes have now been tried and tested for technical properties. Further experiments have now been designed to improve the quality of the crumb produced. The Institute is now in a position to advice on the manufacture of the newer forms of rubber produced by any of the newer processes such as by pelletisation, comminution, granulation or mechanical crumbling. The plasticity retention index (PRI) studies were continued. The manufacture of foam rubber from creamed latex and rubberising of jute hesian also received the attention of this Department.

508. KARUNARATNE, S.W.

Review of the Rubber Chemistry Department, $\angle$ R.R.I.C.
for 1968 $\angle$. Rubb. Res. Inst. Ceylon. Ann. Rev., 1968
(1969), pp. 59-63.

The Rubber Chemistry Department was seriously understaffed during the period under review. The Department continued to provide advisory services to the large estates on problems connected with the manufacture of raw rubber. It also handled many inquiries on the manufacture of new forms of rubber. The estate experimenting on the production of Heveacrumb with the assistance of the Institute, completed production of a trial batch of 5 tons of this form of block rubber from a mixture of cup lump and tree lace. Very little technological research was carried out, other than routine technological testing, and this was mainly due to lack of emphasis on such work. With the recruitment of additional staff and the provision of adequate funds, both of which have already been budgeted for, the Department will be expected to carry out technological research in the

future. A large part of the time of the staff was devoted to carrying out routine tests for technical specification of crumb rubber as well as scrap grades. It is strongly recommended that a separate specification unit be set up to handle specification testing. A survey of PRI of the various grades of estate and smallholders' RSS and estate brown crepe has been launched. Sampling for this purpose is being continued from 6 estates in the Kalutara District. The Department also helped to organise the symposium on the appraisal of new developments in natural rubber processing and presentation.

509. KARUNARATNE, S.W.

Review of the Rubber Chemistry Department [R.R.I.S.L. for 1979]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1979 (1980), pp. 91-113.

An alternative bleaching agent to xylyl mercaptan (RPA3), namely tolyl mercaptan (brand named RR17), was found suitable for use in the manufacture of high quality crepe rubber. At least 10 different types of mercaptans had to be screened in order to select tolyl mercaptan which was found to be even superior to RPA3. The Crepe Rubber Development Unit (CRDU) has concentrated on the manufacture of light coloured high quality NR to consumer requirements. The development of colour (discolouration) during storage of crepe rubber, the colour coding system for crepe rubber, which is based on the production method and the classification of crepe rubber on the basis of its solution viscosity was studied. It was found that storage hardening of liquid rubber could be reduced by incorporating a radical quencher like ZDC. Several attempts inter-related or other-wise have been made in order to introduce thermoplastic properties into NR. Both blending and grafting techniques are described. Attempts have been made to synthesise amine-based antioxidants and dual purpose accelerators. The work on the development of network bound antioxidants in NR by the thiol addition reaction has come to a standstill due to the non-availability of the chemical required in commercial quantities. Several applications for low temperature curing systems are highlighted here. An interesting and useful application is in the rubberising of bullock cart wheels. However without changing the design of the cart, maximum benefit from the above development would not be feasible. Low temperature curing systems based

on NR could be used to safeguard the tea bush against desiccation and borer attacks by effective sealing of pruning cuts. Promising ebonite formulations for compression moulding of engineering components are described. About 5 tons of cyclised rubber per month are manufactured presently in four estate factories. Deproteinised NR prepared by papain/acid coagulation is satisfactory for cyclisation in the open mill using p-toluene sulphonic acid. Incorporation of 5 per cent CaO helps in the neutralisation of excess acid. Metal salts of higher fatty acids such as calcium stearate and the calcium salt of rubber seed oil fatty acid (CARSOE) have been shown to be very effective activators of sulphur vulcanization. Carboxyl methyl cellulose (0.5 per cent) was used as a wetting agent in the manufacture of Rubber/Carbon black masterbatch in the latex stage. It has been found that the sheet form is the most suitable way to prepare the masterbatch for drying. Compounds prepared from the masterbatch have been tested out and found to be satisfactory. The properties of local clay were continually monitored. Some variation in acidity leading to retardation of vulcanization has been spotlighted. In the processing of latex, the work reported includes preservation, concentration and dialysis of NR latex. In the field of raw rubber processing, RRIC 103 was found to be the most suitable of the RRIC 100 series clones for crepe rubber manufacture, whereas RRIC 102 was found to be unsuitable due to discolouration. An attempt to make CV block rubber by direct pressing of CV lace crepe is reported. Solar energy for drying crepe rubber is appropriate in the context of the energy crisis. Technical specification of NR continued to be one of major functions of the Department. 6 block rubber factories are registered with the specifications unit and the average number of samples tested daily is about 100. The clone RRIC 39 has been found to be the best clone for enzyme deproteinization, using papain. Effect of Ethrel stimulation on some of the non-rubber constituents were investigated. No significant change in thiols were observed in the A-serum during the first 24 h after stimulation. An electrophoretic technique for the separation of serum proteins on polyacrylamide has been established. A useful non-rubber resource is rubber seed oil (RSO). Of the triglycerides available in Sri Lanka, RSO is the only one which has useful drying properties. Light coloured alkyl resins were prepared in a purified form and this work is reported. The free import of linseed oil may jeopardise this nascent industry.

510. KARUNARATNE, S.W.

. Strategy for the orderly development of the rubber goods industry in Sri Lanka. R.R.I.S.L. Bulletin (N.S.)

12 (2) 1977 : 69-71.

The author considers the following factors vital for the development of the rubber goods industry : availability of raw materials, machinery and technical know-how; quality control, local demands, and exports. The author also sets out the following strategies for the development of the industry. 1. Adequate financial resources; 2. Unrestricted importation of vital machinery in demand; 3. Research and development; 4. Setting up a Technical Service Centre; 5. A scheme to ensure quality standards; 6. An export promotion council.

511. MENDIS, L.P.

Future of natural rubber industry. R.R.I.S.L. Bulletin (N.S.) 12 (2) 1977 : 114-116.

The author briefly summarises the type of important research being done overseas with a view to develop the natural rubber industry, and then briefly describes attempts in Sri Lanka to develop more and more of quality products. Five aspects of research will be dealt with viz. (a) NR in multi-component systems; (b) crystallinity of NR; (c) injection moulding of NR; (d) fractionation of NR and (e) NR in engineering.

512. NADARAJAH, M.

Possibilities of rubber products manufacture in Sri Lanka. R.R.I.S.L. Bulletin (N.S.). 12 (2) 1977 : 63-66.

The author writes that our efforts in making gigantic strides in the near future to produce rubber products for export does not look very bright and the possible products for export are footwear, dipped goods and rubber bands. The author suggests, 1. the early manufacture of reclaim in Sri Lanka; 2. manufacture of remilled sole crepe in Sri Lanka; 3. co-ordinated increase in research in rubber products and new uses are necessary to make the rubber product industry more active.

513. NADARAJAH, M.

Recent advances in rubber chemistry and technology at the Rubber Research Institute of Sri Lanka. R.R.I.S.L. Bulletin (N.S.). (Conference supplement). 8 (3/4) 1973 : 32-34.

A short review of activities in rubber chemistry and technology at the R.R.I.S.L.

514. NADARAJAH, M.

Speciality rubbers and plastic derivatives based on natural rubber. Polymer Journal. 3, 1971/72 : 37-40, table, 28 refs.; Reprinted in R.R.I.C. Bulletin (N.S.). 7 (3/4) 1972 : 76-84.

The tendency for overproduction of synthetic rubber and their substitute for NR even in areas or production where NR would be more suitable has had generally a depressive effect on price of NR. Hence finding markets for natural rubber at a fair price has off and on become a problem of deep concern to NR producing countries. The solution for this situation is obviously to make NR more competitive in the world market by the evolving of very high yielding clones, by better agricultural methods and more effective tapping methods. Efforts of producing countries should also be directed towards the manufacture of consumer products instead of exporting NR as a primary product. With this in view Research Institutes in NR producing countries should orientate their research programme by laying more emphasis on rubber technology. This article discusses the various types of NR have been produced and their application to industrial uses, all based on the research findings of the Rubber Research Institutes of Ceylon.

515. NADARAJAH, M.

Review of the Chemistry Department, [R.R.I.C. for 1962]. Rubb. Res. Inst. Ceylon. Ann. Rev. 1962 (1963), pp. 113-127.

The systematic study of the latex and rubber has been continued for the second year. Monthly samples of latex of 20 selected clones are tested for dry rubber content, total solids, percentage of yellow fraction and viscosity. The total solids are tested for ash, copper, iron, manganese, magnesium, phosphorous, calcium and iron. The crepe made from the latex of each clone has been tested for colour, plasticity, tensile strength, elongation at break and strain. Crepe rubber manufactured on 3 estates have been sampled weekly and tested for copper and dirt content. Investigations of the copper and manganese content of low grade rubbers mainly Brown Crepes manufactured from scrap rubber, have shown that these low grade rubbers often greatly exceed the specified maximum of 8 p.p.m. for copper and 10 p.p.m. for manganese, as laid down by the Rubber Manufacturer's Association of New York (RMA). The following factory practice for treatment of scraps is recommended as a normal procedure throughout the year to ensure that the copper content of the scraps is kept within the RMA specification. All panel scraps, earth scraps and also cup scraps are soaked for at least one day in five to ten times the volume of fresh sheet or crepe serum to which 0.1 per cent detergent may be added to remove dirt. Care should be taken to ensure that the scraps are properly submerged in the soaking solution. It has been suggested to the RMA that the levels selected for manganese should be based on the quality and form of manganese which will be harmful to rubber products and should take into account that low grade rubbers may absorb manganese from the bark of the trees. The figure of 25 p.p.m. has been suggested as the upper limit for manganese content of low grade rubbers. The extent of copper contamination of panel scraps as a result of spraying with copper formulations for the control of Phytophthora Leaf-Fall is very high at the first tapping following the spray application due to direct contamination, but it assumes reasonable limits on subsequent tapping days, being somewhat higher for the spray formulations than for the copper dusts. Complaints of dirt in Ceylon Thick Pale Crepe have been made by overseas buyers and estates were advised to keep their factories clean and not to use dirty, rusty water for the dilution of latex. Estates are also advised to use ultramarine blue instead of Swedish Red power to facilitate the supervision of the application to the bark of the water-miscible panel fungicides for the control of Bark Rot. Experiments for a direct determination of the colour of latex and for the improvement of the colour of finished scrap ecrepes are in progress. Investigations on the oil-extension of Natural Rubber at the latex stage are

also in progress. Investigation into the causes of discolouration of latex is being continued. A method has been devised to extract phenolic substances from the latex and chromatographic studies of the phenolic extracts are in progress. Advice and demonstrations have been given to the Superintendent of an estate interested in the manufacture of Superior Processing Crepe. Experiments on the treatment of effluents from rubber factories to remove offensive smells have been continued. Several estates have been visited and advice given on crepe manufacture, sheet manufacture, scrap manufacture, weighting of latex, precoagulation of latex, extensions to the factory and centralised rubber manufacture.

516. NADARAJAH, M.

Review of the Rubber Chemistry Division, [R.R.I.C. for 1963]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1963 (1964), pp. 82-95.

Advisory work of the Division has been concentrated on the improvement of the quality of lower grade sheet and crepe and concentrated latex manufactured in Ceylon. A total of 168 visits have been made by the Acting Head of the Division and his technical staff to commercial estates during the year under review. An attempt has been made to determine the mercury content of bark and latex resulting from treatment of tapping panels with organo-mercurial fungicides. With increased acreages of young budded rubber coming into tapping, estates are finding it increasingly difficult to determine the dry rubber content accurately with the use of the metrolac. The work of calibrating the metrolac has been undertaken on several estates. The analysis of latex of 23 clones grown under local conditions has been continued. The results for 1962 have been summarized in Table I of the review of the Division. The cause of brittleness, sometimes found in sheet, manufactured from young trees, is not fully understood. Sheet may be down-graded on this account. Under these circumstances visual grading could be quite inadequate in terms of ultimate properties. It was found that latex from trees up to 10 years of age produced sheets which lacked elasticity and showed a tendency to break on stretching. Satisfactory oil-extended sheet rubber has been manufactured at the Institute. Arrangements have been made with the Ceylon Institute of Scientific and Industrial Research to test this rubber for use in the manufacture of retreated tyres. The calcium content of latex shows an increase with the time of the flow of latex, while in the case of magnesium content there is generally a decrease

with the time of the flow of latex. The potassium content of panel scrap is appreciably less than that of the corresponding latex. Discolouration in scrap rubber is also caused by non-enzymatic browning. Methods of improving the colour of scrap crepe with the use of sodium bisulphite has been recommended for improving the quality of this grade of crepe. Experiments were continued to find ways and means of decreasing the rather high manganese content of scrap crepe in Ceylon, especially that manufactured from panel scrap. A clonal assay of the quantity of phenols in clone RRIC 7, which causes a marked enzymatic discolouration of its latex, indicated the presence of phenolic bodies in the latex. Methods of minimising such discolouration have been recommended. The Rubber Chemist collaborates with the Natural Rubber Producers Research Association in the United Kingdom by sending prepared fresh samples of Hevea brasiliensis, H. benthamiana and H. spruceana latices for carrying out fundamental research on the biosynthesis of latex with the aid of the electron microscope.

517. NADARAJAH, M.

Review of the Rubber Chemistry Division, [R.R.I.C. for 1964]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1964 (1965) pp. 87-98.

The Rubber Chemistry Division has conducted refresher courses for Rubber Makers in the Kalutara and Ratnapura Districts under the auspices of Planters' Association of these districts. The Head of the Rubber Chemistry Division and the Senior Technical Assistant addressed the Estate Superintendents of the Kalutara and Kelani Valley Districts on rubber making at the respective district clubs on application made by Planters' Association of these districts. The Head of the Rubber Chemistry Division and Mr. O.M.R. Sirisena have assisted the Institute of Rubber Industry (Ceylon Section) in conducting part-time lectures for training 28 persons, drawn from the rubber industry in Ceylon, to cover the L.I.R.I. syllabus in 18 months. Latex collected from trees with increased tapping intensities has a lower dry rubber content than that obtained from the more normal intensities of tapping. Double-tapping for increasing crop is a case in point where latex with a reduced d.r.c. presents difficulties in the weighing and determination of the correct d.r.c. for the payment of tappers. Samples of latex from clones PB186, REIM 501, and Nab 12 collected in vessels surrounded by ice

have been sent monthly in polythene containers packed in ice in a thermos flask to the Natural Rubber Producers' Research Association, England for purposes of research. The average values of nitrogen content in samples of latex and rubber from 28 clones collected monthly in 1962 are presented in the report for 1964. Trees stimulated for increased yields lead to late-dripping conditions. The results obtained on the calcium content and yield of stimulated and intensively tapped trees compared with normal yields are recorded in Table II of the report. It has been suggested that there might be a relationship between calcium content and yield and that an increase in a high concentration of calcium ions is connected with the cessation of latex exudation presumably by the coagulation of latex at the cut ends of the latex vessels. Samples of oil-extended ribbed smoked sheet containing 25 per cent naphthenic (Sun Rubber Process Oil 596) and 25 per cent high aromatic (Sundex 1,585) oil were despatched to the Sun Oil Company, U.S.A. for testing. Both oils are suitable when extending natural rubber up to 25 per cent. The soaking of panel scrap in fresh serum for 1 or 2 days reduces the copper content below the specification limit of 8 p.p.m. but not the manganese with a specification limit of 10 p.p.m. No. 3 Pale Crepe which is fractioned yellow crepe contains a higher mineral content than No. IX Pale Crepe, which is fractioned white crepe. The Physical properties of crepe samples made from 21 clones have been determined and presented in Tables 8 and 9. The crepe from clone AVROS 352 gives fast curing crepe (Blue circle) while those of PB 86, 107, Nab 15, RRIC 5, 7, 52, 86, Nil 3/2 and Wagga 6278 give medium curing crepe (Yellow circle). The phenol content of latex from high upward cuts is about double compared with that of latex from the normal cuts. Discolouration of rubber manufactured from high cuts may be due to the excess of phenol. Preliminary investigations have been carried out on the effect of the absorption of phenyl-mercuric-acetate present in Antimucin on yield output. Applications of Antimucin before tapping increased the yields of clone Nab 15, while those of clone RRIC 501 were depressed. These findings will be checked in balanced field experiments with control plots with applications of fungicides with and without mercury compounds by the Plant Pathology Division.

518. NADARAJAH, M.

Review of the ~~Rubber~~ Chemistry Division, [R.R.I.C. for 1965]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1965 (1966), pp. 70-77.

The Rubber Research Board has initiated action to establish a pilot plant for crumbled rubber manufacture in Ceylon. Two officers of the Rubber Chemistry Division visited the Rubber Research Institute of Malaya to study this process as well as to gather information on technical specifications tests. The general objective of technical specification is to work towards the establishment of a limited number of grades of naturally produced rubber which conform to certain standards. Samples of Estate Brown Crepe and Pale Crepe from estates and brokers were analysed and classified with a view to selling them to a technical specification. Experiments were carried out to determine the factors which affect the Plasticity Retention Index of raw rubber. It was found that the PRI could vary with the clone from which the latex is obtained. The PRI of panel scrap and cup lump have a much lower value than that of the corresponding latex. An explanation for this could be that they have been exposed to sunlight and to atmospheric conditions for about 2 days. Another explanation is that there is an increase in calcium content towards the end of latex flow and during spontaneous coagulation the phosphatides in latex get degraded by the enzyme phospholipase D activated by calcium ions. This effect could be minimised by the addition of EDTA before acid coagulation. Another explanation is the higher copper, manganese and iron content. Thiol groups also catalyse the oxidation of phosphatides. The oxidation could be minimised by the addition of very low concentrations of Antimucin. However, higher concentrations of Antimucin lower the PRI as mercury is a pro-oxidant. Oxalic acid is the best coagulant to give a high PRI in crepe manufacture. This may be due to its complexing and hence inactivating the calcium present in latex. The use of RPA 3 causes a lowering in PRI. This is expected as RPA 3 is a peptising agent. Further the thiol group in RPA 3 catalyses the enzymatic degradation of the phospholipids in rubber causing a lowering of PRI. Sodium bisulphite which is used to prevent enzymatic discolouration of rubber acts as an antioxidant increasing PRI. The Rubber Research Institute continued to send monthly samples of latex from certain specific clones to the Natural Rubber Producers' Research Association, England, for purposes of research. Estates were given advice, when sought, on smoke house operation, drying tower operation, sole crepe, crepe and sheet manufacture, pre-coagulation etc. It was found that where calcium causes pre-coagulation (such as in estates in the Matale District) the use of washing soda as an anticoagulant in the field and in the transportation tank was very effective in minimising pre-coagulation. A preliminary trial to ascertain the cost of collection of

rubber seeds was carried out on an estate in Polgahawela. While rubber oil extracted from seed thus collected would not be too suitable as a drying oil it may seem satisfactory in the manufacture of the liquid soap.

519. NADARAJAH, M.

Review of the Rubber Chemistry Department, [R.R.I.C. for 1966]. Q. Jl. Rubb. Res. Inst. Ceylon. 43 (3/4) 1967 : 132-139.

The Rubber Research Institute in collaboration with Lever Brothers (Ceylon) Ltd., carried out an exercise to evaluate the economics of collection and processing of rubber seed. About nine commercial estates participated in this experimental project. This experiment will be continued in 1967 and if the project proves workable may result in a foreign exchange savings of over 5 million rupees. Assistance was given to the P.W.D. in the addition of latex to bitumen in road surfacings. Assistance was also given to Nakiadeniya Group, Nakiadeniya, to carry out dirt content and volatile matter content determinations. Samples of scrap from Ceylon Trading Company, Colombo are being regularly tested for conformity to technical specifications and with a view to improving these grades. Experiments were carried out to detect the substance which is responsible for the natural resistance of some clones to Bark Rot and Bark Cracking. Preliminary experiments indicate that clones susceptible to Bark Rot may contain low concentrations of tannins and those resistant, higher concentrations. Experiments were continued to determine the factors which affect the Plasticity Retention Index of natural rubber. The Rubber Research Institute continued to send monthly samples of latex from certain specific clones to the Natural Rubber Producers' Research Association, England, for purposes of research. With the new research findings at the Natural Rubber Producers' Research Association in England that oil-extended natural rubber (OENR) is in no way inferior to oil-extended styrene butadiene rubber (OESBR) in passenger car tyre treads, preliminary experiments were initiated locally with a view to producing oil-extended rubber sheets on a commercial basis for use in tyre retreads.

520. NADARAJAH, M.

Review of the Rubber Chemistry Department, [R.R.I.C. for 1969]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1969 (1970), pp. 80-89.

The Rubber Research Board has accepted that the Institute should undertake research on all aspects of rubber production and usage. Therefore, the work of the Rubber Chemistry Department has expanded to a great extent during 1969, and a continuing programme of research has been formulated, with emphasis on the uses of natural rubber. A part of the required staff, to carry out this expanded programme, has been recruited and is undergoing the necessary training both at the Institute and abroad. Investigations on the production of viscosity stabilized rubber from lower grades have shown that storage hardening can be successfully inhibited by soaking cup lumps in an aqueous solution of hydroxylamine hydrochloride. Soaking in rubber serum from acid or assisted biological coagulation improved the PRI. The wear properties of oil-extended natural rubber retreads have been found to be superior to those of non-oil-extended rubber, when due regard is paid to compounding. In the related field of the use of field latex in road surface dressings, the problem of the transport of latex to the site has been overcome by preparing rubber-bitumen masterbatches containing an optimum of 12.5 per cent rubber. Vulcastab LW or mixtures of Vulcastab LW and potassium hydroxide or potassium sulphate or sodium carbonate were found to be suitable stabilizers for ammonia preserved field latex for mixing with cement. If the latex is pre-vulcanised, less stabilizer was necessary and if it is granted with methyl methacrylate no stabilizer was necessary. Investigations on the collection of rubber seed kernel have shown that estates can make a profit of about Rs. 150/- to Rs. 175/- per ton of kernel collected. Work done in collaboration with the Ceylon Institute of Scientific and Industrial Research has shown that the tocotrienol contents of field latex exhibit a clonal variation and that these substances could be important antioxidants. Field surveys and other preliminary investigations have been carried out by the Department for the erection of central factory to process latex for smallholders and small estates into new forms of rubber.

521. NADARAJAH, M.

Review of the Rubber Chemistry Department, [R.R.I.C. for 1970]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1970 (1971), pp. 67-77.

The smallholders form an important sector of the rubber industry in Ceylon, one-third of the acreage under rubber being owned by them. A project report was prepared to set up a new process rubber factory at Mawanella, to cater to small-

holders in the area. A micronised form of graphite was successfully incorporated into NR; this would prove useful in such applications as solid tyres. Full scale field experiments are under way, in collaboration with the Department of Highways, on the use of NR field latex for addition to bitumen for road surfacing. Oil-extended, ammonia-preserved NR latex has been found suitable for soil stabilization. Another use for preserved NR field latex is its use by the Ceylon Leather Corporation, in collaboration with the RRIC, for finishing leather. A method has been devised for the production of dark factice from rubber seed oil. This is an important break-through as factice is now imported into the country. Since the method of preparation of pale crepe affects its technological properties, proposals are being made for the grading of pale crepe on this basis. The Institute's suggestions have been well received by buyers of pale crepe. Carbon fibre can be made from cyclised rubber but it has the defect of being brittle. The adhesion and degradation of cyclised rubber during fabrication is undesirable for moulding purposes and studies are being carried out to remedy this problem.

522. NADARAJAH, M.

Review of the Rubber Chemistry Department, [R.R.I.C. for 1971]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1971 (1972), pp. 76-95.

A number of development projects to increase the uses of rubber and improve its technological properties have been undertaken and promising results have been obtained in the production of easy processing RSS by the addition of mineral oil to undiluted latex. Oxalic acid and sodium bisulphite have been shown to increase storage hardening of pale crepe, while RPA No. 3 reduces it. A suitable method for the manufacture of soluble chlorinated rubber from field latex has been devised. This material can be used for adhesives in paints and in printing inks. A form of crumb rubber, made by mixing field latex with paraffin wax, has been found to be suitable for mixing with bitumen for use in roads. Fresh field latex can be used to prepare rubber hydrochloride, but creamed latex has given a faster reaction. Cyclised rubber masterbatch 90 : 10, which is a powder, was found to be suitable for use in injection moulding : the results were improved by substituting methyl methacrylate-granted latex for NR latex when preparing the masterbatch. Oil-extended NR latex has been used to line irrigation channels to prevent seepage and for checking soil erosion, and shows promise for

both purposes. Rubber can be compounded with graphite as a lubricating agent, for improving the rheological properties of the compound in the uncured state. One promising application is in the preparation of stereos for flexographic printing. Coagulation of latex by hydrochloric acid is feasible, but there are safety limits to be adhered to; excessive degradation takes place if acid concentration exceeds 0.2 per cent based on dry rubber. This method is cheaper, however, than oxalic, formic or acetic acid coagulation, and does not alter the molecular characteristics or the technological properties of the rubber. Rubber rainguards, based on the design of the rigiform rainguards currently used in Malaysia, were supplied by the CISIR and tested on eight rubber estates. The preliminary results of these experiments show promise.

523. NADARAJAH, M.

Review of the Rubber Chemistry Department, R.R.I.C. for 1972]. Rubb. Res. Inst. Ceylon. Ann. Rev., 1972 (1973), pp. 79-96.

The Rubber Chemistry Department continued to give advice to large estates on problems connected with the manufacture of raw rubber. Sri Lanka must keep pace with changing market requirements and be prepared to change her RSS and pale crepe manufacture to meet consumer requirements and to market in block form if necessary. Work has been done at the RRIC on manufacturing easy processing RSS by adding 11 per cent mineral oil and 0.3 per cent peptiser to the rubber at the latex stage before coagulation. Over 1000 tons of rubber seeds were collected in 1972 for the extraction of oil which was used in alkyd resin manufacture. There is a large prospective market for rubber seed oil. The manufacture of alkyds provide an opening for the exploitation of the thousands of tons of rubber seeds which are allowed to go waste on rubber estates at present. A significant development has been the work on the use of formaldehyde as the stabilizer for field latex and the manufacture of centrifuged latex from formaldehyde stabilized field latex. This development has enabled the RRI to file Patents on manufacture of chlorinated rubber, use of natural rubber latex as general purpose adhesives, use of natural rubber latex-resin blends as adhesives for plywood and the use of NR latex - Portland cement mixes.

524. KARUNARATNE, S.W.

Review of the Rubber Chemistry Department, [R.R.I.S.L. for 1973]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1973 (1974), pp. 97-121.

Pure research on the biochemical side was aimed at further work on non-rubber constituents in latex, mainly phenolic compounds which cause discolouration of rubber in the presence of thiols. Pure research on rubber seed oil is another line of investigation reported in the review. Purification of rubber seed oil was successfully carried out with Fuller's earth and xylyl mercaptan. Papain was tested further as a coagulant for NR latex. Preparation of cellulose from rubber wood was looked into mainly to explore the possibilities of grafting cellulose from rubber wood on to rubber (in latex form). Procedures for the isolation of cellulose were carefully scrutinised. Attempts were made to prepare NR derivatives by new techniques. On the Applied Research and Technology aspects, innovation in block rubber production such as the production of block rubber via the GPC route and the production of block rubber from conventional crepe rubber are being carefully studied. Use of NR/Bitumen mixtures for road surfacing, use of NR latex/cement mixes for damaged industrial flooring, use of NR latex for both general purpose and special purpose adhesives, based on new formulations, have been tested. Use of leather waste as a substitute for high styrene resin and also as a filler in rubber compounding was carried out successfully and a patent has been filed on this new technique. First fraction NR proved to be a satisfactory raw material for the production of stereo rubber. Analysis of data obtained over a year from a number of recommended clones has shown that the most significant response due to Ethrel stimulation is in the increase in nitrogen levels of stimulated latex coagula. Discolouration of crepe rubber produced from Ethrel stimulated areas is suspected and an experiment was designed towards the end of the year to get more information.

525. NADARAJAH, M.

Review of the Rubber Chemistry Department, [R.R.I.S.L. for 1974]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1974 (1975), pp. 76-89.

The Rubber Chemistry Department with the exception of the Biochemistry Section, shifted from Agalawatta to its new laboratories at Telawala Road, Ratmalana, Mt. Lavinia on the 1st of November 1974. The Department continued to give advice to large and medium sized estates on problems connected with the manufacture of raw rubber. Personnel from the Department also played an active role in assisting the State Rubber Manufacturing Corporation with its programmes of raw rubber manufacture. The Department also increased its role as a technical advisory service unit to the rubber based industries. It is envisaged that this service will be expanded within the Department. Development work has shown that SCR 5L can be made into honey coloured sole crepe which fetches a much higher price than SCR 5L. Sole crepe producers could use idle time in their factory during the rainy season or by working an extra shift to produce sole crepe from SCR 5L and earn more foreign exchange for Sri Lanka. The major use of latex crepe in consuming countries appears to be to convert it to sole crepe. A correct strategy for Sri Lanka crepe is to exploit this use and become the World's largest producer of sole crepe. In order to step up the production of sole crepe and pale crepe in Sri Lanka, a factory development subsidy scheme was announced by the Rubber Controller during the year. To implement this scheme a Research Officer of the Department was appointed as the Technical Liaison Officer by the Rubber Controller. The importance of the crepe rubber industry to the national economy and the need to improve the competitive position of Sri Lanka's crepe rubber in the world markets has been a topic of discussion for some time and a seminar on this was held during the year. A Crepe Rubber Development Unit was formed to improve the competitive position of crepe rubbers. In addition to the normal advisory services extended to the raw rubber producers and pure research, this unit is also involved in the overall marketing aspects as well. In view of the energy crisis and the high price of petrochemicals, the search for import substitutes was actively pursued. This has resulted in the work involved in the preparation of formaldehyde stabilized latex and investigation of its uses as an adhesive for plywood, as a general purpose adhesive, as a binder for pigments in emulsion paints, and in textile printing and in Portland cement mixes for repair work, and for factory floors. Development work on cyclised rubber manufacture has now made it possible for it to be used: (a) as a reinforcing filler in the rubber industry, and (b) as a resin for the paint and printing ink industries. Cyclised rubber has great promise to be exported as a non traditional export and to earn more foreign exchange than if exported as a raw rubber. A new Specifications Laboratory to deal mainly with testing and issuing certificates for block rubber exported from Sri Lanka was set up.

526. NADARAJAH, M.

Review of the Rubber Chemistry Department, [R.R.I.S.L. for 1975]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1975 (1976), pp. 64-74.

A new perspective system, namely sodium hydroxide 0.075 per cent formaldehyde 0.025 per cent tetra methyl thiuram disulphide 0.025 per cent was found to keep field latex fluid for about two days; this latex was suitable for the manufacture of RSS and the use of this process should assist in increasing the latex supply to GPCs; as latex supply can be extended to longer distances and transported at leisure. The Departmental Staff gave active assistance in conducting classes in polymer science and in rubber technology at both postgraduate and undergraduate level at the Vidyodaya and Katubedde Campuses of the University of Sri Lanka. A total of 99 and 69 one-hour lectures, respectively, were given in 1975 by our officers. Royalties are being paid to the Institute on the use of formaldehyde stabilised latex as an adhesive and several firms have informed us of their interest in commercially using our patents on cyclised rubber manufacture. The Department of Highways has reported staisfactorily on the road marking paint based on cyclised rubber supplied to them and have indicated an interest to commercially manufacture it.

527. NADARAJAH, M.

Review of the Rubber Chemistry Department, [R.R.I.S.L. for 1976]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1976 (1977), pp. 124-143.

A market survey has shown the great potential for the sale of sole crepe in overseas markets. Steps are being taken, therefore, to step up the present production of 4500 tons of sole crepe by at least another 4000 tons annually in future. Sri Lanka is unique amongst natural rubber producing countries in that she produces more than one third of her output in the form of light coloured rubbers. The Institute is of the opinion that Rubber Trade Centres should be set up in the major consuming countries to promote sales and at least maintain our markets, as the very vigorous promotional work of other producing countries is eroding this market and more and more SNR 5L is being used in place of pale crepes. The Government should take

cognisance of this immediately and take the necessary action. Steps are being taken to develop the research findings on network bound antioxidants on a commercial scale. This is one of the most important contributions made by this Institute in the field of rubber chemistry. The establishment of small units for manufacturing rubber products as extensions to the existing rubber factories has commenced. Sri Lanka has about 150 crepe rubber factories with the required power, water, workshop facilities and management skills to develop this scheme. These factories can produce high quality rubber goods and thereby increase employment opportunities at minimum cost on a given investment of capital. The following products are already being manufactured on the Estates managed by the Institute, and at the Block Rubber Factory, Mawanella: (1) Cyclised rubber, for use in paints and as a reinforcing filler (Elston Estate, Puwakpitiya); (2) Road marking paints using cyclised rubber (Elston Estate, Puwakpitiya); (3) Pre-vulcanised formaldehyde stabilised field latex for use in emulsion paints and for water-proofing concrete (Block Rubber Factory, Mawella).

528. NADARAJAH, M.

Review of the Rubber Chemistry Department, [R.R.I.S.L. for 1977]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1977 (1978), pp. 129-147.

The Rubber Chemistry Department has given emphasis to providing advice and carrying out research on raw rubber processing and on the manufacture of rubber products. In raw rubber processing, a new system of crepe drying, using a finned air heater-blower arrangement was devised and is being operated commercially. Preservative systems for small-holders latex for conversion to RSS or to latex crepe have been tested, and steps are being taken to exploit these findings on a commercial scale. There is a good market for sole crepe and a process for the manufacture of industrial sole crepe using existing unutilised crepe equipment has been developed and steps are being taken for the large-scale manufacture of industrial sole crepe by this process. Steps to increase block rubber production by converting low grade RSS into SLR 5 and thin latex crepe into SLR EQ and SLR 5L have been formulated and the processes are being exploited at the Mawanella Block Rubber Factory. Two complete Sri Lanka Patents have been filed for (1) formaldehyde stabilised centrifuged latex as an adhesive for cellulosic materials

and (2) room temperature vulcanization of sole crepe. The RRISL patent was used for the production of 30 tons of cyclised rubber, paying a royalty of 6 cts/lb. The projected production in 1978 of this cyclised rubber is 70 tons, and steps are being taken to achieve this target. The main use of cyclised rubber is as a reinforcing filler in rubber products and in paints. Another patent which has earned a royalty of over Rs. 2,000/= in 1977 is the use of formaldehyde stabilized centrifuged latex as an adhesive. In research, room temperature and sunlight vulcanising formulations were developed for use in making vulcanized sole crepe and for rubberising cart wheels. A method of producing satisfactory rubberised fabrics using natural rubber latex has been devised and a provisional patent applied for. Investigations were carried out into various aspects of liquid rubber and rubber powder and the possibility of their commercial manufacture and uses explored. The possibility of the manufacture of deproteinised natural rubber from field latex and good quality rubber from skim latex were investigated. Assessment of industrial and ball clay as a filler for natural rubber was completed. Investigations were carried out into rubberising of coir belting and improving the clarity of feeding bottle teats.

529. NADARAJAH, M.

Review of the Rubber Chemistry Department, [R.R.I.S.L.
for 1978]. Rubb. Res. Inst. Sri Lanka. Ann. Rev., 1978
(1979), pp. 101-117.

The blocking of latex crepe laces on a commercial scale for export on the basis of technical specifications was organised and implemented by the Institute. This should lead to an increased demand for Sri Lanka latex crepe. Since RPA 3 will not be commercially available in future, studies were carried out to find a suitable substitute, and it was found that titanium dioxide at low concentrations (0.01 per cent) to (0.33 percent on d.r.c.) added to latex as a dispersion gave promising results. Thioglycollic acid also looks promising for use as a substitute for RPA 3. It was also established that high quality latex crepe can be produced without using RPA 3 and that the lack of this material will not be a calamity to the industry. A method of preparing low ammonia bacteriostatic creamed latex was perfected and the product is cheaper than high ammonia creamed latex. Topanol A gives a reasonable ageing resistance. Sixteen papers were presented by the staff at local and overseas conference and three patent applications were made. The Department's staff assisted the various University Campuses by giving approximately 200 lectures

on polymer chemistry and technology. Rubber seed oil is used in Sri Lanka as a substitute for coconut oil at 5 to 10 per cent in soap manufacture. It was found that Tapanol A, when grafted to NR, gives a reasonable ageing resistance to NR, and pilot scale trials are being done in preparing the rubber for commercial evaluation. Studies on the commercial production of cyclised rubber was continued. Calcium stearate was shown to possess synergistic antioxidant properties when used with amino antioxidants. Latex from clones BRIC 100, 101 and 102 are suitable for latex crepe manufacture. The use of room temperature curing latex in bathroom carpet backing was developed and the product is now being exported. The Rubber Technology Division continued to give assistance to local industrialists in setting up small and medium scale rubber industries.

530. NADARAJAH, M.

The technology of natural rubber, natural rubber latex and natural rubber derivatives. In: Symposium on the utilization of local raw materials. Colombo, 23-24 October 1969. Proceedings. Colombo, The Chemical Society of Ceylon and The Ceylon Section of the Royal Institute of Ceylon, 1969. pp. 118-129, table.

The author gives a brief outline of rubber manufacturing industry in Ceylon and discusses the lines for further development and expansion.

531. NADARAJAH, M.; PERERA, K.A.; BALASINGHAM, K. and FERNANDO, W.S.E.

Proposals for central factories for latex in Sri Lanka.

R.R.I.S.L. Bulletin (N.S.). 8 (2) 1973 : 55-63, 2 diagrams.,

5 tables, 7 refs.

The development of rubber based industries is of special concern to us. In this context R.R.I.S.L. has proposed the setting up of a central factory for latex in Sri Lanka to produce not only concentrated latex but also preserved field latex. Since a rapid expansion in the production of latex based products for export would only be realised if centrifuged latex is available at world prices, the production of

centrifuged latex is recommended. The equipment necessary for centrifuging latex is given in detail in this article. It is also suggested that the factory should have access to a test laboratory to ensure a consistent high quality latex concentrate at every stage of production. The potential uses of latex concentrate, both at home and abroad are also discussed in this paper.

532. NADARAJAH, M. and VEERABANGSA, M.T.

Production of high quality rubber from smallholders' latex.

In: Report of the fourth seminar and workshop on progress and development of rubber smallholders, Colombo, 17-22 July, 1980. Published by the Association of Natural Rubber Producing Countries, 1980. Appendix 9, pp. 97. (Summary).

The paper discusses the progress made in Sri Lanka on ribbed smoked sheet (RSS) latex crepe, block rubber and centrifuged latex using smallholders' latex, and the proposals for the centralised manufacture of rubber using latex from smallholders and from medium sized estates. Full text will be published in the Proceedings of the fourth seminar and workshop on progress and development of rubber smallholders.

533. PARANAGAMA, G.B.

The significance of and relevance to Ceylon of the new process rubbers. R.R.I.C. Bulletin (N.S.). 3 (3) 1968 : 67-70.

The author pointed out that, as with any marketable product, it is important to present rubber in a form that the consumer requires. He pointed out that natural rubber is up-to-date the best general purposes all-round elastomer available - however, it is unwise to accept this position as a permanent one. The problem we face may not be so acute as Malaysia's, as our production is far less, but we must go ahead with schemes for new process rubbers as synthetics are eating into our markets more and more. The author recommended that for the present, at least try to upgrade off-grades by adopting the new processes of production. This will also give us the know-how and technical skill to change over in bulk to the new process rubbers, when it becomes necessary.

534. RAJAPAKSE, R.P.C.

IDB services to the rubber products manufacturing industry. Karmantha. 5 (1/2) Jan. / Feb. 1978 : 14-16.

The following general services provided by IDB:

1. Financial assistance; 2. consultation and advisory services in technology and management; 3. Assistance in marketing; 4. Assistance in the establishment of new industries; 5. Information service; and 6. Training are discussed in this paper. The results of a survey which was conducted by IDB in 1975, to determine the services needed to promote its development are also outlined. Based on these findings, IDB has formulated a scheme of special services with the following services: 1. Distribution of good quality compounded rubber and pre-vulcanised latex; 2. Centralised imports of raw materials for the small scale industry; 3. A scheme of quality testing and quality certification; 4. Supply of process control and basic quality testing equipment; 5. Product development for small scale industry; 6. Establishment of a mould making plant; 7. Development of suitable machinery; 8. Establishing a suitable scheme of approvals for new rubber based industries, are described in this article.

535. RAJAPAKSE, R.P.C.

Manufactured rubber products development of the small-scale sector. Karmantha. 3 (8) August 1976 : 1-6, 9 photos.

This article highlights the problems faced by the small-scale sector and the steps being taken and also further measures that need to be adopted in order to upgrade productivity in these units. These data based on a survey carried out by the Industrial Development Board of Sri Lanka.

536. RAJAPAKSE, R.P.C.

Services provided by the Industrial Development Board to small scale rubber industries. R.R.I.S.L. (Bulletin) (N.S.). 12 (2) 1977 : 106-110.

Abstract same as in item No. 534

537. RAMENADEN, P.L.

Rubber Products Industry : potential for further expansion? Karmantha. 9 (4) April 1980 : 17-19.

This article is based on information obtained through interviews with entrepreneurs actively engaged in the industry..

538. SRI LANKA. Ministry of Industries and Scientific Affairs.

Vegetable and animal oils and fats, leather, rubber, paper and pulp; report of a panel appointed by the Minister of Industries and Scientific Affairs, August 1975. Colombo, [197..?] : pp. 58-60.

539. SUNDARALINGAM, A.

The development of the rubber manufacturing industry in Ceylon. Industrial Ceylon. 2 (4) Dec. 1962 : 379-381 and 383.

The author gives a brief outline of the growth of rubber manufacturing industry in Ceylon and discusses the lines for further development and expansion.

540. THOMAS, Henry S.

Rubber : process of manufacture. Colombo, The Associated Newspapers of Ceylon Ltd. (Lake House), 1962. XII, 92 p., plates, diagrams, tables.

A comprehensive book of the art of practical rubber manufacture, and deals with the most modern methods of production. Contents: Reception of latex; the manufacture of blanket crepe and sole crepe; Milling.

541. VARATHUNGARAJAN, G.

Techno-economic aspects of the competitive position of natural rubber with special reference to the natural rubber industry in Sri Lanka. XIV, 169, VII leaves, figs., graphs, tables, 76 refs. (Ph.D. thesis. University of Aston, 1973. Unpublished typescript).

This study explores the technological and economic aspects of the competition between natural rubber and the synthetics of the general purpose class. The first part of this thesis reviews the overall competitive position of NR and its future prospects. The effects of the structure of the rubber producing industry (natural and synthetic), economics of production, characteristics of demand and some aspects of marketing on the short and long term competitive position are analysed. It is concluded that NR can remain competitive in all aspects if, greater co-operation between the NR producers can be achieved to formulate a unified programme of production, research and development and marketing. In view of certain problems peculiar to Sri Lanka, the second part analyses the state of the rubber industry in Sri Lanka in respect of the changes taking place in other NR producing countries, the developments in the synthetic rubber industry and the changing technological requirements of the rubber consuming industries. The commercial, economic and technical viability of certain projects in Sri Lanka and the areas for future research at the Rubber Research Institute of Sri Lanka are briefly explored. Since Sri Lanka is the largest producer of premium grade pale crepe rubber and in view of the declining demand for this rubber, the competitive position of pale crepe is studied in some detail and some recommendations are included to improve its competitive position. In view of the anticipated strong demand for NR in the future, it is recommended that Sri Lanka should plan now to increase rubber production at a faster rate by the 1980's. It is also concluded that it is desirable to produce more special purpose premium grades of NR in Sri Lanka than to produce more complex derivatives in the short term and a long term approach towards producing powdered rubber, liquid and thermoplastic rubber from latex is necessary. (Author's summary)

542. VEERABANGSA, M.T. and NADARAJAH, M.

Suggested improvements in the manufacture of Ceylon
natural rubber. Q. Jl. Rubb. Res. Inst. Ceylon. 48

(3/4) 1971 : 260-268, 6 tables, 7 refs.

This paper suggests various methods for the improvement in the manufacture of general purpose Ceylon rubber, and it is suggested that the switch over to new process rubbers must be given the necessary impetus from the private sector.

543. WIJEWANTHA, R.T.

New rubbers - a different approach. R.R.I.C. Bulletin
(N.S.). 3 (3) 1968 : 63-66.

The author stated that new process rubber has come to stay and is expected to be the answer to synthetics. But Before we finally accept this, it is necessary to keep certain facts in mind. These factors were discussed in the paper, and on the basis of such discussion it was concluded that conversion to new rubbers by crepe producers and good quality RSS manufacturers is economically unsound. Although smallholders produce a certain percentage of inferior rubber, it was also the author's opinion that the establishment of group processing factories under local conditions is not feasible.

Physical and Chemical Properties

544. FERNANDO, M.R.N.; PERERA, K.A.R.M.; CROOSE, K.C. and
PERERA, W.C.M.

Network structures and technological properties of room
temperature vulcanisates. Proc. Sri Lanka. Ass. Advmt. Sci.
36 (1) 1980 : 66.

An abstract.

545. FERNANDO, M.R.N. and PERERA, K.A.R.M.

Synergism in binary and ternary combinations of
vulcanization accelerators. Proc. Sri Lanka. Ass. Advmt.
Sci. 35 (1) 1979 : 44.

An abstract.

546. FERNANDO, P.W.R.H.; KARUNASENA, A.A. and MENDIS, L.P.

Effect of reinforcing filler on dynamic mechanical
properties of elastomers. Proc. Sri Lanka Ass. Advmt. Sci.
36 (1) 1980 : 67.

An abstract.

547. NADARAJAH, M. and VEERABANGSA, M.T.

Mineral content of unprocessed panel scraps. Q. Jl. Rubb.
Res. Inst. Ceylon. 40 (1/2) 1964 : 13-20, 6 tables.

Copper manganese and iron content of unprocessed panel scrap is higher than that of the corresponding latex film and this explains the lower quality of panel scrap crepe compared with rubber made from latex or cup lump. Unprocessed panel scrap has also been found to have a very much higher calcium content than the corresponding latex film. Calcium plays an important part in the break-down of phosphatide present in latex and this can result in early precoagulation of the latex on the tree thus reducing the yield. Potassium and magnesium content of untreated panel scrap has been found to be generally lower than that of the corresponding latex film. (Authors' summary).

548. WIJESEKERA, R.O.B. and FERNANDO, M.R.N.

A method for distinguishing different types of processed rubber by gas liquid chromatographic analysis of their volatile emanations. (Notes.) Journal of Chromatography.
65 (3) 1972 : 560-564, 8 graphs, 7 refs.

This work is a preliminary attempt to investigate any relationship that may exist between the volatile matter and the properties of different varieties of natural rubber during processing. The authors report here preliminary work carried out on the volatile emanations from 4 different preparations of natural rubber.

Processing - General

549. FERNANDO, W.S.E.; COOMARASAMY, A. and TILLEKERATNA, L.M.K.

Some aspects of chemical modification of natural rubber.

In: International Rubber Research and Development Board

Symposium, Kuala Lumpur, 15-18, May 1978; organised by

Rubber Research Institute of Malaya, Text of Papers.

[London], IRRDB, 1978. 9 p., 5 tables, 3 refs.; (Preprint).

This paper outlines the methods of preparation of epoxidised liquid natural rubber (NR) and graft copolymers of NR containing acrylonitrile and binary mixtures of styrene and acrylonitrile. Production of glass fibre reinforced plastics from epoxidised liquid NR and thermoplastic processing of graft copolymers containing styrene and acrylonitrile are discussed. (Authors' summary).

550. FERNANDO, W.S.E.; THARMALINGAM, R. and PERERA, M.C.S.

Self reinforced granular rubber. In: International

Rubber Research and Development Board Symposium, Kuala Lumpur,

15-18, May 1978; organised by the Rubber Research Institute

of Malaya, Text of Papers. [London], IRRDB, 1978. 7 p.,

5 tables, 5 refs.; (Preprint).

This paper discusses the preparation and properties of a granular form of rubber with free flowing properties obtained

by encapsulation of rubber particles with the aluminium salt of carboxy-methyl-cellulose. Coagulation of natural rubber (NR) latex containing carboxy-methyl-cellulose (CMC), in the presence of aluminium allum resulted in a lump of coagulum which could be easily broken up into smaller crumbs using a laboratory stirrer. Crumbs containing 15 per cent or more of CMC, when dried in a deep bed drier retained their free flowing characteristics. The technological properties of vulcanisates showed a fair degree of self reinforcement, with a lower abrasion loss, compared to vulcanisates containing 45 per cent ISAF black, without adversely affecting the curing characteristics.

551. HEINISCH, K.F.

Some simple aids for calculating the dilution and the mixing of solutions. Q. Jl. Rubb. Res. Inst. Ceylon. 36 (1/2) 1960 : 17-21.

This note is intended to demonstrate by means of examples, the method of calculation.

552. HEINISCH, K.F. and NADARAJAH, M.

Disposal of factory effluents from crepe and sheet producing factories. Q. Jl. Rubb. Res. Inst. Ceylon. 39 (1/2) 1963 : 32-37, 1 plate (2 photos.), 2 diagrms, 3 tables, 6 refs.

A pilot plant for the purification of the effluent from a crepe rubber factory, which mainly consists of latex serum diluted with water used for washing the serum remnants out of the crepe, was constructed in Ceylon at the cost of Rs. 1,500 (U.S. \$ 1 = Rs. 4/75). It consists essentially of an assembly of 3 tanks : (1) a trap for coarse contamination, (2) a flat bed of coarse limestone where proteins and rubber globules are coagulated by Ca ions dissolved out of the limestone by the acid serum, and (3) a compartment where the coagulated material floats to the surface, from which it is regularly removed. The serum can also be cleared, and the development of a bad smell prevented, by adding ferric alum; the combination of alum and limestone treatments, however, stimulates the development of a bad smell. (T.A. 18 (12) 1963 : no. K. 2930).

553. HEYNEKER, W.G.

Processing of natural rubber. R.R.I.C. Bulletin (N.S.).

3 (3) 1968 : 75-81.

The author in his paper gives details of the process, the cost of the machinery and the economics of mechanical production. He advocates that, because of the particular economic considerations applicable to Ceylon rubber at present, it would be advisable to concentrate on converting scrap and low grade smoke sheet into block rubber. The machinery that the author described, could be used for field latex as well as scrap and therefore, when necessary, the whole crop may be converted to block rubber, without any additional machinery.

554. HEYNEKER, W.G.

Technological developments in natural rubber manufacture :

"the Dynat process". R.R.I.C. Bulletin (N.S.). 2 (3/4)

1967 : 72-73.

This paper discuss the 'Dynat' process of manufacture, which was developed to retain superior properties of natural rubber. The good characteristics and advantages of this process, making attractive to the Ceylonese grower are discussed. A big advantage in the 'Dynat' process is natural coagulation. There are currently 3 grades of Dynat in volume production: (1) Dynat WF-produced from fresh field latex; (2) Dynat CL-produced from cup coagulum caused by the late dripping after latex collection; (3) Dynat S-produced from skim latex - a by-product of the latex centrifuging process.

555. MUNAWEERA, D.

Compounding, processing and materials for tyre treads.

R.R.I.S.L. Bulletin (N.S.). 12 (2) 1977 : 87-89.

A brief discussion on types of tyres, compounding, processing and materials for tyre threads.

556. MUTHUKUDA, D.S.

The technological developments in the rubber industry :
new forms of natural rubber. Ceylon Trade Journal.

33 (7) July 1968 : 215-219, table, 5 refs.

During the 1960s it was found that more rapid, and probably more economic, drying could be obtained by exposing as large a surface area as possible for a given weight of rubber to the drying agent. Investigations carried out in several countries, based on this finding, led to novel methods of processing latex and or field scrap into 'granulated' and 'comminuted' forms. The principal methods are: (a) the Hevea crumb process; (b) the Dynat process; (c) the granulation process for the manufacture of Natcom Lx rubber; (d) Peptorub. A summary of each processing method is given in this article. Processing costs on each of these methods are also given.

557. MUTHUKUDA, D.S.

Technological developments in the rubber industry : new
forms of natural rubber. R.R.I.C. Bulletin (N.S.). 2 (3/4)
1967 : 69-71.

The new presentation granulated and comminuted rubber are produced by the (a) The Hevea crumb process; (b) The Dynat process; (c) The granulation process for the manufacture of Natcom Lx rubber and (d) Peptorub. A summary of each processing method of (a), (c) and (d) is described here. This article is little more in detail than the previous article (i.e. item No. 556)

558. NADARAJAH, M.

Processing of natural rubber in new forms. Ceylon Trade Journal. 33 (19) Dec. 1968 : 470-473, 4 refs.

Whilst in the past the NR industry has concentrated on reducing its cost of production to the competitive with the synthetics, it would now in addition be necessary to improve the technical qualities and presentation of NR to remain competitive with the synthetics, and this paper briefly describes the manufacture of the new process rubbers by

(a) Mechano chemical method, using castor oil - Hevea crumb process; (b) Mechanical methods of comminution - the Dynat process, comminuting processes, and the shreading process. Drying and packing of rubber are also briefly described. The new processes have the following advantages over the conventional methods of manufacture: (1) Reduced manufacturing cost; (2) very short factory dwell time; (3) compact nature of installations.

559. NADARAJAH, M. and MUTHUKUDA, D.S.

Stepping up of latex crepe production in existing factories.

R.R.I.S.L. Bulletin (N.S.). 9 (3/4) 1974 : 56-60, table,

8 refs.

The Land Reform Laws in 1974 have increased the number of rubber holdings below 50 acres, and central processing will overcome the defects of the high cost of processing, low product quality and the lack of bargaining power in the marketing the smoked sheet, factors which continuously militate against the small units. Central processing of latex can be done in 3 ways: (a) Group Processing Centre (GPCs) for RSS; (b) Central factories for pale crepe and (c) Central factories for block rubber. This paper recommends proposals for these central processing of latex crepe production.

560. NADARAJAH, M. and NARANGODA, H.

Easy processing natural rubber. Q. Jl. Rubb. Res. Inst.

Ceylon. 49 (3/4) 1972 : 49-58, 7 tables, 19 refs.

The competitive pressures that are applied by the synthetic rubber (SR) industry compel the natural rubber (NR) producing industry to plan so that NR is competitive in consumer product fabrication. Hot room treatment and premastication, which are necessary steps in the processing of NR and not SR, can be eliminated by adding to field latex a mineral oil which is a physical plasticiser at approximately 11 per cent on the rubber and a peptiser which is a chemical plasticiser at approximately 0.2 per cent or 0.3 percent on the rubber. This could be conveniently done in conventional ribbed smoked sheet (RSS) producing factories. The field latex is coagulated and converted to a grade of ribbed smoked sheet (RSS) called easy processing RSS. (Authors' summary).

Smoke Houses

561. PEIRIS, H.H.

New designs for smallholders' smoke houses. R.R.I.C.

Bulletin (N.S.). 3 (4) 1968 : 143, 2 plates.

A well illustrated design of a smoke house for the 225 lb. and 350 lb. capacities suitable for smallholdings (under 10 acres).

Vulcanization

562. FERNANDO, M.R.N.

Some practical applications of natural rubber formulations vulcanizing at room temperature. R.R.I.S.L. Bulletin (N.S.) 12 (2) 1977 : 102-105, illus. (photo.).

The R.R.I.S.L. has introduced room temperature and sunlight vulcanising systems to produce vulcanised sole crepe, to rubberise bullock cart wheels and "wire con" concrete barges and in soil stabilization. This article draws attention, mainly to practical applications of these findings. A important conclusion which emerged from these investigations was that, the use of special accelerators was not at all essential, to vulcanise rubber compounds in sunlight or at room temperature.

563. FERNANDO, M.R.N. and NADARAJAH, M.

Some practical uses of low temperature and sunlight cured natural rubber compounds. In: International Rubber Research and Development Board Symposium, Kuala Lumpur, 15-18, May 1978; organized by Rubber Research Institute of Malaya, Text of Papers. [London], IRRDB, 1978. 9 p., 2 tables, 15 refs. (Preprint); Abstracted in Proc. Sri Lanka. Ass. Advmt. Sci. 33 (1) 1977 : 36.

Natural rubber is grown in developing countries and to enhance its use in these countries, simple technologies have to be developed. The use of fast curing systems by employing synergistic accelerator combinations is known, and work was done to extend this knowledge to room temperature and sunlight curing systems, which would be useful in the tropics. As vulcanisation was expected to occur at room temperature, we have used semi-efficient vulcanisation systems in the formulations; that is sulphur at levels of 1.5 pphr., and high levels of accelerators at 2.0 pphr and above. Vulcanization was followed using a Monsanto Rheometer (R100) where curing temperature was 100°C and above. A Wallace Plastimeter was used to assess the state of cure of compounded rubber samples kept at room temperature or in sunlight. Practical combinations of conventional rubber accelerators were found for room temperature and sunlight curing of white and black compounds. An accelerator system using common and stable accelerators and capable of effecting vulcanisation at room temperature and in sunlight has been formulated. ZnO is an important activator for NR vulcanization and compounded latex has not been commercially available because of the ZnO reacting with ammonia and causing thickening. The use of formaldehyde stabilised latex has overcome this defect and it is now possible to commercially produce compounded field or centrifuged latex, which could be stored and if suitable compounded, the dry rubber of which will vulcanise. This knowledge gained was extended to practical applications such as: (a) in the manufacture of sole crepe which vulcanises at room temperature, (b) in rubberising bullock cart wheels with a compound vulcanisable in sunlight, (c) in rubberising concrete 'WIRECON' barges for improved impact strength, (d) in rubberising open water channels to minimise water seepage and soil erosion, (e) soil stabilization and (f) room temperature vulcanising carpet backing compounds. Although vulcanization is an essential step in fabricating a usable rubber article there are instances where the sophisticated machinery involved does not permit such fabrications in developing countries. Therefore, the exploitation of room temperature and sunlight curing systems is of utmost importance to such countries. (Authors' summary).

564. FERNANDO, W.S.E. and PERERA, M.C.S.

Cross link degradation of natural rubber sulfur vulcanizates in the presence of ferric complexes. Proc. Sri Lanka Ass.

Advmt. Sci. 35 (1) 1979 : 44.

An abstract.

565. KARUNARATNE, S.W.

Vulcanization of NR latex. Proc. Sri Lanka. Ass. Advmt.

Sci. 36 (1) 1980 : 66.

An abstract.

566. RAJAPAKSE, R.P.C.

A study of the low temperature curing systems for natural rubber. [V], 67 leaves, diagrms., graphs, tables, 19 refs.

(M.Sc. thesis. University of Sri Lanka, Vidyodaya Campus,

[197..?]. Unpublished typescript.)

The vulcanization of Natural Rubber is normally carried out at temperatures in the range of 140° - 130° C. It is also possible to carry out vulcanization at lower temperatures using special accelerator systems. A preliminary survey of the effectiveness of available low temperature curing systems is made first. The best systems are chosen and subjected to a detailed study. Showbury Wallace Curometer is used to determine the cure time, first order rate constant and energy of activation of the different vulcanization reactions. Mooney Viscometer curves are used as a check. Cross linking densities of the vulcanisates are estimated by equilibrium swelling experiments. The Tensometer is used to determine the physical properties of the vulcanisates. (Author's summary).

567. TILLEKERATNE, L.M.K. and SEBASTIAN, S.A.R.D.

Vulcanisates of liquid rubber with similar mechanical properties as conventional rubbers. Proc. Sri Lanka Ass.

Advmt. Sci. 34 (1) 1978 : 50.

An abstract.

Drying

568. RUBBER RESEARCH INSTITUTE OF CEYLON. Advisory Circular No. 12.

Warm air-drying house for crepe rubber. Agalawatta,

R.R.I.C., 1966. 2 p.

The method of crepe drying is to provide a multi-storey building heated by hot water radiators. The source of heat is a slow-combustion coke stove of the design used in green houses. No power is required and the requisite temperature maintained day and night. This circular briefly describes, details of construction, layout, and the method of drying.

569. THARMALINGAM, R.

Drying techniques in the preparation of natural rubber.

R.R.I.S.L. Bulletin (N.S.). (Conference Supplement).

8 (3/4) 1973 : 18-19.

This article is intended particularly for the laymen, to give an idea on the drying techniques of smoke drying, crepe drying, drying of block rubber and spray used in the preparation of NR.

570. WIMALASEKERA, Lalitha

Natural rubber-drying : a bibliography, 1932-1969.

Colombo, Ceylon Institute of Scientific and Industrial Research,

Technical Library and Information Service [1970], 34 p.

(Mimeographed).

A select list of 126 entries with abstracts.

Compounding - Stabilizers and Antioxidants,
etc.

571. AMARAPATHY, A.M.A.

Investigations into natural rubber and polybutadiene blends. Journal of the Plastics and Rubber Institute (Sri Lanka). 1, 1978/1979 : 1-15, 10 graphs, 2 tables, 3 refs.

This paper investigates the properties of blends of NR with polybutadiene. BR (Buna CB 10 - Bayer, which is characterized by a 98 per cent cis 1-4 content) is blend with natural rubber (SLR 5) in different ratios. The effect of different loadings of carbon black (ISAF) in these blends is also observed. In assessing the vulcanisate characteristics of blends, the tensile strength, elongation at break before and after ageing, flexural strength, lupke resilience, oil resistance (engine oil, brake oil and turpentine) and hardness are studied. It is possible to blend NR with BR in various ratios and vulvanize them using conventional sulphur/accelerator systems. The optimum advantage of the properties of both polymers can be obtained by blending BR and NR. The results of this study show that by blending with BR the vulcanisate properties of NR could be improved greatly with respect to Resistance to Flexoracking, Resilience, Hardness, and Tensile Strength. A high percentage of NR is used in the manufacture of tyres. The results indicate that a vulcanisate of NR/BR blend (80 : 20) carrying about 40 p.h.r. I.S.A.F. black is a superior formulation for the tyre tread in comparison to one of pure NR. It not only helps to increase the resistance to flex, cracking, but also helps to minimise the level of carbon black required to give desirable strength properties and hardness values. NR/BR blends can be used for a large number of applications.

572. AMARAPATHY, A.M.A. and SAMANERIS, D.G.

The effect of maturation and pre-vulcanization of compounded latex on technological properties. In: International Rubber Conference, Kottayam, 23-28, Nov. 1980. Abstracts of papers. Kottayam, Rubber Research Institute of India, 1980. Session 6A, Paper 7.

This paper describes the technological importance of maturation and prevulcanization of compounded latex on the manufacture of latex based products. Maturation and prevulcanization of compounded latex was carried out at different temperatures for varying lengths of time. A conventional cure system is used in this study. The technological properties of the resulting films have been correlated with the swelling index measurements. (Authors' summary).

573. AMAR/PATHY, A.M.A. and SAMARAWICKRAMA, L.N.

Method of purifying waste engine oil and studies on black loaded natural rubber mixes containing this ingredient.

Jl. Rubb. Res. Inst. Sri Lanka. 55, 1978 : 23-28, 2 graphs, 2 tables; Abstracted in Proc. Sri Lanka Ass. Advmt. Sci., 34 (1) 1978 : 50.

This paper deals with the investigation of the suitability of pretreated waste engine oil for use as a processing oil in rubber compounding. Technological properties and cure characteristics of mixes containing purified waste oil were found to be comparable to those containing similar dosages of well known commercial processing oils. (Authors' summary).

574. AMARAPATHY, A.M.A. and SCOTT, G.

Rubber-bound antioxidants by reactions of natural rubber in the latex. Jl. Rubb. Res. Inst. Sri Lanka. 54, part 2, 1977 : 520-530, 6 graphs, 3 tables, 6 refs.

Antioxidants containing polymerisable vinyl groups have been successfully grafted to natural rubber in the presence of suitable free radical generators. Reaction parameters such as the mode of initiation, initiator system, reaction time, pH of the reaction medium and swelling time have been investigated in natural rubber latex. Of the free radical generating systems examined, the redox system consisting of tertiary butyl hydroperoxide and tetraethylene pentamine (TBHP/TEP) appeared to be most effective in natural rubber latex. Infra red spectroscopy has been used to estimate the concentration of the bound antioxidants and ageing behaviour was assessed by oxygen absorption and continuous stress relaxation. The

curing characteristics of the grafted rubber samples were found to be satisfactory using the Monsanto theometer. It was found that antioxidants which do not contain vinyl groups also react under the same conditions with natural rubber latex. Some of these appeared to be marginally more effective than the corresponding vinyl antioxidants. It was observed that, in the case of the vinyl antioxidants, only a part of the added antioxidant grafted into the rubber and the rest remained unchanged or was oxidised to coloured products. The by-products formed during the process of grafting were identified and analysed. A conclusion of considerable theoretical as well as practical significance is that rubber bound antioxidants appear to have similar activity to conventional antioxidants with the same functional groups when present at the same concentration. (Authors' summary).

575. BALASINGHAM, C.G.

Leather waste as a filler in the rubber industry.

R.R.I.S.L. Bulletin (N.S.). (Conference Supplement). 8

(3/4) 1973 : 1-2; Reprinted in Karmantha. 3 (1) January 1976 : 19.

Attempts to introduce various fillers into rubber mixes have been made in a purely empirical basis, with the objective of producing cheaper rubber compounds. This article discusses on the use of leather as a filler in rubber industry. The use of this waste brings down the cost of production, and saves foreign exchange.

576. FERNANDO, M.R.N.

Antioxidants in natural rubber. ii, 36, (iii) leaves, diagrams, graphs, tables, 65 refs. (M.Sc. thesis. University of Aston, Birmingham, 1972. Unpublished typescript.)

This work investigates the effects of binding certain molecules containing antioxidant groupings into the rubber network. Several compounds which are expected to be capable of getting attached to the rubber chain have been synthesized, each containing an antioxidant grouping. Natural rubber has been used in all the experimental investigations carried out. Six different antioxidants were synthesized,

only five of them successfully, and the effect of three of them on stabilizing natural rubber was investigated with comparison to a conventional antioxidant, P.B.N. By Monsanto Rheometer curves it was found out that, all the systems investigated had good curing properties, confirming that the presence of the synthesized antioxidants in rubber did not affect the curing characteristics of the rubber. In all the T.M.T.D. systems, the viscosity of the rubber remained at a higher level than in the case of the corresponding C.B.S. systems. The stability of the T.M.T.D. cured rubber was better than the C.B.S. cured rubber. The effect of thermal ageing of the rubber in the presence of only the antioxidant was that there was better stability when the rubber was compounded with the other ingredients and cured subsequently, in comparison to a compound where all the ingredients were added at the time of curing with no previous thermal treatment of the rubber in the presence of the antioxidant. It was interesting to note that this applied to a conventional antioxidant like P.B.N. It was thought that one of the reasons for this better stability may be the availability of a better dispersion. The effects of the synthesized antioxidants were investigated very widely in a variety of different rubber formulations which are common in industry.

577. FERNANDO, M.R.N.

Manufacture of dark factice from rubber seed oil. Q. J1.

Rubb. Res. Inst. Ceylon. 47 (3/4) 1971 : 59-64, graph,

10 refs.

Factice is a rubber substitute, added to rubber, in preparing compounds of different composition for the manufacture of rubber articles, like erasers, tubes and tyres. Factice gives to moulded, calendered, extruded, dipped and proofed goods a smooth finish and supple handle. Mould designs are reproduced with great fidelity. Factice imparts resistance to surface oxidation and to ozone, and improves resistance to moisture. It is found that rubber seed oil is suitable for the manufacture of factice, as it has the necessary amount of unsaturated fatty acid content, vital for factice manufacture. Application of dark factice; chemistry of factice; various effects different activators and accelerators in the manufacture of factice; analysis of factice are discussed in this article. Though factice was manufactured successfully in a small scale, factors like (1) controlling the exotherm, and (2) toxicity of gaseous products, will have to be examined further before manufacturing on a large scale.

578. FERNANDO, M.R.N.

A study of polymer bound sulphur based antioxidants in rubber. ix, 143 leaves, diagrms., graphs, tables, 147 refs. (Ph.D. thesis. University of Aston, 1976. Unpublished typescript).

A commercially available hindered phenolic antioxidant 2, 6-Ditert-butyl phenol has been converted into a mercaptan derivative, viz. 3, 5-Ditert-butyl-4-hydroxy benzyl mercaptan and the latter has been successfully bound to natural rubber by a free radical process.* Reaction parameters such as mode of initiation, initiator concentration, mercaptan concentration, time, temperature etc., have been investigated in rubber solution, natural rubber latex, and in the polymer melt. A masterbatch technique has been developed to saturate a small quantity of rubber with a large amount of mercaptan and to use this concentrate to dilute untreated latex to obtain a desired level of stability. Infra-red spectroscopy has been used to estimate the concentration of adduct phenol, and accelerated ageing tests, viz. oxygen absorption and continuous stress relaxation were carried out to evaluate ageing behaviour. The effects of the presence of 3, 5-Ditert-butyl-4-hydroxy benzyl mercaptan on the vulcanization characteristics have been investigated in detail using a Monsanto Rheometer. To investigate the mechanism of addition, a number of mercaptans and simple unsaturated model compounds have been used and the products have been analysed. The effect of the presence of antioxidant bound rubber on the oxidation of polypropylene was studied by a rapid flowing air oven test. An attempt to add 3, 5-Ditert-butyl-4-hydroxy benzyl mercaptan to a saturated polymer, polythelene, was successful as theoretically expected. Oxidation of an unsaturated compound, tetralin, was studied in the presence of monosulphides which are similar to those obtain by adding mercaptans to olefins. (Author's summary).

579. GAJAWEERA, Bandula Sarath

Effect of transition metal complexes on the degradation of natural rubber. [IX], 161 leaves, graphs, 157 refs. (M.Sc. thesis. University of Sri Lanka, Vidyodaya Campus, 1979. Unpublished typescript).

$\text{Cu}(\text{MBT})_2$, $\text{Ni}(\text{MBT})_2$ and $\text{Ni}(\text{DMGH})_2$ were synthesized characterized and then used in different proportions as additives in natural rubber vulcanising systems DICUP, S/CBS and TMTD/DPG. These additives found to be largely influenced upon curing characteristics such as induction period, first order rate constant and cure time. Their effect on thermal ageing was studied by using stress relaxation and oxygen absorption techniques, and found that the activity of these complexes depend on the vulcanising system and the nature of the ingredients. Effect on photo-degradation is measured by synergistic effect upon direct exposure to natural sunlight. Carbonyl indices obtained by infra-red studies of the S/CBS, suggest a stabilizing activity by coloured $\text{Ni}(\text{MBT})_2$ and $\text{Ni}(\text{DMGH})_2$. This action may be due to their hydroperoxide decomposition or screening effect. $\text{Ni}(\text{MBT})_2$ and $\text{Cu}(\text{MBT})_2$ found to be showing good stabilising activity during thermal ageing in TMTD/DPG, System, $\text{Cu}(\text{MBT})_2$ was an pro-oxidant in all other cases during synergetic, photo-thermal ageing as well. These were further evidenced by their physical appearance (film and tensile test pieces) on further exposure. (Author's summary).

580. KALUARACHCHI, Janaka

An investigation of the stabilizing activity of transition metal complexes of mercaptobenzothiozole in natural rubber. VIII, 87 leaves, graphs, tables, 20 refs. (M.Sc. thesis. University of Sri Lanka, Vidyodaya Campus, 1976. Unpublished typescript).

Transition metal complexes namely, Nickel and Copper complexes of Mercaptobenzothiozole were synthesized and characterized using the Infra-red Spectra. The ability of the complexes and the Mercaptobenzothiozole to decompose Hydroperoxide were tested with 0.1 per cent Cumene Hydroperoxide in Chlorobenzene, varying the concentration of the complexes. The Iodometric determination of the amount of hydroperoxide remaining at intervals of time were used in these studies. The two Complexes and Mercaptobenzothiozole were found to be effective as a peroxide decomposer and the effectiveness tended to decrease in the order:

Copper Complex of Mercaptobenzothiozole > Mercaptobenzothiozole

> Nickle Complex of Mercaptobenzothiozole.

The decomposition rate with various concentration of the stabilizer at various temperatures were examined and it was found that the stabilizers were more effective at higher concentration and at higher temperatures. The complexes and Mercaptobenzothiozole were added to natural rubber and the stabilizing effect was noted. The effect of these complexes on natural rubber was also studied by a series of physical tests. These results too showed the complexes to be more effective at higher concentrations. (Author's summary).

581. KARUNARATNE, S.W.; GOONEWARDENA, L. and MEDAGAMA, D.D.

Evaluation of locally available raw material in the natural rubber industry. Part 1 : Graphite. Q. Jl. Rubb. Res. Inst. Ceylon. 47 (3/4) 1971 : 65-69, 3 tables, 4 refs; Abstracted in Proc. Ceylon Ass. Advmt. Sci. 26 (1) 1970 : 110.

Difficulty in incorporating graphite into rubber in the banbury on the two roll mill has discouraged earlier workers to carry out any extensive investigations in the use of graphite in Rubber Compounding. This paper describes the possibility of incorporating Graphite into rubber in the latex stage. The preparation of rubber/graphite mixtures in masterbatch form is discussed and rubber extended with carbon black/graphite mixtures are evaluated for technological properties and suitable areas of application are suggested. A survey of properties of natural rubber extended with Boralasgamuwa clay and dolomite is given in the second half of the paper. (Authors' summary).

582. KARUNARATNE, S.W. and PATEL, M.

Evaluation of locally produced clay in the rubber industry.

Proc. Sri Lanka Ass. Advmt. Sci. 33 (1) 1977 : 58.

Sri Lanka is self-sufficient in supplies of China clay for the rubber industry. However, so far, no systematic evaluation has been carried out and reported. The work reported in the paper is an attempt to study the properties of two grades of China clay available locally in relation to their suitability in the rubber products industry. (Author's summary).

583. KORATHOTA, S.M.

Use of cashew nut shell liquid as an antioxidant in black loaded natural rubber vulcanizates. [V], 41 leaves, graph, tables, 11 refs. (M.Sc. thesis. University of Sri Lanka, Vidyodaya Campus, 1976. (Unpublished typescript).

584. KULARATNE, K.W.S.

Reactions of hindered phenols with unsaturated hydrocarbons in the presence of free radicals. [X], 173 p., graphs, tables, 95 refs. (Ph.D. thesis. University of Aston, Birmingham, 1977. Unpublished typescript).

The reaction of hindered phenolic antioxidants, notably ditert-butyl-4-methyl-phenol (TBC) and 3, 5-ditert-butyl-4-hydroxy-benzyl mercaptan (BHBM) with rubber has been investigated and the percentage of antioxidant bound under optimum conditions has been determined. The byproducts formed during the adduct formation and their effect on binding reaction was also studied. The reaction mechanism involved in both cases has been studied. It has been found that BHBM adduct was formed by the addition of thiol to the rubber double bond and that of TBC by the attachment of the benzylic carbon atom to the allylic carbon atom of natural rubber. Tensile measurements, oxygen absorption tests and stress relaxation measurements have been used to evaluate the antioxidant activity of the bound antioxidants. Comparison of their performance with commercial antioxidants has shown that the latter are completely removed under severe environmental conditions, whereas, rubber-bound antioxidants

exhibit exceptional stability. A major advantage of the rubber-bound systems, which has emerged during the evaluation was their suitability for the preparation of bound antioxidant concentrates and the superior performances of rubbers prepared using concentrate masterbatches have been demonstrated under severe testing conditions. Similar studies were carried out with nitrile-butadiene (NBR) latices and it has been found that NBR containing bound antioxidants, particularly, the BIBM adducts exhibit superior stability to conventionally added antioxidants, when used in applications where loss of antioxidants by volatilisation or leaching or by extraction may occur. (Author's summary).

585. KULARATNE, K.W.S. and SCOTT, G.

Mechanisms of antioxidant action, auto-synergistic antioxidants based on thiol rubber adducts. European Polymer Journal (U.K.). 15, 1979 : 827-832, 4 graphs, 3 tables, 15 refs.

The mechanism of by-product formation in the reaction of a thiol antioxidant, 3, 5-di-tert-butyl-4-hydroxybenzyl mercaptan (BIBM) with rubber latices is shown to involve two processes, viz. dimerization of the intermediate thiyl radical to give disulphide (BIBDS) and the reaction of the intermediate quinonemethide with water to give the aldehyde and with BIBM to give the monosulphide (BIBMS). The two sulphides themselves react with rubber in a slower reaction. The bound antioxidants obtained with natural rubber and nitrile-butadiene rubber are very much more effective than the present generation of commercial heat ageing antioxidants under conditions where the antioxidants can be lost from the rubbers by volatilization or solvent or detergent leaching. This is partly due to their resistance to removal from the polymers but there is also evidence that the auto-synergistic antioxidant bound to the rubber is more effective than single function antioxidants, due to the presence of the sulphide linkage. (Authors' summary).

586. KULARATNE, K.W.S. and SCOTT, G.

Mechanisms of antioxidant action, the reaction of hindered phenols with rubber in the presence of free radicals. European Polymer Journal (U.K.) 14, 1978 : 835- , 8 graphs, 4 tables, 13 refs.

Simple hindered phenols containing ortho or para methyl groups react with natural rubber latex in the presence of oxidising free radicals (alkoxy or acyloxy), giving up to 20 per cent yields of bound antioxidant. This reaction is most efficient when the concentration of the phenolic antioxidant in the rubber is less than 1 per cent. As the concentration is increased side reactions involving both the phenol (stilbene quinone formation) and the rubber (cross-linking) supervenes. The efficiency of the bound antioxidants is much than conventional antioxidants under aggressive conditions of air oven ageing and solvent or detergent extraction. This has been shown to be primarily due to the non-removal of the bound antioxidants under these conditions whereas the conventional antioxidants are removed completely. (Authors' summary).

587. NADARAJAH, M.

Preparation and uses of two new types of natural rubber latices in Sri Lanka. R.R.I.S.L. Bulletin. 14, 1979 : 1-6, 15 refs.; In: Proceedings, Institute of Chemistry, Sri Lanka, 8th annual sessions, 1979, pp. 13-17.

The acceptance speech on presentation of Institute of Chemistry Gold Medal, for the work done by the author on the preparation and uses of two new types of natural rubber latices, viz. Formaldehyde stabilized latex and LATZ latex. Formaldehyde stabilised latex has found use as an adhesive, in carpet backing, and in mixes with bitumen emulsions for water proofing concrete roofs. This latex is only being produced and used in Sri Lanka. LATZ latex is used to manufacture latex-based rubber products. The main advantage is that it needs no deammonition as was required by the high ammonia centrifuged latex.

588. NADARAJAH, M.; COOMARASAMY, A.; DE SILVA, K.P.N.; WEERARATNE, W.G. and MUNASINGHE, B.K.S.

Preparation and uses of formaldehyde stabilised natural rubber latex. In: Proceedings of the International Rubber Conference, Kuala Lumpur, 1975. Kuala Lumpur, Rubber Research Institute of Malaysia, Vol. 5, 1976, pp. 183-200, 2 photos., 9 tables, 23 refs.

Formaldehyde stabilized centrifuged latex is a good general purpose adhesive. Its preparation is described and its use in mixes with Portland Cement and with bitumen, in the manufacture of rubber products and in cord dipping is discussed. (Authors' summary).

589. NADARAJAH, M.; COOMARASAMY, A.; KASINATHAN, S. and TIRIMANNE, A.S.L.

Some naturally occurring antioxidants in Hevea brasiliensis latex. Journal of the Institution of the Rubber Industry (U.K.). 8 (1) 1972 : 26-29, 8 tables, 20 refs.

The antioxidants present in natural rubber latex are mainly phospholipids, amino acids, phenols, tocotrienols and betaines. This paper describes tocotrienol in nr; clonal variation of tocotrienol content in field latex; effect of coagulation conditions on tocotrienol content; effect of oxidation on tocotrienol content of rubber from clone PB 86; betaines, amino compounds and phenolic compounds in natural rubber. When field latex or to some extent concentrated latex made from it is used as such, then the antioxidants such as phenols, amino acids would play an important part in addition to the tocotrienols. However where rubber is made from field latex in the form of RSS, new process rubbers, pale crepe, estate brown crepe etc., then the tocotrienols would be expected to be very important antioxidants.

590. NADARAJAH, M.; TIRIMANNE, A.S.L.; COOMARASAMY, A. and KASINATHAN, S.

Some naturally occurring antioxidants in Hevea brasiliensis latex. Q. Jl. Rubb. Res. Inst. Ceylon. 48 (3/4) 1971 : 202-211, 8 tables, 19 refs.

This paper discusses naturally occurring antioxidants present in NR latex from various clones. These antioxidants are mainly phospholipids, amino acids, phenols, tocotrienols and betaines. Describing tocotrienols in NR, this paper describes, clonal variation of tocotrienol content in field latex; effect of centrifuging on tocotrienol content; effect of coagulation conditions on tocotrienol content; effect of alkali on tocotrienol content; and the effect of oxidations on tocotrienol content of rubber from PB 86. Betaines, amino compounds and phenolic compounds in NR are also described in the paper. Where field latex, or to some extent, concentrated

latex made from it is used as such, then the antioxidants such as phenols, amino acids would play part in addition to the tocotrienols. However, where rubber is made from field latex in the form of RSS, new processed rubbers, pale crepe, estate brown, crepe, etc., then the tocotrienols would be expected to be very important antioxidants.

591. PATHIRAGE, D.B.K.

A study of natural rubber-carbon black interaction at moderate temperature. VI, 58 leaves, diagrams., graphs, tables, 21 refs. (M.Sc. thesis. University of Sri Lanka, Vidyodaya Campus, 1978. Unpublished typescript).

Interaction of natural rubber with carbon black (ISAF) was studied in the presence of sunlight and artificial heat (at 40° C.) as well, for a period of 28 days. The effect of the presence of an antioxidant in these mixes was also investigated. During the course of this study special attention was made towards the measurements of reinforcing properties such as abrasion resistance, tensile strength, modulus etc., and also ageing characteristics which were measured on the basis of stress relaxation test. It was found that there is some sort of interactions attributed to bound rubber formation which is insignificant at 40° C. It was obviously seen that the formation of bound rubber takes place to some extent in the presence of sunlight. (Author's summary).

592. PIERIS, Henry Sri Mevan

Studies on natural rubber mixes and vulcanisates, containing antioxidant 'C' as an antidegradant. [V], 120 leaves, diagrams., tables, graphs, 45 refs. (M.Sc. thesis. University of Sri Lanka, Vidyodaya Campus, 1978. Unpublished typescript).

Heat ageing properties of natural rubber mixes containing Antioxidant 'C' (based on cashew nut shell liquid) were studied using continuous stress relaxation techniques at 85°C and 100° C. The results of these studies were compared with the results of similar investigations on rubber mixes containing commercial antioxidants and without any antioxidant. These

experiments show Antioxidant 'C' at 5 p.h.r. to have good antidegradant properties. The antioxidant activity of Antioxidant 'C' in natural rubber vulcanisates has already been reported by other workers using air oven ageing at $70 \pm 1^\circ\text{C}$. The effect of Antioxidant 'C' on cure characteristics were investigated in detail by rheometer studies. A detail study on the technological properties of the rubber mixes and the vulcanisates based on a standard tyre tread formulation indicates that Antioxidant 'C' used at 5 p.h.r. level, serves to give good antidegradant properties and may also be used as a substitute for Dutrex R, which acts as a processing aid. (Author's summary).

593. RAJAPAKSE, R.A.

Cashew nut shell liquid as an antioxidant in natural rubber compounding. Proc. Sri Lanka Ass. Advmt. Sci., 32 (1) 1976 : 82.

An abstract.

594. RAJAPAKSE, R.A.

Development of local raw materials for the rubber industry. Journal of the Plastics and Rubber Institute (Sri Lanka). 1, 1978/79 : 17-20, 3 tables, 18 refs.

The compounding ingredients or the rubber chemicals play a important role in the enhancement of the physical and mechanical properties of the rubber products and also they exercise a considerable control over the cost. Ceylon Institute of Scientific and Industrial Research (CISIR) has initiated a programme of research to develop local raw materials for their ingredients. This paper describes work that has already being carried out at CISIR, the work that is in progress and outlines other possibilities that are worth investigation.

595. RAJAPAKSE, R.A.; GUNASENA, W.A.S. and JOGANATHAN, B.

Use of pitch oil in natural rubber compounding. Jl. Rubb. Res. Inst. Sri Lanka. 53, 1976 : 17-21, 6 tables, ref.

Pitch oil is the residue from the fatty acid manufacture at the Fats and Oils Corporation, Sri Lanka. It contains about 40 - 50 per cent of the fatty acids. This paper describes investigations carried out on the use of pitch oil in natural rubber compounding. It has been established that pitch oil can replace stearic acid or coconut oil fatty acids in rubber compounding formulations. (Authors' summary).

596. RAJAPAKSE, R.A.; GUNASENA, W.A.S.; WIJEKON, K.B. and KORATHOTA, S.

Antioxidant activity of cashew-nut-shell liquid in black loaded natural rubber vulcanizates. Polymer. 19 (2) 1978 : 205-211.

The efficiency of cashew nutshell liquid as an antioxidant for black loaded natural rubber was studied and a mechanism for the process was elucidated. The antioxidant activity of the liquid is due to the formation of dimeric products and of a network-bound antioxidant during vulcanization with S, rather than by activation of the phenolic group by the substituents to facilitate H donation to a peroxy radical.

597. RAJAPAKSE, R.A. and ILAPPERUMA, D.B.

Local raw materials for the rubber industry. In: CISIR contribution to science and industry; proceedings of the 21st anniversary seminar, May 4-6, 1976, held in B.M.I.C.H., Colombo. Colombo, Ceylon Institute of Scientific and Industrial Research, 1976, pp. 73-76, 4 tables.

Of the various material used in compounding of rubber constitutes about 35 per cent by weight. This article discusses the use of various local raw materials as substitutes, e.g. Pitch oil of the Oils and Fats Corporation for stearic acid; cashew nut shell liquid as an antioxidant; local resin Kekuna as a tackifier; ground paddy-hull ash as a filler; and sulphur from gases that are burnt at the Petroleum Refinery.

598. RAJAPAKSE, R.A.; KADIRAGAMANATHAN, S.; GUNASENA, W.A.S.
and WIJEKOON, K.B.

Some aspects of the mechanism of the antioxidant activity of cashew nut shell liquid. In: Proceedings, Institute of Chemistry, Sri Lanka, 6th annual sessions, 1977, pp. 17-20, 2 graphs, 3 tables, 5 refs.

This paper summarises the results of investigations carried out at the Ceylon Institute of Scientific and Industrial Research on the possibility of using cashew nut shell liquid (CNSL) as an antioxidant in natural rubber compounding. Its antioxidant efficiency has been found to be comparable with that of conventional general purpose amine and phenol types of antioxidants. Experiments were carried out with rubber vulcanizates based on various curing systems. For comparisons, the deterioration in tensile strength and elongation at break of vulcanized rubber samples containing general purpose conventional antioxidants of the amine type and also that of samples with no added antioxidants were also studied. It can be qualitatively concluded that CNSL phenols get attached to rubber chemically via sulphur bonds.

599. RAJAPAKSE, R.A. and NADARAJAH, M.

Ageing properties of natural rubber with cashew nut shell liquid incorporated into latex. Proc. Sri Lanka Ass. Advmt. Sci. 34 (1) 1978 : 51.

An abstract.

600. RANAWEERA, Ramani

Some recent developments in the mechanism of antioxidant action of nickel chelates. Journal of the Plastics and Rubber Institute (Sri Lanka). 1, 1978/79 : 29-36, 6 graphs, 8 refs.

601. SURANIMALA, Ranjani Chandrika

A study on maleimide based antioxidant. [VI],
67 leaves, diagrms., graphs, tables, 65 refs. (M.Sc.
thesis. University of Sri Lanka, Vidyodaya Campus, 1976.
Unpublished typescript).

Two maleimide based antioxidants, an amine antioxidant N-(4-anilinophenyl) maleimide and a phenolic antioxidant N-(3, 5 ditertiary butyl-4-hydroxy) phenyl maleimide were synthesised. The stability of the antioxidants synthesised were studied by volatility measurements. N-(4-anilinophenyl) maleimide was reacted with natural rubber in toluene at 80° C. for 18 hours in the presence of benzoyl peroxide as initiator. The efficiency of binding under these conditions were studied by varying the concentration of initiator and also the ratio of antioxidant to rubber (isoprene units). Infra-red spectroscopy was used for the estimation of the extent of binding in each case. The efficiency of the antioxidant synthesised was evaluated by oxygen absorption measurements in cumene at 100°C. and also in vulcanised rubber. (Author's summary).

602. THANGAVELAUTHAM, M.

Experiment on preparation of masterbatches of rubberised bitumen. Proc. Ceylon Ass. Advmt. Sci. 30 (1) 1974 : 81,
2 refs.

An abstract.

603. WEERASOORIYA, U.; WIJERATNE, M.S. and RAJAPAKSE, R.A.

Carbon black - natural rubber latex masterbatches. Proc. Ceylon Ass. Advmt. Sci. 30 (1) 1974 : 108.

An abstract.

Heveacrumb

604. KARUNARATNE, S.W.

Preparation of Heveacrumb from first fraction coagulum.

Q. Jl. Rubb. Res. Inst. Ceylon. 48 (3/4) 1971 : 252-259,

3 tables, 3 refs.

Production of Heveacrumb in a pilot plant installed at Peenkande Estate is discussed with special reference to conversion of first fraction coagulum to Heveacrumb. The information presented in this paper is intended to assist in the evaluation of Heveacrumb rubber from first fraction coagulum. Production records from the time the pilot plant has been commissioned for regular production, are set out with analytical data on raw rubber properties of each consignment lot. Data illustrating the behaviour of first fraction coagula in two representative compounds, both in the form of crumbled rubber and pale crepe, are also given. (Author's summary).

605. KARUNARATNE, S.W. and THOMPSON, M.W.

Experimental crumb rubber project at Peenkande. R.R.I.C.

Bulletin (N.S.). 4 (1/2) 1969 : 1-5, table.

The experimental crumb rubber project in Peenkande Group, Ceylon, was initiated by the Rubber Research Institute of Ceylon, based on a decision by the Rubber Research Board in 1965. With a view to get an insight to this project, the authors write an intimate account of its working.

606. POULIER, R.F.

The Heveacrumb process. R.R.I.C. Bulletin (N.S.). 3 (3)

1968 : 71-74.

The author gives a detailed description of the Heveacrumb process and also enumerates the various teething troubles that have cropped up in the operation of this machinery in Ceylon.

Crepe Rubber

607. FERNANDO, W.S.E.; TILLEKERATNE, L.M.K. and
FERNANDO, M.R.N.

A new bleaching agent for Sri Lanka latex crepe.

R.R.I.S.L. Bulletin. 14, 1979 : 7-8.

Tolyl mercaptan (commercially named RRI 7) has been found to be a suitable substitute for, if not better than RPA 3 in the manufacture of latex crepe. This article highlights the work done by the Rubber Research Institute of Sri Lanka on this project. The use of RRI 7 has been designed in such a way that no change in the old methods of latex crepe manufacture such as the addition of bisulphite, fractionation, coagulation, drying, etc., is required.

608. FERNANDO, W.S.E.; TILLEKERATNE, L.M.K.; FERNANDO, M.R.N.
and PERERA, M.C.S.

Bleaching agents for crepe rubber manufacture in place of xylyl mercaptan (RPA 3). Proc. Sri Lanka Ass. Advmt. Sci.
35 (1) 1979 : 48-49.

An abstract.

609. HEINISCH, K.F.

Cutting of blanket crepe and sole crepe. Q. Jl. Rubb.
Res. Inst. Ceylon. 36 (3/4) 1960 : 52-55, 7 plates.

The cutting of blanket or sole crepe to standard size is still a manual operation in Ceylon, but interest is being shown in the mechanization of this cutting process. A brief description is given of the following devices which have proved to operate satisfactorily on estates in Ceylon or in Indonesia : "Trough method"; Guillotine Cutters; Rotary Cutting Machine; Hand Cutters; and Punching Devices.

610. HEINISCH, K.F.

Dirt content of scrap rubber. Q. Jl. Rubb. Res. Inst.
Ceylon. 37 (1) 1961 : 13-17, 1 graph, 6 tables.

On the basis of statistical surveys a classification scheme for harmful dirt content of rubber, 0.3 per cent, or more, may be considered as an excess. A very high per cent of scrap crepes have a dirt content above 0.3 per cent. To reduce this percentage, it is recommended that the scraps, prior to milling, should be soaked in a solution or surface active agents, for instance, 2-3 days in a solution, containing 0.1 - 0.2 per cent of "detergent 40E" and 0.1 per cent trisodium phosphate. The soaking solution can be used upto 3 times.

611. HEINISCH, K.F.

The discolouration of bleached crepe rubber. The Planters'

Chronicle. 55 (11) 1960 : 281-283 & 291, 6 refs.

The discolouration of bleached crepe is influenced by a number of factors during all stages of manufacture and therefore properly controlled conditions and cleanliness are essential for the manufacture of a first quality product. The condition of the latex and the manufacturing and drying conditions are as important as the quality of the chemicals and the factory water. It would appear that small amounts of iron have quite an important role, probably due to the formation of some iron sulphur compounds. An improvement in colour and colour-holding properties can be obtained by using oxalic acid as coagulant implying, at least in certain cases with white latex, that a removal of a first yellow fraction might be unnecessary, thus increasing the out-turn of the first quality crepe.

612. KARUNARATNE, S.W.

Quality control, technical specifications and presentation of latex crepes. R.R.I.S.L. Bulletin (N.S.). 9 (3/4) 1974 : 28-33, 2 figs., 9 refs.

A discussion of factors controlling the quality of latex crepe and of its technical specification is followed by a presentation of a process flow lines for pale crepe and sole crepe. A scheme is proposed for technical specification of latex crepe. It should be free from dirt in which case there would be no need for a specification. Practically, however, a simple scheme would start by guaranteeing an upper limit on dirt content because it is so important. Standard latex crepe would then be all of one class below a certain maximum dirt

level. A colour index should also be fixed for latex crepe and on this basis a maximum of 2 grades is recommended. A maximum level of acetone extract value is also recommended and all latex crepe should fall into one grade. The scheme is based on the following considerations: its simplicity; the specifications should be understood by, and be of value to consumers; and the producers should be able to adjust their production methods easily. (Abstracts on Tropical Agriculture. 3 (3) 1977 : No. 13643).

613. MENDIS, E.G.

Quality control of sole crepe. R.R.I S.L. Bulletin (N.S.)
12 (1) 1977 : 14-16.

614. NADARAJAH, M.

An assessment of the potentialities of latex crepe
manufacture in Sri Lanka. R.R.I.S.L. Bulletin (N.S.). 12 (1)
1977 : 5-8.

615. NADARAJAH, M.

Rubber factory development in Sri Lanka. Central factories
for latex crepe. Karmantha. 7 (2) Feb. 1979 : 7-9, photo.

The production of rubber goods for export in preference to exporting the raw rubber has been accepted as a objective by the Sri Lanka Government. This article highlights the great potential that exists at present for central factory development to produce more latex crepe. Recommended manufacturing procedures, necessary equipment and the approximate capital and the operational cost for these factors, are outlined.

616. NADARAJAH, M.; BARTHOLOMEUSZ, P.A. and MUTHUKUDA, D.S.

Proposals to improve and increase quality production of pale
crepe in Ceylon. R.R.I.C. Bulletin (N.S.). 6 (3/4) 1971 :
62-75, 2 diagrams., 7 tables, 6 refs.

In order to maintain a happy economic position for the highest quality pale crepe produce in Ceylon, the author has laid down various proposals to improve quality production of pale crepe, in this article. The importance of Government participation in setting up central factories for pale crepe production in order to assist small estate manufacture a production of consistent quality is apparent. The need for market promotion, and effective technical service, to bridge the gulf between the producer and the consumer has been aptly stressed. It has also been suggested that the grading of pale crepe be dependent, among other things, on the method of preparation and on technological properties. A model preliminary project study for a new pale crepe factory is also detailed in this article.

617. NADARAJAH, M. and MUTHUKUDA, D.S.

Standardization of production methods of latex crepes to suit end-use requirements. R.R.I.S.L. Bulletin (N.S.). 9
(3/4) 1974 : 45-49, 7 refs.

The colour and some curing properties of pale crepe and sole crepe are discussed in this paper.

618. NADARAJAH, M.; NARANGODA, H. and COORAY, B.

Specifications in relation to production methods in some conventional grades of raw rubber. R.R.I.C. Bulletin (N.S.).
6 (3/4) 1971 : 86-94, 6 tables, 16 refs.

The four conventional grades of rubber, pale crepe, RSS, scrap crepe and sole crepe which are dealt with in this article, under the following headings: 1. Grading of pale crepe, 2. Sun-drying of RSS, 3. Use of conventional grades of natural rubber (NR) in tyre manufacture in NR producing countries, 4. Manufacture of scrap crepe to specifications, 5. Preparation of sole crepe for direct use. So long as appearance remains the basis of market valuation, a fair price cannot be guaranteed. The time will come, soon than expected, when pale crepe would not "sell itself" on sheet natural superiority, but would have to "earn its price" among the multiple forms of block and synthetic rubbers. One safeguard against this possibility is to introduce tight technical specifications and ensure standardization of production. The situation as far as

Ceylon is considered, is not entirely unhappy, because clone PB 86 with its white latex, which is considered to be the best for pale crepe manufacture, is widely planted in Ceylon. Therefore, central factories have a greater chance of success and as such, the possibility of standardization of manufacture, as suggested by the authors in this paper.

619. PERERA, Meegodage Cyril Senake

Technical and technological properties of crepe rubber from RRIC 100 series clones. [vii], 59 leaves, graphs, tables, 45 refs. (M.Sc. thesis. University of Sri Lanka, Vidyodaya Campus, 1979. Unpublished typescript.)

The Plant Breeding Department of R.R.I.S.L. has now introduced the RRIC 100 series clones, which are high yielding compared to the PB 86 and have a shorter immature period. Earlier work shows that crepe rubber manufactured with latex from some of the RRIC 100 series clones was comparable to that prepared from the PB 86 latex according to Green Book gradings. The aim of this work is to evaluate the technical and technological properties of crepe rubber manufactured from different clonal latices to compare the properties of some common clones with the RRIC 100 series clones. This work will enable us to make a firm recommendation for commercial scale planting of RRIC 100 series clones so as to increase the production of latex crepe and other forms of light coloured rubbers. The manufacture of xylyl mercaptants the only bleaching agent available for crepe manufacture, have decided to discontinue its production. There it is anticipated that within two or three years crepe rubber will have to be manufactured without a bleaching agent, unless a suitable alternative is found. It is also reported that quality crepe can be manufactured from some of the RRIC 100 series clones even without using a bleaching agent. The commercial plantation of the RRIC 100 series clones will not only increase the production but will help maintain our reputation as the producer of best quality crepe. (Author's summary).

620. PERERA, M.C.S.; THARMALINGAM, R. and FERNANDO, W.S E.

Suitability of hundred series clones for crepe manufacture.

Part I. Jl. Rubb. Res. Inst. Sri Lanka. 56, 1979 : 21-28, graph, 7 tables, 5 refs.

The latex of clone PB 86, which is widely planted in Sri Lanka is eminently suitable for the production of latex crepe. Recently there has been a great interest in Sri Lanka in the RRIC 100 series clones owing to their significantly better immature vigour and yields in comparison with earlier selections such as PB 86. A series of tests showed that the crepe produced from RRIC 100 and RRIC 103 latex is comparable to that from PB 86 in quality and technical properties. (Authors' Summary).

621. SCOTT, G. and VARATHUNGARAJAN, G.

A "new look" for Ceylon's pale crepe. RRIC Bulletin (N.S.)

6 (3/4) 1971 : 76-78.

This article appeared in the Ceylon Daily News 5th September 1971. Competition from synthesis rubber, specifications of pale crepe, marketing, and on outlook for the future.

622. THARMALINGAM, R.

Crepe rubber development unit. R.R.I.S.L. Bulletin (N.S.).

12 (1) 1977 : 9-13.

The author gives details of electrically heated fin type dryers used in the tea industry being successfully used in two crepe factories to dry crepe latex. This paper also describes the Crepe Rubber Development Unit (CRDU) which was set up under the purview of the Rubber Chemistry Department of the R.R.I.S.L. to deal with all aspects of NR processing in Sri Lanka with the view to carry out research to improve the quality of crepe rubber to meet consumer demand and to undertake market research and market promotion. Research work carried out by the Unit, involves mainly the processing aspects of crepe rubber and block rubber.

623. THARMALINGAM, R.; PERERA, M.C.S. and GOONATILLAKE, M.D.R.J.

Sri Lanka latex crepe : New developments in production and marketing. In: International Rubber Conference, Kottayam, India, 23-28 Nov. 1980. Abstracts of papers. Kottayam, Rubber Research Institute of India, 1980. Session 6A, Paper 1.

An abstract.

624. THOMPSON, M.W.

The possibilities of increasing crepe rubber production and the implications thereof. R.R.I.S.L. Bulletin (N.S.).

9 (3/4) 1974 : 25-27.

Smoked sheet manufacture is now largely confined to smallholders. Assuming an estate factory could handle an average of 2,400 lbs. of latex per day, the following requirements also need to be met : transport (tractor and truck) Rs. 100,000; extension for mills, packing and storage Rs. 70,000; new machinery Rs. 380,000; and additional drying facilities amounting to an outlay of Rs. 30,000.

625. TILLEKERATNE, L.M.K.

Elimination of the use of RPA 3 in crepe rubber manufacture.

R.R.I.S.L. Bulletin. 14, 1979 : 9-12, table.

This paper reports results of experiments carried out, to determine whether RPA 3 is essential for the manufacture of high quality crepe rubber, or it could be totally dispensed with, in the event of RPA 3 going out of production. The results indicate that RPA 3 is not required for the manufacture of high quality crepe, and its bleaching action, on the latex is not essential. Factors like factory hygiene, quality of water, mills availability, and the skill of the factory staff seem to play an important part.

626. VARATHUNGARAJAN, G.

Strategy for Sri Lanka's latex crepes. R.R.I.S.L. Bulletin

(N.S.). 9 (3/4) 1974 : 50-52.

Sri Lanka produces about 44,000 tons of high quality pale crepe annually. The main competition to pale crepe at present comes from SMR 5L and its equivalent from other countries. This article briefly describes the reasons for the large scale replacement by the competitors, and the role played in the development work by the Rubber Research Institute of Sri Lanka.

Sheet Rubber

627. ANON

Manufacture of smoked rubber sheet. R.R.I.C. Bulletin

(N.S.) 1 (1) 1966 : 7-10.

This leaflet explains to smallholders in simple terms the process of making good quality sheet. Published separately as the R.R.I.C. Smallholdings Folder No. 11.

628. HEINISCH, K.F. and NADARAJAH, M.

Investigation of mould growth on sheet rubber. In:

Proceedings of the Natural Rubber Research Institute, Kuala Lumpur, 1960. Kuala Lumpur (Malaysia), Rubber Research Institute of Malaya, 1961, pp. 893-902, 7 tables, 15 refs.

Three species of mould commonly found on Ceylon sheets, one a Penicillium and the other two Aspergillus species, have been tested against several fungicides, in aqueous media and on smoked sheet, in order to find an alternative to paranitrophenol, the use of which has been disallowed in Ceylon in raw rubber manufacture. The tests showed that salicyclic acid anilide and sodium-o-phenyl phenolate could be considered as suitable substitutes for paranitrophenol. Phenylmercuric acetate showed a marked inhibiting effect on the growth of Aspergillus but very little effect on that of Penicillium. Sodium bisulphite and RPA 3, chemicals used in rubber manufacture, have a noticeably delaying effect on mould growth. Growth curves of mixed infections show maxima and minima caused by changes in the composition of mould population due to changes in environment. (Authors' summary).

629. NADARAJAH, M.; BARTHOLOMEUSZ, P.A. and MUTHUKUDA, D.S.

Proposals to increase quality production of RSS in Sri Lanka. R.R.I.C. Bulletin (N.S.). 7 (3/4) 1972 : 50-63, 2 diagrms., 4 tables.

The efforts made in the past by way of propaganda and assistance to individuals to build standard smoke houses and purchase suitable equipment with a view to the improvement of the quality of sheet rubber produced by smallholders have not had commensurate results. The success which a few co-operative societies of smallholders had achieved since their inception indicated that collective effort would ensure the achievement of the objective of quality sheet rubber. The scheme under which Group Processing Centres are being established with funds made available by the Government is based on that experience. Its purpose therefore is to extend the collective principle in the faith that above can achieve this objective. This article describes this scheme and points to the necessity of establishing round about 500 such centres.

630. PEIRIS, H.H.,

Improvement in sheet production by smallholders. R.R.I.C.

Bulletin (N.S.). 2 (1/2) 1967 : 18-21, plate.

Improvements in the quality of sheet-rubber produced by smallholders has resulted from an intensive programme carried out by the Smallholdings Department of the R.R.I. A brief account of the activities relating to this programme is given here.

631. PEIRIS, H.H.

Some observations on the crash programme (1966) for the improvement of smallholders' rubber smoked sheet to Grade I quality. R.R.I.C. Bulletin (N.S.). 3 (1/2) 1968 : 1-7, 2 graphs, 3 tables, 2 refs.

In order to induce the smallholder to increase the out-put of Grade I sheet, a rubber crash programme has been launched by the Government of Ceylon, by offering an incentive of an extra -/02 cts. per lb. for this grade. This paper reports the progress made in 6 divisions during a certain period. Detailed monthly data for each division indicate a rapid improvement expressed in a shift towards Grade I, at the expense of the lower grades. The influence of rain and weather on quality improvement has also been shown. Seven suggestions are laid down by the author to obtain better results.

632. RUBBER RESEARCH INSTITUTE OF CEYLON.

Defects in smoked sheet. Q. Jl. Rubb. Res. Inst. Ceylon
36 (1/2) 1960 : 22-28; Reprinted in Planters' Chronicle.
55 (21) 1960 : 492-495.

633. RUBBER RESEARCH INSTITUTE OF SRI LANKA.

Manufacture of smoked rubber sheet. Ratmalana, R.R.I.S.L.
Advisory Service Dept., 1975, 11 p. (In Sinhala and English).

The purpose of this leaflet is to explain the smallholders as simply as possible the process of making good quality sheet under conditions especially applicable to them.

Stereo Rubber

634. NADARAJAH, M. and MEDAGAMA, D.D.

The use of first fraction rubber in the manufacture of stereo rubber. R.R.I.S.L. Bulletin (N.S.). 8 (2) 1973 : 36-38,
11 refs.

Sri Lanka is the world's largest producer of latex crepe and this is the first of a series of articles dealing with special uses for the varying grades of latex crepe produced by the R.R.I.C. This paper deals with a special use for first fraction rubber, i.e. in the manufacture of stereo rubber. First fraction rubber is obtained by the fractional coagulation of latex in the manufacture of latex crepe and sole crepe. Although there is considerable variability in the preparation of first fraction rubber, it is found to be a suitable raw rubber in the preparation of stereo rubber. Formulations for stereo rubber are discussed in this paper, and a available mixture, using first fraction rubber, which has been successfully used by commercial firms in Sri Lanka, has been established.

Technically Specified Rubber

635. AMARASOORIYA, Jayalathge Don

The cyclisation of natural rubber. VI, 61 leaves, graphs, tables, 55 refs. (M.Sc. thesis. University of Sri Lanka, Vidyodaya Campus, [197..?]. Unpublished typescript.).

The efficiency of Lewis acid catalysts in bringing about cyclisation of different grades of natural rubber is examined. In assessing the cyclisation behaviour, crepe rubber and its deproteinised grades were used. Certain properties of the final cyclised rubber sample obtained by the action of a set of Lewis acid catalysts on rubber are discussed. (Author's summary).

636. ANON

Cyclised rubber. Karmantha. 4 (1) January 1977 : 13.

A brief note. The simplest method for preparing cyclised rubber is by mixing 100 parts of NR with 8 parts of para toluene sulphuric acid and heating for several hours at 140°C. This method does not give a homogenous product. Improvements made by the R.R.I.S.L. in preparing the raw rubber by adding a phenolic antioxidant to the NR enabled a homogenous cyclised rubber to be obtained in half an hour at 110°C. Uses of cyclised rubber as a reinforcing filler, in paints and in printing inks are outlined.

637. COOMARASWAMY, A.

Oxidative modifications of rubber. Ph.D. thesis. University of Aston, 1973. (Unpublished).

638. COOMARASAMY, A. and NADARAJAH, M.

Commercial manufacture and uses of cyclised rubber. Proc. Sri Lanka. Ass. Advmt. Sci. 33 (1) 1977 : 57.

An abstract.

639. COOMARASWAMY, A.; NADARAJAH, M.; SILVA, L.B.K.;
KURERA, S. and SURENDRAKUMAR, R.

Commercial manufacture and uses of cyclised rubber.

R.R.I.S.L. Bulletin. 13, 1978 : 7-14, 2 photos., diagrms.,

3 refs; Abstracted in Proc. Sri Lanka. Ass. Advmt. Sci.

33 (1) 1977 : 57.

This paper outlines a simple, cheap method for the commercial production of cyclised rubber from papain coagulated low nitrogen natural rubber. Two different processes for the preparation of papain coagulated rubber are also described. This cyclised rubber is now used commercially as a reinforcing filler and for the manufacture of road marking paints. The best results obtained with cyclised rubber as a reinforcing filler are given. The paper also gives the details of the machinery which has been locally fabricated for the manufacture of paints. Possible uses of cyclised rubber in floor paints, machinery paints and in stencilling inks are suggested. (Authors' summary).

640. JAYATILAKE, K.G.K.; COOMARASWAMY, A. and FERNANDO, W.S.E.

Use of acrylic polymers for the preparation of granular natural rubber. Proc. Sri Lanka Ass. Advmt. Sci. 36 (1) 1980 : 66.

An abstract.

641. KARUNARATNE, S.W.

Use of oil-extended natural rubber in passenger car retreads in Ceylon : performance of retreads based on OENR and OENRM.

R.R.I.C. Bulletin (N.S.). 4 (3/4) 1969 : 33-36, 4 plates,
refs.

Ceylon is the only country in the world which produces passenger car tyres entirely of natural rubber (NR). One of the drawbacks in NR for tyre treads is its lack of skid resistance. Oil-extended natural rubber (OENR) compares favourably with synthetic rubbers (SR) in this respect. It is also found that the wear rating too of NR is enhanced by oil extension. An interesting experiment on this subject is described in this paper.

642. KARUNARATNE, S.W. and YAPA, P.A.J.

Production of viscosity stabilized rubber with improved PRI from low grades. Q. Jl. Rubb. Res. Inst. Ceylon.

44 (3/4) 1968 : 35-43, graph, 6 tables, 12 refs.

The consumer of natural rubber is faced with the problem of its hardening during storage and the successful control of this hardening effect is regarded as one of the significant contributions to natural rubber research. It is now accepted that aldehyde and aldehyde condensing groups, present as an integral part in the rubber molecules, cause this storage hardening through inter-molecular condensation and this could be arrested by the addition of hydroxylamine hydrochloride to latex prior to coagulation. Experiments were carried out to examine the possibilities of producing constant viscosity rubber with improved PRI from cup lump material. Soaking of cup lump in granulated or comminuted form in an aqueous solution of hydroxylamine hydrochloride results in viscosity stabilized rubber of low content and improved PRI. (Authors' summary).

643. NADARAJAH, M.

The use of oil-extended natural rubber (OENR) in passenger car retreads in Ceylon. Q. Jl. Rubb. Res. Inst. Ceylon. 45

(1/2) 1969 : 1-13, 11 tables, 16 refs.; Abstracted in

Proc. Ceylon Advmt. Sci., 23 (1) 1967 : 57.

In spite of the considerable amount of work done by the Natural Rubber Producers' Research Association, England, over the past few years on the oil extension of natural rubber, OENR is as yet not used on a commercial scale to manufacture passenger car tyres or retreads. This paper is an attempt made by the Ceylon Institute of Scientific and Industrial Research (CISIR) over the past two years to introduce OENR for use in retreads in Ceylon. Their experiments have shown that there is no significant difference in the physical properties of the vulcanisate whether the oil is added in the Banbury or in the latex stage. If a retreader has a Banbury, it would be preferable for him to make his own OENR, than to buy the OENRM from the plantations. Tread crumb can be used as a compounding ingredient to cheapen the mix. The use of even low grade scrap crepe, e.g. scrap crepe No. 4 as the raw rubber was found to give oil-extended compounds with satisfactory properties within BS specifications for car tyre treads for use in

retreading. A commercial retreading firm in Ceylon is retreading 150 carcasses with OENR camelback compound as an experiment before getting on to commercial production. (Author's summary).

644. NADARAJAH, M.; COOMARASAMY, A.; VARATHUNGARAJAN, G.; THARMALINGAM, R.; NARANGODA, H. and JAYASINGHE, P.P.

Recent developments in cyclised rubber and latex crepe production in Sri Lanka. In: Proceedings of the International Rubber Conference, Kuala Lumpur, 1975. Kuala Lumpur Rubber Research Institute of Malaysia, 1976. Vol. 4, pp. 321-334, 7 tables, 21 refs.

A simple and inexpensive method of producing cyclised rubber was developed using papain as coagulant and p-toluene sulphonic acid as the cyclizing agent. The use of sodium sulphate and sodium bisulphite was avoided. In an attempt to standardize latex crepe production methods to suit end-use requirements, 4 main grades of latex crepe were processed, viz. fractionated and bleached, unfractionated and bleached, fractionated but not bleached, and the yellow fraction. (Authors' summary).

645. NADARAJAH, M.; NARANGODA, H.; BALASINGHAM, C.G.; KIRUBAKARAN, J.K. and JAYASINGHE, P.P.

Preparation and uses of cyclised rubber and of chlorinated rubber. Q. Jl. Rubb. Res. Inst. Sri Lanka (Ceylon). 50 (3/4) 1973 : 157-165, 24 refs.

If cyclised rubber and chlorinated rubber could be produced by simple methods in the natural rubber (NR) producing countries, then they could have several important uses in these countries. The production of these derivatives by simple methods should considerably lower the prices from the rather high prices at which they are at present available, thus resulting in their increased world wide usage. The simplest method for preparing cyclised rubber is by mixing 100 parts of NR with 8 parts of para toluene sulphonic acid and heating for several hours, at 140°C. This method does not give a homogenous product. Improvements made by R.R.I.S.L. in preparing the raw rubber and by adding a phenolic antioxidant

to the NR enabled a homogenous cyclised rubber to be obtained in half an hour at 110°C. Uses of cyclised rubber as a reinforcing filler, in paints and in printing inks are discussed. The simplest method of preparing chlorinated rubber is from stabilised field latex and the chlorine generated in situ using sodium chlorate and concentrated hydrochloric acid. Modifications necessary to prepare chlorinated rubber and some of its possible uses are discussed. (Authors' summary).

646. NARANGODA, Hema

Industrial uses of cyclised rubber. R.R.I.S.L. Bulletin (N.S.). (Conference Supplement). 8 (3/4) 1973 : 35-36.

Various industrial uses of cyclised rubbers as a reinforcing organic filler for shoe soling and in the manufacture of shock resistant plastics; as a binder in emulsion paints, as a raw material for electrical insulating lacquers; in ink industry; as a plastic coating for coconut shell collection cups are described briefly.

647. SENEVIRATNE, J.

Block rubber. Journal of the Plastic and Rubber Institute (Sri Lanka). 1, 1978/1979 : 25-27, diagram.

The name block rubber applies to all new forms of Technically Specified Rubbers, and this article briefly describes the manufacture of block rubber. Process flow lines of block rubber production are indicated on the diagram.

648. THARMALINGAM, Ramalingam

Demonstration and training plant for block rubber based on smallholders' latex, Mawanella. Report on Mawanella block rubber factory process plant and plant recommendations for future factories. (AGO : SRL/71/526; Technical Report PRO/CEI). Colombo, Food and Agriculture Organization of the United Nations, 1975, 33 p., 5 figs., 16 tables.

The Mawanella Block Rubber Factory produces about 8 to 9 tonnes of block rubber/day on normal cropping days. This crop is obtained from 14 collection centres. About 95 per cent of the production qualifies as SLR.5L (i.e. cleaner grade of rubber). The variation between the Agent's figures and the actual throughput of the factory is very high. The metrolacs at the Collection Centres should be calibrated to minimize such variations. Acid dosage used for coagulation is in excess of the requirement. Reducing the acid dosage will not only minimize the cost of chemicals used for processing, but will reduce the maintenance cost of the machinery used for processing, latex grades. The performance of machinery installed for the size reduction of latex grades is satisfactory. Recommendations are made for additional machinery to process scrap satisfactorily and to increase the output of the latex flow line to about 20 tonnes/day. Suggestions are made to improve the performance of the dryers. The sizes of boxes in the process installed in the factory should be standardized.

649. THARMALINGAM, R. and DEKUMPITIYA, A.S.

Conversion of crepe rubber to block form at the packing stage. R.R.I.S.L. Bulletin (N.S.). 9 (3/4) 1974 : 34-40, 2 graphs, chart, table.

Sri Lanka processes only a small fraction of its crop in block form. About 60 per cent of our rubber is exported in the form of Ribbed smoked sheet (RSS) and the remainder mainly as thick and thin lace crepe. The aim of this study is to develop a method to convert certain grades of crepe rubber into block form at the packing stage. This envisages centralized packing and will reduce the machinery required for Sri Lanka to produce block rubber, as scrap grades can be processed in existing crepe rubber factories, resulting in considerable savings on exchange, and on machinery for block rubber factories to process scrap grades. Blocking of scrap crepe and first fraction crepe is worthwhile implementing as early as possible. These two grades of rubber amount to about 15 per cent of the total production (about 22,000 tons/annum) of rubber in Sri Lanka. This paper discusses the method of conversion, the expenditure involved and the effect of this process on some properties of the rubber. A figure describes the flow chart for the proposed process of blocking.

650. TILLEKERATNE, L.M.K.

Liquid rubber with solar power? R.R.I. makes break-through ; another blow to synthetics. Karmantha. 9 (4)
April 1980 : 7 & 9.

This article describes briefly a method of manufacturing rubber products using solar energy. The Rubber Research Institute of Sri Lanka has discovered a method of expediting the decay of plastics with a photo-activator, and according to this principle certain complex salts in certain metals become active with the absorption of strong UV rays and these active molecules compound long rubber and plastic molecules with oxygen and breaks them into short molecules. Allowing to continue this process, these strong plastic and rubber molecules converts into a liquid state. Experiments have revealed that when 1 per cent of Nitro benzene, which is the best suited to soften rubber, is mixed with dry crepe rubber and the mixture is spread on glass plate and is exposed to the sun, becomes soft and converts into a liquid state after an hour. These liquid rubber produced could use for the manufacture of gums, glues and selotape, etc.

651. TILLEKERATNE, L.M.K.

Some problems of block rubber production in Sri Lanka.

R.R.I.S.L. Bulletin (N.S.). 12 (1) 1977 : 17-18.

In Sri Lanka block rubber produce at two factories, Cenat Factory, Paiyagala and Mawanella and they are manufactured according to two major processes, comminution or crumbling. This paper discusses some problems such as dropping of Plasticity Retention Index (PRI) to a low value; high Volatile Matter Content (VM); infestation by bores in TSR pallets; and unavailability of correct grades of polythene for wrapping purpose, caused in the manufacture of block rubber at these two factories.

652. TILLEKERATNE, L.M.K.; FERNANDO, W.S.E. and DE SILVA, A.J.S.K.

Epoxidation of depolymerised natural rubber and industrial uses of its product. Proc. Sri Lanka. Ass. Advmt. Sci. 33
(1) 1977 : 57-58.

An abstract.

653. TILLEKERATNE, L.M.K.; PERERA, P.V.A.G.; DE SILVA, M.S.C. and SCOTT, G.

Studies on the use of solar energy for the preparation of liquid rubber. Jl. Rubb. Res. Inst. Sri Lanka. 54, part 2, 1977 : 501-507, 3 graphs, 2 tables, 7 refs.

The demand for SMR 5CV and 5LV is increasing, because of their constant and low viscosity which reduces or completely eliminates mastication before processing, thus lowering the cost of production. Premastication can be completely eliminated by converting solid rubber into the liquid form, with the added advantage of easy shaping of the vulcanizate by casting techniques or by curing in situ for gaskets and seals. The results of the experiments on the use of solar radiation, in the presence of certain metal complexes, and liquid-phase photo-initiators, for the production of liquid rubbers with good physical properties, under conditions in Sri Lanka, are presented in this paper. The results indicate that the liquid rubber obtained through the medium of solar energy shows fairly good properties in comparison to liquid rubber obtained by other methods. An attractive feature of this method is its low production cost. If better poly-functional reagents such as bis hydrazide are used in the cross linking of these soft elastomers, products with much better vulcanizing properties could be obtained.

654. TILLEKERATNE, L.M.K.; VIMALASIRI, T. and DE SILVA, A.

Production of CV 50 using high viscosity rubber latices from smallholders. Proc. Sri Lanka Ass. Advmt. Sci. 36 (1) 1980 : 32.

An abstract.

655. WICKRAMASINGHE, D.C. and KARUNARATNE, S.W.

Production of technically specified rubber (TSR) by the Conat process. Q. Jl. Rubb. Res. Inst. Sri Lanka (Ceylon). 50 (3/4) 1973 : 143-150, 4 tables, 2 refs.

This paper on the installation and operation of the first commercial TSR factory in Sri Lanka is presented in four parts: Part 1 : Building, machinery and installation; Part 2 : Maintenance and performance of machinery; Part 3 : Production and pelletisation; Part 4 : Marketing and purchase of raw material. The data presented in this paper has shown that a readily marketable product can be produced from sheet cuttings, low grades and cup lump material by the Cenat process. There is a demand for CENAT block rubber from a number of countries suggesting that is a form of natural rubber acceptable to the consumer.

656. YAPA, P.A.J.

De-proteinized natural rubber. Alembic. Chemical Society,
Peradeniya Campus. 1973/74 : 79-81.

Deproteinized natural rubber in addition to reduced nitrogen and ash contents, certain improved characteristics displayed by it, such as, uniformity in cure behaviour, reduced creep, superior fatigue life and superior dynamic properties. It has already evoked interest in application such as engineering components and heavy duty tyres because of its low heat build up.

657. YAPA, P.A.J.

The preparation and properties of low nitrogen constant viscosity rubber. Q. Jl. Rubb. Res. Inst. Sri Lanka. 52,
1975 : 1-9, 2 graphs, 8 tables, 9 refs.

A method for the preparation of a viscosity stabilised version of low nitrogen rubber is described. The process basically involves a simultaneous treatment of latex with hydroxylamine hydrochloride and papain hydroxylamine apparently prevents storage hardening by blocking aldehyde groups in rubber whilst papain reduces the nitrogen content usually by about 40 per cent. In addition, the latter acts as a coagulant. Carbonyl condensing chemicals such as hydroxylamine sulphate and hydroxylamine hydrochloride can also be used in the manufacture of low nitrogen CV rubber. Preliminary studies have shown that several other commercially available proteolytic enzymes viz. protease, trypsin, superase or esperase can be used with hydroxylamine hydrochloride to produce the same effect. (Author's summary).

658. YAPA, P.A.J. and KARUNARATNE, S.W.

Effect of storage hardening on the PRI of chemically treated rubber. Q. Jl. Rubb. Res. Inst. Ceylon. 49 (3/4) 1972 : 59-64, 8 tables, 5 refs.

The observations made during the study of the production viscosity stabilized rubber from low grades are reported in this paper. Chemical treatments, viscosity determinations and accelerated storage hardening tests were carried out as described by Karunaratne and Yapa (1969) (See item no. 642) using field coagula from a number of selected clones in RRIC. This investigation deals only with the effect of chemical treatment on the storage hardening of low grades of rubber, and gives useful information on the storage stability of such rubbers. While sodium bisulphite and oxalic acid treatment reduces the PRI of rubber hydroxylamine hydrochloride and, to a lesser extent, phosphoric acid bring about an increase in PRI after accelerated storage hardening.

659. YAPA, P.A.J.; NADARAJAH, M. and LOGANATHAN, K.S.

Use of papain treatment of NR latex to produce superior quality rubbers. Plastic and Rubber : Materials and Applications, February 1980 : 32-36, 2 figs., 6 tables, 16 refs.

Enzyme deproteinization of Hevea latex with papain (dried papaw milk) improves the technological and dynamic properties of the resulting low-protein rubber, popularly known as deproteinized natural rubber (DPNR). Significant improvements are observed in tensile strength and heat-build-up properties. The method of papain treatment is fairly simple and can be applied directly to fresh Hevea latex, thus making it commercially attractive. It can also be used on skim latex to produce low-protein rubber with improved technological properties. Preliminary investigations on further improvements in the process by the removal of sludge are satisfactory. Papain treatment of NR latex can be adopted in the manufacture of general-purpose rubber more suitable for the tyre industry. The main drawback as regards commercial implementation of papain treatment is the low availability and consequent high prices of papain in NR-producing countries. This can be overcome by the rubber plantations, producing their own papain by growing the papaya tree as an intercrop in the immature rubber plantations. (Authors' summary).

Polymers

660. AMARAPATHY, A.M.A.

Graft polymerization of antioxidants into natural rubber.

Ph.D. thesis. University of Aston, 1975. (Unpublished).

661. AMIN, M.U.; SCOTT, G. and TILLEKERATNE, L.M.K.

Mechanism of the photo-initiation process in polyethylene.

European Polymer Journal (England). 11, 1975 : 85-89,

4 graphs, 1 table, 26 refs.; Reprinted: Q. Jl. Rubb. Res.

Inst. Sri Lanka. 52, 1975 : 20-28.

It is shown that, during the processing of low density polyethylene, the hydroperoxide content increases rapidly to a very sharp maximum and then declines. Vinylidene groups initially present in the polymer, decreases to zero after an induction period and the rate of destruction is related to hydroperoxide concentration. Carbonyl concentration increases in an auto-accelerating mode in a process which follows the formation and decay of hydroperoxide; when the carbonyl concentration is low, hydroperoxide and vinylidene are the main source of the photo-initiation step. In the later stages of the reaction, Norrish II photolysis of carbonyl is the most important process. (Authors' summary).

662. COOMARASAMY, A.; CAMPBELL, D.S.; MENTE, P.G. and TINKER, A.J.

Natural rubber analogues of styrenediene thermoplastic rubber.

Proc. Sri Lanka. Ass. Advmt. Sci. 36 (1) 1980 : 67.

An abstract.

663. HERATH BANDA, R.M.; SELVARATNAM, M. and CANAGARATNA, S.G.

Graft polymerization of acrylonitrile on rubber. Proc. Ceylon

Ass. Advmt. Sci. 27 (1) 1971 : 94.

An abstract.

664. MENDIS, Leslie Palitha

Multi-component polydiene-epichlorohydrin elastomeric systems. XII, 183 leaves, photos., diagrams., tables, 232 refs. (Ph.D. thesis. Loughborough University of Technology, 1975. (Unpublished typescript))

The polymerization of epichlorohydrin (ECH) to a crystalline elastomer has been shown to proceed relatively unhindered when performed in the presence of diene and some other elastomers. Gross products obtained by this type of in situ polymerization were compared with blends prepared from the respective homopolymers to detect any improved compatibility, processability and covulcanization behaviour. Natural rubber/poly (ECH) systems have been investigated in greater detail. It was also found necessary to investigate the crystallinity and vulcanization behaviour of ECH homopolymers both crystalline and amorphous. Selective solvent extraction of NR/poly(ECH) gross products indicated graft copolymer formation. However a detailed study of crystallinity and unvulcanized gross products failed to reveal improved compatibility which normally accompanies graft copolymer formation. The anomalous extraction data were shown to be probably due to interpenetrating network formation caused by a novel type of NR gelation. Crystallinity studies also showed that the location of filler was similar in both blend and gross mixes at interdomain boundaries - resulting in poor dispersion. Other observations regarding increase of melting point and "double melting" of poly (ECH) appear to qualitatively confirm a pioneering theory of fibrillating crystal growth based on "impurity" segregation. Concepts of filler-polymer adhesion previously applied to elastomer blends and block copolymers were extended to diagnose graft copolymer formation in a natural rubber/methyl methacrylate (Heveaplus) graft copolymer, using a differential swelling technique. Application of these procedures to covulcanized polydiene - ECH multi-component systems failed to reveal graft copolymer formation or adhesion and showed evidence of poor covulcanization. Similar conclusions were reached from studies of IR spectra, glass transition and microscopy of both covulcanized and unvulcanized multi-component systems. Also mechanistic studies do not appear to favour NR/poly (ECH) graft copolymer formation. Notwithstanding poor compatibility and covulcanization behaviour, vulcanizates of poly (ECH) multi-component systems possessed fairly satisfactory technological properties. For example NR/poly (ECH) blends showed improved

oil resistance and ageing resistance compared with NR vulcanizates and improved "elastomeric" properties compared with crystalline poly (ECH) vulcanizates. These could be of commercial interest. (Author's summary).

665. MENDIS, L.P.; PEMAWANSA, K.P.W. and HETTIARACHCHI, S.

Electrochemical initiation in methyl methacrylate - natural rubber latex systems. Polymer (U.K.). 18, 1977 : 100-101, 3 tables, 11 refs.

A letter. Investigations of electrochemical initiation of monomers both in aqueous and non-aqueous systems have progressed in recent times. The preparation of Heveaplus type, natural rubber (NR)-g-methyl methacrylate (MMA) copolymer is investigated and some preliminary results of research in progress are reported.

666. SELVARATNAM, M.; SUSEELADEVY, S. and SOTHEESWARAN, S.

Graft polymerization of natural rubber. Q. Jl. Rubb. Res. Inst. Sri Lanka (Ceylon). 50 (3/4) 1973 : 181-193, 6 graphs, 1 table, 4 refs.

A useful method of modification of the properties of NR involves the polymerization of monomers (particularly vinyl monomers) in the presence of NR. Graft polymers are obtained by a chemical reaction between the monomer (or polymerizing monomer) and the rubber molecule, under suitable conditions. The objective of this work is to study broadly the kinetics of the reaction of rubber in latex form (ammonia preserved field latex) with monomers under various conditions. A general survey of the factors affecting the rate of polymerization of vinyl monomers in field latex has been carried out, and from the results it has been concluded regarding the mechanism of the reaction that, the influence of monomer concentration and initiator concentration (at low concentrations) on the rate is consistent, at low conversions, with a simple free radical mechanism. It also appears that free radicals are formed on the monomer by hydrogen abstraction rather than by addition, that the propagation step involves, at least partially, the addition of monomer to rubber, that solvation effects are important. The kinetics become increasingly complex as the reaction proceeds.

667. WIJESINGHE, D.L.C.U.P.

A study on the uses of copolymers containing maleic acid derivatives in natural rubber. X, 80, VI leaves, diagrm., graphs; tables, 71 refs. (M.Sc. thesis. University of Sri Lanka, Vidyodaya Campus, 1979. Unpublished typescript).

The copolymer of styrene and maleic anhydride was used as its aluminium salt to produce granular rubber from latex. Soluble ammonium salt of the copolymer was mixed with latex and a dilute solution of potash alum was used as the coagulant. Though the copolymer was used upto 25 per cent weight on rubber, the gum formulations did not show improvement in technological properties, whereas ISAF black formulations showed improvement of technological properties upto 15 per cent by weight of copolymer on rubber, with 25 per cent black. N-(4-anilinophenyl) maleimide-styrene 1 : 1 copolymer and di(3, 5-Di tert butyl-4-hydroxybenzyl) maleate-styrene, 1 : 1 copolymer were prepared by modifying the 1 : 1 copolymer or styrene and maleic anhydride. These polymeric derivatives were tested for their antioxidant properties using nitrile rubber, since their compatibility with natural rubber was found to be poor. The compatibility with nitrile rubber was good. Both N-(4-anilinophenyl) maleimide-styrene and di(3, 5-Di tert butyl-4-hydroxybenzyl) maleate-styrene copolymers were found to show antioxidant properties at temperatures of 80°C and 100°C. (Author's summary).

Grading, Specifications and Units

668. BUREAU OF CEYLON STANDARDS.

Code of practice for packaging of natural rubber latex in drums. Colombo, [], 7 p. (Sri Lanka Standards 323 : 1974).

Preserved latex is susceptible to decomposition due to contamination, evaporation or loss of preservatives. It should therefore, be packed in clean, air tight and corrosion resistant strong containers. Attempts have been made in this standard to lay down a code for proper selection of container, cleaning, packing and marking. This code prescribes the method of packing, and marking of natural rubber latex in clean, disinfected and painted drums.

669. BUREAU OF CEYLON STANDARDS.

Code of practice for packaging of standard Lanka rubber.

Colombo, [], 20 p., 3 figs., table. (Sri Lanka Standards 385 : 1976).

This standard prescribes the methods of packaging to be employed when Standard Lanka Rubber (SLR) is marketed. It also specifies the packaging materials, procedures and the method of marking to be adopted. All standard values given in the standard are in S.I. units.

670. BUREAU OF CEYLON STANDARDS.

Methods of testing natural rubber latices. Colombo,

[]. 55 p., 7 figs., 3 tables. (Sri Lanka Standards 325 : 1974).

It is well known that the variability in latex concentrate can arise from the type of clonal latex used, the harvesting conditions the methods of preservation and the methods of concentration. Technology based on natural rubber latex, therefore demands the characterisation of latex by a number of quality parameters; this information is useful for the technologist in deciding whether the latex would be suitable for a specific application. The function of this standard is to describe the various methods of evaluating the physical and chemical characteristics of latex, for purposes of assessing the suitability of a latex for a particular application and for the purpose of quality control. This standard specifies test for natural rubber latices which contain preservatives and which may or may not have been submitted to some type of concentration process. These tests are not necessarily suitable for latex from natural sources other than Hevea brasiliensis, and are not intended for latices of synthetic rubber, compounded latex, vulcanized latex or artificial dispersions of rubber. In this standard, test methods and

investigational procedures are considered in detail. All the values given in this standard are in S.I. units.

671. BUREAU OF CEYLON STANDARDS.

Methods of testing vulcanized rubber. Part I :

Determination of relative density and density. Colombo,

[]. 11 p. (Sri Lanka Standards 297 : 1974).

This Sri Lanka standard prescribes two producers for determining relative density and density of solid vulcanized rubber. This is one of a series of Sri Lanka standards on test methods for vulcanized rubber and is expected to furnish the rubber industry with standard procedures and terminology in the field of testing rubber products.

672. BUREAU OF CEYLON STANDARDS.

Methods of testing vulcanized rubber. Part 2 :

Determination of tensile stress-strain properties. Colombo,

[]. 18 p., 3 figs., table. (Sri Lanka Standards 297 : 1974).

This Sri Lanka Standard prescribes methods for determining the effect of the application of a tension lead to vulcanized rubbers and similar rubber like materials. They are not applicable to the testing of the material ordinarily classified as ebonite or hard rubber or to latex films. This standard is one of a series of Sri Lanka Standards on test methods of test for vulcanized rubber and is expected to furnish the rubber industry with standard procedures and terminology in the field of testing rubber products.

673. BUREAU OF CEYLON STANDARDS.

Methods of testing vulcanized rubber. Part 3 :

Determination of tear strength. (Crescent test piece).

Colombo, []. 12 p., 3 figs. (Sri Lanka Standards 297 : 1974).

This Sri Lanka Standard prescribes a procedure for determining tear strength of vulcanized rubber and similar rubber like material. This is one of a series of Sri Lanka Standards on test methods for vulcanized rubber and is expected to furnish the rubber industry with standard procedures and terminology in the field of testing rubber products.

674. BUREAU OF CEYLON STANDARDS.

Methods of testing vulcanized rubber. Part 4 :

Determination of hardness. Colombo, []. 34 p.,
7 figs., 7 tables. (Sri Lanka Standards 297 : 1975).

This Sri Lanka standard prescribes 5 methods for determining the hardness of vulcanized rubbers. The methods are as follows: Method N Determination of hardness (normal test); Method H Determination of hardness (high hardness test); Method L Determination of hardness (Low hardness test); Method M Determination of hardness (microtest); Method CN, CH, CL, CM Determination of apparent hardness of curved surfaces using N, H, L and M respectively. This standard is one of a series of Sri Lanka Standards on test methods for vulcanized rubber and is expected to furnish the rubber industry with standard procedures and terminology in the field of testing rubber products.

675. BUREAU OF CEYLON STANDARDS.

Methods of testing vulcanized rubber. Part 5 : Accelerated

ageing tests. Colombo, []. 20 p., (Sri Lanka
Standards 297 : 1976).

This Sri Lanka Standard prescribes two methods of test for accelerated ageing on vulcanized rubbers. The two methods are (a) air oven methods using either a cell type oven or a normal oven (b) oxygen pressure method. This standard is one of a series of Sri Lanka Standards on test methods for vulcanized rubber and is expected to furnish the rubber industry with standard procedures and terminology in the field of testing rubber products.

676. BUREAU OF CEYLON STANDARDS.

Moulded solid rubber soles and heels. Colombo, [],
10 p., table (Sri Lanka Standards 252 : 1973).

This standard prescribes the requirements and methods of sampling and test for rubber full-soles with or without heels, half-soles, with or without heels, half-soles and heels sold as finished products. This standard does not cover micro-cellular rubber soling, resin rubber soling, and very soft moulded rubber soles and heels normally used for canvas or all rubber footwear. All standard values given in this standard use in S.I. units.

677. BUREAU OF CEYLON STANDARDS.

Rubber teats and valves for feeding bottles and soothers.
Colombo, []. 15 p., table. (Sri Lanka Standards
253 : 1973).

This standard prescribes physical and chemical requirements, sampling and methods of tests for rubber teats, and valves for feeding bottles and soothers.

678. BUREAU OF CEYLON STANDARDS.

Specification for surgical rubber gloves. Colombo,
[], 14 p., fig., 2 tables. (Sri Lanka Standards 359 :
1975.)

This standard prescribes the requirements, sampling and methods of test for surgical rubber gloves of sizes 6, $6\frac{1}{2}$, 7, $7\frac{1}{2}$ and 8 made by the latex-dipped process. Notes on the method of obtaining the maximum life from the gloves are given in Appendix B. All dimensions in this specification are given in S.I. units.

679. BUREAU OF CEYLON STANDARDS.

Technically specified raw natural rubber. Colombo,
[1971]. 30 p. (Ceylon Standards 72 : 1970).

This specification deals with the grading of raw material rubber in terms of measurable chemical and physical factors in contrast to the commonly used system of visual inspection. It also covers methods of packing, sampling and testing. The standard is in two parts: Part I covers grades, requirements, packing and sampling while Part II deals with methods of test. These specifications define the limits of natural and adventitious contaminants normally present in raw rubber and which are known to effect the final properties of finished rubber articles. The parameters on which the specifications are based are the dirt, ash, volatile matter, copper, manganese and nitrogen contents. This specification also tentatively introduces the Plasticity Retention Index (PRI).

680. DE SILVA, M.S.C.

Quality testing scheme for small scale rubber industry.

Karmantha. 4 (5/6) May - June 1977 : 1-3, 3 photos., graph.

This article describes briefly on the quality control, the statistical quality control methods, and the Central Quality Testing Scheme which aimed to help the small scale rubber industries, by utilizing the testing facilities at the C.I.S.I.R. and the R.R.I.S.L.

681. KARUNARATNE, S.W.

The International System of Units : aids to its use.

R.R.I.S.L. Bulletin (N.S.). 10, 1975 : 14-21, 5 tables,

1 ref.

This article provides valuable information to both the layman and the research worker, and its scope is specially limited to the rubber industry. It can be noted that the relationships between the comparatively small number of different metric unit are simple, more rational, and therefore easier to learn and more convenient to handle in calculations than the cumbersome British System, used previously.

682. KARUNARATNE, S.W.

Standards for raw natural rubber. R.R.I.S.L. Bulletin (N.S.)

(Conference Supplement). 8 (3/4) 1973 : 44-45.

This article briefly describes the progress made towards International Standards for raw natural rubber.

683. NADARAJAH, M.; RAJASINGHAM, Mangaleswari; MUTHUKUDA, D.S. and JAYASINGHE, P.P.

Some suggested improvements in the grading of pale crepe.

Q. Jl. Rubb. Res. Inst. Ceylon. 47 (1/2) 1971 : 20-29,

7 tables, 21 refs.

In marketing pale crepe, it is suggested that in addition to the Green Book grading based on colour, other information which has an influence on technological properties be also specified. (Authors' summary).

684. TILLEKERATNE, L.M.K.

Scope of standardising rubber products in Sri Lanka.

R.R.I.S.L. Bulletin (N.S.). 12 (2) 1977 : 111-113.

Most of the chief uses of rubber products depends on its unique combination of properties such as tensile strength, resistance to ageing, resistance to wear and tear, permeability to gases etc. The measurement of these properties by chemical and physical methods which is a vital part in the rubber technology are classified by quality control tests, specification tests, and research and development tests, are described in this article.

685. WHITE, D.R.

The importance of research in developing rubber goods to serve the local and export markets. R.R.I.S.L. Bulletin (N.S.) 12 (1) 1977 : 90-93.

The author shows that rubber as a raw material, possesses many properties and it is this spectrum of properties which allows its use in so many different types of products and therefore lends itself so readily to research and development work. He has tried to show that research, and developing do not stop with product development but is then carried through into the production process by means of in-process control testing with a view to maintaining product standards. He examined the importance of foreign markets and the influence they must wield on the up-grading of our rubber products industry by spotlighting the importance of product acceptability

which is so closely linked to product development and quality control. Finally he has briefly examined the instruments necessary for bringing up the activities of research and development.

686. WIJEWANTHA, Ronald T.

Technical specifications in rubber manufacture and the steps necessary for their implementation in Ceylon. R.R.I.C.

Bulletin (N.S.). 2 (3/4) 1967 : 66-68.

A summary of a paper presented at the Symposium on the problems of the rubber industry, Colombo, B.M.I.C.H., on 10th July 1967. This gives a brief general account on the technical specifications in rubber manufacture and the steps necessary for their implementation in Ceylon.

Patents

687. COOMARASAMY, A. and CHANDRASIRI, L.A.N.

Binding antioxidant groupings to polymer. Sri Lanka Patent No. 7428.

688. ELIATAMBY, D.A.R. and NADARAJAH, M.

Stabilized natural rubber latex as an adhesive for plywood. British Patent No. 1,455,744 (1974).

689. ELIATAMBY, D.A.R.; NADARAJAH, M.; AMARASINGHE, U.P.P. and LIYANAGE, N.

The use of natural rubber-resin blends as an adhesive for plywood. Sri Lanka Patent No. 6911 (1972).

690. FERNANDO, M.R.N. and NADARAJAH, M.

The use of a room temperature vulcanizing natural rubber latex compound in carpet backing. Sri Lanka Patent No. 7733 (1978).

691. GANESHASUNDERAM, S. and NADARAJAH, M.

The manufacture of emulsion paints from preserved and concentrated natural rubber latex. Ceylon Patent No. 6082 (1967).

692. JOHN, C.K.; LAU, C.M.; NG, C.S.; RAMA RAO, P.S. and NADARAJAH, M.

Preservation of natural rubber latex. British Patent No. 1,517,025 (1978).

693. NADARAJAH, M.; COOMARASAMY, A. and NARANGODA, H.

Improvements relating to the manufacture of cyclised rubber. Sri Lanka Patent No. 7427.

694. NADARAJAH, M.; DE SILVA, K.P.N. and GUNASENA, G.W.

Stabilising of natural rubber latex for mixing with Portland Cement. Sri Lanka Patent No. 6938 (1972).

695. NADARAJAH, M.; KASINATHAN, S. and BALASINGHAM, C.G.

Use of papain as a natural latex coagulant in raw rubber manufacture. Sri Lanka Patent No. 6939 (1972).

696. NADARAJAH, M.; KIRUBAKARAN, J.K. and JAYASINGHE, P.P.

Modification of latex to be used as a general purpose adhesive. Sri Lanka Patent No. 6972 and 7656 (1972).

697. NADARAJAH, M. and MENDIS, E.G.

The preparation of bitumen-natural rubber master-batches using field latex. Sri Lanka Patent No. 6531 (1970).

698. NARANGODA, H. and NADARAJAH, M.

Cyclised rubber from latex for use in emulsion paints. Sri Lanka Patent Nos. 6910 and 7040 (1973).

699. RAJASINGHAM, M.; NADARAJAH, M.; KIRUBAKARAN, J.K. and JAYASINGHE, P.P.

Manufacture of chlorinated rubber from natural rubber latex. Sri Lanka Patent No. 6909, 1972.

700. YAPA, P.A.J.; NADARAJAH, M. and LIONEL, W.

The manufacture of high quality rubber from skim latex. Sri Lanka Patent No. 7713, 1978.

Packing, Preservation and Storage

701. DAYARATNE, W.C. and MUNASINGHE, H.L.

Mould contamination of rubber. Q. Jl. Rubb. Res. Inst. Ceylon.
48 (1/2) 1971 : 136-146, 5 illus. (some col.), 2 tables, 5 refs.

This paper gives the results of a study of the problem of mould contamination of rubber and the possibilities of checking by its physical means, without the use of chemicals. These studies shows that mould growth can be controlled by manipulating temperature and relative humidity (RH). The importance of RH on mould growth has been illustrated. The mould growth can be retarded to a large extent by the proper management of rubber purchasing stores, with a view to reducing RH. Seven other reasons for mould growth are also briefed.

702. HEINISCH, K.F. and NADARAJAH, M.

Preservation of sheet rubber against mould. Part I.

Mould growth in aqueous media. Q. Jl. Rubb. Res. Inst. Ceylon.

37 (2) 1961 : 43-48, 5 tables, 9 refs.

Methods of prevention of mould growth on sheet rubber is investigated using 4 suitable fungicides. Pure cultures of 4 fungi are used for the experiments and found that Santobrite, Preventol ON and Shirilan are superior in fungicidal activity to paranitrophenol in artificial liquid medium or in rubber serum. Phenols, cresols and chlorophenols are effective in an acidic medium and to exhibit reduced activity in alkaline solutions. Preventol ON maintain the same activity in different media and against all 4 fungi at an inhibiting concentration of 1 : 25,000. Although Santobrite and Preventol ON precipitate out in acidic medium they remain in unneutralized rubber serum as a very fine dispersion and show nevertheless the highest activity of all the fungicides tested. It has also found that sodium bisulphite used in sheet manufacture has a delaying effect on mould growth, and inhibition has been obtained in rubber serum at a concentration of 1 : 1,000. Although Penicillium chrysogenum observed on sheet rubber, it showed no growth at all in unneutralised rubber serum, due to the presence of some natural inhibitors.

703. HEINISCH, K.F.; NADARAJAH, M. and MUTHUKUDA, D.S.

Preservation of sheet rubber against mould. Part 2 : Mould

growth on smoked sheet. Q. Jl. Rubb. Res. Inst. Ceylon.

38 (3/4) 1962 : 40-46, 6 tables, 8 refs.

Method of prevention of mould growth on smoked sheets is investigated using 4 suitable fungicides. Pure cultures of 4 fungi are used and results indicate Shirilan is inferior to P.N.P. in sheets.

704. TILLEKERATNE, L.M.K.

Insect infestation of TSR pallets. R.R.I.S.L. Bulletin (N.S.)

11, 1976 : 1-3, 3 refs.

The problem of insect infestation of TSR pallets is causing grave concern among the NR producing countries in S.E. Asia. This is specially so because consumer countries are enforcing strict regulations whereby whole ware-houses and go-downs are fumigated should even a single pallet be found to contain insect or any other form of infestation. Sri Lanka has been using pallets made of rubber wood for shipment of block rubber since 1968; but so far Sri Lanka have been free of this problem, and it is claimed that this is due to the effective preservative treatment given to the wood used in the manufacture of TSR pallets. This article describes different methods used in treating the wood, and research is going on to find the most inexpensive method of treatment.

Rubber Machinery

705. THARMALINGAM, R.

Mathematical model of an extruder. R.R.I.S.L. Bulletin

(N.S.). 12 (2) 1977 : 94-101, diagrms., 4 refs.

The extruder is a piece of equipment used in the polymer processing industry for the purpose of extrusion. This article explains on what an extruder is, what the mathematical model of extruder denotes, and how the model can be utilized, in actual practice.

706. THARMALINGAM, R.

Solar-powered crepe drying towers. Karmantha. 8 (9)

September 1980 : 23-26, 3 diagrms.

A model designed by the Rubber Research Institute of Sri Lanka for drying crepe rubber utilizing solar energy is outlined with illustrations. Since crepe rubber drying requires low temperatures, flat plate collector is used. The cost of a solar collector system (area about 100 m²) for a 4000 kg. capacity drying tower to provide adequate heat for 9 hours on a cloudless day is about Rs. 25,000/.

Application of Latex and Rubber

707. AMARAPATHY, A.M.A.; NADARAJAH, M. and MANEL, M.G.

Manufacture of high quality rubberized fabrics using natural rubber latex. In: International Rubber Research and Development Board Symposium, Kuala Lumpur, 15-18 May 1978; organized by the Rubber Research Institute of Malaya. Text of Papers. [London], IRRDB, 1978. 5 p., 4 tables, 2 refs.; (Preprint); Abstracted in Proc. Sri Lanka Ass. Advmt. Sci. 33 (1) 1977 : 58.

Using natural rubber (NR) latex for coating fabrics is not something new. However, its commercial use is severely restricted by the availability of cheap plastic water proofing materials such as PVC. As a result of rising prices of plastic materials, there is an impetus in Sri Lanka for more development work for use of NR latex for coating fabrics. This paper reports the development work done by the Rubber Research Institute of Sri Lanka in collaboration with M/s. Richard Peiris & Co., Limited to water-proof fabrics, using compounded formaldehyde stabilised centrifuged latices, and using only a thin top surface layer of PVC. (Authors' summary).

708. ANON

Leather colours hold fast by natural latex. Rubber Developments (Malaya). 25 (4) 1972 : 119, photo, 2 refs.

Leather industry of Sri Lanka could replace 50 per cent of imported binders with the NR graft copolymer binder give a saving of foreign exchange. It has been suggested that the simple polymerization process could conveniently be carried out by the Ceylon Leather Products Corporation itself.

709. CHANDRASIRI, A.L.

Manufacture of rubberised coir mattresses and cushions. Karmantha. 9 (4) April 1980 : 21-22, 7 diags.

Raw materials required are 60 per cent concentrated natural rubber latex, coir fibre and by way of chemicals vulcastab, L.W., KOH, Sulphur, Z.D.C., Z.M.B.T., Zinc Oxide, dispersol, China clay, etc.; machinery and equipment required are illustrated; and preparation and compounding of latex is outlined.

710. COOMARASAMY, A.

Use of rubber derivatives and rubber seed oil in paints.

R.R.I.S.L. Bulletin (N.S.). 12 (2) 1977 : 75-82, 4 diagrams., table, 5 refs.

This paper is concerned mainly with the steps that have to be taken to make natural rubber and rubber seed oil suitable as binders for paints. NR latex is used in water based paints either by graft copolymerization or by pre-vulcanization of latex. Chlorinated rubber and cyclised rubber are suitable for the preparation of quick drying chemical resistant paints. Cyclized rubber is prepared by a very simple and cheap process using low nitrogen rubber prepared by papain coagulation. Rubber seed oil is used to manufacture alkyl resins in paint industry.

711. DE SILVA, M.S.C.

Manufacture of rubberised coir products using rubber latex.

Karmantha. 3 (12) December 1976 : 12-13.

This process of manufacturing rubberised coir products can be carried out by one of the two methods given below and these methods are described in this article. (1) Preparation of dust-free coir fibre into curled form; (2) Preparation of compounded latex (i.e. latex mixed with other chemical ingredients to obtain the required physical properties in the final product).

712. FERNANDO, M.A.U.G.; FERNANDO, M.R.N.; NADARAJAH, M. and DAHANAYAKE, P.

Further progress in the use of rubber for improvement of impact resistance in ferrocement boats. Proc. Sri Lanka Ass. Advmt. Sci. 34 (1) 1978 : 32-34, 7 refs.

An abstract.

713. FERNANDO, M.A.U.G.; NADARAJAH, M. and PERERA, W.A. Roger

Further development of natural rubber Portland Cement mixes for engineering applications. Proc. Sri Lanka Ass. Advmt. Sci., 33 (1) 1977 : 37.

An abstract.

714. FERNANDO, M.J.

More about natural rubber latex in road construction.

Proc. Ceylon Ass. Advmt. Sci. 24 (1) 1968 : 45.

An abstract.

715. FERNANDO, M.J.

Uses of rubber in roads. In: Symposium on the utilization of local raw materials. Colombo, 23-24 October 1969.

Proceedings. Colombo, The Chemical Society of Ceylon and The Ceylon Section of the Royal Institute of Chemistry, 1969.

pp. 106-117, table.

Attempts were made to study the effective uses of different types of latex blended with bitumen for road surfacings. Definite improvements were observed in the physico-chemical properties of rubberized bitumen so vital to the roads engineer. Difficulties in the addition of latex to bitumen were overcome. Laboratory experiments were conducted to study the dispersion of rubber particles, temperature-dependent properties, rheological properties, ageing and stripping of rubberized bitumen. Uses of rubber in mix-designs are also evaluated. A new stripping test is devised to study the use of rubberised bitumen. An effective mechanism is proposed to understand the behaviour of rubber particles in bitumen. Advantages of rubberised bitumen to the road engineer and its other uses are also discussed. Discussion.

716. FERNANDO, M.J. and NADARAJAH, M.

Uses of natural rubber latex in road construction.

Journal of Rubber Research Institute of Malaya. 22 (5)

1969 : 430-440, graphs, 6 tables, 19 refs.; Reprinted in

Q. Jl. Rubb. Res. Inst. Ceylon. 46 (1/2) 1970 : 39-51.

Latex is the most effective form of natural rubber for road construction, both centrifuged latex and Revertex being used. The authors found creamed skim latex most effective for road-making. Because of its easy availability, however, field latex is more suitable for road-making in the natural rubber producing countries. Results of laboratory studies on cationically stabilized, compounded and peroxide-vulcanized field latex are reported. The studies concerned the dispersion of rubber particles, temperature-dependent and rheological properties, ageing and stripping of rubberised bitumen and uses of rubber in mix designs. Experimental stretches of road surfacing have been laid with bitumen containing up to 4 per cent field latex. Further test stretches are being laid with rubber-modified premix using field and creamed skim latices.

717. FERNANDO, W.S.E.

Centrifuged latex as a raw material for the production of rubber goods. R.R.I.S.L. Bulletin (N.S.). (Conference Supplement). 8 (3/4) 1973 : 22-24.

This article is intended particularly for the laymen, to give an idea on the manufacturing techniques, of rubber goods, made from centrifuged latex.

718. GUNASEKERA, Donald

Reclaimed rubber : a useful raw material for Ceylon.

Industrial Ceylon. 4 (4) December 1964 : 437-438.

Discarded articles of rubber are chopped and cracked and mixed with a reclaiming agent, digested and milled in an internal mixer and blended and marked as reclaimed rubber to be used in the manufacture of moulded rubber goods. These are cheaper, useful compounding ingredient and helps to produce finished rubber goods of uniform quality, good ageing, and many other advantages.

719. INDUSTRIAL DEVELOPMENT BOARD OF CEYLON.

Latex from rubber products. Katubedde, Moratuwa, IDB,

1971. ii, 15 p. (Industry prospect report, 33).

In 1971 when the Department of Small Industries, Sri Lanka called upon Government Agents to establish small scale industrial units on an electoral basis, with the co-operation of the Members of Parliament concerned two questions were asked. What industries and how? This industry prospect report prepared by a Committee from the I.D.B. is an attempt to answer the two questions? Latex foam is widely used in applications requiring a cool and comfortable cushioning material. This report describes on the following: Market; scope for the development; capital requirements; raw materials; machinery and equipment with the costs; manufacturing process; employment; profitability statement, etc.

720. INDUSTRIAL DEVELOPMENT BOARD OF CEYLON.

Model project report on rubberised coir production.

Katubedde, Moratuwa, IDB, 1979. 13 p.

Rubberised coir is mainly used in cushions, upholstery and mattresses. It is usually produced in the form of blocks or slabs by spraying concentrated compounded rubber latex onto curled coir fibre and vulcanizing it. This model project report serves as a guide for setting up an industrial unit for manufacture of rubberised coir mattresses and cushions. For the purpose of financial evaluation, in this report it has been assumed that a unit of the nature proposed in this report would produce 6,000 mattresses of the size 6' x 3' x 1/3' or an equivalent amount of any other size per year of 250 working days on a single shift operation. This project provides employment for 28 persons. The total investment in this project is Rs. 500,000/= comprising Rs. 285,000/= as fixed capital and Rs. 215,000/= as working capital.

721. INDUSTRIAL DEVELOPMENT BOARD OF CEYLON.

Rubber beading and stripping. Katubedde, Moratuwa, I.D.B.

1971. ii, 9 p. (Industry prospect report, 39).

In 1971 when the Department of Small Industries, Sri Lanka called upon Government Agents to establish small scale industrial units on an electoral basis, with the co-operation of

the Members of Parliament concerned, two questions were asked. What industries and how? This industry prospect report prepared by a Committee from the I.D.B. is an attempt to answer the two questions. Rubber beading, stripping and wiper blades are classified under solid and cellular extruded rubber goods and are mostly used as automobile component parts such as door glass drop pads. The proposed scheme is for the manufacture of all types of beading and stripping required for the models and makes of automobile that are available in the island. This report described the following: Market; scope for development; capital requirements; raw material; machinery and equipment; manufacturing process of rubber beading; employment; profitability statement, etc.

722. INDUSTRIAL DEVELOPMENT BOARD OF CEYLON.

Rubber belting. Katubedde, Moratuwa, I.D.B., 1971.

ii, 16 p., figs. (Industry prospect report, 43).

In 1971 when the Department of Small Industries, Sri Lanka called upon Government Agents to establish small scale industrial units on an electoral basis, with the co-operation of the Members of Parliament concerned two questions were asked. What industries and how? This industry prospect report prepared by a Committee from the I.D.B. is an attempt to answer the two questions. Belting of two main types are discussed in this report, namely, conveyer and transmission. This reports on the following: Market; investment; capital requirements with the costs; raw material; machinery and equipment with the cost; technical process; employment; profitability statement, etc. Each must provide employment opportunities for about 16 persons.

723. INDUSTRIAL DEVELOPMENT BOARD OF CEYLON.

Rubber carpeting. Katubedde, Moratuwa, I.D.B., 1971.

ii, 9 p. (Industry prospect report, 42).

In 1971 when the Department of Small Industries, Sri Lanka called upon Government Agents to establish small scale industrial units on an electrocal basis, with the co-operation of the Members of Parliament concerned, two questions were asked. What industries and how? This industry prospect report prepared by a Committee from the I.D.B. is an attempt to answer the two questions. This report describes on the following: Market; investment; capital requirements; raw

material; machinery and equipment; profitability statement, etc. There will be employment opportunities for about 11 people in the rural sector.

724. INDUSTRIAL DEVELOPMENT BOARD OF CEYLON.

Rubber dipped goods. Katubedde, Moratuwa, I.D.B., 1971.

ii, 15 p. (Industry prospect report, 17).

In 1971 when the Department of Small Industries, Sri Lanka called upon Government Agents to establish small scale industrial units on an electoral basis, with the co-operation of the Members of Parliament concerned, two questions were asked. What industries and how? This industry prospect report prepared by a Committee for the I.D.B., is an attempt to answer the two questions. The products considered here are teats and valves, soothers, surgical gloves and contraceptives as these have a relatively wide local market. This prospect report describes on the following: Market; investment; capital requirements; raw materials; machinery and equipment with the costs; technical process; employment with the labour costs; profitability statements, etc. There will be foreign exchange saving of Rs. 0.2 m. - 0.3 m. (the value of 1971 imports) approximately. The envisaged plant would supply the products to the consumer at a very low price.

725. INDUSTRIAL DEVELOPMENT BOARD OF CEYLON.

Rubber soling. Katubedde, Moratuwa, I.D.B., 1971.

ii, 21 p. (Industry prospect report, 40).

In 1971 when the Department of Small Industries, Sri Lanka called upon Government Agents to establish small scale industrial units on an electoral basis, with the co-operation of the Members of Parliament concerned, two questions were asked. What industries and how? This industry prospect report prepared by a Committee for the I.D.B. is an attempt to answer the two questions: In the manufacture of footwear in Ceylon, rubber continues to be the basic soling material, contributing to about 75 per cent of the soling of the footwear produced. This report describes on the following: Market; investment; capital requirements; raw materials; machinery and equipment; technical process and specifications; process of manufacture; employment; profitability statement, etc. The proposed scheme provides employment opportunities for about 11 people.

726. INDUSTRIAL DEVELOPMENT BOARD OF CEYLON.

Rubber toys. Katubedde, Moratuwa, I.D.B. 1971.

ii, 18 p. (Industry prospect report, 10).

In 1971 when the Department of Small Industries, Sri Lanka called upon Government Agents to establish small scale industrial units on an electoral basis, with the co-operation of the Members of Parliament concerned, two questions were asked. What industries and how? This industry prospect report prepared by a Committee from the I.D.B. is an attempt to answer the two questions. This reports on the following: Market; investment; capital requirements; raw material; machinery and equipment; technical process; employment; profitability statement, etc.

727. INDUSTRIAL DEVELOPMENT BOARD OF CEYLON.

Rubberized coir products. Katubedde, Moratuwa, I.D.B.

1971. ii, 12 p. (Industry prospect report, 6).

In 1971 when the Department of Small Industries, Sri Lanka called upon Government Agents to establish small scale industrial units on an electoral basis, with the co-operation of the Members of Parliament concerned, two questions were asked. What industries and how? This industry prospect report prepared by a Committee from the I.D.B. is an attempt to answer the two questions. This reports on the following: Market; investment; capital requirements; raw material; machinery and equipment; technical process; employment; profitability statement, etc.

728. INDUSTRIAL DEVELOPMENT BOARD OF CEYLON.

Rubberized fabrics. Katubedde, Moratuwa, I.D.B. 1971.

ii, 16 p., diagram. (Industry prospect report, 35).

In 1971 when the Department of Small Industries, Sri Lanka called upon Government Agents to establish small scale industrial units on an electoral basis, with the co-operation of the Members of Parliament concerned, two questions were asked. What industries and how? The industry prospect report is an attempt to answer the two questions. Rubberized fabrics are made by coating fabrics with compounded rubber solution or by impregnation and coating with compounded latex so that the resultant fabrics is flexible and water-proof. The proposed scheme is for the production of hospital sheeting and similar

material. This report describes on the following: Market; scope of development; capital requirements; raw material; machinery and equipment with the costs; technical process; employment; profitability statement, etc.

729. JAYASINGHE, Pinshree

The future of natural rubber in adhesives. R.R.I.S.L.

Bulletin (N.S.). (Conference Supplement). 8 (3/4) 1973 :

42-43. Reprinted Karmantha. 2 (10) October 1975 : 8-9.

This article is intended particularly for the laymen, on natural rubber in adhesives and discusses various types, preparation, properties and their uses.

730. KANNANGARA, Gamini

Extent of usage of NR in footwear manufacture. R.R.I.S.L.

Bulletin (N.S.). 12 (2) 1977 : 117-118.

Usage analysis of NR and the conventional processing stages in footwear manufacture are outlined in this article. Some of the achievements are also highlighted, to find alternative uses of NR as substitute for imported materials which consumed large amount of foreign exchange.

731. KARUNARATNE, S.W.

Natural rubber (NR) as an insulating material. R.R.I.S.L.

Bulletin (N.S.). 13, 1978 : 15-16, 3 tables.

The electrical properties of polymers are largely dependent on their structural properties. This paper discusses natural rubber as an insulating material. It should be noted in compounding of NR for maximum electrical resistance, to use clean rubber to begin with, and the selection of compounding ingredients should be such as to produce a grade of rubber which has maximum heat ageing properties.

732. MENDIS, E.G. and NADARAJAH, M.

The use of rubber in Ceylon roads. R.R.I.C. Bulletin (N.S.)

6 (1/2) 1971 : 12-18, 8 refs.

The use of natural rubber (NR) field latex in the preparation of masterbatches and the use of field latex or masterbatches for road work with bitumen in Ceylon is discussed. The experimental stretches of rubberized bitumen roads laid in Ceylon are listed. For the large scale use of rubber in roads in Ceylon, it may be necessary to mix the bitumen with the NR latex at the Petroleum Corporation refinery. For estate roads the use of bitumen emulsions such as colas, mixed with field latex, would be more convenient. (Authors' summary).

733. MENDIS, L.P.

Gelation of natural rubber caused by trialkyl aluminium compounds. Jl. Rubb. Res. Inst. Sri Lanka. 53, 1976 : 1-7, 2 tables, 26 refs.

A gelation reaction of natural rubber (NR) brought about by trialkyl aluminium compounds is described. It is shown that trialkyl aluminium compounds modified with a suitable cocatalyst could get a toluene solution of NR; at the same time the original NR chains could undergo scission. A reaction mechanism is proposed and the significance of the gelation in the formation of interpenetrating networks is discussed. (Author's summary).

734. MOTH, J.T.S.

Reinforcement of natural rubber with poly methyl methacrylate in graft copolymer and poly blends - a comparative study. IV, 65 leaves, diagrams., graphs, tables, 65 refs. (M.Sc. thesis. University of Sri Lanka, Vidyodaya Campus, 1975. Unpublished typescript).

The use of an adhesion analysis technique based on differential swelling has been worked out by G. Kraus, to differentiate between reinforcing filler-polymer systems and non-reinforcing filler-polymer systems. This method has been later applied by L.P. Mendis and C. Hepburn to distinguish between a physical blend of two polymers, natural rubber (NR) and poly methyl methacrylate (PMMA), and their corresponding graft copolymer. Their studies have been confined to NR-PMMA systems obtained by polymerising methyl methacrylate monomer

(MMA-) in NR solution in Toluene using (a) benzoyl peroxide (BZ_2O_2) and (b) azo-bis-iso butyronitrile (AZBN) as initiator. With BZ_2O_2 as initiator one obtains a NR-MMA graft copolymer and with AZBN mainly a polymer blend. The aim of this work is to verify the validity of these findings on (a) NR/NMA graft copolymer obtained by the graft copolymerization of MMA in NR latex and (b) NR-PMMA blends obtained by the mechanical mixing of NR and PMMA latices in the latex stage. The results obtained from: (1) Measurement of mechanical properties; (2) Swelling measurements and (3) Selective extraction data, show signs of reinforcement of both the blend and graft, as compared with the pure gum, but fail to indicate any substantial difference between the physical blend and graft. It is possible that physical cross-links (chain entanglements) play a role in the case of the blend, comparable to that of the chemical attachment between the two polymers in the graft copolymer system. The results of the selective extraction experiments support this view. (Author's summary).

735. NADARAJAH, M.

Use of natural rubber in engineering application. Proc.

Sri Lanka Ass. Advmt. Sci. 35 (2 R) (Review Papers) 1979:

40-48, graph, 7 tables, 21 refs.

The use of nr in engineering applications such as bridge bearing, building mountings, anti-impact devices, engine mountings, pipe sealing rings, electric power industry, drainage and irrigation works, railways, tyres, rubber in roads, Portland cement, NR latex mixes and NR latex-bitumen emulsion mixes for water proofing applications are discussed in this paper. Various physical properties in natural rubber that promote the use of nr in engineering applications are also discussed.

736. NADARAJAH, M. and COOMARASAMY, A.

Recent developments in the use of natural rubber in Sri Lanka.

Plastics and Rubber International (U.K.). 2 (6) 1977 : 271-274,

photo., 6 tables, 20 refs.

Sri Lanka has pioneered several new uses of natural rubber, e.g. in general purpose adhesives, in plywood adhesives, in emulsion paints, in Portland cement mixes, in the preparation

by a simple process of cyclized rubber and also found new uses for this cyclized rubber. Further development work carried out on the above projects, is reported in this article.

737. NADARAJAH, M.; FERNANDO, M.R.N.; FERNANDO, M.A.U.G. and DAHANAYAKE, P.

The use of rubber for improvement of impact resistance in ferrocement boats. Jl. Rubb. Res. Inst. Sri Lanka. 56, 1979 : 48-51, 4 tables, 6 refs.

An attempt was made to improve the impact resistance of ferrocement boats. It was found, that the resistance to fracture of such boats can be improved by the incorporation of 10 per cent by weight of natural rubber into the portland cement in the form of low ammonia centrifuged latex. Lining these boats with rubber sheets, which vulcanise at room temperature in the sunlight, enhances their impermeability. (Authors' summary).

738. NADARAJAH, M. and FERNANDO, Upali G.

Development of natural rubber latex - Portland cement mixes for engineering applications. Jl. Rubb. Res. Inst. Sri Lanka. 55, 1978 : 5-12, 4 tables, 19 refs.; Abstracted in Proc. Sri Lanka Ass. Advmt. Sci. 32 (1) 1976 : 55.

The deficiency in properties when Portland cement is used in mixes with natural rubber latex is due to non-rubber substances and especially sugars found in latex serum. These non-rubber substances could be reduced by centrifugation and further by dilution with water and recentrifugation. A rubber/cement ratio of $(1 : 1\frac{1}{2})$ cement sand mortar could be used up to 0.03 per cent for field latex, up to 0.10 per cent for centrifuged latex and up to 0.20 per cent for double centrifuged latex without drastically impairing physical properties; on the other hand some improved properties are observed. The latices could be prevulcanised with vulcanising chemicals without serious reduction in strength when compared with the unvulcanised latices. The incorporation of natural rubber latex in "Wirecon" boat building material has shown that appreciable improvement in impact strength is obtained by the incorporation of the rubber latex. (Authors' summary).

739. NADARAJAH, M. and GANESHASUNDARAM, S.

Use of natural rubber latex in paints. Journal of Rubber Research Institute of Malaya. 22 (5) 1969 : 423-429, 2 tables, 13 refs.; Reprinted in Q. Jl. Rubb. Res. Inst. Ceylon 46 (1/2) 1970 : 30-37.

Polymers in latex form have recently been introduced in water-thinned paints as film binders. The latices used in emulsion paints have been exclusively of the synthetic types. Initial experiments using natural rubber latex in such paints showed its serious disadvantages in hardness, stability, brushability and pigment-binding capacity. These properties were improved by grafting natural rubber latex with a monomer such as styrene or methylmethacrylate, vulcanisation using cumene hydroperoxide or by a combination of both methods. Emulsion paints made from stabilised field latex can be manufactured easily by these methods in natural rubber producing countries to displace distemper paints. (Authors' summary).

740. NADARAJAH, M.; PIERIS, Hemal and DE SILVA, K.P.N.

Development of natural rubber - Portland cement mixes for practical applications. R.R.I.C. Bulletin (N.S.). 7 (3/4) 1972 : 71-75, 13 refs.; Abstracted in Proc. Ceylon Ass. Advmt. Sci. 28 (1) 1972 : 130-131.

There is no record of natural rubber latex-Portland cement being used in practical applications in Sri Lanka. Nearly all the work reported so far in other countries has been with concentrated NR latex. For a NR producing country such as Sri Lanka, it would be cheaper and more convenient to use field latex. This paper discusses some preliminary work done on the use of formaldehyde stabilized natural rubber latex in Portland cement mixes in practical applications. (Authors' summary).

741. NARANGODA, Hema

Natural rubber latex for carpet backing. Karmantha. 3 (7) July 1976 : 11-13, 4 diagrms., 1 table.

This article reveals the latest development work connected with the carpet backing industry; and its possible process modifications to suit local conditions are discussed.

742. PERERA, Raigamage Upendra

Micromolecular soling material based on cyclised rubber/
natural rubber blends. XI, 72 leaves, photos., graphs,
tables, 20 refs. (M.Sc. thesis. University of Sri Lanka,
Vidyodaya Campus, 1979. Unpublished typescript).

Cyclised rubber produced in Sri Lanka as a stiffening agent in microcellular soling was compared with imported synthetic high styrene resin. Laboratory compounding procedures were followed and vulcanized samples were tested for technological properties. It was seen that compression set of microcellular soles with cyclised rubber (styranat) was superior in comparison with high styrene (Butakon) resins. Compression set especially showed marked improvement almost at all temperatures with higher loading of inert filler and with increase of stiffening resin content. However, when other properties namely, Abrasion loss, heat shrinkage and hardness were considered, high styrene resin proved to be superior as a stiffening agent. In case of water absorption both types of resins appeared to perform in a similar manner, though cyclised rubber showed marginal improvement over high styrene resin when 30 parts of resin was incorporated. It was also shown that cyclised rubber could be used with advantage in solid soles and also cellular rubber and low density soling materials. (Author's summary).

743. RAJASINGHAM, M.

Preliminary investigations into the preparation of carbon fibre from cyclised rubber and the use of cyclised rubber for injection moulding purposes. Proc. Ceylon Ass. Advmt. Sci.

26 (1) 1970 : 106.

An abstract.

744. SIRIWARDANA, T.A.S.K.

A study on natural rubber based adhesives. [V], 100
leaves, diagrms., graphs, tables, 19 refs. (M.Sc. thesis,
University of Sri Jayawardenapura, Sri Lanka, 1979.
Unpublished typescript).

The aim of this work has been to study the tendency to use natural rubber based adhesives for the footwear industry. Both natural latex and natural rubber solvent adhesives were prepared and adhesive properties were modified by the incorporation of Resorcinol Formaldehyde resin. In all cases the formation of Resorcinol formaldehyde was carried out in situ. The adhesion effect of Resorcinol-formaldehyde resin level on natural rubber was tested through band strength using leather to leather and leather to rubber test specimens. These tests were carried out separately after immersion in water for 24 hours and after heat ageing at 70° - 2°C for 100 hours. Same tests were carried out on the adhesives which are now available for the foot-wear industry and these were compared with the above results. (Author's summary).

745. SIVAGURUNATHAN, L.

Heat ageing, of natural rubber inner compounds. VI, 36
leaves, graphs, tables, 19 refs. (M.Sc. thesis. University
of Sri Lanka, Vidyodaya Campus, 1975. Unpublished typescript).

The Sri Lanka Tyre Corporation uses natural rubber for the manufacture of inner tubes. Most foreign manufacturers use synthetic rubber e.g. butyl or a mixture of synthetic e.g. chloro butyl and natural rubber. Butyl rubber, being saturated has good ageing properties and very low permeability to gases. A problem encountered with natural rubber tubes made by the Corporation is the gradual increase in size during service. This results in folding and creasing of the tube within the tyre. The problem is particularly acute in the case of the larger sizes which are used by heavier vehicles e.g. buses and trucks. This enlargement reduces the operational life of inner tubes. Oxidative degradation may be the major cause of this growth. Oxidative degradation is a cumulative effect of time, temperature, and oxygen concentration. Choice of vulcanisation system is the most critical factor which determines how a rubber compound will perform in service at high temperatures. EV systems have been

found to produce heat resistant vulcanisates. The aim of this work has been to study the heat ageing characteristics of the natural rubber tube compound presently used by the Corporation and then to modify the formulation to obtain better heat ageing properties. Due to the limited time available it has not been possible to complete the project and arrive at a definite conclusion but results have shown that a formulation with low sulphur-high accelerator ratio is more resistant. (Author's summary).

746. SRIHARAN, Thavarajah

The suitability of lower grades of natural rubber for use in tyre compounds. vi, 39 leaves, 2 graphs, 16 tables, 25 refs. (M.Sc. thesis. University of Sri Lanka, Vidyodaya Campus, 1976. Unpublished typescript).

This research is an investigation on a laboratory scale on the suitability of the lower grades of natural rubber for use in tyre tread compounds. Tyre tread compounds were prepared using RSS grades 1 to 5 and brown crepe. The properties of unvulcanized and vulcanized compounds were tested. Due to the limited time available it was not possible to carry out a sufficient number of trials to arrive at a definite conclusion. The results so far obtained show that there are no significant differences between the different grades of RSS. There are however significant variations between estate brown crepes and smoked sheets. It is suggested that trials be repeated using a much larger number of samples as determined statistically to arrive at more definite conclusions.

747. THEVARASAH, A. and SELVARATNAM, M.

Effect of latex on the physical properties of cement and concrete. Proc. Ceylon Ass. Advmt. Sci. 25 (1) 1969 : 78.

An abstract.

748. WEERARATNE, A. and NADARAJAH, M.

Road performance studies and an investigation of some problems associated with rubberized bitumen road construction. Q. Jl. Rubb. Res. Inst. Ceylon. 47 (1/2) 1971 : 37-49, 10 graphs, 11 refs.

The work on this project so far carried out indicates that: (i) the addition of 5-10 per cent kerosene oil by volume of bitumen reduces the viscosity and improves the workability characteristics of an otherwise cumbersome binder; (ii) "masterbatches" are not only convenient, but are essential to save time in blending of natural rubber latex and bitumen and in the ensuring of better quality control; (iii) a mixture of NaOH and ammonia is a better stabilizer than either NaOH or ammonia; (iv) better bending was achieved with rubberized bitumen than with neat bitumen with the aggregate tested; (v) bleeding taking place on the rubberized bitumen sections was less than in the control sections with rubber. (Authors' summary).

749. WEERARATNE, W.G.; ELIATAMBY, D.A.R.; AMARASINGHE, U.P.P.; LIYANAGE, N.S. and NADARAJAH, M.

The use of natural rubber latex-resin blends as an adhesive for plywood. Journal of the Institution of the Rubber Industry. 8 (2) April 1974 : 74-77, diagram., 9 tables, 18 refs.; Abstracted in Proc. Ceylon Ass. Advmt. Sci. 28 (1) 1972 : 131-132. Q. J. Rubb. Res. Inst. Ceylon. 49 (3/4) 1972 : 37-48, 8 tables, 17 refs.;

Approximately 1,300 tons of urea formaldehyde (UF) and 100 tons of phenol formaldehyde (PF) resins involving a foreign exchange expenditure of 2½ million rupees are expected to be imported annually into Sri Lanka for bonding plywood. This project is an endeavour to substitute part if not all of this with a locally available adhesive. The basis of this work is

the use of natural rubber (NR) latex-UF resin blends or of NR latex-PF resin blends as the adhesive for plywood. China clay or wheat flour or a mixture of both is used as the extender and it is found that a minimum adhesive total solids content of 55 per cent is necessary to obtain minimum plywood bond strength specifications. Formaldehyde is used as the stabilizer for NR⁺ latex as its use enables the blending of UF resin with NR latex without any coagulation of the latex and gives an acidic pH which is necessary to cause polymerization of the UF resin. Using NR latex-UF resin blends, it should be possible to substitute satisfactorily 2/3rds of the imported UF resins by NR. This would result in an annual saving of to the Plywoods Corporation of Rs. 800,000 and of a foreign exchange involvement of approximately 1½ million rupees. It also finds a new use of NR in Sri Lanka. Using NR latex-PF resin blends it should be possible to replace half of the imported PF resin for use in commercial plywood. This would result in an annual saving of approximately Rs. 100,000 to the Ceylon Plywoods Corporation and of a foreign exchange involvement of approximately Rs. 100,000. (Authors' summary).

750. WICKRAMARATNE, Illeperuma Achchillage

Blends of natural rubber and polybutadiene rubber in tyre tread compounds. vii, 39 leaves, 2 photos., diagrms., graphs, 19 refs. (M.Sc. thesis. University of Sri Lanka, Vidyodaya Campus, 1977. Unpublished typescript).

Technological properties of blends of natural rubber and cis-polybutadiene rubber in different proportions were compared. Two vulcanizing systems with N-oxydiethylene benzothiozyl sulphenamide and sulphur were used, one being the conventional system and the other the semi EV system. The requirements of a tyre tread compound were met by the two formulations with the ratios of NR ; BR, 60 : 40 in both cases. Anyhow the ageing characteristics of these two formulations were found to be inferior to the standard tread formulation based on 100 per cent NR used by the Sri Lanka Tyre Corporation. (Author's summary).

751. WICKREMASINGHE, W.

Use of natural rubber latex in leather finishing.

Q. J. Rubb. Res. Inst. Ceylon. 49 (1/2) 1972 : 1-5,

2 graphs, 5 refs.

This paper describes a method whereby modified natural rubber (NR) latex can be used in leather finishing. It not only acts as an important substitute, but can even improve the important property of rubfastness. Pending further research work, a 50 per cent substitution of the imported synthetic binders by methylmethacrylate-grafted copolymer NR latex, for finishing embossed and lining leather is recommended. (Author's summary).

752. WIJERATNE, Mervyn Soyza

A study of the exploitation of the properties of natural rubber in tyres. [xi], 279 leaves, diagrms., graphs, tables, 162 refs. (M. Phil. Thesis. University of Alston, Birmingham, 1975. Unpublished typescript).

Tyres account for over 80 per cent of the world's total rubber usage. The distribution of rubbers used in tyres between natural and synthetic rubber varies from country to country. The treads of tyre development are indicated. The properties of natural rubber and the main synthetic rubbers used in tyres are described. Newer synthetic rubber types and new forms of natural rubber are also described. The suitability of the different rubbers for use in the various components of tyres is discussed. The other factors besides technological suitability are then taken up. These include availability and price. The manufacture of synthetic rubbers from petrochemical based materials is traced and the problems facing synthetic rubber manufacturers are discussed. An attempt has been made to indicate the factors favouring and opposing a bright future of natural rubber in tyres. The need has arisen to evaluate new materials and re-evaluating older materials with a view to techno-economic optimization of tyre manufacture. An exercise carried out as part of this project to obtain optimum levels of four compounding ingredients used in a natural rubber based truck tyre tread compound is described. The technique used was computer aided regression analysis in which regression equations are used to predict the cost and properties of a

large number of different compounds and these predicted values are analyzed to select the best levels of the ingredients.

753. WIJESINGHE, W.P.

Rubberized coir products from Narammala. Karmantha.

2 (8) 1975 : 12, 2 photos.

The main items used are coir, latex and a mixture of certain chemicals. The various items of equipment which cost only about Rs. 45,000 have been made out of scrap iron and other pieces of machinery.

BY-PRODUCTS

General

754. PERIES, O.S.

Subsidiary products of economic importance from the rubber tree. Industrial Ceylon. 11 (2) September 1971 : 19, 21, 23, 25, 27, 29 and 31. 9 refs.

A discussion of the economic utilization of the by-products of the rubber tree. The subsidiary products the author discusses here are the by-products mainly of rubber wood (e.g. production of school furniture, ligno-plastic wood, hard board, chipboard-plywood, paper pulp, production of tea chests) and of rubber seed (i.e. use of rubber seed oil, seed cake and shell in the manufacture of soap, paint, alkyl resin, filler in the plastics industry, and seed meal).

Rubber Wood

755. ANON

Boron treated wood rubber. Karmantha. X 2 (6)

June 1975 : 1-2.

A brief note on the research carried out by the National Small Industries Corporation, the Industrial Development Board, the Forest Department, CISIR and in 3 Universities in Sri Lanka on the boron treatment of wood rubber.

756. GUNASEKERA, S.A. and SUMANAWEEERA, H.A.N.

Control of blue-stain on rubber (Hevea braziliensis) wood during the boron diffusion treatment. Q. Jl. Rubb. Res. Inst. Sri Lanka (Ceylon). 51 (1/2) 1974 : 45-56, 6 illus. (photos.), 1 graph, 5 tables, 14 refs.; Abstracted in Proc. Ceylon Ass. Advmt. Sci. 29 (1) 1973 : 110-111.

Stain development was caused by the discolouration and accumulation of dark deposits and mycelia in wood ray cells and xylem tracheids due to the growth of a *Penicillium* sp. and an *Aspergillus* sp. A Double Dip method of treatment where timber was first treated with aqueous sodium pentachlorophenate and subsequently with borax/boric acid solution was developed and was found to be effective. (Authors' summary).

757. INDUSTRIAL DEVELOPMENT BOARD OF CEYLON.

Boron treated rubber wood. Katubedde, Moratuwa, I.D.B., 1971. ii, 8 p. (Industry prospect report, 20).

In 1971 when the Department of Small Industries, Sri Lanka called upon Government Agents to establish small scale industrial units on an electoral basis, with the co-operation of the members of Parliament concerned, two questions were asked. What industries and how? This industry prospect report prepared by a Committee from the I.D.B. is an attempt

to answer the two questions. This project envisages utilization of rubber wood planks treated chemically with boron salts and air or kiln seasoned, and sold for use in the manufacture of furniture, in interior parts of buildings etc. This report describes the following: Market supply; Demand; Investment and Location; Capital requirements with the costs; Raw materials; Machinery and equipment with the costs; Technical process; Employment; profitability statement, etc.

758. JAYASINGHAM, T.

Rubber wood is abundant and accessible; will it ever be successfully exploited? Pulp and Paper International,

June 1973 : 44-47; reprinted in Q. Jl. Rubb. Res. Inst. Sri Lanka (Ceylon). 51 (1/2) 1974 : 13-15, ref.

Rubberwood abounds in South East Asia, and most of it is in easily accessible plantations. It must be cut regularly and replanted so there is continuous yield of rubberwood as a by-product of the natural rubber industry. After special wood preparation, pulp was produced and bleached. High freeness characterized the pulp and it behaved similar to other short fibre on the paper machine. The presence of latex is still a problem.

759. KIRTISINGHE, D. and DE SILVA, W.C.A.

Rubber wood hardboard as panels for tea chests. R.R.I.C. Bulletin (N.S.). 5 (3/4) 1970 : 53-57, 3 tables, 6 refs.

The results in this article is based on the investigations carried out by the authors in collaboration with the Ceylon Hardboard Corporation to determine the suitability of introducing into the market, chests made of rubber wood hardboard. Experiment were carried out comparing rubber wood hardboard chests with three other varieties. From the results of this experiment, it is seen that rubber wood hardboard and imported hardboard are as suitable materials, as plywood for the construction of tea chests in relation to the keeping properties of tea.

760. SILVA, S.S.

Industrial utilization of rubber wood for wood-based panel products. (A background paper). Rome, Food and Agriculture Organization of the United Nations, 1963.

15 p., diagrs., 10 tables, 7 refs. (FAO/PPP CONS/PAPER 2.5, 16th July 1963).

This background paper is based on the investigations carried out by the author in research institutions in Australia, India, and Ceylon, for a long time.

761. SILVA, S.S.

Industrial utilization of rubber wood for wood-based panel products. R.R.I.C. Bulletin (N.S.). 5 (3/4) 1970 : 40-52, 15 tables, 6 refs.

This article is based on the investigations carried out by the author in research institutions in Australia, India and Ceylon for a long time.

762. SILVA, S.S.

Rubber wood as an industrial raw material for the wood and wood products industries. In: Symposium on the utilization of local raw materials. Colombo, 23-24, 1969. Proceedings. Colombo, The Chemical Society of Ceylon and the Ceylon Section of the Royal Institute of Chemistry, 1969. pp. 100-105.

A brief description of properties of the rubber wood manufactured by the Ligno-Plastic Rubber Wood Manufacturers which was developed by the Ceylon Institute of Scientific and Industrial Research. This is a process of up-grading inferior woods to superior grades. The cost of manufacture is about 75 cents/sq. foot of one inch thick board.

763. SILVA, S.S.

The wonder wood (ligno-plastic wood). R.R.I.C.

Bulletin (N.S.). 5 (3/4) 1970 : 38-39.

Ligno-Plastic Rubber Wood is an improved rubber wood, prepared from normal rubber wood, according to an invention developed at the CISIR, which uses only elevated temperatures and pressures and no chemicals at all. Advantages, cost of manufacture, and comparison to test results with normal rubber wood, are briefly described in this article.

764. TISSEVERASINGHE, A.E.K.

Preservative treatment of rubber Hevea brasiliensis wood by the boron diffusion process. Ceylon Forester. 9 (1/2) 1969 : 77-83.

The author states that rubber timber should be perfectly suitable for making furniture after treatment. Boron diffusion treatment being cheap, simple and effective seems to be the answer. However, continuous quality control is essential. He further states that treatment with boron salts is cheap and prevents attack powder post beetle which are the greatest obstacles to the use of rubber wood.

765. TISSEVERASINGHE, A.E.K.

The utilization of rubber wood. Karmantha. 2 (6) June 1975 : 2-3 & 7, photo.

This paper gives a description of the preservative treatment of rubber wood by the boron diffusion process. Essentially this consists in momentary immersion of the fresh sawn wood in a hot concentrated solution of a mixture of borax and boric acid (both of which are cheap and readily available). These chemicals pass into the wood by diffusion through the moisture contained within the wood.

766. TISSEVERASINGHE, A.E.K.

The utilization of rubber wood. R.R.I.C. Bulletin (N.S.) 5 (3/4) 1970 : 31-33, 2 plates.

Rubber estate produce not only rubber but also timber which could be used for making various manufactured products. Rubber wood contain large quantities of starch, which makes it very attractive to wood borers, and this is the reason why the wood has not been used before. The key to the utilization of rubber wood therefore, is the prevention of attack by borers. The method of control advocated in this article is preservative treatment by the boron diffusion process. But this article is not intended to be exhaustive.

767. TISSEVERASINGHE, A.E.K.

The utilization of rubber (Hevea brasiliensis) wood.

Ceylon Forester. 9 (3/4) January - December 1970 : 87-94,

3 photos., 8 refs.

In an earlier paper (Tisseverasinghe, 1969, see item 764), the preservative treatment of rubber wood by the Boron diffusion process was discussed. Since that date several hundreds of cubic feet of rubber have been treated by this process and it is felt that a useful purpose would be served by setting down the experience gained in the course of treating and using the timber. The Forest Department has collaborated with the National Small Industries Corporation whereby the sawing, treatment and the subsequent seasoning of the wood was done and produced model furniture for schools to be tested in use. Prospects are now very good for the increased utilization of rubber wood for furniture.

768. TODD, Hope

Feasibility study on the manufacture of school furniture with boron-treated rubber wood. R.R.I.C. Bulletin (N.S.).

5 (3/4) 1970 : 35-37, 4 refs.

The Government of Ceylon has taken steps to exploit the use of rubber wood for the production of school furniture, through the Department of Small Industries. The feasibility of producing school furniture with boron-treated rubber wood, on the basis of research done by the Forest Department on this aspect, is considered in this paper.

769. TODD, Hope

Modern furniture from boron rubber wood. Karmantha.

1 (11/12) November - December 1974: 3-4, 3 illus.

Rubber wood ~~once~~ treated with the boron treatment process has been found to be ideal for turning out cheap furniture, particularly for schools. The boron treatment process had made this wood ideal for light weight and light coloured furniture. The illustrations of the chairs, and tables as shown in this article give an idea of the potential of this treated wood. The processing, the statistical data of raw material and its uses are briefly described in this article.

770. TODD, Hope

Rubber wood furniture. Karmantha. 2 (6) June 1975 :

4 & 7.

A brief article on the research carried out by the National Small Industries Corporation, the Industrial Development Board and at 3 Universities in Sri Lanka on the rubber wood manufacture.

Rubber Seed

771. ANON

Rubber seed oil. Industrial Ceylon. 6 (4) December 1966 : 415.

772. BUVANENDRAN, V.

The effect of rubber seed meal on hatchability of hen's eggs. Tropical Agriculturist (Ceylon). 127 (3/4) 1971 : 111-115, graph, 2 tables, 4 refs.

The hatchability of eggs was compared from hens receiving different levels of rubber seed meal in their rations. Increasing levels of the meal in the maternal diet caused an increase in embryonic mortality. There was a delay between commencement of feeding the rubber seed cake can cause depression in hatchability which suggests that cyanogenetic glycosides cannot be responsible for this diet. (Author's summary).

773. BUVANENDRAN, V. and SIRIWARDENE, J.A. de S.

Rubber seed meal in poultry diets. Ceylon Veterinary

Journal. 13 (2) June 1970 : 33-38, graph, 6 tables, 4 refs.

Rubber seed meal was found to be a very useful substitute for coconut meal in both broiler and layer rations. Diets containing up to 20 per cent rubber seed meal in broiler rations gave significantly better weight gains. Rubber seed meal up to 55 per cent level in layer rations did not significantly effect egg production and egg weight, when compared with rations containing similar levels of coconut meal. (Authors' summary).

774. COOMARASWAMY, A. and KANTHASAMY, T.

Epoxidation of rubber seed oil. Karmantha. 4 (1) January

1977 : 10-11, 2 photos., 3 tables, 11 refs.; An abstract in

Proc. Sri Lanka. Ass. Advmt. Sci. 32 (1) 1976 : 92.

This article describes the method for the preparation of epoxidised rubber seed oil and its possible uses as a plasticizer/stabilizer for PVC, chlorinated rubber, rubber hydrochloride and other chlorinated polymers. Epoxidation experiments were carried out using hydrogen peroxide/glacial acetic acid as the reagent under different set of conditions. It has been found that epoxidized product with satisfactory exirane content could be prepared using this reagent. Resin catalysed epoxidation was found to be more efficient compared to the mineral acid catalysed process and addition of solvents such as ethyl acetate, benzene results in improvement in the extent of epoxidation. Epoxidized oil could be commercially exploited and will have a good market.

775. DAYARATNE, W.C.

Oil from rubber seeds. R.R.I.S.L. Bulletin (N.S.).
(Conference Supplement). 8 (3/4) 1973 : 20-21. Reprinted
in Karmantha. 2 (11/12) November - December 1975 : 7.

This article is intended particularly for the laymen, to give an idea on the preparation of oil from the seeds, uses and its economic benefits.

776. NADARAJAH, M.

The collection and utilization of rubber seed in Ceylon.
R.R.I.C. Bulletin (N.S.). 4 (3/4) 1969 : 23-32, 8 photos.,
4 tables, 12 refs.

This paper describes the uses of rubber seed oil as a quick drying oil, for replacement of linseed oil in paints, and the manufacture of alkyl resin which is used in the preparation of paints and lacquers. The powdered rubber seed shell may be used as a filler in the plastic industry, and milled seed cake forms a high protein animal feed stuff, seed collecting, drying, decorticating, sorting and milling are also described and their costs are listed.

777. NADARAJAH, M.; ABEYSINGHE, Ariya; DAYARATNE, W.C. and THARMALINGAM, R.

The potentialities of rubber seed collection and its utilization in Sri Lanka. R.R.I.S.L. Bulletin (N.S.). 8 (1)
1973 : 9-21, 3 photos., 2 tables, 19 refs.

Rubber seed oil is on the way to being accepted in industry as a drying oil, and it is opportune for Sri Lanka to produce the maximum possible amount of rubber seed oil and to export the surplus. It would be preferable if the rubber seed oil could be converted to alkyl resin both for local use and for export. Sri Lanka can well claim to be the first country in the world to have pioneered the commercial use of rubber seed oil in alkyl resin manufacture. (Authors' summary).

778. NADARAJAPILLAI, N. and WIJEWANTHA, Ronald T.

Productivity potentials of rubber seed. R.R.I.C.

Bulletin (N.S.). 2 (1/2) 1967 : 8-17, 1 plate, 5 tables,

6 refs.

An attempt is now being made to utilize the millions of rubber seed that would otherwise go waste each year. R.R.I. in collaboration with Messrs. Lever Brothers (Ceylon) Ltd., have conducted a large scale experiment to ascertain the feasibility of economically extracting from rubber seed, oil which could be used in the manufacture of soap. An appraisal of the results and details of the experiment are included in this article.

779. RAJAGURU, A.S.B.

Effects of rubber seed meal on the performance of mature chicken. Journal of the National Agricultural Society of Ceylon. 8, 1971 : 38-47, 7 tables, 5 refs.; Reprinted in R.R.I.S.L. Bulletin (N.S.). 8 (2) 1973 : 39-45.

This paper is intended to investigate in detail the effects of rubber seed meal (RSM) on maturity of pullets, egg production, egg size, shell quality, fertility, hatchability, livability of chicks hatched out and semen quality of the cocks. The pullets that were raised on 10 per cent, 20 per cent, 30 per cent and 40 per cent RSM in diets from the third month of age matured late, but the egg production was normal in all the groups. However, the increase of RSM in diets lowered egg size, shell thickness, hatchability and of incubated eggs and the weights of the chicks hatched out. Further it was observed that the RSM increased the percentage of infertile eggs that were produced. But RSM had no effects on the quality of semen of the cocks used for artificial insemination. These effects may be due to an amino acid imbalance of RSM that lowers the biological value of proteins in diets, when incorporated in rations and the presence of an anti-fertility factor which has not been identified yet. The results indicate that RSM should not be used in breeder rations at all. In layer rations it could be used upto only 20 per cent level since it affects egg size and shell thickness. (Authors' summary).

780. RAJAGURU, A.S.B.

Potential use of rubber seed oil as an energy supplement for growing chickens. Journal of the National Agricultural Society of Ceylon. 11/12, 1974/75 : 115-119, 3 tables, 6 refs.

The work reported in this article is an attempt to study the edible properties and utilization of rubber seed oil (RSO) by growing chickens, with the ultimate objective of evaluating it as an edible oil. RSO was used upto 8 per cent level in broiler rations without causing any deleterious effects. In fact growth responses and feed efficiency similar to the control rations carrying coconut oil at 2 per cent and 4 per cent level were obtained when RSO was used at 2 per cent, 4 per cent and 8 per cent levels. Lack of significance in the difference of feed intake of the two experiments indicate that RSO does not alter the palatability of rations. The data suggests that RSO has a considerable potential as an edible oil if properly evaluated. (Author's summary).

781. RAJAGURU, A.S.B. and WETTIMUNY, S.G. de S.

Rubber seed meal as a protein supplement in poultry feeding. Journal of the National Agricultural Society of Ceylon. 8, 1971 : 1-12, 7 tables, 12 refs.; Reprinted in R.R.I.S.L. Bulletin (N.S.). 8 (2) 1973 : 46-54.

The experiments reported in this article is designed to study the possible ways of using rubber seed meal (RSM) effectively as a protein supplement in grower rations and to evaluate the levels of supplementation possible, taking into account the likely limiting factors. Rubber Seed Meal (RSM) could be used successfully for broilers depending on the source of animal protein supplement used. RSM could be used satisfactorily up to a 10 per cent level with imported meat meal supplemented with a methionine and up to 20 per cent with protein source, RSM could be supplemented up to 40 per cent satisfactorily in rations for pullets from 3-6 months of age. The reduction in growth response observed when the RSM level in the diets was increased, particularly in broilers and growers less than 3 months of age, may be attributed to an

amino-acid imbalance rather than to the presence of deleterious factors as often suggested. The pale liver condition and the feather picking observed in the 40 per cent RSM group in all experiments also confirm the possibility of amino-acid imbalance in the diet. It would appear that birds have the capacity to overcome the adverse effects caused by the higher levels of RSM as they mature and are then able to maintain a normal body weight and performance up to 40 per cent levels of RSM. (Authors' summary)..

782. WHEELER, Louis Cutter

Hevea (rubber) seeds for human food. R.R.I.S.L. Bulletin

13, 1978 : 17-21, 32 refs.; Abstracted in Proc. Sri Lanka
Sri Lanka Ass. Advmt. Sci. 32 (1) 1976 : 73-74.

It is well known that the seeds of Hevea are poisonous when raw. They are cyanogenic and may contain phytotoxins (poisonous lectins). Feeding tests in poultry and swine in Sri Lanka have shown that there are also unidentified growth-depressant and anti-fertility factors. In order to identify and evaluate the factors hindering use of the seeds of Hevea for human food a project has been initiated at the University of Southern California using seeds supplied by the Rubber Research Institute of Sri Lanka, Rubber Research Institute of Malaysia, and Instituto Nacional de Pesquisas da Amazonia, Brazil. Dependable means will be sought for counteracting the deleterious factors in order to make the seeds available for human food. The methods already used successfully in Ammonia and Indonesia for preparing Hevea seeds for human food will be summarized so that gastronomically adventurous pioneers in Sri Lanka can try eating the seeds in order to determine the feasibility of using this potential source of human food. These trials should be made cautiously starting with small amounts and never exceeding moderate amounts.