ANNUAL REPORT - 2003

TEA RESEARCH INSTITUTE OF SRI LANKA

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ANNUAL REPORT FOR THE YEAR 2003

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CONTENTS

THE MISSION OF THE TEA RESEARCH INSTITUTE

To raise the productivity of the tea holdings in both in the estate and small holder sector through the advocacy of

1. Appropriate technologies for improving tea productivity and quality

2. Forward-looking human and resource management practices that will facilitate all-round development of the tea industry including the quality of life of all Sri Lankan people

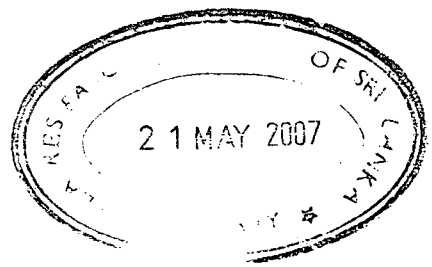
In striving to achieve the mission, the goals of the Institute shall be:

1. To accelerate development of location specific planting material with desirable attributes

2. To rationalise and optimise the fertilizer inputs

3. To manage pest and diseases using rational , integrated methods

4. To improve the quality of made tea and develop value added products.



REPORT OF THE CHAIRMAN
TEA RESEARCH BOARD

Again, as in the previous year, a change in the Management of the Tea Research Institute (TRI) took effect in compliance with a decision of the Cabinet of Ministers. The new Director, Dr M T Ziyad Mohamed, assumed duties in the first week of August, and immediately recognized the significance of Institutional image-building and of bridging any gaps that may have existed between the stakeholders and the Institute. In pursuance of these objectives, the interactive meetings with the Chief Executive Officers of the corporate-sector plantations, representatives of the smallholder sector, and other stakeholders of the tea industry, were continued. Streamlining the activities of the TRI, and establishing disciplinary procedures in the Institute's administration and general management, were the other areas that received attention.

During the year under review, the Tea Research Board (TRB) held eleven Board meetings. The membership of the TRB varied from 11 to 13, inclusive of an observer member, the immediate past Director of TRI. A number of management and other issues received the concerted attention of the TRB. These are detailed below.

• Merit Scheme for Research Officers of the TRI

The objective of this merit scheme is to recognize the achievements of the scientists in the generation of new technologies for the development of the tea industry. It is also meant to motivate them towards greater productivity through increased dedication and commitment. Supernumerary positions of Principal Scientists and Associate Scientists are to be created, each with an enhanced salary or incentive allowance which would be personal to the holder. Two experts in relevant fields, from outside the TRI, will evaluate the applicants for these supernumerary positions, and selection will be done by a TRB-appointed panel. Evaluations are to be based on contributions to tea research and development, evaluated on research papers and other documented contributions, and the impact of research on the tea industry.

Duties of Senior Management *vis-à-vis* "Responsibilities of Senior Management to the Governing Bodies of Public Enterprises": Actions were taken in respect of instructions from the General Treasury.

Human Resources Development

i. Review of activities of the TRI Research, Advisory and Extension Centre at Hantane, with particular emphasis on overstaffing, through a consultancy undertaken by the Sri Lanka Council for Agricultural Research Policy.

ii. Review of salary structures, schemes of promotion and rectifying salary anomalies at TRI, utilizing the consultancy services of the National Institute of Business Management.

iii. Staff promotions. Promotions effected were those of three officers from Grade I to the Selection Segment of Grade I; five officers from Grade II to Grade I; and one officer from Grade II Recruitment Segment to Grade II Selection Segment.

iv. Advisory and Extension Division. The need to strengthen the Advisory and Extension Division of the TRI, which is the most important interface between the TRI and its various stakeholders, was recognized. Owing to the current attenuated condition of the Advisory and Extension Division, the need for external interventions was considered by the TRB and, accordingly, the services of an advisory and extension specialist with wide national and international experience were obtained. The crux of the intervention was to ensure the impact of the TRI on the end-user, by jettisoning outdated processes of passive communication, and re-engineering a system which is dynamic enough to achieve a spectacular rapport between the TRI and its stakeholders. This is a four-pronged system, somewhat aggressive, requiring a concerted effort by the advisory staff, heads of scientific divisions and senior scientific staff. The approaches to be followed include estate visits to cover all RPC-managed estates; Wednesdays to be announced as Visitors' Days, to enable estate managers and their juniors to familiarize themselves with the *modus operandi* of the TRI and its staff, and to enable one-on-one discussions with scientists and Advisory Officers for stakeholders to raise specific problems pertaining to the tea industry; and revision and issuing of a new series of Advisory Circulars, inclusive of new topics. The objective of the above exercise is to make the TRI a user-friendly institution with a definite stakeholder focus.

v. Restrictions on recruitment. Owing to Government policy, recruitment of cadres to the TRI have been frozen. However, through special permission obtained from the Management Services Division of the

General Treasury, graduates with first- or second-class degrees were appointed to the research divisions on a three-year contract basis. Further, because of defections and defaulting of bonds leading to a serious attenuation of trained staff cadres, as a matter of policy, with a view to minimize defections, overseas training is now confined to universities in the Asian region, followed by a short duration of specialized training in advanced laboratories in the developed world.

vi. Posts of Heads of Divisions. For many years, these positions have not been filled, but effective 1st January, 2003, with the creation of cadre positions, these positions were filled.

vii. The post of Superintendent, St Coombs Estate, Talawakelle, and the post of Senior Accountant, were filled.

- **International Exchange Visits**

A delegation of scientists from the TRI of the Chinese Academy of Agricultural Sciences visited the TRI.

Three TRI scientists visited the United Planters' Association of South India, and toured their laboratories and tea factories.

- **Emerging Research, New Technologies and Proposals**

i. Identification of issues, related to the development of the organic tea industry in Sri Lanka, was the outcome of an interactive meeting with leading players in this sector. Consequently, the need for Sri Lanka to establish policy directives under five aspects of the organic tea industry was recognized, namely a) national concerns and policy instruments, b) market intelligence and marketing, c) promotion, d) costs of production and subsidies, and e) research and technology transfer. Popular articles are to be written to create awareness among the public, and the TRI is to produce a booklet giving details of agricultural practices in the cultivation of organic tea.

ii. Review of Research on Tea Breeding at TRI

The objective of this review was to assess past and present work on tea breeding, and to formulate strategies to meet future challenges. The review session comprised internal and external participants. They were the Directors of the Sri Lankan crop research institutes of tea, rubber, coconut, sugarcane and rice; a renowned sugarcane breeder

from India; plant breeders from the five local crop research institutes and the Department of Agriculture; university professors; the Executive Director of the Council for Agricultural Research Policy; representatives of the Tea Smallholdings Development Authority; and senior scientists of TRI. In summary the review revealed the following.

a. The need for clear identification of the problems and their prioritization, and sustained interaction with other specialized research divisions to fast-track the breeding process.

b. Selection in the early stages of breeding to be done for characters having high heritability, and selection for yield to be done at the later stages, owing to its low heritability. Periodicity of shoot growth was recognized as a useful trait in selection owing to its high heritability, and therefore weightage was to be given to it in selection.

c. The need for physiologists, pathologists, entomologists, biochemists, and specialists of other relevant disciplines, to collaborate with and assist the plant breeder in the selection process, in order to ensure incorporation of desired traits in the final product.

d. The need to identify chemical parameters that are related to quality, and develop rapid evaluation methods to screen for quality in the early stages of selection. Also, to identify biochemical and DNA markers as aids to selection.

e. The need to identify cultivars suitable for mechanical harvesting, owing to the shortage of workers for plucking as a consequence of educational, socio-economic and demographic changes.

f. Nutrient responsiveness, accession of genetically-diverse tea germplasm for hybridization, use of wide-hybridization to broaden the genetic base, data-processing facilities, and tissue culture and biotechnology, were recognized as areas needing attention.

iii. Land-Suitability Assessment of Tea Lands

Tea is grown in 14 out of the 24 agro-ecological regions (AERs) in the country, which shows that it is subjected to a diversity of growing conditions, some of which are obviously far removed from the ideal. With rising costs of production and low productivity levels, there is an

imminent need to identify and demarcate the lands best suited for tea, by making use of modern methods of land-suitability assessment, in order to sustain the industry. Through a consultancy, this study is being undertaken initially in the Ratnapura District. The expected outputs and benefits to the industry are: a set of land suitability maps showing the different suitability classes and sub-classes on the 1: 25,000 scale; a supporting text with recommendations; and easily-usable management maps for estates and smallholders on a 1:10000 scale, to enable field-by-field identification *vis-à-vis* their land characteristics.

iv. Product Development in Tea

The survival of the tea industry is considered to be dependent *inter alia* on the availability of diversified products. The TRI has successfully developed many such products, but they have not got beyond the pilot-scale production stage. The TRB has decided that future product diversification at the TRI should be done in collaboration with the private sector, as this would facilitate marketing of new products besides providing necessary feedback for further product development.

v. Pesticides Residue Laboratory

The TRB, being cognizant of the emerging trends towards pesticides residue-free tea amongst consumers, particularly in developed countries, has proposed to the task force on tea in Regaining Sri Lanka the establishment of a pesticides residue analytical laboratory with international accreditation. This laboratory is to be located in Colombo for logistical reasons, under the aegis of the Sri Lanka Tea Board, with expert consultations from TRI specialists.

vi. National Policy on Tea

At present there is no national policy on tea, despite its importance in the national economy. Towards this end, the TRI has now developed a draft policy on tea cultivation and processing. This will be followed by interactive meetings with all sectors of the industry, spearheaded by the Ministry of Plantation Industries, to formulate a national policy on tea. It is anticipated that this national policy will address *inter alia* issues related to extents, new plantings, re-planting, infilling, diversification, reforestation and afforestation, soil conservation and soil-fertility management, factory modernization, type of manufacture,

support for research and development, new product development, trading and brokering, etc.

vii. Restructuring of Tea-Related Institutions

Under the Asian Development Bank-funded Tea Development Project, re-structuring of tea-related institutions has been undertaken by a consultancy team. The TRB and the TRI have made their inputs to the consultants. Commercialization of some of the TRI's activities to enable generation of additional funds to supplement contributions from the tea cess, and down-sizing through offer of a voluntary early-separation package to staff, are under consideration.

• Workshops, Seminars, Training Courses, Symposia and Conferences

Human resources development is an essential adjunct for an institution and, towards this end, the TRB has encouraged and supported TRI-staff participation in HRD activities, as detailed below.

i. Regional Workshop on Impacts of and Adaptation to Climate Change, 24 - 28 March, 2003, Bangkok, Thailand.

ii. Official visit to UPASI (United Planters' Association of South India) Tea Research Foundation, India, 17 - 28 March, 2003.

iii. Third International Symposium on the Dynamics of Physiological Processes in Woody Roots, 29 September - 4 October, 2003, Perth, Australia.

iv. Commencement of a programme for a PhD degree by a Research Officer, at the PGIA, University of Peradeniya.

v. Short-term training on Design and Development of Instructional Materials using desktop, web and multimedia tools, 30 April - 27 May, 2003, AIT, Thailand.

vi. MSc programme, G B Pant University of Agriculture and Technology, Pantnagar, India, 4 January, 2001 - 8 February 2003.

vii. Plant Breeding and Biotechnology Course of the Sustainable Agricultural Programme, 28 April - 4 July, 2003, Wageningen, the Netherlands.

viii. Split-study programme for a PhD degree, 28 April, 2002 - April 25, 2003, James Cook University, Australia.

ix. Outward Bound training programme for senior scientists, Dambulla, Sri Lanka.

x. International Conference on the Science and Application of Neem, 28 March, 2003, Glasgow, UK.

xi. 19th Asian-Pacific Weed Science Society Conference, 17 - 21 March, 2003, Manila, Philippines.

xii. Research planning meeting, Asian-Swedish research partnership programme project on Environmentally-Accepted Pest Control Methods, 28 September - 3 October, 2003, Uppsala, Sweden.

xiii. Fourth Asia Pacific Crop Protection Conference and Exhibition, 18 - 19 September, 2003, New Delhi, India.

xiv. ISO/TC 34/SC 8 Meeting, 21 - 23 October, 2003, Hangzhou, China.

xv. ICAR-CARP training, National Academy of Agricultural Research Management, Hyderabad, India, 2 - 26 February, 2003.

Dr S D I E Gunawardena
Chairman,
Tea Research Board

REVIEW OF THE DIRECTOR TEA RESEARCH INSTITUTE

Cess Allocation and Corporate Plan

The cess allocation during the year was reduced from 30% to 26%. Owing to war in Iraq, during the early part of the year tea exports were restricted, and as a result there was a delay in the flow of cess funds. Despite the restricted flow of cess funds, the Institute has done remarkably well to fulfill its objectives.

The Corporate Plan of the Institute was revised or 'rolled over' to cover a further period of five years, that is from 2003 to 2007. The Institute's scientists met the Chief Executive Officers of Regional Plantation Companies with a view to identifying their problems in relation to production, processing and socio-economic issues, in the tea industry. Some of the issues identified were formulated into research thrusts and incorporated in the revised Corporate Plan.

As in the past, the research programmes continued in a multi-disciplinary mode.

Achievements and Research Highlights

The major achievements and research highlights, during the period under review, may be summarized as follows.

- Management of the new Amali weed (*Commelina* spp.) at Pedro Estate, Nuwara Eliya. This weed was successfully controlled by the application of either two rounds of Gramoxone + MCPA + petrol (as an additive), or glyphosate + MCPA + ammonium sulphate.

- Control of the problematic Passali weed. Germination of this weed was suppressed when it bulbils were dipped in extracts of *Eucalyptus* and *Brachiria brizantha* for 24 hours.

- Incorporation of mulching materials was found to increase gram-positive bacteria, and reduce gram-negative bacteria, in soils.

- Cultivars responded variably to fertigation in terms of yield. Cultivars like TRI 2023, TRI 2025, TRI 3072 and DT1 respond positively to fertigation, while DN do not.

- GC-ECD methods for detection of endosulfan, DDT, dicofol, fenvalerate, μ-HCH and propiconazole were tested. Analytical methods for bitertanol and tubufenozide were established, and limits of detection fixed.

- A rapid mini-prep method for the extraction of DNA from tea leaves was developed using leaf discs. This method will enable future studies on AFLPs (Amplified Fragment Length Polymorphisms) and SSRPs (Simple Sequence Repeat Polymorphisms).

- Results from trials, carried out to find the effect of black tea extracts on different strains of *Staphylococcus aureus,* revealed that black tea extracts could inhibit their growth. The catechin and theaflavin fractions of the tea extracts were the most effective fractions against *Staphylococcus aureus* strains.

- Following the discovery of the anti-fungal activity of catechins and theaflavins against *Candida albicans, Candida parapsilosis, Candida tropicalis*, *Canddia krusei* and *Candida glabrata*., a patent has been applied for. This will help to enhance the promotion of tea as a health drink.

- Interaction of tea with milk. It was found that tea from cultivars with higher amounts of theaflavins and total polyphenols take milk well. It was also found that hard-withered, short-fermented teas take milk poorly.

- Studies on cell morphology, cell thickness, and nematode-damage symptoms, showed that cell damage is less in organically-grown tea plants than in conventionally-grown plants.

- The addition of water to soil with thorough mixing during roasting, and incorporation of paddy husk into the soil, ensure a total killing of nematodes. The process is suitable as a substitute for methyl bromide in the control of nematodes.

- "Regent" (fiprinol) was found to be on par with fenthion in controlling shot-hole borer.

- A 'magic bullet'. A compacted nursery medium was developed, composed of coir-dust and latex, which could be used as nursery bags for raising tea plants.

- A health assessment of estate workers under organic and conventional cultivation has shown that the reproductive capacity of workers in organic tea cultivation was better than the capacity of those in conventional tea cultivation, in terms of motility and volume of sperm.

- Modeling the development of shot-hole borer, under different agro-climatic conditions, was done using a software package called 'DYMEX'. This would help to formulate strategies to control the borer.

- *Beauveria bassiana,* a fungus, was successfully tested for shot-hole borer control at all three elevations.

- Biological control agents of tea nematodes, brought from Australia, have been cultured and, for the first time, the ring-forming fungi (*Arthrobotrys* spp.) was observed, *in vitro,* to strangulate *Pratylenchus loosi*. These fungal cultures are being multiplied for large-scale testing.

- *Trichoderma pseudoconingi* was successful in the *in vitro* control of the Horse-Hair Blight fungus.

- *Trichoderma harzianum,* a fungus cultured in rice medium, gave better control of Red Root Disease than systemic fungicides.

- *Centella asiatica*, a weed common in tea plantations, was found to harbour Vesicular Arbuscular Mycorrhizae (VAM) in abundance.

- Three species of weeds (*Centella asiatica, Browwalia americana* and *Alternanthera dentata)* proved capable of promoting the availability and the perpetuation of VAM inoculum in tea soils, while adequately supplementing the organic matter by way of biomass. Further, these weeds were found to be capable of trapping significant amounts of N, P and K minerals from unfertilized soil media. The interaction of P was most significant.

- Based on canopy, leaf and root characteristics, a list of more than 100 tree species that can be used as alternative shade trees, has been compiled.

- A simple mechanical device for making stocks, and a motorized scion-maker, were developed to hasten the process of grafting.

- Twenty-two seedling progenies from diverse germplasm accessions have been established in the field, for evaluation as potential cultivars. Under the estate cultivar selection scheme, 80 promising seedling selections were made from old seedling blocks at Fairlawn Estate, Maskeliya.

- A comprehensive document was prepared, incorporating all the evaluated characteristics of germplasm accessions available, as a preliminary measure for documenting necessary information according to "IPGRI Tea Descriptors".

- A protocol for synthetic seed production was developed for cold storage of isolated zygotic embryos of hybrid seeds.

- The quality of compost, made out of municipal solid waste, was improved in the laboratory, in terms of carbon content and cation exchange capacity. The unpleasant odour was completely removed by a low-cost chemical treatment.

- A novel method was developed in the laboratory to produce good quality compost, enriched with humic substances, using factory tea waste. Trials were initiated to test the effect of the new compost under field conditions.

- User-friendly computer software was developed by the Soils and Plant Nutrition Division, in collaboration with the Technology Division, to estimate the macro- and micronutrient fertilizer requirements, and dolomite requirements, of tea plantations. This will be a useful tool for Managers to estimate the fertilizer requirement of their fields.

- Development of a temperature alarm indicator unit at the weir end of FBD-4. An electronic circuit was designed, fabricated and tested to indicate drier temperatures in the TRI-CCC Fluidized Bed Drier. This will help the drier operator in regulating feeding of the drier for uniform tea drying.

- Measurement of harmonics in the Variable Speed Drive, in collaboration with the Faculty of Engineering, University of Peradeniya, indicated that harmonics in the power supply is about 11.5%, which is below the risk level. This stresses the need for installation of harmonic filters with Variable Speed Drives.

Patents

The following innovations were patented by the Institute.

1. A low cost chemical treatment for converting municipal solid waste into good quality compost, which contains heavy metals in their bound forms, and which is devoid of unpleasant odour.

2. A rapid method to convert refuse tea into a good quality compost enriched with humic substances.

Publications

1. Corporate Plan for 2003-2007 (revised)
2. Agricultural Profile of the Corporate Tea Sector
3. Tea Information (Sinhala)
4. Annual Reports 2002 (English/Sinhala/Tamil)
5. Leaflet on "The Leaf to the Cup" (Sinhala)
6. TRI Update, Vol. 8, No. 1 & 2, 2003
7. Te Thathu, Vol. 2 Part 2, 2002
8. Sri Lanka Journal of Tea Science, Volume 68, Part 1, 2003
9. Tea Bulletin Volume 17, Nos. 1 & 2, 2002
10. Sri Lanka Journal of Tea Science, Cumulative Index
11. Twentieth Century Tea Research in Sri Lanka
12. Twenty one Advisory Circulars and New Advisory Circular Folder
13. Canker Control (Sinhala)
14. Guidelines

    a. Guidelines for inter-cropping tea with export agricultural crops, such as coffee, pepper and vanilla, prepared in consultation with the Department of Export Agriculture

    b. Guidelines for the use of the TRI Selective Tea Harvester (TSTH)

c. Guidelines for management of Horse-Hair Blight in tea (Sinhala/ English)

d. Guidelines towards saving electrical energy in withering.

Advisory and Extension

Twenty documents, highlighting the agricultural profiles of each and every tea estate managed by 20 Regional Plantation Companies, were prepared. Using the same information, a corporate-sector document entitled "Agricultural Profile of the Corporate Tea Sector" was published.

Awards and Recognition

Two scientists, Dr I S B Abeysinghe and Mrs J Balasuriya, received awards from H E the President in recognition of their contribution to science, their research papers having been listed in the Science Citation Index.

The Director and Institute staff attended the following international meetings and seminars.

i. IGG/FAO meeting held in Colombo. The Country Report on "Usage of pesticide on tea plantations" was prepared by the Institute, in consultation with the Sri Lanka Tea Board. Based on deliberations at the conference, "Action Plans" were drawn up, one at the Institute level and the other at the national level.

ii. International Tea Convention and Exhibition under the theme "Diversitea in Specialitea", organized by the Colombo Tea Traders' Association. The Institute also had a stall at the Exhibition, and the Director chaired a session of the Convention.

iii. Meeting of the ISO Technical Committee on Tea, ISO/TC 34/SC8, held in China from October 21 - 23.

ADB-Funded Mother Bush Project

In spite of several setbacks at the early stages, the mother bushes established under this project have progressed well in most of the sites managed by the Institute, except for the site at Deniyaya which was affected by the floods in May.

The Building Expansion Project, Low Country Station, Ratnapura

Under the Second Tea Smallholder Development Project, a sum of Rs. 42 million was allocated for the construction of six staff quarters (two 'B' type, two 'C' type and two 'D' type quarters), two glasshouses, and a Seminar/Lecture Hall. The State Engineering Corporation was selected as the contractor, and action has been initiated to select an Engineer- Consultant for the project. Formal approval from the Asian Development Bank is awaited for awarding this contract.

End of Service

Dr S S B D G Jayawardena left the Institute on 04 August after serving as Director for one year.

Felicitation of Past Directors

A ceremony to felicitate the past Directors of the Institute was held in August. The photographs of the past Directors were unveiled in the Director's Tea Parlour.

Restructuring of the Institute

M/S P E International Consultants Ltd. has been assigned the task of making proposals towards restructuring of the Institute. The final report by the Consultants is expected to be submitted to the Ministry of Plantation Industries by the 2nd week of February 2004.

Outward Bound Training

The senior staff of the Institute followed the 'outward bound' training programme conducted at Dambulla.

Dr. M. T. Ziyad Mohamed
Director

REPORT OF THE ADMINISTRATION DIVISION

1 Introduction

The Tea Research Board of Sri Lanka was established on 12th November 1993 under the provisions of the Tea Research Board Act No. 52 of 1993.

According to this Act, which came into operation on 7th March 1994, the functions of the Tea Research Board shall be to engage in, encourage, foster and facilitate research into the planting and manufacture of tea.

2 Functions of the Tea Research Board

The specific functions of the Tea Research Board are:

(a) to conduct, assist and encourage scientific and technological research into, and investigations of, all problems and matters affecting the production and manufacture of tea, including the prevention and control of pests affecting tea, the prevention and control of diseases affecting tea, and the improvement of the quality of tea, as well as the diversification of products manufactured from tea, and to disseminate and publish, at its discretion, the results of such research;

(b) to conduct, assist and encourage research into the economic viability of the tea industry in Sri Lanka, including future economic trends in the industry;

(c) to establish and maintain relations with research institutions in Sri Lanka and abroad; and

(d) to conduct, in the discharge of its functions, joint study programmes, seminars or symposia, with foreign research institutions and research institutions in Sri Lanka.

3. The Tea Research Institute

The head office of the Tea Research Institute at Talawakelle is responsible for the maintenance, administration, overall planning and execution of research, and extension and advisory programmes, from the main station at Talawakelle and from five other stations located in the different tea-growing districts.

4. Members of the Tea Research Board

1.	Dr S D I E Gunawardena	–	Chairman, TRB.
2.	Dr M T Ziyad Mohamed	–	Director, TRI.
3.	Mr Y G Wijeratne	–	Member
4.	Mr George Pelpola	–	Member
5.	Prof. H P M Gunasena	–	Member
6.	Mr M. Malin Goonetilleke	–	Member
7.	Dr (Ms) Damitha de Zoysa	–	Member
8.	Mr M L M Aboosally	–	Member
9.	Mr K M Opananda	–	Member
10.	Mr Ronnie Weerakoon	–	Member
11.	Mr K P Govindaraj	–	Member
12.	Mr M Sunderalingam	–	Member
13.	Mr R L Juriansz	–	Member
14.	Dr S S B D G Jayawardena	–	Observer
	Dr (Mrs) A C Liyanage	–	Convenor/Secretary

5. Members of the Consultative Committee on Estate and Advisory Services

1.	Mr D V Seevaratnam	–	Chairman
2.	Dr S D I E Gunawardena		
3.	Dr M T Ziyad Mohamed		
3.	Mr Asoka Somaratne		
4.	Mr Nihal Bopearachchi		
5.	Mr Kamal Obeysekera		
6.	Mr W M P B Wijekoon	–	Observer
7.	Mr D A Jayatunga	–	Observer
	Mr B A D Samansiri	–	Convenor/Secretary

6. Members of the Consultative Committee on Research

1.	Dr S D I E Gunawardena	–	Chairman
2.	Dr M T Ziyad Mohamed		
3.	Prof. Y D A Senanayake		
4.	Mr Camillus Silva		
5.	Dr Dhayan Kirtisinghe		
6.	Mr N F G P Athukorala		
7.	Mr R K Nathaniel		
8.	Dr D T Wettasinghe		

9. Mr K G B Obeysekera
10. Mr Deepal Chandrasekera
11. Mr Anil Perera
12. Mr Romesh Croos-Moraes
13. Mr D V Seevaratnam
14. Mr S K L Obeysekera
15. Mr G K Seneviratne
16. Mr K Gunasinghe
17. Mr R W Harley
18. Mr S Wickremasinghe
19. Mr Yshan Fernando
20. Mr L H Munasinghe

Dr M T Ziyad Mohamed	–	Convenor/Secretary (up to July 2003)
Dr A Anandacoomaraswamy	–	Convenor/Secretary (from September 2003)

7 Members of the Audit and Management Committee

1. Dr (Ms) Damitha de Zoysa
2. Mr Y G Wijeratne
3. Mr K M Opananda
4. Mr R Kariyawasam

Mr D A Jayatunge	–	Convenor/Secretary

8 Senior Management Staff as at 31st December, 2003

1. Director	–	Dr M T Ziyad Mohamed
2. Deputy Director Research	–	Vacant (Production)
3. Deputy Director Research	–	Vacant (Technology)
4. Deputy Director (Administration)	–	Mr W M P B Wijekoon

9. Executive Staff (Grades I & II) as at 31st December, 2003

Administration Division

Mr W M P B Wijekoon	–	Deputy Director (Administration)
Ms. S Anusha	–	Administrative Officer
Mr K G Piyasena	–	Public Relations Officer

Finance Division

Mr D A Jayatunge	–	Senior Accountant
Mr M F Y Arafath	–	Accountant
Mr K D H Pathirana	–	Stores Executive

Internal Audit Division

Mr. R Kariyawasam	–	Internal Auditor

Engineering Division

Ms D W Manawadu	–	Resident Engineer

Library

Ms R W M W K Illangantilake	–	Librarian

Publication Unit

Vacant	–	Publication/Publicity Officer

Advisory and Extension Services Division

Mr B A D Samansiri	–	Head/Senior Advisory Officer
Mr V S Sidhakaran	–	Advisory Officer

Agronomy Division

Dr A Anandacoomaraswamy	–	Head/Senior Research Officer
Ms M S D L de Silva	–	Research Officer

Agricultural Economics Unit

Ms J A A M Jayakody	–	Head/Senior Research Officer
Mr D P B Herath	–	Research Assistant (on overseas study leave)
Mr G Ganewatte	–	Research Assistant

Biochemistry Division

Dr A M T Amarakoon	–	Head/Senior Research Officer
Dr I S B Abeysinghe	–	Senior Research Officer
Dr (Ms.) A C Liyanage	–	Senior Research Officer
Mr P A N Punyasiri	–	Research Officer
Ms J Jayasundera	–	Research Officer

Entomology and Nematology Division

Ms S I Vitharana	–	Head/Senior Research Officer
Dr M M Keerthi	–	Senior Research Officer
Mr R S Walgama	–	Research Assistant (on overseas study leave)

Plant Pathology Division

Dr A Balasooriya	–	Head/Senior Research Officer
Ms N H L Pradeepa	–	Research Assistant
Ms B A P Cooray	–	Research Assistant

Plant Physiology and Plant Propagation Division

Mr V Shanmugarajah	–	Head/Senior Research Officer
Dr (Ms) A J Mohotti	–	Senior Research Officer

Plant Breeding Division

Dr (Ms) M T K Amarakoon	–	Head/Senior Research Officer
Mr M Ratnayake	–	Research Officer
Mr M A B Ranatunga	–	Research Assistant

Soils and Plant Nutrition Division

Dr L S K Hettiarachchi	–	Head/Senior Research Officer (on sabbatical leave)
Dr A K N Zoysa	–	Senior Research Officer
Ms S Anandacoomaraswamy	–	Research Officer
Mr G P Gunaratne	–	Research Officer
Mr P S Munasinghe	–	Research Assistant

Technology Division

Mr K Raveendran	– Chemical Engineer
Mr W S Botheju	– Research Officer
Mr S Koneswaramoorthy	– Mechanical Engineer

Deniyaya Station

Mr J A S K V Jayasinghe	– Officer-in-Charge/Advisory Officer

Low Country Station, Ratnapura

Dr M A Wijeratne	– Officer-in-Charge/Senior Research Officer
Mr D S E Weerasooriya	– Administrative Officer
Dr.K G Premathilake	– Senior Research Officer
Mr G L C Galahitiyawa	– Research Officer
Mr N P S N Bandara	– Research Assistant
Ms S M Samarasinghe	– Research Officer
Mr M K S L D Amaratunge	– Advisory Officer

Mid-Country Station, Hantane

Mr P B Ekanayake	– Officer-in-Charge/Senior Research Officer
Mr S T Yatawatte	– Advisory Officer
Ms R M D T Pallemulla	– Research Officer

Kottawa Station

Mr K D Dahanayake	– Officer-in-Charge/Advisory Officer

Passara Station

Mr J C K Rajasinghe	– Officer-in-Charge/Advisory Officer

10. Other Administrative, Scientific, Research and Advisory Staff - Grades III-V, as at 31st December 2003

Office of the Director

Ms S M Jeyasingham	– Secretary to the Director

Office of the Deputy Director Research (Production)

Ms D Ratnayake	– Stenographer/Typist (English)

Office of the Deputy Director (Administration)

Ms S Shanmuganathan	–	Stenographer/Typist (English)

Other Administration Staff

Mr R Nandasena	–	Administrative Assistant
Ms C S K Kiribathgoda	–	Stenographer/Typist (English)
Mr R Nadarajah	–	Clerk/Typist
Ms W M G R Jayasinghe	–	Clerk/Typist
Mr K R M Priyantha	–	Clerk/Typist
Ms W M S R Wanasinghe	–	Clerk/Typist
Ms R M D K Ratnayake	–	Clerk/Typist

Purchasing Unit

Mr B Tilakeratne	–	Purchasing Officer
Mr P D S L de Silva	–	Clerk/Typist
Ms Chandrika Jeyaram	–	Clerk/Typist

Transport Division

Mr M L H Perera	–	Transport Officer
Mr S H Chandrasena	–	Clerk/Typist
Ms W R P de Silva	–	Clerk/Typist

Engineering Division

Mr D V D Vithanage	–	Clerk of Works
Mr W P A N Jayasinghe	–	General Clerk
Mr V Shanmuganathan	–	Clerk/Typist
Mr C J B Abeykoon	–	Works Supervisor
Mr W C K Fernando	–	Chief Plumber Mechanic
Mr J G Gamage	–	Filter Plant Assistant
Mr P T Perera	–	Clerk/Typist

Motor Garage

Mr G G E H Gamage	–	Chief Motor Mechanic
Mr R Gabriel	–	General Mechanic
Mr S N W M Premaratne	–	Tinker/Welder

Electrical Division

Mr U A Wickramasinghe	–	Electrical Foreman
Mr J M R K Bandara	–	Electrician
Mr R W Rengasamy	–	Electrician

Telephone Exchange

Mr K M Seneviratne Banda	–	Telephone Operator
Ms P K N Damayanthi	–	Telephone Operator
Mr A P Thomas	–	Telephone Operator
Mr S Karuppiah	–	Telephone Linesman

Finance Division

Mr S G Punchibanda	–	Accounting Assistant
Mr C B Koswatte	–	Accounting Assistant
Ms D M R Dissanayake	–	Accounting Assistant
Mr B G D Premadasa	–	Clerk/Typist
Ms N Saparamadu	–	Stenographer/Typist (English)
M. V Pahalage	–	Accounts Clerk
Ms G A S Gunasekera	–	Accounts Clerk
Ms W G Piyaseeli	–	Accounts Clerk
M Saman Hewasiliyan	–	Accounts Clerk
Mr K T U Kulatunga	–	Assistant Store Keeper
Mr W A Nishantha	–	Data Entry Operator
Ms R Godage	–	Clerk/Typist
Mr H P W Gunasekera	–	Stores Assistant
Mr H B Talgahagoda	–	Cashier/Accounts Clerk
Ms A P Amaratunga	–	Accounts Clerk
Ms P V D Chandrakanthi	–	Accounts Clerk
Mr W G Weeratillake	–	Cashier

Internal Audit Divison

Mr P S Wickramasinghe	–	Internal Audit Officer
Ms L N K Udumulla	–	Internal Audit Clerk
M. N C Jayaweera	–	Internal Audit Clerk
Ms W N K I Ariyaratna	–	Audit Clerk

Library

Mrs R W M S K Amunugama	–	Library Assistant

Publication Unit

Ms A P V Kalyani	–	Stenographer/Typist (English)

Advisory and Extension Services Division

Mr L A M R C Liyanarachchi	–	Extension Officer
Mr M J A S Fernando	–	Extension Officer
Ms.M A H Nishanthi	–	Extension Officer
Mr K K P Katulanda	–	Extension Officer
Ms I Jayawickrema	–	Clerk/Typist
Mr K G R Niroshan	–	Photographer
Mr J T Thevadasan	–	Photography Dark Room Attendant
Mr N S Ekanayake	–	Audio Visual Attendant

Agronomy Division

Mr A R Amarasekera	–	Experimental Officer
Mr U P Abeysekera	–	Experimental Officer

Agricultural Economics Unit

Ms H W Shyamalie	–	Experimental Officer
Mr W M J C Bandara	–	Technical Assistant

Biochemistry Division

Mr M D L P Gunatilaka	–	Experimental Officer
Mr K M Mewan	–	Experimental Officer (on study leave)
Mr G A A R Perera	–	Experimental Officer
Ms J M D Abeysinghe	–	Technical assistant
Ms A D M Damayanthi	–	Technical Assistant
Ms R W T Dharshani	–	Technical Assistant
Mr P K P Muthukumarana	–	Technical Assistant
Mr P C Priyantha	–	Technical Assistant
Mr M W Silva	–	Skilled Mechanic

Entomology and Nematology Division

Mr D D Liyanage	–	Experimental Officer
Mr A H M L S Abeysinghe	–	Experimental Officer
Mr N Nawaratne	–	Experimental Officer
Ms P V A R Abeysekera	–	Experimental Officer
Ms R D P Dharmalatha	–	Experimental Officer
Mr G P Udumulla	–	Experimental Officer
Ms S S C J de Seram	–	Technical Assistant

Plant Pathology Division

Mr J W K Jayasundera	–	Experimental Officer
Mr R M A Ratnayake	–	Experimental Officer
Ms. W G N Udayangani	–	Technical Assistant

Plant Physiology Division

Ms V Sidhakaran	–	Experimental Officer
Ms D M S Navaratne	–	Experimental Officer
Mr H P Baddage	–	Technical Assistant

Plant Propagation and Plant Breeding Divisions

Mr R Paskaradevan	–	Experimental Officer
Mr B A Rathnagoda	–	Technical Assistant
Mr J D Kottawa Arachchige	–	Technical Assistant

Soils and Plant Nutrition Division

Mr R G A Wijayawardana	–	Experimental Officer
Mr S M Dissanayake	–	Experimental Officer
Mr H A P Warnasiri	–	Experimental Officer (on no-pay leave overseas)
Mr T C N Peiris	–	Technical Assistant
Mr O G K A Gunaratne	–	Technical Assistant
Mr D H B N Dissanayake	–	Technical Assistant
Ms D H Kalikotuwa	–	Stenographer/Typist (English)

Technology Division

Ms S H P Waduge	–	Experimental Officer
Mr D L D H Dahanayake	–	Experimental Officer
Mr L Jayasinghe	–	Technical Assistant
Mr A M M V Abeykoon	–	Technical Assistant
Mr U D Alagiyawadu	–	Technical Assistant

Mechanical Workshop

Mr A Nandasiri	–	Workshop Mechanic
Mr P D L B de Silva	–	General Mechanic
Mr M C Gabriel	–	General Mechanic
Mr D L J Weerasooriya	–	General Mechanic

Low Country Station, Ratnapura

Mr H S N Peiris	–	Experimental Officer
Mr E R Perera	–	Experimental Officer
Mr P D Upali	–	Experimental Officer
Mr W M U A B Marapana	–	Experimental Officer
Mr A K Prematunga	–	Experimental Officer
Mr D W Vithana	–	Experimental Officer
Mr A G Gamage	–	Experimental Officer
Mr K G J P Mahindapala	–	Extension Officer
Mr T G N Mahinda	–	Extension Officer
Mr K A D Mervin	–	Accounting Assistant
Ms P V G Karunanayake	–	Stenographer/Typist (English)
Mr K A S Kumarapperuma	–	Clerk/Typist
Mr H K Seetha	–	Accounts Clerk
Mr J S K de Silva	–	Electrician
Ms B S N Vithana	–	Experimental Officer
Mr K Gunawardena	–	Works Supervisor
Mr J H N Piyasundera	–	Experimental Officer
Ms E W D P Prematunga	–	Experimental Officer
Mrs P I Jayawardena	–	Telephone Operator/Receptionist
Mr M A B de Silva	–	General Mechanic
Mr M A Chamindra	–	Technical Assistant
Mr M M Jayatillake	–	Technical Assistant
Mr A K Mudalige	–	Technical Assistant

Mid-Country Station, Hantane

Mr H J M de Silva	–	Extension Officer
Mr T M Sarathchandra	–	Experimental Officer
Mr K R W B Kahandawa	–	Extension Officer
Mr A P D A Jayasekera	–	Experimental Officer
Mr U B Herath	–	Experimental Officer
Ms B Sureshkumar	–	Experimental Officer
Mr S Wijetunga	–	Experimental Officer
Ms U Sridaran	–	Experimental Officer
Ms S N Wijesekera	–	Experimental Officer
Ms K Sarathchandra	–	Experimental Officer
Mr H Jayaweera	–	Experimental Officer
Mr K R W B Kahandawa	–	Extension Officer
Ms K M N K Ratnamalala	–	Experimental Officer
Ms P L K Tennekoon	–	Experimental Officer
Ms C N K Edirisinghe	–	Station Assistant
Ms B K S Herath	–	Accounts Clerk
Mr K Palathantirige	–	Works Supervisor
Mr C S K Ratnayake	–	Experimental Officer
Ms P Marapana	–	Stenographer/Typist (English)

Kottawa Station

Mr P K Jayawickrama	–	Experimental Officer
Mr E K Somapala	–	Station Assistant
Mr S P Ratnayake	–	Extension Officer

Passara Station

Mr R M A C Rajakaruna	–	Extension Officer

Deniyaya Station

Mr O W Jayawardana	–	Station Assistant

Walahanduwa Laboratory Complex

Mr M A Wijedasa	–	Experimental Officer
Mr W T B Priyantha	–	Experimental Officer
Mr J R Y Abeywardana	–	Technical Assistant

Estates

Mr J U Hulangamuwa	–	Superintendent, St.Coombs
Mr M S E Perera	–	Superintendent, St. Joachim

11. Retirements during the year

(a) Mr C C Mawilmada, Deputy Director (Administration), retired after seven years of service, on 14/04/2003.

(b) Mr S Sinnathamby, Field Supervisor, retired after 16 years of service, on 18/04/2003.

(c) Mr A K M Jayasena , Experimental Officer, retired after 39 years of service, on 07/09/2003.

(d) Mr N M Gunapala, Carpenter, retired after 19 years of service on 16/10/2003.

12. Resignations during the year

(a) Mr E N C S Edirisinghe, Technical Assistant, resigned on 31/01/2003.

(b) Mr S G Ekanayake, Superintendent, St. Coombs Estate, resigned on 31/03/2003.

13. Recruitments during the year

(a) Mr D A Jayatunga was appointed Senior Accountant as from 05 February.

(b) Mr J U Hulangamuwa was appointed Superintendent, St. Coombs Estate as from 16 June.

(c) Dr M T Ziyad Mohamed was appointed Director on a contractual basis as from 04 August.

(d) Mr W M P Wijekoon was appointed Deputy Director (Administration) as from 04 August.

(e) Ms T U S Peiris was appointed Research Assistant, Biometrics as from 26 August.

(f) Fifteen (15) Research Assistants were appointed on a contractual basis:
twelve (12) as from 23 July;
one (01) as from 28 July;
one (01) as from 01 August; and
one (01) as from 04 August.

(g) Five (05) Technical Assistants were appointed on a contractual basis as from 28 August.

14. Overseas Training, Seminars and Conferences

(a) Dr K G Premathillake, Senior Research Officer, Agronomy Division, Ratnapura, attended the 19th Conference of the Asian Pacific Weed Science Society, held from 17 to 21 March 2003 in Manila, the Philippines, and made an oral presentation of a research paper on "Impact of various cultural and agronomic practices on the management of Getakola-weeds in high-grown tea".

(b) Dr S S B D G Jayawardena, Director, Dr M T Ziyad Mohamed, Deputy Director, Research (Technology) and Mr J C K Rajasinghe, Advisory Officer/OIC, Advisory and Extension Centre, Passara, participated in a Symposium on "Tea: Emerging Technologies World-Wide" in Coimbatore, South India from 17 to 27 March 2003.

(c) Dr M A Wijeratne, Senior Research Officer, Ratnapura, attended the Regional Workshop on "Impacts of, and Adaptation to, Climate Change" in Bangkok, Thailand from 24 to 28 March 2003.

(d) Mrs S I Vitharana, Head, Entomology Division/Senior Research Officer, attended the International Conference on "The Science and Application of Neem" in Glasgow, United Kingdom on 28 March 2003.

(e) Mr M A B Ranatunga, Research Assistant, Plant Breeding Division followed a training programme on Plant Breeding and Biotechnology at the International Agricultural Center, Wageningen, the Netherlands from 26 April to 06 July 2003.

(f) Mr J A S K V Jayasinghe, OIC, Deniyaya, attended a short-term training programme at the Asian Institute of Technology, Thailand from 29 April to 28 May 2003.

(g) Mr R M A C Rajakaruna, Extension Officer, Advisory and Extension Centre, Passara, attended the Advanced Programme on Tea Plantation Management at the Kothari Agricultural Management Centre, Coonoor, India, from 01 September to 31 October 2003, held under the Colombo Plan.

(h) Dr I S B Abeysinghe, Head, Biochemistry Division, attended the IVth Asia Pacific Crop Protection Conference and Exhibition, New Delhi, India, from 17 to 21 September 2003, and presented a paper on "Changes of Volatile Compounds in Tea upon Shot-Hole Borer Infestation".

(i) Dr I S B Abeysinghe, Head, Biochemistry Division, participated in the Research Planning Meeting of "Asia–Swedish Research Partnership Programme on Environmentally-Acceptable Pest Control Methods" in Sweden from 27 September to 03 October 2003.

(j) Dr (Mrs) A J Mohotti, Senior Research Officer, Physiology Division, attended the 3rd International Symposium on "The Dynamics of Physiological Processes in Woody Roots" in Perth, Australia from 29 September to 04 October 2003.

(k) Mr S Koneswaramoorthy, Mechanical Engineer, Technology Division, is attending the Advanced Programme in Tea Testing and Quality Assurance at the Kothari Agricultural Management Centre, Coonoor, India, being held from 01 October to 31 June 2004.

(l) Dr M T Ziyad Mohamed, Director, and Dr I S B.Abeysinghe, Head, Biochemistry Division, participated in the ISO/TC34/SC8 Meeting in China from 21 to 23 October 2003.

(m) Mrs J A A M Jayakody, Head, Agricultural Economics Division, attended a Training Workshop from 30 October to 22 November 2003 in Thailand, and presented a research paper at the Regional Course in Environmental and Natural Resource Economics.

(n) Dr A K N Zoysa, Acting Head, Soils and Plant Nutrition Division/ Senior Research Officer, and Dr K G Premathillake, Senior Research Officer, Agronomy Division, attended a short-term training programme from 11 to 30 November 2003 at the National Academy of Agricultural Research Management in Hyderabad, India.

(o) Mr M S L D Amaratunga, Advisory Officer, and Mr K G J P Mahindapala, Extension Officer, Ratnapura attended a short-term training programme on Agricultural Extension from 06 to 18 December 2003 at the Indian Agricultural Research Institute, New Delhi, India.

15. Maintenance Divisions

Engineering

The total work undertaken by the staff of the Engineering Division were:

Building- and road-maintenance work	–	375 Nos.
Water supply-maintenance work	–	214 Nos.
Electrical maintenance work	–	312 Nos.
Motor garage–vehicle repairs and allied maintenance work	–	551 Nos.
Telephone maintenance work	–	40 Nos.

Maintenance of Buildings

The annual programme for Internal colour-washing was completed during the year in the following residential quarters.

05 Nos. "A" Type Bunglaows;
01 No. "B" Type Bungalow;
07 Nos. "C" Type Bungalows; and
12 Nos. "D" Type Quarters.

In addition, internal colour-washing of the Entomology and Nematology, Plant Breeding, and Pathology Divisions, and the Museum, including all public areas, were carried out during the year.

The details of the maintenance work are as follows.

Work carried out under the vote, C/ENGW/4.02-MB	269 Nos.
Work carried out under the vote, C/ENGW 05.6 -	23 Nos.
Work carried out under other votes	83 Nos.
Work completed: total number	375 Nos.

In addition to the maintenance work detailed above, special work was carried out by the Divisional staff under the maintenance programme.

(a) Felicitation Programme – Refurbishing the Guest House and the Director's Office.

(b) Road works and landscaping.
(c) Renovation of Duke's Bungalow.

Work carried out by Outside Contractors

(a) Main repairs and external colour-washing of old laboratory buildings.
(b) Main repairs and colour-washing of new laboratory and Administration buildings.

Construction Work in progress at the Institute in Talawakelle

(a) Construction of rubble-retaining wall.
(b) Construction of Inoculation Pit in the Pathology Division.
(c) Renovation of the Nematology laboratory.
(d) Construction of a hot-house and a nursery for the Plant Physiology Division.
(e) Repairs to road to Duke's Bungalow.
(f) Construction of main water-line from the Filtration Plant.

Facilities afforded to the Engineering Division

(a) A new lap-top computer was purchased.
(b) A new wood-working machine was purchased for the Carpentry Workshop.
(c) Net-work facilities were installed.

Water Supply

(a) Total work attended to under the vote, C/ENGW 05.3 (b) - 198 Nos.
(b) Total work attended to under various votes - 16 Nos.
(c) Installation of water-supply system in the Extension Building of the Soils and Plant Nutrition Division laboratory.

Electrical

The Electrical Division completed the following work during the year.

(a)	Maintenance of Bungalows	136 Nos.
(b)	Maintenance of Laboratories, Office Buildings, etc.	121 Nos.
(c)	Maintenance of sub-stations	09 Nos.
(d)	Maintenance of street lights, security lights, etc.	44 Nos.

The following electrical work was completed at the Institute in Talawakelle.

(a) Installation and re-construction of "D" type 3-phase overhead line.
(b) Re-wiring and repairs, etc. to the Nemotology glasshouse.
(c) Re-wiring and installation of electrical system at Duke's Bungalow.

Re-wiring, repairs, etc. were completed at the Research, Advisory and Extension Centre, Hantane, Kandy.

Motor Garage

The Motor Garage completed the following work during the year.

(a)	Servicing of vehicles	219 Nos.
(b)	Replacement of tyres and tubes	105 Nos.
(c)	Repairs, and replacement of spare parts	28 Nos.

Telephone

The Telephone Exchange and Test Room personnel attended to the following work.

(a) New telephones lines were given to seven divisions and six bungalows.

(b) A new PABX system for the exchange at the Passara extension was installed. This included the intercom system for the Guest House, office and bungalows.
(c) Re-wiring of Duke's Bungalow was completed.
(d) The replacement of a damaged earth-wire C D T was completed.
(e) The repairing and servicing of defective telephone receivers, or replacement with new receivers were completed.

REPORT OF THE FINANCIAL DIVISION

TEA RESEARCH BOARD

BALANCE SHEET AS AT 31ST DECEMBER - 2003

2002 Rs.			Tea Research Institute 2003 Rs. Cts.	St. Coombs Estate 2003 Rs. Cts.	St. Joachim Estate 2003 Rs. Cts.	Total 2003 Rs. Cts.
	FIXED ASSETS					
509,766,346	Property, Plant, Equipment etc.	(Anx. I)	596,135,980.14	–	–	596,135,980.14
(286,498,011)	Less: Accumulated Depreciation	(Anx. I)	(332,449,145.02)	–	–	(332,449.145.02)
223,268,335			263,686,835.12	–	–	263,686,835.12
55,275,750	Capital Work in Progress	(Anx. II)	37,769,165.67	741,647.80	–	38,510,813.47
278,544,086			301,456,000.79	741,647.80		302,197,648.59
15,550	Other Assets-Patents		22,550.00	–	–	22,550.00
278,559,636			301,478,550.79	741,647.80	–	302,220,198.59
	CURRENT ASSETS					
11,776,166	Stocks	(Anx. III)	10,487,908.44	1,052,332.53	1,953,565.27	13,493,806.24
83,196,097	Debtors and Other Debit Balances	(Anx. IV)	138,462,005.91	6,136,800.93	2,254,274.40	146,853,081.24
32,828,277	Deposits, Pre-Payments & Purchase Advances	(Anx. V)	23,868,771.89	365,440.93	163,174.00	24,397,386.82
27,138,485	Loans and Advances to Staff & Employees	(Anx. VI)	24,747,097.51	3,839,557.12	1,005,982.87	29,592,637.50
116,000,000	Short Term Investments - 7 day Call Deposits	(Anx. VII)	54,000,000.00	–		54,000,000.00
40,661,988	Cash and Bank Balances	(Anx. VIII)	7,783,053.60	64,917.30	60,529.45	7,908,500.35
311,601,013			259,348,837.35	11,459,048.81	5,437,525.99	276,245,412.15
500,558	Identified Losses	(Anx. IX)	500,557.87	–	–	500,557.87
300,511	Excess & Shortages	(Anx. X)	439,295.42	–	–	439,295.42
312,402,082			260,288,690.64	11,459,048.81	5,437,525.99	277,185,265.44
	CURRENT LIABILITIES					
(46,796,445)	Creditors and Provisions	(Anx. XI)	(18,915,053.15)	(7,511,251.69)	(7,449,943.55)	(33,876,248.39)
265,605,638	Net Current Assets		241,373,637.49	3,947,797.12	(2,012,417.56)	243,309,017.05
544,165,273	**TOTAL ASSETS LESS CURRENT LIABILITIES**		542,852,188.28	4,689,444.92	(2,02,417.56)	545,529,215.64
	REPRESENTED BY					
89,984,591	Grants and Reserves	(Anx.XII)	123,828,688.96	–	–	123,828,688.96
419,092,529	Tea Research Fund		381,213,620.95	–	–	381,213,620.95
–	A/C Current St. Coombs Estate		7,585,644.83	(7,585,644.83)	–	–
–	A/C Current St. Joachim Estate		6,964,163.54	–	(6,964,163.54)	–
35,074,903	Long Term Liabilities - Provision for Gratuity	(Anx. XIII)	23,246,420.00	12,275,089.75	4,951,745.98	40,473,255.73
13,250	Petrol Deposit Refundable	(Anx. XIV)	13,650.00	–	–	13,650.00
544,165,273			542,852,188.28	4,689,444.92	(2,012,417.58)	545,529,215.64

Senior Accountant - T.R.I.

Director - T.R.I.

Chairman - T.R.B.

TEA RESEARCH BOARD
OPERATING ACCOUNT FOR THE PERIOD 1ST JANUARY TO 31ST DECEMBER - 2003

2002 Rs.				2003 Rs. Cts.
		INCOME		
230,242,024	1	Cess	(Note 1)	192,309,725.92
5,093,317	2	Income from Other Commercial Activities	(Annx. XV)	5,112,445.49
5,802,045	3	Interest on Investments		5,497,480.72
4,085,266	4	Miscellaneous	(Annx. XV)	10,315,596.81
245,222,652				213,235,248.94
(4,362,172)	5	Estate Profits/(Loss) - St.Coombs Estate	(Annx. XVII)	(2,544,953.68)
(3,200,384)		- St. Joachim Estate	(Annx. XVIII)	(1,258,852.20)
237,660,096		Total Income		209,431,443.06

Total		EXPENDITURE		Administration Finance and Common Service Rs. Cts.	Advisory, Extensions & Publicity Rs. Cts.	Research Rs. Cts.	Total Rs. Cts.
63,454,094	01	Personnel Emoluments		26,166,372.66	14,503,959.84	30,978,546.28	71,648,878.78
4,582,344	02	Travelling		2,086,867.45	1,219,450.78	2,297,997.35	5,604,315.58
21,515,885	03	Supplies and Requisites		5,424,773.39	5,177,817.93	20,882,523.18	31,485,114.50
25,711,651	04	Repairs and Maintenance of Capital Assets		16,017,618.30	6,351,639.61	1,263,546.07	23,632,803.98
39,237,501	04	Depreciation of Fixed Assets		10,845,777.88	6,878,536.16	28,995,498.23	46,719,812.27
37,624,114	05	Transportation, Communication, Utility and Other Service		24,778,761.36	10,982.233.26	714,260.52	36,475,255.14
2,530,887	07	Contributions, Grants and Subsidies		1,946,171.17	173,769.57	258,498.34	2,378,439.08
5,951,630	08	Pensions and Retirement Benefits		2,162,485.32	1,012,441.58	3,113,908.80	6,288,835.70
1,972,306	08	Gratuity Provision		6,745,895.50	–	–	6,745,895.50
1,064,427	10	Media, Advertising, Publicity and Gifts		328,277.70	1,027,167.75	6,637.00	1,362,082.45
8,516,321	11	Cultivation and Field Trials		–	5,033,840.08	3,639,298.81	8,673,138.89
5,733,168	12	Miscellaneous	(Annx. XVI)	1,502,556.23	670,623.00	2,951,247.74	5,124,426.97
217,894,828		**Total Expenditure**		98,005,556.96	53,031,479.56	95,101,962.32	246,138,998.84
19,765,268		**Operating Surplus for the year 2002**					**(36,707,555.78)**
(931,067)		Less: Tax Payments					(1,171,352.42)
18,834,201		Surplus after the Tax Payments					(37,878,908.20)
(52,446,904)		Less: Prior years Adjustments					–
(33,612,703)		**Operating Surplus/(Deficit) transferred to Tea Research Fund**					**(37,878,908.20)**

Note : 1. Tea Cess receivable as at 31st December 2002 - Rs. 95,878,608.81

TEA RESEARCH BOARD
CASH FLOW STATEMENT 2003

The following statement show the cash flow of the board during the year under review and in the previous year.

	Year ended 31st December			
	2003		2002	
Cash flows from Operating Activities	Rs.	Rs.	Rs.	Rs.
Surplus/(Deficit) for the year excluding interest on investments		**(43,376,389)**		**13,032,156**
Adjustment for items not involving movement of cash:				
Depreciation	50,825,582		43,835,318	
Provision for Gratuity	5,398,352		553,140	
	56,223,934		44,388,458	
Less: Income from sale of fixed assets	(4,957,939)	51,265,995	(19,274)	44,369,184
		7,889,606		57,401,340
Adjustment for items not involving movement of cash:				
Less: Prior period items-Cess Adjustment		–		(52,446,904)
Operating surplus before changes in items of working capital		**7,889,606**		**4,954,436**
Changes in items of working capital				
Stocks - (Increase)/Decrease	(1,717,640)		(1,586,190)	
Debtors and other balances - (increase)/Decrease	(63,463,094)		115,665,230	
Deposits, Prepayments and purchase advances - (Increase)/Decrease	8,430,890		3,805,426	
Loans and advances to Staff & Employees - (increase)/Decrease	(2,454,152)		(3,689,392)	
Other Current Assets - (Increase) / Decrease	(7,000)		–	
Excesses and shortages - (Increase)/Decrease	(138,784)		(18,622)	
Creditors and provisions - (Decrease)/Increase	(12,919,797)	(72,269,577)	9,259,985	123,436,437
Cash generated from operating activities		**(64,379,971)**		**128,390,873**

Cash generated from operating activities C/F		**(64,379,971)**		**128,390,873**
Cash Flows from Investing Activities				
Interest on investments	5,303,591		5,341,771	
Purchase of fixed assets	(91,244,087)		(45,168,471)	
Proceeds from sale of fixed assets	4,957,944		19,278	
(Increase)/Decrease in capital work-in-progress	16,764,937		(30,448,755)	
Cash used in investing activities		**(64,217,615)**		**(70,256,177)**
Cash Flows from Financing Activities				
Grants received from :				
NRC	6,000		348,784	
ADB	33,520,098		29,623,469	
UNDP	318,000		329,278	
Cash generated from financing activites		**33,844,098**		**30,301,531**
Net Increase/(Decrease) in cash and cash equivalents		**(94,753,488)**		**88,436,227**
Cash and cash equivalents at beginning of the year		156,661,988		68,225,761
Cash and cash equivalents at end of the year (Note)		**61,908,500**		**156,661,988**
Note: Head Office				
Short Term Investments - 7 Day Call Deposits		54,000,000		116,000,000
Bank of Ceylon Corporate Branch		2,690,581		35,266,176
Bank of Ceylon - Talawakelle		2,117,648		1,614,347
Bank of Ceylon - Talawakelle ADB		1,879,835		2,267,985
Bank of Ceylon - Deniyaya		5,392		5,642
Petty Cash Imprest		1,049,318		1,241,793
Stamp Imprest		40,279		8,960
St. Joachim Estate				
Cash In Hand		1,738		6,911
Cah at Bank		58,740		17,013
Stamps		51		126
St. Coombs Estate				
Cash in Hand		20,140		28,663
Cash at Bank		44,774		204,216
Stamps		4		156
		61,908,500		**156,661,988**

TEA RESEARCH BOARD
ST. COOMBS & LAMILIERE ESTATES WORKING ACCOUNT FOR THE PERIOD 1ST JANUARY TO 31ST DECEMBER 2003

Annex - XVII

2002 Rs.	2002 Kg.		Kg.	Rs.	
		INCOME			
		Tea Sales Gross Proceeds			
37,075,254.28	264,414	Tea Sales Ex Brokers (Gross)	254,711	38,828,691.43	(Note 1)
2,703,365.78	30,786	Tea Sales Local & Graties	32,776	3,283,299.76	
39,778,620.06	295,200		287,487	42,111,991.19	
21,480.76		Less: Over valued Tea last year		63,086.91	
39,757,139.30				42,048,904.28	42,048,904.28
38,264.11		Add: Sale of green leaf			
39,505.79		Miscellaneous Income		174,284.45	174,284.45
39,834,909.20		Total Income		–	42,223,188.73
		EXPENDITURE			
		Less: Estate Expenditure			
9,622,811.95		General Charges		8,893,623.89	
5,917,458.07		Field work & Cultivation		4,911,980.07	
23,995,460.16		Production		25,426,304.98	
–		Bought Leaf (including transport charges)		179,729.80	
39,535,730.18				39,411,638.74	
		Administration & Finance			
1,887,126.48		Bonus and Holiday pay		2,446,723.45	
1,905,689.76		Depreciation		1,995,341.57	
3,792,816.24				4,442,065.02	
		Sales Tax & Distribution Expenses			
868,534.83		Brokerage, Handling chgs., & Sales Expenses		914,438.65	
44,197,081.25		Total Expenditure		914,438.65	44,768,142.41
(4,362,172.05)		**Profit/(Loss) transferred to TRI Operating A/c**			**(2,544,953.68)**

Notes:- (1) 2345 Kgs. unsold Teas valued NSA@162.86

Prepared by: S. G. Punchibanda

TEA RESEARCH BOARD

Annex - XIII

ST. JOACHIM ESTATE WORKING ACCOUNT FOR THE PERIOD 1ST JANUARY TO 31ST DECEMBER 2003

2002 Rs.	2002 Kg.	INCOME	Kg.	Rs.	
		Tea Sales Gross Proceeds			
107,197,333.70	717,388	Tea Sales Ex Brokers (Gross)	689,344	103,674,115.48	(Note 1)
511,891.13	6,302	Tea Sales Local & Graties	6,890	569,013.43	
107,709,224.83	723,690		696,234	104,243,128.91	
325,216.62		Add: Sale of BM Tea made in 2000			
(53,499.38)		Less: Over provision 2002 as per NSA		(1,713,851.52)	
107,980,942.07				102,529,277.39	102,529,277.39
		Add:			
365,378.93		Nursery Working A/c (Net) & Sale of Cuttings		280,177.86	
20,318.69		Miscellaneous Income		66,985.51	
236,348.00		Income from Rubber		765,287.00	1,112,450.37
108,602,987.69		Total Income			103,641,727.76
		EXPENDITURE			
		Less: Estate Expenditure			
6,022,193.16		General Charges		19,703,797.66	
4,710,631.12		Field work & Cultivation		1,632,917.78	
24,696,493.02		Production		3,171,386.74	
629,271.23		Expenditure on Rubber		1,102,137.98	
69,902,665.25		Bought Leaf (icluding transport charges)		73,704,510.75	
105,961,253.78				99,314,750.91	
		Administration & Finance			
741,904.27		Bonus and Holiday pay		1,009,014.21	
2,692,127.00		Depreciation		2,110,427.99	
		Sales Tax & Distribution Expenses			
2,408,087.54		Brokerage, Handling chgs., & Sales Expenses		2,466,386.85	
5,842,118.81		**Total Expenditure**		5,585,829.05	104,900,579.96
111,803,372.59					
(3,200,384.90)		**Profit/(Loss) transferred to TRI Operating A/c**			**(1,258,852.20)**

Notes:- (1) 14942 Kgs. unsold Teas valued NSA@145:84

Prepared by: S. G. Punchibanda

AGRONOMY DIVISION

Head - A. Anandacoomaraswamy

Research Activities (see Corporate Plan)

1 Thrusts A 9 – A 11. Development of an economically viable system to eliminate/reduce the soil rehabilitation period, prior to replanting, in the up-country, mid-country and low country.

The objective of these thrusts is to develop an economically-viable system to eliminate or reduce the soil rehabilitation period, prior to replanting, in the high, mid- and low elevations.

The systems tested are:

(1) soil organic carbon enrichment by incorporating coir dust, refuse tea and compost;

(2) in situ soil rehabilitation;

(3) growing economic crops such as cowpea, 'tur-dhal', green gram, citronella and sweet corn in-between the replanted tea; and

(4) growing *Flemingia congesta*.

The above systems were compared with traditional soil rehabilitation by growing mana for two years.

There are six experiments located at high, mid- and low elevations. In all the trials, none of the alternative systems matched the traditional soil rehabilitation in terms of establishment, growth and yield of tea.

Incorporation of coir dust and/or compost at 2-4 kg per planting hole is the next best option to traditional soil reconditioing with grass. However, the yield improvement is very marginal compared to direct planting of tea. In most trials, the benefits of soil reconditioning was seen in the second cycle as well.

2. Thrusts A 12 – A 14. Development of intercropping systems for tea lands in the estate and small holder sectors.

The objectives of these thrusts are (1) to evaluate the compatibility of intercrops such as pepper and coffee at different spacing, and their effect on the yield of tea, in marginal tea lands in the mid-country estate and the small holder sectors, and (2) to develop intercropping systems at low elevations with plantation crops

such as rubber and coconut. This year, in addition to the above intercrops, fruit crops such as rambuttan and durian, and the spice crop, cinnamon, were also tested under the tea-rubber intercropping system in the low country in collaboration with the Department of Agriculture and the Department of Minor Export Crops.

The coffee varieties, Catiemore and IYM, and the pepper varieties, Paniyur and the local variety, were tested at 13.3' x 13.3' and 20' x 20' spacings, in both mid-country small-holder estates and corporate sector estates. During the year, the trial in the small holder sector in Manikdewela was terminated owing to a change in the ownership of the land. This trial was re-located at Galaha. The trial at New Peacock Estate gave no yield differences between any of the treatments, since the intercrops are still too small to make any difference.

There are six experiments with tea and rubber intercropping. The treatments were mono-cropped tea, mono-cropped rubber, and tea and rubber at various spacings The rubber spacing varied from 40' x 8', 27' x 8', 20' x 12' and 60' x 8' x 8'. In one experiment, tea was planted with, and without, soil rehabilitation. Generally, mono-cropped tea gave the highest yield compared to tea intercropped with rubber. Further, tea yields were higher at wider spacings of rubber (60' x 8' x 8').

There are two experiments with tea and coconut intercropping at low elevations carried out in collaboration with the Coconut Research Institute and 'Tea Shakthi'. The treatments included tea with and without soil rehabilitation, and different spacings for coconut (12' x 30', 12' x 30', 20' x 30', 20' x 40' and 20' x 60').

3. Thrust A 19. Development of water management techniques for young tea in drought-prone areas to minimize casualities.

The objective of this thrust is to (1) determine the quantity of water and the frequency of its application for drought-susceptible clones, and (2) to evaluate existing technologies for water application in tea. Under this project, three studies were undertaken in the low country, the up-country and the Uva.

In the the low country, growth of young tea was tested with and without irrigation (drip-irrigation with liquid fertilizers), under two systems of planting, namely on raised beds and flat beds (as control), with two clones, TRI 2023 and TRI 3025. Clone TRI 2023 had given a higher yield than TRI 3025. In another trial, fertigation was tested at three frequencies of water application with 100% water-soluble fertilzer. The yield response for fertigation was not evident

In the up-country, fertilizer was given with the irrigation water at the rate of 180, 225 and 300 kg N ha^{-1} as urea, for 300 days. There was an additional treatment

of water application only, with surface broadcasting of fertilizer at the rate of 360 N kg ha^{-1} in four splits. The experimental plots were rested from July and pruned in October.
In the Uva, four treatments of varying frequencies of water application were tested in large blocks of land (0.25 ha). Fertilizer was given with the irrigation water at the rate of 180 kg N ha^{-1} as urea, for 300 days. Fertigation every other day, and every two days, gave higher yields than daily fertigation.

4. Thrust A 20. Development of harvesting devices to overcome labour shortage.

The objective of this thrust is to (1) evaluate harvesting devices, (2) modify harvesting intervals, and (3) modify bush management practices for mechanical harvesting

There were two trials with the Kawasaki NV 60H motorized machine on two clones, TRI2027 and H1/58, and two harvesting intervals, 14 and 21 days, and with different levels of potassium (K). The results showed that there was a significant decline in yield, of 20-40%, with the use of the machine. The use of machines on four other clones, TRI 3063, TRI 3041, TRI 3047 and TRI 2027, with enhanced K also showed that yield was not affected by an enhanced K application.

There were two experiments with varying planting densities to modify the bush architecture. A single hedgerow (1.2 m x 0.6 m) was compared with double hedgerows (0.6 m x 0.9 m x1.5 m, 0.6 m x 0.9 m x 1.5 m and 0.45 m x 0.9 m x1.5 m) in two clones, TRI 2026 and DG 39. The tea bushes were pruned in November 2003. The statistical analyses of yield (January-August), and weight of prunings, showed no significant difference between spacings. However, TRI 2026 gave a yield about 20% higher than DG 39. The highest ground coverage was established by the spacing of 0.6 m x1.2 m (76%), followed by the spacings of 0.6 m x 0.6 m x1.5 m (72%) and 0.6 m x 0.9 m x1.5 m (65%). The spacing of 0.9 m x 0.45 m x1.5 m gave the poorest ground coverage (50%).

5. Thrust A 21. Development of devices for improving pruning efficiency.

The objective of this thrust is to develop a mechanical pruning device to minimise the worker requirement for pruning.

A new hand-pruner had been designed, fabricated and patented. Improvements were being made to this pruner with the assistance of Messrs. Flowerland Lanka to allow for mass-scale production.

6. Thrust A 24. Development of weed management strategies in tea.

The objective of this thrust is to develop an integrated strategy to control weeds in tea plantations. The approaches made were to (1) screen new herbicides, (2) test different combinations of weed management, and (3) control problem weeds in each of the agro-ecological regions.

Screening of Deverinol (Napropamide 45% sc), a pre-emergent herbicide, and Amiphosate (50%, a granular formulation of glyphosate, were continued.

Control of passali kodi (*Anredera cordifolia)* was investigated in field trials. A cocktail mixture of Diuron and 2,4 D, and of Diuron and glyphosate controlled passali kodi.

Divisional Activities:

1. Impact of global climate change on the productivity of tea plantations.

An experiment on the impact of enhanced CO_2 on yield of mature tea was commenced at both St. Joachim and St. Coombs Estates. The ambient CO_2 level was enhanced by supplying CO_2 to open-top chambers prepared by covering tea bushes with a thick polythene sheet. Analysis of weekly yield records showed that the tea yield under enhanced CO_2 was higher than under ambient CO_2 at both locations. The percentage of dormant shoots was lower in the enhanced CO_2 plot. The tea leaves in the CO_2 enhanced plots had a higher chlorophyll content, and were smaller, than in the ambient CO_2 plots. As a result, the tea yield in the CO_2 enhanced plots were higher than in the controls.

2. Land suitability mapping for tea-growing lands in the Ratnapura District.

A new project for classifying tea lands in the Ratnapura district was commenced in September 2003.

Initially, flight indices, flight lines and district boundaries were demarcated on maps. Aerial-photograph interpretation, and demarcation of existing tea lands within the Ratnapura district, were carried out and validated by field visits.

The compilation of data from existing tea lands, and other details extracted from aerial photographs, are in progress. These details were copied into 1:50,000-scale ABMP maps with the help of the Optical Pantograph.

Demarcation of the present agro-ecological regional (AER) boundaries on 1:63,000-scale topo-maps, and 1:50,000-scale ABMP maps, were effected. Transferring the AER boundaries onto provincial maps, identification and location of all available rain-gauge stations, generalization of elevation boundaries in the high, mid- and low country, and transferring the generalized boundaries onto agro-ecological maps have been completed.

A Productivity Index (V.P. yield per 100 mm of rainfall at 75% expectancy) was generated. It was observed that the value of this Productivity Index ranged from 40 to 15 for most of the estates. The Index was grouped into five classes, class 01 (a) above 100, class 01 (b) 80 - 100, class 02 60 - 80, class 03 40 - 60 and class 04 below 40. Estates can be categorized according to these classes, and each group of estates, situated within a particular productivity class, falls within a recognized agro-ecological sub-region.

3. Effect of different rates of earthworm casts and T 750 on growth and yield of tea.

The trial on the effect of earthworm casts on growth and yield of tea indicated that earthworm casts, in combination with the inorganic fertilizer mixture T 750, gave significantly higher yields than earthworm casts alone.

BIOCHEMISTRY DIVISION

Head - I. S. B. Abeysinghe

Research Activities (see Corporate Plan)

1. Project B 26. Biochemical and chemical methods in the control of Blister Blight leaf disease of tea caused by *Exobasidium vexans.*

This project aims at studying the chemistry and biochemistry of disease resistance mechanisms in relation to blister blight leaf disease in tea, with the ultimate objective of controlling the disease in an environmentally-friendly manner by exploiting natural disease resistance traits inherited in the tea plant.

The work carried out during 2003 focused on the identification and characterisation of proanthocyanidins in both healthy and infected leaf tissues. Proanthocyanidins from healthy and infected leaves were isolated and subjected to several methods of characterization.
Infection of leaves of tea, *Camellia sinensis*, by blister blight, *Exobasidium vexans*, resulted in a shift of the proanthocyanidin stereochemistry away from 2,3-*trans* stereochemistry (e.g. catechin and gallocatechin) and towards 2,3-*cis* stereochemistry (e.g. epicatechin and epigalocatechin).

Proanthocyanidins isolated from uninfected tissue had predominantly 2,3-*trans* stereochemistry which accounted for 51% and 61% of the total initiating and extension units, respectively. Conversely, in infected tissue proanthocyanidin subunits with a 2,3-*trans* stereochemistry accounted for 27% and 40% of the total initiating and extension units, respectively.

Infection also resulted in increased gallic acid esterification of the initiating subunits of proanthocyanidins in these tissues. There were clearly more of the gallated oligomers in the proanthocyanidins from diseased leaves than from healthy leaves. This confirms that tea leaf contains only procyanidin and prodelphindin.

2. Project B 17. Development of chemical/biochemical methods in the control of shot-hole borer *(Xyleborus fornicatus)* in tea.

The study of insect chemical ecology in particular has shown that the development of semiochemicals for the management of pests has the potential of providing control methods more in line with current demands than from conventional pesticides. Twenty-five volatile compounds present in the leaves and stems of the tea plant were identified by GC-MS (Gas Chromatography-Mass Spectroscopy). The changes of diastereoisomers of linalool and its oxides in

resistant and susceptible clones, and their changes upon shot-hole borer (SHB) infestation, were established.

Olfactometry and field trials on some of the volatile compounds identified were carried out. Preliminary field tests were only partially successful, owing to the small number of beetles captured in the traps. It was found that tea volatiles attract not only SHB, but also other insects belonging to the orders Diptera, Hymenoptera and Coleoptera.

In 2003, olfactometry studies on the volatile compound, cis-2-hexeno, were extended. Results indicate that SHB is not specifically attracted to this volatile.

3. Project B 18. Use of DNA markers for molecular characterisation of tea.

A tea genomic library has been constructed to screen for SSRP (Simple Sequence Repeat Polymorphism) markers. SSRPs are very specific and reproducible markers that can be used for molecular characterisation. A few clones that are thought to be positive have been identified. Secondary screening of these clones is being carried out at present.

In addition, the use of AFLP (Amplified Fragment Length Polymorphism) markers, which are informative and accurate, is being attempted at present.

Phase II of RAPD (Random Ampified Polymorphic DNA) of tea cultivars, in order to look for diverse cultivars, was initiated in the Molecular Biology Laboratory which was recently set up in the Institute. At present, DNA extraction of the cultivars is in progress.

Studies have been initiated to develop molecular markers for Blister Blight resistance..

4. Project B 19. Effect of tea on oral micro-organisms.

Trials were carried out to find the effect of black tea extract on different strains of *Staphylococcus aureus which cause oral infections*. The results reveal that tea extract could inhibit the growth of these strains. The catechin and theaflavin fractions of black tea extract were the most effective fractions against the *Staphylococcus aureus* strains.

Further trials were carried out to find the effect of tea on methicillin-resistant *Staphylococcus aureus* (MRSA) strains. (Methicillin is a semi-synthetic penicillin, active against penicillin-resistant staphylococci.) The results confirm that tea extracts inhibit MRSA.

5. Project B 22. Establishment/monitoring of flavour profiles of made tea for various agro climatic regions.

The study on changes of flavour profiles in made tea, owing to seasonal variation in the Dimbulla region, was continued during the year. Made-tea samples from 14 estates in the Dimbulla region were collected during the season, and subjected to gas chromatographic analysis to establish their aroma profiles.

6. Project D 28. Establishment of factors responsible for the Bogo Valley character.

Some teas produced in the Bogo and the Maskeliya Valley regions show an extra redness in their liquors, which cannot be totally accounted for by the contributions made from TF and TR to the liquor. Polyphenols often forms coloured complexes with trivalent cations, and these may contribute to the redness of the liquor. Therefore, in addition to the investigations on the TP, TF, TR, B, TC and fluoride contents, Fe, Al, Cu and Mn were also included in the analysis. Teas from the Dimbulla region were used as controls.

It was found that the aluminium and the fluoride content in the teas from the Bogo Valley are higher than in teas from the Dimbulla region.

7. Project D 30. Development of multi-residue methods for the analysis of pesticide residues in made tea.

The indiscriminate use of pesticides, and concern about residues remaining in edible crops by consumers, led to national authorities, particularly in the Western countries, to introduce legislation to restrict the use of pesticides to a minimal level. There is thus a need for pesticide levels in exported tea to be contained within acceptable levels.

To address this issue, the development of reliable and economical analytical methods for pesticide-residue analysis in tea is being carried out. Twenty-one pesticides were selected for this study. Initially two different solvent systems, and two clean-up methods, were tested on five pesticides to develop multi-residue methods for these pesticides.

In 2002, a multi-residue method for the analysis of chloropyriphos-ethyl, dimethodate and diazinon was developed. Method development for pesticides was continued in 2003, and as a result a HPLC method for the analysis of bitertanol and tebufenozide was successfully employed. In this method, ethyl acetate extraction and GPC clean-up were used.

A study on the effect of pesticide application in vegetable fields on made tea and the environment was initiated. For this purpose, vegetable plots in and around Nuwara Eliya were selected. Soil and water from the experimental site, and tea flush and made tea from the surrounding tea fields, were analysed for chloropyriphos-ethyl, diazinon and chlorfluazuron.

8. Project B 60. Comparison of quality parameters of organic and conventional teas.

This project was initiated as a result of a request made by the industry, to ascertain if there is a difference in quality between organic and conventional teas.

For this study, six estates producing organic teas were selected, with ten estates producing conventional teas as controls. All 16 samples were analysed for flavour, TF/TR, caffeine, catechins, total polyphenols, soluble solids, crude fibre and moisture, and subjected to tasters' evaluation.

The project was carried out for a period of six months at two-week intervals, amounting to a total of 12 trials. The results are being statistically analysed.

9. Project A 1.5. Screening lines for quality.

The development of tea clones suitable for the up country, the mid-country and the low country plays an important rôle in the Institute's tea breeding programme. In addition to high yields and other desirable characteristics, the quality potential of a clone is also considered when developing new cultivars. Therefore, evaluating the quality potential of clones at an early stage of the breeding programme is important.

In 2003, a preliminary screening of 35 selections belonging to the Phase I stage of the breeding programme was carried out. The results of the experiment was made available to the Plant Breeding Division.

Screening for another 21 selections belonging to Phase II of the breeding programme was started, and is now in progress.

10. Project A 29.2. Improvement of technology for producing a liquid tea concentrate.

Trials to replace clarifying agents (aluminium sulphate and bentonite) with microfiltration have been initiated. The samples are being observed visually for clarity at three-month intervals. Samples filtered through 0.30 μm and 0.22 μm filters are found to have the same degree of clarity as that of the control, at the end of the three months. The observations will be continued up to a period of 12 months.

11. Project A 30.3. Development of a tea sherry/wine.

A commercially-accepted product has been developed, and medium-scale production of tea wine is being carried out in order to supply samples to interested parties.

12. Project B 16. Evaluating quality parameters in the early stages of the breeding programme.

Manufacturing properties of the cultivar, TRI 2025

Large extents of tea lands in Sri Lanka are cultivated with the cultivar, TRI 2025. However, owing to the poor withering and fermenting properties of this cultivar, processing TRI 2025 to obtain a quality product is difficult, especially when it is mixed with flush from other cultivars. Therefore, a study was initiated to find the reasons for the poor withering and fermenting properties of TRI 2025.

Preliminary results indicate that the pH of the leaf juice is below the optimum range for polyphenol oxidase. Physical properties related to withering were also studied. It was found that the stomata density in the leaves of TRI 2025 are comparatively lower than in TRI 777 and DT 1, and this results in poor withering.

Interaction of tea with milk

Some teas, produced in the up-country regions of Sri Lanka, do not take milk well while some teas do. As this factor is important in some markets where tea is taken with milk, a study was initiated to find the factors that affect interaction of tea with milk.

Preliminary results indicate that the cultivar has a significant effect on the milk-taking ability. Some cultivars (e.g. K 145) do not take milk well, while tea made from some other cultivars do (e.g. DT 1).

Chemical constituents in different parts of fresh tea flush, and their contribution to quality in made tea

A study was carried out to find the chemical constituents in different parts of the fresh tea flush (bud, 1st leaf, 2nd leaf, etc.), and their contribution to made tea.

Notable findings were that the content of aluminium and fluoride increased with leaf maturity, while caffeine content decreased with leaf maturity. This indicates that the plucking standard has an effect on the content of these constituents in made tea. Thus, intake by consumers of these compounds from tea could vary with the quality of tea or plucking standard.

ENTOMOLOGY DIVISION

Head - Sushila I. Vitarana

Research Activities (see Corporate Plan)

1. **Project A 1.2. Screening lines for resistance to shot-hole borer (SHB) and livewood termite.**

   Assessments in the following Phase II trials for the Plant Breeding Division have been completed: VP 37, Passara; VP 75, St.Coombs; and VP 76, St.Coombs.

2. **Project A 1.6. Continued screening of newly-released clones for resistance and tolerance to plant parasitic nematodes attacking tea in the up country.**

   The experiment established with 11 clones for 2003/2004 is ongoing. Evaluation is scheduled for 2004 (15 months).

3. **Project A 2.2. Screening lines for resistance to shot-hole borer in the mid-country.**

   Seed stocks at Hantane (Plant Breeding trial)

   Interim assessments, based on branch breakage owing to SHB, showed that TRI 3013 is highly susceptible.

4. **Project A 2.5. Continued screening of newly-released clones for resistance and tolerance to plant parasitic nematodes attacking tea in the mid-country.**

   N 1 B trial. Screening against *R. similis*.

   TRI 4053, being virtually immune to the pest, had the best growth out of nine clones tested. Even though TRI 4052 and TRI 3069 exhibited similar resistance to the nematode, they had comparatively poor growth in the nursery. The others (TRI 4006, 4014, 3019, 3055, 3015, 3069 in order of merit) exhibited high tolerance. TRI 4006 was better than TRI 2025 in every way. TRI 3025 was found to be extremely susceptible to this nematode.

5. **Project A 3.2. Screening lines for shot-hole borer in the Uva.**

One assessment was carried out in August in the LVP 74 trial of the Plant Breeding Division at Deniyaya. The other assessments are scheduled for 2004.

6. **Project A 3.5. Screening lines for resistance to the tea nematodes, *P. loosi* and *R. similis* in the Uva.**

The building-up of nematode infestations in testing tanks is on-going.

7. **Project A 4.2. Screening lines for resistance to the low-country livewood termite.**

LE 83. Observation blocks of 34 selections from Maratenna Division of Balangoda Estate, L.P.G Division.

Block planted in 1999.

Three growth assessments and bioassays for termite-resistance were carried out. Out of the 15 clones tested, only three clones showed good growth. Six clones, namely MT 131, MT 105, MT 142, MT 128 and MT165, were found to be resistant to livewood termite. These six clones were pruned in October in order to take cuttings for further study.

LE 50. Hapugastenna Estate, Lower Amunutenna Division (planted in 1990).

Shoots were collected in June from 26 clones that are still free of livewood termite (after 12-20 years) and canker, and having good branching. More cuttings were propagated in the Plant Breeding Division nursery at St. Joachim Estate for further studies.

LE 78. Hapugastenna Estate, Hadarganga Division (planted in 1998).

Screening of 37 clones selected from field No. 04 of Hadaraganga Division.

Prune-time assessments were carried out in January on 37 selections.

None of the clones was found to be susceptible to livewood termite damage. There were no significant differences between clones, based on yield data.

LE 81. Hapugastenna Estate, Upper Wewelketiya Division (planted in 1997).

Screening of TRI 4000 series clones for resistance to low-country livewood termite is in progress, and the plots are being maintained for the second prune-time assessments.

8. Project A 22.1. Screening of synthetic pesticides for reducing shot-hole borer in tea.

The following treatments are being compared at three locations in the mid- and low country, in fields having mature TRI 2025 bushes.

T1-Laybacid @ 3500 ml/ha;
T2-Regent (fipronil) @ 1 litre/ha;
T3-Regent @ 1250 ml/ha;
T4-Buldock (beta-cyflothrin) @ 750ml/ha;
T5-Trebon @ 750ml/ha;
T6-Control.

In respone to a decision not to allow the use of pyrethroids on tea, the spraying of Buldock was omitted from the trial, the relevant plots being kept unsprayed. The other spraying was continued every three months.

ME 14. Rangala Estate, Field No. NC 99.

Spraying commenced in February. Assessments show that Regent, Lebaycid and Trebon are significantly superior to the untreated controls in lowering the populations, and also in lowering the number of galleries in the branches.

ME 15. Rangala Estate, Kalduria Division, Field No.13 .

There were significant differences between the untreated controls and the treatments, Regent @ 1 litre and Trebon, in terms of the number of galleries and live stages.

LE 87. Hapugastenna Estate, Dehanakanda Division, Field No. 27.

Plucking records indicate that there are no significant differences between the treatments in relation to yield in the same period, when compared to the control. However, there were significant differences between the untreated controls and the treatments, Regent @ 1 litre and Trebon, in terms of the number of galleries and live stages.

To confirm these results, two experiments were initiated, in the latter part of the year, at Brunswick Estate, Maskeliya with DT 1 (E 320) and at Levellon Estate, Pupuressa with TRI 2025 (ME 26)., using the following treatments with untreated controls.

T1- Fenthion - 3500 ml/ha
T2- Regent - 1000 ml/ha
T3- Regent - 1250 ml/ha
T4- Trebon - 750 ml/ha

The first chemical applications were carried out in October. These experiments are now in progress.

9 Project A 22.2. Screening of biological control agents for reducing SHB damage in tea.

ME 18. Culturing of *Beauveria bassiana* (*in vitro*)

Culturing of *Beauveria bassiana* fungus in liquid agar medium, and on autoclaved rice medium, continued. It was observed that spore production is better in rice culture. Rice cultures were continued in order to multiply the fungus for other studies.

Efficacy of *Beauveria bassiana* on SHB.

Treated and untreated plots were compared at the following four locations.

ME 22. Kurugama Estate, Muruthalawa (Cultivar TRI 2026).

There were no dead females at the commencement of the experiment in either set of plots. After one month of treatment, there were dead beetles in the stem galleries in treated plots, while the count of dead beetles was zero in untreated plots.

The highest number of dead females was found after five months of treatment in treated plots. However, dead beetles were also found in untreated plots. The conclusion is that air-borne fungal spores had contaminated the control bushes.

ME 23. Levellon Estate, Pupuressa (Cultivar TRI 2025, one year from prune).

Significant differences between treated and untreated bushes were seen in relation to open (fresh) galleries.

E 303. Haputale Estate, Golkonda Division, Field No. 9.

This trial was abandoned since the untreated plots were found to be contaminated with air-borne fungus.

E 311. Templestowe Estate, Field No.12 A.

This trial was also abandoned since the untreated plots were found to be contaminated with air-borne fungus.

These experiments confirm that the fungus is effective on the borer, and that spores of the entomopathogenic agent could be air borne and transmitted in that fashion.

Application methods for *B.bassiana* spore suspension.

E 313 a. Haputale Estate, Haputale Division, Field No.7.

Knapsack sprayers and mistblowers were compared with reference to untreated controls. This experiment is now in progress.

10. Project A 22.5. Modifying potassium fertilizer to reduce shot-hole borer damage.

One experiment is in progress.

There are no differences between treatments, but there are differences between the clones.

It was decided to continue SHB assessments till the 1st prune.

11. Project A 22.7. Computerized data bases and modelling of the yield relationship with shot-hole borer.

Formulation of a population model to describe the dynamics of the shot-hole borer for forecasting purposes has been investigated. The model is built using DYMEX®, a modular modelling package developed by the Corporate Research Center for Tropical Pest Management (CRCTPM) in Australia. Supplementary data needed to complete the model has been identified (W. Danthanarayana & L.D. Amarasinghe, Annual Report 1998), and experiments have been initiated to fill in gaps in knowledge in relation to the biology of the shot-hole borer.

E 315. Temperature-dependent development and reproductive parameters of shot hole borer.

Experiments have been initiated in order to determine the development parameters of the life-cycle stages of shot-hole borer, under different, constant temperatures (15°C to 32°C). The development parameters form the basis for the life-cycle module of DYMEX.

The relationship between the development time (in days), the development rate (1/days) and the temperature, was highly significant for all the stages (GLM, SAS). Linear models fitted well to the development data, and the extrapolation of the linear regression line to the x-axis yielded development thresholds for eggs and pupae, namely 15.4°C and 14.3°C, respectively. Percentage survival of life-cycle stages under the same constant temperatures was also determined. The diet-tube method proved to be better than the Petri-dish method as a tool for obtaining generations of beetles for these studies. The study is in now progress.

Survey of the distribution of shot-hole borer in tea-growing areas in Sri Lanka.

This study was initiated to determine the present distribution of the borer and its activity, in different areas. This is in order to map the present distribution, and the level of infestation in the tea-growing areas, and to build a database which would be useful for future studies involving changes in borer activity with climate change.

There was high correlation ($R^2 = 0.99$, with SE = 4.2) between G% and the number of galleries per 30 cm length of stem of new growth.

Surverys carried out in the low country, the mid-country and the Uva were completed during the year. The incidence of galleries varied from zero to nine in 30-cm samples of branches of the current cycle; the highest number of estates recording a G exceeding 80%. The number of galleries exceeding three per 30 cm was recorded from the Uva and the mid-country, followed close by the Galle and Matara districts, which had all estates recording less than 60% of G, and less than two galleries per 30 cm length of stem. The study is in progress.

12. Project B 29. Refining the techniques of screening tea clones for natural resistance to the major pests of tea.

One set of cultivars of TRI 4000 was assessed using the insect-cage method. The findings of the preliminary studies were confirmed by this method.

13. Project B 30. Biochemical resistance of tea clones to major pests, such as nematodes and low-country livewood termite.

A Research Officer continued with these studies for a PhD degree.

14. Project C 2. Eelworm analysis.

Soil and root samples for nematode analysis were received throughout the year from estates and small holdings, and reports have been sent to all who requested the service.

15. Project D 17. Management of nematode pests in tea lands.

Cultivar screening for resistance to *Radopholus similis*.

N 1 B. Hantane Estate.

The cultivar TRI 3025 was found to be the most susceptible to *R. similis*.

In spite of being highly susceptible, TRI 2025 exhibited high compensatory growth. The cultivars, TRI 4052 and 4053, were virtually immune to the nematode, TRI 4053 showing significantly better growth than TRI 4052.

Of the others, the best all-rounder (which is much better than TRI 2025) is TRI 4006. The cultivars, TRI 4014, 3015, 3019 and 3055 (in that order), were found to be average performers with moderate resistance to the nematode. The cultivars, TRI 3069 and DN, though highly resistant to the nematode, did not show good growth.

16. Project D 18. Management of the up-country livewood termite.

E 319. Gouravila Estate, B Division, Field No. 2 B.

The following treatments were tested.

T1. Fipronil (Regent 50 SC) @ 3.5 l/ha;
T2. *Beauvaria bassiana* spore-solution;
T3. *Beauvaria bassiana* spore-solution (applied through the branches);

T4. Fipronil (Regent 50 SC) @ 3.5l/ha (applied through the branches); and
T5. Untreated controls.

The treatments, T2, T3 and T4, gave 100% mortality in some of the replicates. The trial is continuing.

17. Project D 19. Management of low-country livewood termite.

Three experiments, with newly-recommended tea cultivars, were set up to study the feasibility of using easily-available agricultural by-products (coir dust and paddy husk), as partial soil substitutes, for tea nurseries in low-country tea nurseries, where scavenging termites are active in the soil.

LE 88. Panambalana Estate, Kahatapitiya, Horana.

Final assessments were carried out in November at 10 months.

There were no differences between the organic media. There were significant differences between cultivars. The cultivar, TRI 4042, had the best growth in both media.

Scavenging termites were not attracted to the organic media at any time during plant growth, either in the nursery or after transplanting.

LE 90. Plant Breeding Division nursery, Ratnapura.

Observations in this trial were similar to those in LE 88, confirming that properly-decomposed material of either type was safe to use in low-country nurseries.

LE 93. Rassagalla Estate, Balangoda.

At this location, paddy husk, tea waste, etc., as partial soil substitutes for soil (seven treatments x two replicates) have been studied since December.

18. Project D 20. Identification of safe insecticides and acaricides, and the designing of IPM methods for control of seasonal pests of tea.

ME 6 (02). Screening of insecticides to manage scavenging termites in the mid-country.

Duckwari Estate, Lolgama Division, Field No. 10.

Observations taken at two-month intervals gave inconclusive data.

PLANT BREEDING DIVISION

Head - M. T. K. Gunasekara

Highlights

- For the development of new VP cultivars, 982 genotypes were evaluated under different phases in different regions, in order to develop region-specific VP cultivars.

- A brain-storming session on tea breeding was conducted on the 17th January 2003, with the participation of the Directors and plant breeders from crop research institutes, relevant staff from universities, and staff members of the Plant Breeding Division and senior scientists of the Institute. The outcome of the brain-storming session was documented, and an Action Plan was presented to the Tea Research Board.

- The "Tea Reserve" concept was introduced to the plantation sector aiming at preserving valuable genetic material *in situ* (that is, on-estate).

- A new controlled-hybridization programme was initiated at the Institute in Ratnapura, and over 6,700 crosses were carried out aimed at generating improved genotypes.

- Open-pollinated progenies of germplasm accessions were established to increase the genetic diversity of breeding lines, and to develop potential VP cultivars.

- Under the Estate Cultivar Selection Scheme, plants, raised from seedling selections made from Labukelle Estate, were established in the field for evaluation.

- Eighty-four promising seedling selections were made from the old seedling block on Fairlawn Estate, Maskeliya, with the aim of incorporating a diverse collection to the existing germplasm, and also to select potential VP cultivars suitable for the Upcot area.

- A preliminary selection of potential seed cultivars for the low-country region was completed.

- An extensive evaluation was undertaken to determine the existence and assess the availability of *ex-situ* gene banks, at various regional Centres and at St Coombs, according to the original conservation inventory.

- The inspection of ADB mother-bush sites located at the Institute's Centres, and at regional stations of the TSHDA, was initiated. Ten ADB mother-bush sites were evaluated to monitor the performance, purity and identity of cultivars in the mother bush blocks.

- New evaluation trails were established, three on St Coombs Estate, one on St. Joachim Estate, and one at the Institute's Kottawa Centre.

- Three research articles were published.

1. Research Activities (see Corporate Plan)

Thrust A 1. Development of VP cultivars for the up country.

1.1. Project A 1.1. Evaluation of VP cultivars for the up country.

A total of 468 accessions are currently under evaluation in Phase I and Phase II trials, in the up-country region.

Evaluation of Accessions: Phase I

Two hundred and ninety-eight accessions are currently under evaluation in the Phase I trials in the up-country region. VP 75 and VP 76 trials were terminated after selecting promising accessions for establishment in the Phase II trials.

Evaluation of Accessions: Phase II

One hundred and seventy accessions are currently under evaluation in the Phase II trials in the up-country region.

A new Phase II evaluation trial was established at St Coombs, Field No. 13, in June, using promising selections made from the trials VP 71, VP 72 and VP 73.

Evaluation of Accessions: Phase III

Evaluation of TRI 3000- and 4000-series cultivars in Venture Estate, Norwood.

This evaluation trial was terminated and handed over to the estate, after recording yield for a three-year period in the 2nd cycle. Data showed that TRI 4071 gives constantly higher yields under organic conditions. TRI 3019, 3016 and 4006 recorded higher yields than the standard cultivar, TRI 2025, while TRI 3069, 3015, 3017, 4063, 3020 and 3073 recorded higher yields than the standard cultivar, N2 (Norwood 2).

1.2. Project A 1.2. Screening accessions for shot-hole borer, blister blight, stem canker and Poria.

Shot-hole borer

Arrangements were made to carry out evaluation of accessions in the following plant-breeding trials, for shot-hole borer-resistance or susceptibility, with the Entomology Division.

Phase I trials: VP 75, 76, 82.
Phase II trials: VP 80.
Phase III trials: Venture Estate and Stockholm Estate.

Blister blight

Accessions in phase I and II trials (VP 71, 72, 73, 80 and 82) were screened for blister blight by the Pathology Division.

Poria

Shoots of the following cultivars were issued in October to the Pathology Division, for screening for Poria:

TRI 3013, 3015, 3020, 3072, 3073, 4053, 4071 and 4078.

1.3. Project A 1.5. Screening accessions for quality.

VP 81. Testing for quality of accessions was commenced in collaboration with the Biochemistry Division. Samples for quality assessment were continued, and all accessions (21 Nos.) were completed for first-round quality screening along with the standard cultivar, DT 1, from 12th March to 30th June.

A second batch of samples for quality assessment was undertaken, and samples from 21 accessions were issued to the Biochemistry Division.

1.4. Project A 1.6. Screening accessions for nematodes.

Cuttings of the following 32 accessions from VP 80 were issued in September to the Entomology Division for screening for nematodes: VP 80/5, 15, 20, 21, 22, 24, 35, 39, 40, 43, 50, 53, 88, 89, 99, 101, 110, 189, 190,193, 208, 210, 213, 215, 216, 225, 230, 272, 497, 498, 557 and 582.

Shoots of cultivars TRI 3016, 3047, 3072, 3073, 4014, 4046 and 4049 were also issued to the Entomology Division for nematode screening.

Thrust A 2. Development of VP cultivars for the mid-country wet zone.

1.5. Project A 2.1. Evaluation of cultivars for the mid-country wet zone.

Regional evaluation of TRI 3000- and 4000-series cultivars in phase III trial at the TSHDA, Sooriyagoda

Recording of yield in this trial was terminated in February, 2003, and the bushes were pruned. Before pruning, arrangements were made to assess cultivars for shot-hole borer with the Entomology Division. After these assessments, the plots were handed over to the TSHDA, Sooriyagoda for use as mother-bush plots.

No evaluation trials are being conducted, except for the propagation of cuttings of selected accessions from LVP 73, in order to establish an evaluation trial in the mid-country.

In order to establish phase II evaluation trials in the mid-country, cuttings of the following 30 selected accessions, from VP 80 and LVP 75, were propagated in the Institute's mid-country nursery.

VP 80/5, 15, 22, 24, 88, 89, 99, 582.

LVP 75/1, 4, 10, 11, 12, 29, 57, 62, 89, 107, 131, 133, 139, 142, 146, 151, 163, 294, 613, 10/1, 12/11, 23/5.

Thrust A 3. Development of VP cultivars for the mid-country semi-dry zone (Uva).

1.6. Project A 3.1. Evaluation of cultivars for the mid-country semi-dry zone.

Of the 57 accessions, which are under evaluation in phase I and phase II trials in the Uva, six were found to be promising when compared to the standard cultivars.

Thrust A 4. Development of VP cultivars for the low country.

1.7. Project A 4.1. Evaluation of cultivars for the low country.

Evaluation of 377 accessions in phase I and II in the low country has been continued.

Observational trial, Kottawa

Promising cultivars selected from LVP 74, Deniyaya, have been established for a large-scale observational trial at the Institute's Kottawa Centre, with a view to selecting suitable cultivars for conditions prevailing in Kottawa.

Seven cultivars, namely LVP 74/01, 59, 85, 93, 168, 195 and 278, were established (130-200 plant blocks), together with the standard cultivars, TRI 2026 and 4042.

1.8. Project A 4.2. Evaluating accessions for resistance to LCLWT, stem canker and SHB.

Macrophoma canker

Accessions in phase II trials of LVP 74, Deniyaya, and LVP 75, Ratnapura, were assessed by the Pathology Division for Macrophoma canker.

Low-country live-wood termite and shot-hole borer

Accessions in LVP 74 and LVP 75 were screened for LCLWT and SHB by the Entomology Division.

1.9. Project A 4.4. Evaluating accessions amenable to mechanical harvesting.

A study was initiated to evaluate the suitability of new accessions for mechanical harvesting, with the collaboration of the Agronomy Division. Fifty high-yielding accessions in LVP 73 were evaluated under this project.

Thrusts A 5 - A 8. Development of biclonal and polyclonal seed cultivars.

1.10. Evaluation of seed cultivars for the different regions.

The performance of the seed stocks in the four field-trials established during 2000, in the different regions, has been monitored with the aim of developing seed cultivars.

1.11. Project A 5.1. Development of seed varieties for the up country.

Evaluation of seed progenies, Field No. 6, St Coombs Estate, 2000.

Yield recording of 11 seed stocks in the up country was continued over a year.

According to the first-year average yield data, only one, polyclonal seed cultivar gave better performances than the standard VP cultivars, TRI 4006 and DT1.

1.12. Project A 6.1. Development of seed varieties for the mid-country.

Evaluation of seed progenies, Field No 6, Mid-Country Centre, Hantane, 2000.

Yield recording of nine seed stocks under evaluation at Hantane, in the mid-country, commenced in January.

1.13. Project A 7.1. Development of seed varieties for the mid-country semi-dry zone.

Evaluation of seed progenies, Uva Centre, Passara, 2000.

Yield recording of seed stocks under evaluation in the Uva commenced in May.

Evaluation of new seed progenies

At the Uva Centre, Passara, germination rates of seed material, from seed gardens at Reucastle, Rambukkanda, Halpe and Salawa, were assessed as a preliminary measure in testing their performance as potential seed cultivars for the Uva region.

Evaluation of the performance of seed stocks planted by estates

Aislaby Estate

A detailed inspection of the demarcated seedling blocks in Field Nos. 2 and 12 of Aislaby Estate, which is being used to record the commercial yields of seed cultivars, was carried out.

It was found that almost 51% of the bush stands consisted of VP cultivars, and so the evaluation of yields of seedling blocks was terminated.

1.14. Project A 8.1. Development of seed varieties for the low country.

Evaluation of seed progenies, Field No. 2 , St. Joachim Estate, Ratnapura.

Yield recording of 11 seed stocks, and three VP cultivars (TRI 2023, TRI 4046, DG 39) as the controls, was continued for the 2nd year of the 1st cycle.

Average yield data collected over a two-year period showed that none of the seed cultivars were better than the VP cultivars, TRI 2023 and TRI 4046, used as controls. In contrast, some seed cultivars, such as Salawa, Karadupona, Halpe, St Coombs and Reucastle seed progenies, showed significantly higher yields than DG 39, which was also used as a control.

1.15. Project D 1. Use of *in vitro* techniques.

The following experiments were terminated, and the protocol developed in relation to each study was documented.

(a) Development of the embryo-rescue technique, and the monitoring of fruit development to aid embryo rescue.

(b) Culture of immature embryos.

(c) Callus culture.

(d) Anther culture.

Quantification of shoot multiplication rate in stem nodal explants

Nodal explants of TRI 2025 and DG 39 were used in the study. The results showed that the two cultivars responded differently, in relation to their growth response to the established culture medium. Incorporation of Cefatoxim, into the normal surface-sterilization mixture, improved the survival rates of established nodal explants.

Production of artificial seeds

A protocol was perfected for encapsulation of isolated zygotic embryo axes, with alginic acid as a matrix, in combination with $CaCl_2$. Encapsulated embryos were stored at low temperatures for a six-month period, and the ability to germinate, on media supplemented with growth regulators, is being tested, in order to determine if there is a possibility of using this technique in the preservation of genetic resources, or hybrid-seed material *in vitro*.

2. Activities for Generating Information for Plant Breeding Programmes

2.1. Germplasm

(a) A survey was undertaken to assess the existence of accessions in *ex-situ* gene banks at St Coombs and Passara, according to the original conservation inventory. A total of 565 accessions have been conserved at St Coombs (472 Nos.), St Joachim (228 Nos.), Passara (120 Nos.) and Kottawa (70 Nos.).

An inventory of germplasm accessions at three regional Centres and at St Coombs was prepared, and all available information on evaluated traits were documented in a preliminary form for 381 accessions.

(b) Twenty-two open-pollinated seedling progenies derived from accessions in an *ex situ* gene bank was planted in Field No. 13 at St Coombs Estate in August.

Another 73 progenies, raised from open-pollinated seeds of some *ex-situ* gene bank accessions, were established in the nursery for further evaluation in field-evaluation trials.

(c) New genetic materials were introduced to the existing germplasm. These were received from a former member of the International Camellia Society.

(d) A study was commenced to develop a model for categorization of germplasm accessions conserved in an *ex situ* gene bank in the low country, at Ratnapura. This study is being continued, and the data collected is being subjected to analysis.

(e) Observations on the flowering behaviour of the germplasm accessions at St Joachim were started, and these are to be continued throughout until November, 2004.

2.2. Controlled-Hybridization Programmes

Over 200 crosses, involving different parental combinations, were carried out in the up country, commencing from December 2003.
A controlled hybridization programme was also initiated this year in the low country, at Ratnapura, and was continued almost throughout the year. Over 6,500 single and poly-crosses were carried out using selected parental combinations having desirable characteristics, aimed at generating improved VP cultivars for future plant breeding programmes.

Studies to increase the effectiveness of the controlled-hybridisation programmes.
The success of hybridization programmes depends on the availability of cultivars with synchronized flowering patterns, and the use of pollen in the appropriate stage in controlled-pollination experiments. Hence studies were undertaken to study the following.

(a) Observations on synchronization of flowering in tea cultivars.

Observations showed that there is high variability among the cultivars studied in terms of their flowering and fruit-set patterns.

(b) The optimum anther dehisicion stage of tea cultivars.

Significant variations were observed in pollen viability among different cultivars, as well as among their development stages. Results revealed that the optimum stage to collect pollen varies with the cultivar. Hence, the stage of flowers or flower buds, used to collect pollen for hybridization, in all cultivars would not be the same. It is therefore necessary to select the appropriate bud or flower stage, depending on the parental cultivar, to collect mature pollen for effective controlled pollination.

2.3. Alternative Selection Indices in Tea

Data from two phase II trials in the up- and low-country regions (VP 80 and LVP 75) were analyzed to determine the relationship between pruning weight, annual yield and average yield in young tea. A positive correlation between pruning weight and average yield in the first cycle was observed. Correlation coefficients were significant in both trials.

2.4. Establishing Early Selection Criteria for Quality Traits

A preliminary identification of tea accessions with quality attributes is essential, for narrowing down the number of accessions to be established in the subsequent phases of evaluation. The possibility of distinguishing morphological characteristics, which help in identifying tea cultivars capable of producing quality, was therefore an important factor to be considered during preliminary selection.

A study was undertaken to find morphological markers related to quality characters, using known high-quality cultivars (N2, DT 1, TRI 777, TRI 62/9 and TRI 4067) and poor quality cultivars (TRI 2023, TRI 2025, TRI 3013, TRI 4052 and DN). In the dendrogram developed using the quantitative morphological parameters studied (pubescence, number of active shoots, number of dormant shoots, terminal-bud length, number of buds per gramme, inter-nodal length, dry weight of harvested buds, second-leaf colour and petiole pigmentation), it was found that two prominent clusters were present. The cultivar, DN, was clustered in the cluster formed from quality cultivars. All the other poor-quality cultivars formed another, separate cluster, suggesting the possibility of using this method in the preliminary selection of quality cultivars in breeding programmes.

2.5. Establishing Seedling Populations for the Identification of Molecular Markers for Blister Blight

A population of TRI 2043 x TRI 2023 was segregated.

Seedling progeny was established in Field No. 13, St Coombs Estate, in July. Plants were established in a single-plant randomization design, 50 plants per each parent in three blocks. The cultivars TRI 2023 and 2043 were planted as standard cultivars.

2.6. Polyploid Breeding

Monitoring the performance of, and morphological differences between, 17 colchicine-treated TRI 2027 plants were continued in Field No. 9, St Coombs Estate.

2.7. Mutation Breeding

Open-pollinated seeds were irradiated at dosage rates of 0.5 kr, 1 kr, 2 kr and 2.5 kr. Seeds were planted in sand beds, and germination and morphological changes are being recorded. In general, significant reduction in plant height and survival rate was observed in seedlings derived from treated seeds, as compared to the controls.

Plants raised from VP cuttings of TRI 2025, exposed to gamma rays at 5.4 kr, were planted in the field along with untreated plants. Assessments of the morphological characters, such as plant height, number of leaves, number of branches, mortality rate and morphological aberrations, are being recorded once a month commencing from July.

Another 1,200 cuttings of TRI 2025 and DG 7 were exposed to gamma radiation to induce mutations.

2.8. Performance Evaluation of Cultivars, and Confirmation of Cultivar Identity and Purity, at ADB Mother-Bush Sites

A programme was initiated to assess the performances of cultivars established at various ADB mother-bush sites, and to confirm the identity and purity of the cultivars established. Under this programme, five sites at the Institute's Centres (St Coombs, Ratnapura, Passara, Hantane and Kottawa), and five sites at TSHDA Regional Centres (Tisapane, Sooriyagoda, Nelligolla, Hali-ela, Bandarawella and Mawarala), have been completed this year, and reports were submitted to the Institute's ADB Mother Bush-Project Coordinator.

2.9. Survey on the Spread and Popularity of TRI 3000- and 4000-Series Cultivars on Tea Plantations

A survey was conducted to generate the following information, with regard to the issuance of planting material by the Institute, to end-users in the corporate sector.

(a) The awareness and popularity of the TRI 3000- and 4000-series cultivars among end-users.

(b) A collation of the necessary information for setting up breeding targets in developing future cultivars for commercial exploitation.

(c) An analysis of the spread of the new cultivars distributed to the corporate-sector estates.

Estates in the Uva region were used as a target group. The results revealed that most of the cuttings issued by the Institute have not been utilized effectively in establishing the estates' own mother-bush blocks, and that most of the end-users' preferences are still a few of the estate cultivars. Further, it has been revealed that planting material was used for infilling purposes, and the elite cultivars issued have not been planted separately. As such, end-users were unable to comment on the performances of these cultivars. This may be the reason for their not being able to identify the most suitable cultivars for their specific localities.

This survey was carried out in collaboration with the Institue's Passara Centre.

3. Estate Cultivar Selection Programme

Seedling Selections from:

(1) Labukelle Estate

Of the 23 selection made and propagated in the nursery, 12 selections were planted in Field No 13, St Coombs Estate, in a phase I trial (10 plants per selections in two replicates, with TRI 2025 and PK 2 as control cultivars).

(2) Liddesdale Estates

Plants raised from seedling selections, made from Liddesdale Estate, were found to be not ready for planting in the field this season.

(3) Fairlawn Estate

Eighty-four promising seedling selections were made from the old seedling block on Fairlawn Estate, Maskeliya with the aim of incorporating a diverse collection

to the existing germplasm, and also for selecting potential VP cultivars suitable for the Maskelliya region.

4. Seed Tea Reserves

The 'Tea Reserve' concept has been introduced to the plantation sector with a view to preserving valuable genetic material *in situ* (that is, on estates).

Under this programme, 10 locations in eight estates belong to Horana Plantations Ltd., were identified, and measures taken to preserve valuable germplasm on these estates (Bambarakelle, Eildon Hall, Tillicultry, Gouravilla, Stockholm, Mahanilu, Fairlawn and Alton Estates).

Locations suitable for establishing Tea Reserves were identified, and promising bushes were selected for raising as seed bearers. Another Tea Reserve was earmarked at Millakanda Estate, Bulathkohupitiya, in an abandoned tea land.

5. Seed Gardens

Seed gardens in the low country

Most of the seed gardens established previously in the low country were revived for use in future plant breeding activities.
Various cultural practices, such as removal of unproductive branches and fertilizer application, were undertaken with the assistance of the respective estates. Follow-up visits were made to monitor the seed-setting of parental cultivars, and to collect seeds from different sources.

Micro-seed garden

One micro-seed garden, with a parental combination of TRI 4049 x TRI 3072, at the Institute's Kottawa Centre, was re-supplied in November.

Seed garden at St Coombs Estate

Vacancies that arose in some clonal rows in the seed-bearer plot in Field No. 8, St Coombs, were replaced by three new cultivars, namely TRI 4006, PK 2 and N 2.

6. Issuance of Planting Material

Up-Country

A total of 2,230 shoots of TRI 3000 series cultivars, and 18,980 shoots of TRI 4000 series cultivars, was issued from the Plant Breeding Division's mother-

bush blocks at St Coombs, to the estate and the small holder sectors. Issuing of shoots for the Tea Development Project, funded by the ADB (Asian Development Bank), was almost completed according to schedule, 3,000 shoots of TRI 4000 series cultivars being issued .

Low Country

About 1,800 shoots (approximately 9,000 cuttings) of 3000- and 4000-series clones were supplied to the small holders in the low country, and about 3,060 shoots (approximately 15,000 cuttings), were supplied to the ADB Project for the establishment of large-scale multiplication blocks.

7. Other Divisional Activities

7.1. Review of Research Programmes

The research programmes of the Division were reviewed, with the participation of the Plant Breeding staff, on 18th December.

7.2. Training Programmes, Workshops and Appointment

One officer was awarded a fellowship, to follow a 10-weeks training programme on Sustainable Agricultural Development at Wageningen, the Netherlands, starting from the 28th April.

Another five officers attended various training programmes and workshops.

A senior scientist of the Division was appointed to the National Committee on Plant Breeders and Biotechnologists, by the CARP, with effect from January.

7.3. Publications

Ranathunga M A B and Gunasekare M T K, 2003. A comparative assessment of some morphological and anatomical attributes to identify markers for screening polyploidy genotypes of tea (*Camellia sinensis* L.). Sri Lanka J. of Tea Sci. 68 (1), 12-19.

Gunasekare M T K, Ratnayake M and Ratnagoda B A, 2003. "Tea Reserves": Preserving the old seedling tea. TRI Update 8 (1).

Gunasekare M T K and Ranathunga M A B, 2003. Polyploidy in tea (*Camellia sinensis* L.) and its application in tea breeding: A Review. Sri Lanka J. of Tea Sci.68 (II) (In press).

7.4. Training Programmes for University Students

One post-graduate candidate continued her research work for the Ph.D. degree.

One undergraduate from the Sabaragamuwa University underwent a six-months Industrial Training programme in the Division.

One undergraduate from the Faculty of Agriculture, University of Peradeniya, commenced a final-year research project in the Division in October.

7.5. Familiarization Programmes and Demonstrations

Familiarization programmes on plant-breeding activities were conducted for Assistant Superintendents and Planter Trainees, from various plantation companies and estates, by Divisional staff.

Discussion and demonstrations on plant-breeding activities were conducted for various officials, both local and from overseas.

7.6. Identification Services

Staff of the Division offered their services for identification and correct labelling of cultivars to four estates.

7.7. Correspondence

The Division corresponded 79 times with growers and others on various matters.

7.8. Re-structuring of the Division

The Plant Propagation and Plant Breeding Division was re-structured, and re-named the Plant Breeding Division. Activities related to plant propagation have been amalgamated with the Plant Physiology Division.

PLANT PATHOLOGY DIVISION

Head - A. Balasuriya

Research Activities (see Corporate Plan)

1. Project A 1.2. Screening for resistance, up country

Screening for resistance to *Poria*

PP/POR1/03. Screening of new cultivars for resistance or susceptibility to *Poria* root disease (St Coombs Estate)

Objective: To screen new clones which are to be released by the Plant Breeding Division, for resistance/susceptibility to *Poria* root disease, as a serialised activity.

A new series of screening was started in October, using both pits. In pit No. 01, the cultivars, TRI 4071, 4078, 4053 and 3072, are being tested alongside TRI 2025. In pit No. 02, the cultivars TRI 3020, 3015, 3013 and 3073 are being tested also, alongside TRI 2025. Inoculation of the plants with the root pathogen, *Poria hypolateritia,* was done two months after planting. *Poria hypolateria* was mass-multiplied in sawdust before introduction into the pits.

Screening and selection for resistance to blister blight

PP/BB1/03. Assessment of progenies on their resistance or susceptibility to blister blight leaf disease under nursery conditions (St Coombs Estate)

It was found that the progeny coming from the TRI 2043 female parent comprised more individuals (54.4%) that did not have any blisters at the time of testing, than did the progeny of the TRI 2023 female parent (33.9%).

The average blisters number of per plant were also less in the TRI 2043 progeny (4.8%) than in the TRI 2023 progeny (7.3%).

PP/BB2/03. Screening of lines or cultivars for their resistance or susceptibility to blister blight leaf disease (Phase I and Phase II trials, St Coombs Estate)

Objective: To screen tea accessions from existing Plant Breeding trials with a view to rating them for resistance or tolerance to blister blight.

Completed assessing lines or cultivars using the total blister count on 2nd leaves in four Phase I trials (VP71, VP72, VP73 & VP82) and two Phase II trials (VP80 & VP81).

Based on their proneness to infection by blister blight, guidelines were prepared and communicated to the Plant Breeding Division, indicating their suitability for given areas.

PP/BB3/99. Selection of OST bushes for their resistance to blister blight disease (Diyagama East Estate)

Objective: To select tea bushes from existing old seedling teas that show good resitance or tolerance to blister blight, with a view to recommending them to the Plant Breeding Division for inclusion in their breeding programmes.

Out of the 17 lines or bushes selected and screened, mainly for tolerance to blister blight, and secondly for other bush characteristics, eight were selected for field planting for further evaluation. These plants are being maintained by the estate, under supervision by the Plant Pathology Division.

2. Project A 4.2. Screening for resistance, low country

Screening and selection for resistance to *Macrophoma* canker disease and wood rot.

PP/MC1/00. Selection of OST bushes for their resistance to *Macrophoma* canker (Hulandawa Estate, Akuressa).

Objective: To select tea bushes from existing old seedling teas that show good resistance or tolerance to *Macrophoma* canker and frame debilitation, with a view to recommending them to the Plant Breeding Division for inclusion in its breeding programmes.

Out of the 10 lines or bushes selected and screened, mainly for the tolerance of canker, and secondly for other bush characteristics, five were selected for field planting for further evaluation. These plants are being maintained by the estate, under supervision by the Plant Pathology Division.

PP/MC1/03. Screening of lines or cultivars for their resistance or susceptibility to *Macrophoma* canker in Phase II trials (low country)

Two assessments were completed during the period under review, namely 2/ LVP30/LC at the nursery site in Deniyaya, and LVP/75 in St Joachim, Ratnapura. The ratings were communicated to the Plant Breeding Division.

3. Project A 23.1. Screening and evaluation of biological control organisms

Objective: To screen and evaluate naturally-occurring microorganisms from Sri Lankan tea soils as regards their ability to suppress some of the common root diseases of tea, with a view to reducing the usage of fungicides.

Biological control of root and stem diseases of tea

Several antagonistic fungi and bacteria were isolated from tea soils, both from the up country and the low country. Their antagonistic potential against the root pathogens was tested under *in vitro* conditions. Among these fungi and bacteria, *Trichoderma* spp. gave the best control over most of the root pathogens (*Poria hypolateritia*, *Rigidoporus microporus* and *Phellinus noxius*). A strain of *Trichoderma harzianum*, isolated from tea soils, was found to be the most potent among the antagonists tested for the control of root-disease pathogens. These were also tested successfully against *Macrophoma theicola* (stem and branch canker) and *Maramius equicrinis* (horse-hair blight).

PP/BC1/02. A pot experiment to test the efficacy of saprophytic organisms in the control of *Poria* (Glass-house, St Coombs Estate)

The clone TRI 2025 was used with the saprophytic fungi, *A. niger*, *T. pseudokoningii* and *P. aurantiogriseum,* singly and in all combinations, together with a control. The second application of treatments (approximately 10^5 spores ml^{-1}), using the same organisms was completed. This is still under observation.

PP/BC2/02. Bulking and storage of potential antagonists (laboratory testing)

The antagonists were made into commercial preparations, for testing as regards shelf life and field applicability.

4. Project A 23.2. Screening and multiplication of VAM

Objective: To determine the best possible combination of plant/potting-mixture medium for the multiplication of VAM under local conditions, with a view to introducing it in planting holes of tea for multiple benefits.

Two local grass species, *Elusine coracana* (Kurakkan) and *Panicum miliaceum* (Meneri), were tested for their adaptability to the area and, most importantly, their inherent capacity to harbour and nurture the VAM infections. The root infections were associated with spore counts of 40 and 77, and 1196 and 508, respectively.

E. coracana had a delayed start but was then followed by a faster growth rate, compared to *P. miliaceum*.. Using a mixture of the two species should increase the potential for multiplying the inoculum in a future inoculum-bulking process.

5 Project A 23.3. Role of VAM in reducing root-disease incidence and as a mineral-nutrient improviser

Objective: To assess the impact of introducing VAM in nursery bags on the rate of success, rate of growth and on the disease incidence of tea during its early establishment.

Three previously-tested plant or weed species (*Centella asiatica, Browallia americana* and *Alternanthera dentata*) were used to multiply the VAM inoculum to be incorporated in tea nursery bags.

In preparing the inoculum, both sieved rhizosphere soils and macerated roots of the three plant species were composited. Three levels of this inoculum were used in tea nursery bags.

Five tea cultivars (TRI 3016, 3972, 4052, 4067 and 4071) were selected for the experiment. The cuttings are raised in the nursery.

Initial values of the following parameters were recorded at the beginning of the experiment: the VAM spore count, the nematode count, the soil pH, and the percentages of soil N, P, K and C.

6. Project D 21. Leaf disease control

PP/BB/03/03. Blister blight control using fungicides (Field No. 13, St Coombs Estate)

The treatments used were tridemorph (0.05%), bitertanol 0.05%, F-500 (0.05%) and the control (no fungicide).

Natural infection levels were not maintained at high levels for most part of the test period. However, the available data revealed that the new fungicide, F-500, at 0.05% was performing better than the others in controlling blisters. Shaded columns indicate the second week after spraying.

7. Project D 22. Stem Disease Control

Wood rot control trials

PP/WRG1/03. Testing of RRI latex-bitumen protective paint (St Coombs)

Objective: To study the efficacy of protective paints in reducing the die-back of snags after pruning, and their development into wood rots.

A latex-bitumen mixture, developed by the Rubber Research Institute, was amended with different concentrations of hexaconazole (Contaf), for application on pruning cuts as a protective paint. Initial results showed that latex-bitumen mixture, amended with 0.1% hexaconazole, resulted in more buds in close proximity to the cut end, thus reducing the volume of snags that will eventually die off.

Observations will be continued throughout the pruning cycle in order to evaluate the final contribution of the mixture.

PP/WRG1/99. Replicated experiment to assess the effect of different protective paints in reducing the extent of wood rot (St Coombs, Field No. 8)

Objective: Since pruning cuts serve as one of the main focal points in wood rotting, different protective paints were used in order to establish a suitable method to quantify such decay, under different treatments.

There was no new activity in this trial, as the next round of wood-rot assessments can commence only after pruning which is now being awaited.

PP/WRH4/96. Observational experiment on training of the bush frame (Nuwara Eliya Estate, Oliphant Division)

Objective: To discourage new shoots arising at or near ground level of the bush, by their periodic removal while they are still tender. In this manner, it is intended to maintain clearance from ground to the branching-off point (the 'neck effect'), so that in the event of any future infection by *Hypoxylon*, the total infection could be removed through the process known as rejuvenation pruning.

This trial was visited on six occasions during the year, and the necessary treatments were effected. There is no sign of any *Hypoxylon* stem blight infections as yet.

8. PROJECT D 23. Root Disease Control

PP/RDC1/02. Field testing of new or revised systemic fungicides in the control of *Poria* root disease (Lankaberiya Estate, Ittakanda)

This trial was initiated in June 2002. Eighteen naturally-infected patches were selected for six treatments (Thungala Division, Field No. 8). The treatments were five fungicides and the control.

This trial had to be abandoned as the trial area became inaccessible after bad weather experienced in the area.

9. Project D 25. Miscellaneous Activities

9.1. The horse-hair blight (HHB) problem in the low country

PP/MSC/02/02. Horse-hair blight control trial, using hydrated lime and fungicides (Silvery Estate (Pvt), Nagoda)

Objective: The reason for HHB in the low country is believed to be due to lack of cleaning of the bushes following pruning. Spraying of hydrated lime has been advocated to remedy this situation in the past. This is now being re-tested, along with other treatments. A new hypothesis, that spores carried by flood-water start fresh populations, is also to be examined.

The treatments were repeated once, following heavy floods experienced in the region.

9.2. The TRI 2025 Die-Back Syndrome (the 'High Forest problem')

Objective: To identify the cause of the problem, with special reference to any possible microbial involvement, and a possible interaction with environmental factors and the physiological condition of the tea bushes.

During the eight months under investigation in the Nuwara Eliya Estate, the affected area expanded by 129.75 m^2. A distinct increase in the rate of spread was observed during drier months, indicating a significant relationship between the spread of the disease and environmental stress. The rate of spread of the disease was also higher with low RH and rainfall. It was also found that the spread followed the direction of the wind, leading to the conclusion that it could be airborne.

Pantoea agglomerans (*Erwinia herbicola*) of the Family Enterobacteriaceae, a Gram-negative rod, was repeatedly isolated from the xylem sap of diseased bushes and in the dew samples collected from the leaves. The sap of healthy-looking bushes, upon incubation for over 72 hours, developed traces of the same bacterium.

Stem-section analysis of the cultivar showed that there is significant xylem blocking in diseased plants, which is increased when the symptoms are more severe. *P. agglomerans* is known to produce high molecular weight, extra-cellular polysaccharides, and some strains are capable of causing frost damage with ice-nucleating properties. Therefore, it can be assumed that colonization by *P. agglomerans* is the cause for the blockade and the resultant die-back problem.

It is further concluded that this bacterium is a secondary colonizer of stressed plants. Thus, it is imperative to recognise this syndrome of the cultivar TRI 2025 at higher elevations as a stress-driven disease, in which the bacterium, *Pantoea agglomerans*, plays a significant opportunistic role.

9.3. Smut of *Panicum repens* (couch grass)

PP/MSC/01/02. Biological control of couch grass (St Coombs, Field No 10)

Objective: A natural fungal infection of *Panicum repens* was found to occur in and around St Coombs Estate. Since this fungus, *Ustilago digitariae*, causes a smut of the *P. repens* panicle, it could prove useful for the biological control of the weed in tea plantations.

It was intended to test and quantify the significance of this phenomenon as a biological weed-control tool. However, the trial had to be abandoned owing to disturbance by intruders. It will now be relocated, possibly as a pot experiment, near the glasshouse where more protection is available.

9.4. Made Tea Quality

Eighty samples were analysed for total plate counts in the Microbilogy Department of Kelaniya University. Thirty samples were analysed for total coliforms and *Escherichia coli*, out of which 12 were positive for coliforms and two for *E. coli*.. Eighteen samples were analysed for species of the *Salmonella* bacterium, with negative results.

Of the moulds, species of *Aspergillus* and *Penicillium* were prominent. There were also other species like those of *Pestalotia, Mucor* and *Fusarium*. Among these, *Aspergillus* species may be a reason for concern because of the ability of some of its strains to produce aflatoxins.

It was observed that, although high levels of moisture in made tea often yield high counts of microbial colonies, moisture levels are not necessarily a prerequisite for such counts. Moisture levels as low as 3-4 % sometimes gave high counts, probably owing to unhygienic exposure of the product during processing.

Analysis of samples will continue depending on manpower availability. A fresh lot of 26 samples have been collected from brokers to add to the data base.

Using the data generated so far, and the limits fixed by some importing agencies, the Division is presently suggesting maximum allowable mould levels of 1000 cfu/g, and total aerobes at 5000 cfu/g.

Testing of made-tea samples sent by the Tea Commissioner

More recently, the Tea Commissioner has started sending questionable samples for analysis and report on microbiological levels. This has resulted in the analysis of 37 samples with the reports leading to about 10 rejections.

9.5. Identification of organisms

Altogether, 10 samples were sent to the CABI Bioscience Centre in the UK for identification. Six samples were identified to species level (*Pantoea agglomerans, Trichoderma harzianum, Aspergillus flavus, A. tamarii, A. niger* and *Paecillomyces variotii*), and four up to genus level.

Publications

1. Edirisinghe C, Balasuriya A and Abeysinghe D C, 2003. The extent, severity and the major contributory factors that influence the Horse Hair Blight (*Marasmius equicrinis*) of tea in Galle District of Sri Lanka. Proceedings of the 3rd Agricultural Research Symposium, Wayamba University of Sri Lanka, Makandura, 39-44 pp.

2. Udayangani W G N, Balasuriya A, Ratnayake R M A, 2003. Abundance of VAM in tea lands. TRI Update, Tea Research Institute of Sri Lanka, 8 (2) (short communication.)

3. Cooray B A P, Pradeepa N H L and Balasuriya A, 2003. The importance of natural control agents in the integrated management of major tea diseases. TRI Update, Tea Research Institute of Sri Lanka, 8(2) (short communication).

4. A guideline on the 'Management of Horse Hair Blight in the Low Country', in English and Sinhala, has been prepared for circulation.

Personnel

M r E M C S Edirisinghe resigned from the post of technical assistant at the end of January.

Mr C P Ranasinghe, post graduate student (MSc) from Kelaniya University (Department of Microbiology), Ms Sujeewa Ratnayake, undergraduate student from Peradeniya University (Faculty of Agriculture) and Mr Chaminda Edirisinghe, undergraduate student from Wayamba University (Faculty of Agriculture and Plantation Management) completed their research programmes in March and September, under the supervision of Dr Balasuriya.

Four in-plant trainees, Mr H M Dumindu, W M M P K Wanninayake (both from ATI, Naiwala), Ms I M D K Illangasinghe (ATI, Naiwala) and Mr U G K G Jayaratne (Hardy) were assigned to the division through the National Apprentice and Industrial Training Authority (NITA), for four months inJanuary and July respectively.

PLANT PHYSIOLOGY AND PROPAGATION DIVISION

Head - V. Shanmugarajah

Research Activities

1. Project B 11. Studies on Photosynthesis and Dry Matter Partitioning (see Corporate Plan)

Partitioning of assimilates in relation to aging of clonal tea in a pruning cycle (St Coombs Estate, 1992)

Variation of yield with age was investigated for two cultivars, TRI 2025 and DT 1, which have a different canopy architecture and leaf morphology. In addition, leaf area index (LAI) and rate of photosynthesis were measured, and the chlorophyll content of the leaves determined. Leaf fall was also monitored.

Comparatively, TRI 2025 gave a higher yield than DT 1, the highest yield being in the second year. The lowest yield, obtained during the fourth year in both cultivars, is significantly different from that in the other years.

In both cultivars, the lowest LAI obtained during the first year after pruning is significantly different from that in the other years. However, in TRI 2025, a significant difference was seen between the second and the third years only. In DT1, a significant difference was seen between the second and the third years, and between the third and the fourth years.

No significant difference in the rate of photosynthesis among the different years was observed in DT 1. In TRI 2025, a significant difference was seen only between the rates in the first and the third years.

In both cultivars, the chlorophyll content was high during the first and the fourth years. However no significant difference among the different years was seen.

In TRI 2025, the amount of leaves fallen during the first year is significantly lower than that during the other years. Though not significantly different from each other, the amount of leaves fallen during the first and the fourth years is less than that during the second and the third years in DT 1.

2. Experiments on shade effects and shade trees

2.1. Effect of shade on the yield of mature tea

The yields of tea under different shade treatments showed no significant difference.

2.2 . Photoinhibition of photosynthesis in tea

Physiological parameters were monitored in order to assess the photoinhibition in shaded and unshaded treatments. The tea bushes were subjected to three shade treatments: artificial shade (30% shade), no shade and shade (provided by the tree, *Grevillea robusta* L.).

A mid-day drop in the rate of photosynthesis was attributed to photoinhibition (PI) of photosynthesis. The rate of photosynthesis was significantly lower in the unshaded plants compared to that in the shaded plants ($p<0.05$). Moreover, unshaded leaves had a significantly lower fluorescence ratio (Fv/Fm) ($p<0.05$), at around 09:00 to 11:00 h local time, compared to shaded plants. This clearly indicates PI.

PI could also be observed on days with intermittent bright and cloudy conditions. On cloudy days, PI was not apparent. No relationship could be observed between a lowering in the rate of photosynthesis and the leaf temperature, and between stomatal conductance and leaf water potential. The yield, which is indicative of the ultimate effect of all the conditions throughout the year, was however significantly higher in the shade tree treatments. These data confirm the importance of correct adherence to the recommended shade tree management practices in tea, for obtaining higher productivity.

The experiment is in progress.

2.3. Possible alternative shade tree species

A comprehensive database of about 200 possible species that can be used as alternate shade species was developed based on canopy, leaf and root characteristics. Identification of the best species from this list and the feasibility of using these species in tea plantations based on physiological measurements are being studied.

2.3.1 Growth and yield of tea (TRI 2025) under medium and high shade at high elevation

Shoot growth and the yield in plots containing approximately 16 tea plants around the shade trees, *Erythrina lithosperma* and *Grevillea robusta,* L. and unshaded plots were monitored. The yields from January -December 2003 showed no significant difference between treatments.

3. Experiments on tea root physiology

The following experiments were carried out in order to gain a comprehensive understanding of tea root physiology.

Experiment 1. Root studies in young tea

Approximately one year-old tea plants (clone DT1) were established in rhizotrons, and treatments of different organic manure were imposed.

Experiment 2. Root studies in field-grown tea

Periodic root samples were taken from mature tea plants of the 'TRI-ORCON' organic vs inorganic long-term field experiment, in order to study the root physiology of field-grown tea.

The results of Experiments 1 are 2 are summarized below.

More roots penetrated into the deeper layers of the soil with organic management systems, but in conventionally-grown plants, more roots were present in the 0-15 cm depth. None of the nutrients was deficient in any of the treatments but, in the deeper layers of organically-managed soils, more nutrients were available than in conventionally-managed soils. The root-starch content too was higher in organically-managed plants than in conventionally-grown plants. However, the above-ground measurements did not show any significant differences between the treatments.

Further studies are in progress with young and mature tea with the objective of obtaining a better understanding of the physiology of the tea root system and rhizosphere interactions.

Experiment 3. Anatomical studies of tea roots

Root samples were taken from the 'TRI-ORCON' organic vs inorganic field experiment, in order to study possible anatomical changes in the roots of field-

grown tea under organic and inorganic treatments. Two different sizes of roots, with diameters of 1-2 mm (small) and 2-5 mm (large), were examined.

Organically-grown tea resulted in thicker cork layers and smaller xylem-vessel diameters and xylem-wall diameters. The thickness of the epidermal layer did not change owing to the management system. In smaller roots, the cork layer was significantly thinner when grown conventionally. However, this was not evident in the larger roots. The xylem-vessel diameter in larger tea roots was greater in conventionally-managed tea roots. The smaller roots did not show any difference between treatments. The thickest xylem-vessel walls were found in plants grown in tea waste, followed by plants grown conventionally, and plants grown in neem oil cake. The smallest thickness in xylem-vessel walls was found in compost-grown plants.

Further studies are in progress for obtaining a better understanding of the anatomy of the tea root system.

4. Tea leaf anatomy

Anatomical features and changes in the tea leaf according to cultivar, and according to some selected management practices, are being studied.

5. Studies on organic tea

5.1. Yield of organic tea vs conventional tea

The second year, following the first pruning of the 'TRI-ORCON' organic vs inorganic field trial, was completed. The yield showed no significant difference between the treatments.

Some plots were marked in an adjoining field on Mattakelle Estate, and planted with the same clone in the same year, with the objective of comparing the yield with that from conventional treatment.

5.2. Shoot- and root-growth in organic and conventional tea cultivation

Shoot- and root-growth, in relation to organic and conventional tea cultivation, are being studied with mature tea in the 'TRI-ORCON' organic vs inorganic field trial.

6. Studies on drought mitigation

Effect of foliar application of potassium on drought-tolerance of young tea

This study was initiated to identify the physiological impact of spraying K on the improvement of drought-tolerance of tea, and to determine whether there are differences in plant response to drought with K_2SO_4 and KCl spraying. One each of a drought-susceptible cultivar (TRI 2026), and a drought-tolerant cultivar (TRI 4046), were selected. KCl and K_2SO_4 were sprayed and the physiological changes monitored.

In water-stressed plants of both cultivars and both K treatments, LWP, photosynthetic rate, stomatal conductance Fv/Fm, and fluorescence yield decreased gradually with time.

The decrease in the LWP of KCl-sprayed plants was less than that in K_2SO_4-sprayed plants. The decrease in photosynthesis in KCl-sprayed plants was less than that in K_2SO_4-sprayed plants.

The highest total soluble-sugar content was observed with K_2SO_4 spraying, followed by KCl and no spraying at all. It was consistently higher in TRI 4049 than in TRI 2026.

As shown by measurements, the drought tolerance of TRI 4049 occurred mainly owing to osmotic adjustments.

Development of selection criteria for drought tolerance in tea

Cuttings of known drought-tolerant and susceptible cultivars were planted for use in these experiments.

7. Development and management of nurseries (see Corporate Plan)

7.1. Project A 38.2. Developing techniques for the production of quality bed plants

A trial was initiated in the nursery at the Kottawa station, in order to explore the possibility of producing good quality bed plants. The trial is of a split–split plot design, with four replicates. The treatments are (1) height of beds (6, 9 and 12 inches); (2) addition of amendments (compost, vegetation and sand); and (3) spacing of cuttings on the bed (2 and 4 inches).

Cuttings of the cultivar TRI 4042 are being used and the trial is now in progress.

7.2. Project A 38.8. Identification of graft combinations for different requirements

Identification of graft combinations for high quality and high yield

Three high-quality cultivars, TRI 777, 4067 and 4079, were grafted on to five high-yielding cultivars, TRI 2025, 3019, 3020, 4052 and 4053, in order to identify combinations combining high yield and high quality. The selected stocks have some other desirable characters not found in the scions. The method adopted was the grafting of fresh cuttings, and the grafts were raised under sealed polythene.

The combinations are: (1) TRI 777/2025, (2) TRI 777/3019, (3) TRI 777/3020, (4) TRI 777/4052, (5) TRI 777/4053, (6) TRI 4067/2025 (7) TRI 4067/3019, (8) TRI 4067/3020, (9) TRI 4067/4052, (10) TRI 4067/4053, (11) TRI 4079/2025, (12) TRI 4079/3019, (13) TRI 4079/3020, (14) TRI 4079/4052 and (15) TRI 4079/4053.

Casualties at six months after planting were slightly more than at three months. Three combinations (Nos. 10, 11 and 13) had no casualties, five combinations (Nos. 4, 6, 8, 14, 15) had less than 10 %, and one combination (No. 1) had more than 50 % casualties. The others had 11 – 30 % casualties.

At six months after planting, three combinations (Nos. 12, 13, 15) had more than 80 % casualties, and another three combinations (Nos. 2, 6, 14) had 71 – 80 % of the plants showing satisfactory growth of the scion. Five combinations (Nos. 1, 5 7, 9, 11) had less than 50 % casualties, and the others had 50 – 70 % plants showing satisfactory growth.

8. Studies on plant propagation

In order to hasten the process of grafting, a motorized scion-maker, and a mechanical device for making stocks, were developed with the help of the Mechanical Workshop.

9. Other studies on propagation

9.1. Effect of some growth substances on rooting of cuttings

Using cuttings of a moderate rooting cultivar TRI 4079, a trial was initiated to study the effect of four growth substances (Secto, an UPASI formulation, Clonex powder and Clonex gel) on the induction of roots. There were only a few casualties at the end of the first and second months. The trial is in progress.

9.2. Effect of age of bushes on growth of cuttings

Two trials, one in the up country and the other in the low country, were initiated to compare the growth of cuttings from bushes of different ages. Cuttings were obtained from bushes, which are one, two and three years of age, and from bushes in the multiplication plots. The cultivars used for these nursery trials are TRI 4052 in the up country (Mattakelle Estate, Talawakelle), and TRI 4042 in the low country (St. Joachim Estate, Ratnapura). No significant differences between the treatments were observed for the parameters studied, when the growth of cuttings in the up-country trial was assessed at three months after planting. The trials are in progress.

9.3. Effect of black polythene on the growth of cuttings

A trial established in the nursery at St Joachim Estate, Ratnapura to study the effect of black polythene on the growth of the cuttings of two cultivars, TRI 3025 and 4042, is in progress.

9.4. Observation trials

Studies were carried out to investigate the possibility of inducing early callusing, with a view to reducing the nursery period. In one trial, ten cuttings each were bundled together using rubber bands, and wet paper was wrapped around the stems of half the number of bundles. Each bundle was then put into a closed transparent or black polythene bag separately, and left in the dark on a bed of moist sand. High humidity was maintained around the bags by sprinkling water onto the bed.

The other trial also had the same treatments, but the cuttings used were obtained from ring-barked and etiolated shoots.

No satisfactory callusing was obtained in any of the treatments in both trials, and all the cuttings died in six weeks.

Publications

1. Mohotti A J, Wickremaratne D S D, Nissanka S P, Munasinghe P S and Hettiarachchi L S K, 2003. Effect of foliar applications of potassium on drought tolerance of young tea (*Camellia sinensis* L.). Proceedings of the 23rd Annual Sessions of the Institute of Biology, Sri Lanka, Abstracts of Scientific Sessions; 8-9.

2. Mohotti A J, Nalika Damayanthi, Tennakoon K T, Mohotti K M and Sangakkara U R, 2003. Anatomical differences of tea roots grown under organic and conventional management systems. Programme and Abstracts of the 3rd International Symposium on Dynamics of Physiological Processes in Woody Roots; 77.

3. Mohotti A J, Mahesha Vajirakanthi W M, Mohotti K M and Bandara Deepthi C, 2003. Growth and distribution of tea root system under organic and conventional management systems. Programme and Abstracts of the 3rd International Symposium on Dynamics of Physiological Processes in Woody Roots; 151.

4. Karunaratne P M A S, Mohotti A J, Nissanka S P and Gunasinghe W A D S K, 2003. Effect of shade in minimizing photoinhibition of photosynthesis of high grown tea (*Camellia sinensis* L. O. Kuntze) in Sri Lanka. Tropical Agricultural Research 15, 133-143.

5. Mohotti A J, Sithakaran V and Anandacoomaraswamy A, 2003. Physiological studies on the tea plant: Sri Lankan contributions. Accepted for publication in the Institute's Jubilee Volume.

Seminars and Workshops

1. V Shanmugarajah and A J Mohotti attended the Outward Bound Training held in Dambulla, July 18 – 20.

2. A J Mohotti attended the 3rd International Symposium on the Dynamics of Physiological Processes in Woody Roots, which was held in Perth, Australia in October – November 2003, and presented an oral paper entitled "Anatomical differences of tea roots grown under organic and conventional management systems", and a poster presentation entitled "Growth and distribution of tea root system under organic and conventional management systems".

3. A J Mohotti, N Damayanthi, R K Kudahettige and S Navaratne attended the 15th Annual Congress of the Post Graduate Institute of Agriculture, University of Peradeniya, held on 20 - 21 November 2003, at the PGRC, Gannoruwa.

SOILS AND PLANT NUTRITION DIVISION

Acting Head - A. K. N. Zoysa

General

The research focus of the Soils and Plant Nutrition Division is to establish and maintain optimum quantities of nutrients that are necessary to enhance yields and made-tea quality, whilst minimizing the harmful impact on soil and the environment. The Division also places emphasis on research and understanding of the mechanisms of plant-nutrient uptake, root mechanics, product development and soil fertility, which are issues important to the tea growing community.

Research Activities (see Corporate Plan)

Applied Research

1. Thrust A 15. Development of regional and site-specific fertilizer recommendations for improvement and productivity of made tea quality.

Characterization of soils to series level in the tea-growing areas of Sri Lanka.

A detailed description of the objectives, work, outcomes and publications is reported in the Institute's Annual Reports of 1996 to 2002. The field activities of the second phase on characterizing soils of the Intermediate Zone have been completed, and the results are now in the process of being produced as a publication.

Characterization of soils in the tea growing estates in the mid-country.

The objectives and a description of the work carried out were reported in the Institute's Annual Reports of 1996 to 2001. The soil physico-chemical parameters are being incorporated into maps.

Project A 15.2. Estimating crop response to macro-nutrients (N, K, Mg, S and P) at regional level.

Fertilization experiments

(a) Effects of application of different rates of N, K and Mg on growth, soil- and plant-nutrient status and yield.

Rates: N - 240, 420 and 600 kg ha^{-1} yr^{-1}
K_2O - 120, 210 and 300 kg ha^{-1} yr^{-1}
MgO - 60, 105 and 150 kg ha^{-1} yr^{-1}

(1) Clone PK 2, Field No. 15 B, Court Lodge Estate, Kandapola (1999)

There is no significant increase in yield from increasing rates of N in the 5th year. As in previous years, no significant effect on yield was seen from increasing rates of K and Mg. The increasing rates of N significantly decreased soil pH, at depths of both 0-15 cm and 15-30 cm. Soil Ex. K levels increased significantly with increasing rates of K at both depths. A significant decrease in Ex. Mg was seen in the current year at the 0-15 cm depth from increasing rates of N and K. However, Ex. Mg increased with increasing rates of Mg fertilizer.

Leaf N, K, Mg and Ca concentration, determined in the current year, showed that the leaf N concentration showed a significant increase only at the highest N rate. However, a significant reduction in leaf K and Mg was found at the highest N rate. With increasing rates of K fertilizer, N, K, Mg and Ca concentrations reduced, but this reduction was significant only at the highest K rate. With increasing rates of Mg fertilizer, leaf Mg and N concentration increased significantly, but they did not significantly change the K and Ca concentration in the leaf. The experiment continues.

(2) Clone TRI 2026, Field No. 1, Tokatiyamulla Estate, Galle (1999)

No significant increase in yield was found from increasing rates of N, K or Mg fertilizers. The soil pH significantly decreased in the 0-15 cm depth, when N and K rates increased to its highest rate. This could be due to acidification of the added nitrogen fertilizer, and also by the replacement of H^+ ions to the soil solution from soil colloids caused by the mass action of K ions at their highest rates. The increasing rates of N and K did not significantly reduce Ex. Mg concentration in the soil but, as expected, increasing rates of Mg fertilizer significantly increased the concentration of Ex. Mg in the soil.

The reason for the reduction of leaf N concentration, with increasing rates of N, could be the relative dilution of N in the tissues at high yields, in the highest N treatment. Increasing rates of N significantly decreased Mg and Ca in the leaf. The increasing rates of K fertilizer gave an increase in leaf K concentration. However at the highest K rate, leaf N concentration decreased significantly. As in the case of K, increased rates of Mg also increased leaf Mg concentration, but it decreased K and Ca concentration at the highest rate. The trial continues.

(3) Clone TRI 2027, Field No.8, Talgaswela Estate, Galle (1999)

The increasing rates of N, K and Mg fertilizer did not increase tea yields significantly in the first year after pruning. The trial continues.

(4) Clone TRI 2025, Field No.85, Houpe Estate, Kahawatte (1999)

The increasing rates of N, K and Mg fertilizer did not increase yields significantly. However, increase of K fertilizer rates from 120 to 210 kg ha^{-1} yr^{-1} increased yield, although a further increase of K to 300 kg ha^{-1} yr^{-1} did not increase yield significantly.

The increasing rates of N fertilizer significantly decreased soil pH at both soil depths. However, an increase of K and Mg fertilizer rates did not give a significant influence on soil pH. The increase of the N fertilizer rate from 240 to 420 kg ha^{-1} reduced Ex. K concentration in the soil significantly. Further increase in the N rate did not significantly affect the Ex. K concentration in the soil. The increasing rates of Mg also did not give any significant effect on Ex. K in the soil, but the increasing rates of K increased Ex. K at both soil depths. The increasing rates of N, K and Mg fertilizers had no effect on Ex. Mg concentration at the 0-15 cm depth, but increasing rates of Mg fertilizer increased the soil Ex. Mg at the 15–30 cm depth. The increasing rates of N fertilizer reduced Ex. Ca in the soil, but K and Mg fertilizer rates had no significant effect on Ex. Ca concentration in the soil. The trial continues.

(5) Clone TRI 2026, Field No. 4 B, Lumbini Estate, Deniyaya (1999)

No significant effect was found from increasing rates of N, K and Mg fertilizers on tea yield. The analysis of soil and plant samples is in progress. The trial continues.

(6) Clone TRI 3019, Field No. 2, Ury Estate, Passara (1999)

The increasing rates of N application increased tea yields up to the highest rate, but the increasing rates of K and Mg fertilizers did not give any significant effect on yield. The increasing rates of N fertilizer significantly reduced soil pH. The concentration of soil Ex. K increased with the increase in K fertilizer rate, but an increase in N fertilizer rates reduced Ex. K in the soil. The increase of Mg fertilizer rates significantly increased Ex. Mg in the soil. The trial continues.

(7) Clone TRI 2025, Field No. 23, Rangala Estate, Karaliyadda (2002)

The increasing rates of N fertilizer increased yields up to the highest N rate, but increasing rates of K and Mg fertilizers did not give any significant improvement in yield. The increasing rates of N decreased soil pH significantly, but the application of K and Mg fertilizers showed no significant effect on soil pH. The increasing rates of N application showed no effect on Ex. K, but an increase in K and Mg rates increased the Ex. K and Mg in the soil, respectively. The trial continues.

(8) Clone TRI 2025, Field No NC 5, Midland Estate, Ratthota (2000)

The increasing rates of N fertilizer significantly increased tea yields, but the increase in K and Mg fertilizer rates did not give any significant improvement in yield. The increase in N fertilizer rates decreased soil pH significantly at the 0-15 cm depth, but the increasing rates of K and Mg fertilizers showed no significant effect on soil pH. The increasing rates of K and Mg fertilizers increased Ex. K and Mg, respectively. The trial continues.

(b) Effects of application of different rates and frequencies of N and K on growth, soil- and plant-nutrient status and yield.

(1) Rates: N - 100, 200, 300, 400 and 500 kg ha^{-1} yr^{-1}
K_2O - 100, 300 and 500 kg ha^{-1} yr^{-1}

Clone TRI 2025, St James Estate, Hali Ela (1990)

The yield data collected for January to December 2003 showed that there is no significant impact of increasing levels of both N and K on yields. This experiment continues.

(2) Rates: N - 240, 420 and 600 kg ha^{-1} yr^{-1}
K_2O -120, 300 and 480 kg ha^{-1} yr^{-1}
Frequencies 6, 8 and 12 weeks

Clone TC 9, Field No. 4 B, Brunswick Estate, Maskeliya (1998)

The increasing levels of N and K did not show any significant improvement in yields. The increase in N rate significantly reduced soil pH, but the K rate had no significant influence on soil pH. The increasing rates of K significantly increased Ex. K in the soil, and an increase in N rate significantly decreased Ex. K in the soil. The increasing rates of both N and K fertilizers did not significantly affect Ex. Mg status in the soil.

The increasing rates of N significantly increased the leaf N concentration. The increasing rates of K showed a highly significant increase in K concentration in the leaf. Also, it was found that the increase in K rate significantly decreased Mg concentration in the leaf, but Mg concentration was not affected by the N rate. The trial continues.

(c) Effects of application of different levels of N with different levels of compost manure on growth, soil- and plant-nutrient status, and yield.

(1) Rates: N - Seven levels ranging from 0 to 720 kg ha^{-1} yr^{-1}
Compost - 0 and 5 t ha^{-1} yr^{-1}

Clone DT1, Field No. 3, St.Coombs Estate, Talawakelle (1992)

As in previous years, the yield obtained during the 5th year of the current cycle (August 2002 to July 2003) showed a significant increase with increasing rates of N, up to a maximum which was then followed by a decline. However, the application of five metric tonnes of compost did not make any significant influence on the tea yields. This experiment continues.

(2) Rates: N - 200, 400 and 600 kg ha^{-1} yr^{-1}
Compost - 0, 10, 20 and 30 t ha^{-1} yr^{-1}

Clone TRI 2025, Baddegama Estate, Baddegama (2000)

The effect of increasing rates of N and compost application on yield in the 1st year after compost application showed that neither N rate, nor compost application, showed any significant impact on yields. A clear relationship between compost and N rates could not be observed on pH and C levels in the soil.

(3) Rates: N - 200, 400 and 600 kg ha^{-1} yr^{-1}
Compost - 0, 10, 20 and 30 t ha^{-1} yr^{-1}

Clone TRI 2026, Anninkande Estate, Deniyaya (2001)

A significant increase in yields could not be observed from either N or compost rates. Also increasing rates of N, or compost, did not show any significant effect on soil pH. A clear result could not be obtained in the trial from the application of compost with regard to soil C levels.

(d) Effects of application of different rates of N as urea and sulphate of ammonia, and their proportions (urea:S/A) on growth, soil- and plant-nutrient status and yield.

The following seven trials were conducted to collect research information, for a post-graduate study on S nutrition, with specific objectives. Detailed investigations are continuing.

(1) Rates:N as urea as well as S/A – 200 to 500 kg ha^{-1} yr^{-1}
Urea : SA ratio - 100-0, 75-25, 50-50, 25-75 and 0-100

Clone TRI 2025, Field Nos. 11 and 13, St Coombs Estate, Talawakelle (1979)

The increase in the N application rate significantly increased yields, but there was no significant effect on yields from differences in the proportion of ammonium sulphate and urea, for a given N rate. The effect of application of urea and ammonium sulphate on soil pH and SO_4-S levels (at depths of 0-15 and 15-30 cm), and leaf sulphur concentrations, was assessed. The N rate, and the ratio of N sources, showed a significant influence on soil pH. An increase in N rate reduced soil pH significantly and, when the proportion of ammonium sulphate to urea increases in the mixture, the soil pH reduced at both soil depths. Compared with urea, an increase in the proportion of ammonium sulphate, as the source in the total N rate, significantly increased the SO_4^--S at both soil depths.

The increase in the proportion of ammonium sulphate in the N source increased the total S concentration in the leaf tissues, as well. The experiment continues.

Clone TRI 2027, Field No. 8, Talgaswela Estate, Galle (1999)

The yields obtained during the 2nd year (September 2002 to September 2003) showed that neither the increasing rates of N, nor the proportions of N, had any significant effect. The experiment continues.

Clone TRI 3018, Field No.2, Ury Estate, Passara (1999)

The increasing rates of N increased tea yields significantly in the second year, but did not show a significant effect on yields from the proportions of the N fertilizer. The trial continues.

Clone TRI 2023, Field No. 3, Mahaousa Estate, Madulkelle (2001)

The yields obtained in the 1st year of the trial showed that the increasing rates, or the proportion of the N source, did not show any significant influence on yields. The trial continues.

Clone TRI 2027, Field No. 7, Milakande Estate, Horana (2001)

The yields collected, before and after imposing the treatments during the 3rd year, showed that no significant increase in yield was due to the N rate, or the proportion of the N source. The experiment continues.

Clone TRI 2026, Field No. 13, Kiriwangange Estate, Deniyaya (2001)

No significant effect on yield could be observed in the 2nd year from the increase in the N rate, or the proportion of the N source. The experiment continues.

Clone TRI 2025, Field No. 3 A, Dessford Estate, Nanu-oya (2001)

The yield information, collected in the immature phase of the trial, showed no significant impact from the increasing rates of N, or the N source. The trial continues.

Project A 15.3. Estimating crop response to micro-nutrients (Zn, B, Mn, etc.) at regional level.

Micronutrient foliar feeds: Multiplez, Kiecite, and Zinc Sulphate (two solution combinations of 11 kg Zn ha^{-1} yr^{1}).

(1) Clone TRI 2025, Field No.3B, St Coombs Estate, Talawakelle (1999)

(2) Clone TRI 2025, Madulkelle Estate, Madulkelle (2000)

(3) Clone TRI 2025, Greenwood Estate, Nawalapitiya (2000)

(4) Clone TRI 2025, Indola Estate, Deniyaya (2000)

At Site 1, basal soil fertilizations along with foliar fertilizations were carried out. The N and K_2O were supplied at the rates of 300 and 150 kg ha^{-1} yr^{-1}, respectively. Multiplex, Kiecite and zinc sulphate treated plots gave significantly higher yields than with the control treatment. The experiment continues.

At Site 2, the plots were pruned. The trial continues.

At Site 3, basal soil fertilizations along with foliar fertilizations were carried out. The rate of N supplied was 320 kg ha^{-1} yr^{-1} from U 709. No significant differences in yields were found between the foliar treatments. The experiment continues.

At Site 4, basal soil fertilizations along with foliar fertilizations were carried out. The N and K_2O were supplied at the rates of 320 and 100 kg ha^{-1} yr^{-1}, respectively. No significant improvement in yields was found owing to foliar spraying of the different formulations. The experiment continues.

Project A 15.4. Evaluating effects of foliar application of macro- and micro-nutrients on soil- and plant-nutrient status, quality (biochemical parameters) and yield.

Foliar application of P at 0, 1, 2, 3 and 4% DAP and TSP.

Clones DT 1 and CY9, St Coombs Estate, Talawakelle (1992)

The required nutrients were provided through soil fertilisation. Foliar P treatments were conducted. Yield records were maintained and soil- and plant-nutrient status was assessed. The increasing rates of foliar P spraying did not significantly increase made tea yields in any of the clones tested. The experiment continues.

Project A 15.6. An island-wide survey on identifying factors affecting response to potash, K (and S).

The analysis of surveyed samples (collected soil and leaf samples) and the tabulation of collected information were completed. The results will be published in due course.

2. Thrust A 16. Development of regional and site specific dolomitic limestone recommendations, for ameliorating soil acidity and enhancing soil productivity.

Project A 16.4. Establishing dolomitic limestone requirements for better growth, soil- and plant-nutrient status, and yield of mature plants in different tea-growing regions at soil-series levels.

Rates of dolomitic limestone: Increasing levels
Frequencies: Cycle, Mid-cycle and Yearly

Clone TC 9, Field No. 4, St.Coombs Estate, Talawakelle (1989)

Results, as regards the yields obtained from rates and frequencies of dolomitic limestone applications, were similar to that of the previous year. There were no differences in yields between the control and rates of 1,250 and 2,500 kg ha^{-1}, at any of the frequencies. No interactions were found between rates and frequencies of application. The trial continues.

3. Thrust A 17. Development of fertilizer and/or dolomite applicators for improving broadcasting efficacy and overcoming labour shortage.

Project A 17.1. Evaluating and improving the efficiency of fertilizer applicators.

Some of the physical properties of tea fertilizer mixtures, and their component fertilizer material, were tested. It was found that the bulk density, repose angle and friction angle intervene directly in the free flowing of fertilizers and their smooth release.

Suitable materials have been identified for the fabrication of the applicator. PVC plastic and stainless steel can be used as they are not corroded by the fertilizers, and they also provide a smooth surface for fertilizer materials to flow freely. When mature tea fertilizer is moist, it creates problems in the applicator, such as its losing its free-flowing nature and consequently making bridges over the opening of the container. To overcome this problem, an active mechanism, which does not depend on the free-flowing nature of the fertilizer, has to be included in the applicator. By using a small auger, wet fertilizer can be drawn out, and the amount of fertilizer can be varied by changing the speed of the auger and its dimensions. A mechanism, which provides a given volume of fertilizer confined in a cavity, and allows for its subsequent release, was considered.

A field trial was started to monitor the distribution of T 200, T 750 and dolomite fertilizers. Effective screw speed (in rpm), pitch size, and diameter are being evaluated.

4. Thrust A 32.1. Evaluating soil fertility status in organic tea lands.

Field trials at Gemi Seva Sevana

Information on field trials laid down at Gemi Seva Sevana is given below.

(a) Farmer-centred research on organic tea was started. Soil and leaf samples were collected periodically. Analyses are continuing.

(b) An observation trial was commenced at 11 locations in the Kandy area. There are two treatments, and each treatment plot consists of 150 tea bushes. The treatments are as follows.

T1 – 2 kg compost applied to each bush at six-monthly intervals.
T2 – 2 kg compost + 400 g poultry manure + 20 g ERP, mixed and incorporated into the soil, followed by wetting of the foliage of each bush with one litre of *Glyricidea* solution, at two-week intervals. The trial continues.

Field trials at Raigam Estate

a) Effect of application of Humat-treated waste-tea compost (a rapid method of composting) on tea yield, and soil chemical and physical properties.

An immature tea field was chosen from Raigam Estate, Lower Division, Field No. 2000 (3 ha). Soil samples were collected from a depth of 0-15 cm and analyzed for chemical parameters. Nine plots consisting of 30 bushes (cultivar TRI 2027) were marked in June 2003. The treatments used in the trial are chemically-treated waste-tea compost at 5 metric tonnes, and at 10 metric tonnes, and a control. The treatments were replicated thrice. The first treatment application to the soil was carried out in October 2003. The trial continues.

b) Effect of spraying Humate on made-tea yield.

A field trial was started in June 2003 at Raigam Estate, Lower Division, Field No. 2000 (3 ha). Soil samples were collected and analyzed for chemical parameters. There are 39 plots consisting of 30 plants (cultivar TRI 2027) per plot. The treatments are:

T1 - Super Humate 3 l/400 l water
T2 - Super Humate 5 l/400 l water
T3 - Super Humate 7 l/400 l water
T4 - Super Humate 3 l/400 l water + 3 kg urea/400 l water foliar application
T5 - Super Humate 5 l/400 l water + 3 kg urea/400 l water foliar application
T6 - Super Humate 7 l/400 l water + 3 kg urea/400 l water foliar application
T7 - Super Humate 3 l/400 l water + normal Humate 3 l/400 l water ground
T8 - Super Humate 5 l/400 l water + normal Humate 3 l/400 l water ground
T9 - Super Humate 7 l/400 l water + normal Humate 3 l/400 l water ground
T10 - Super Humate 3 l/400 l water + 3 kg urea foliar + normal Humate 3 l/400 l water ground
T11 - Super Humate 5 l/400 l water + 3 kg urea foliar + normal Humate 3 l/400 l water ground

T12 - Super Humate 7 l/400 l water + 3 kg urea foliar + normal Humate 3 l/400 l water ground

T13 - Control - normal ground fertilizer with $ZnSO_4$ foliar application

The fertilizer application to the ground was carried out in September 2003, and the 1st treatment application was done in October. The trial continues.

Basic Research

a) Effect of mixing organic amendments on the dissolution of ERP and high-grade ERP (HERP) in organic tea soils.

Soils collected from the Stassen Bio Tea Project at Haputale were used for this study. Six organic amendments (seed-oil cakes of castor, kapock, rubber, black caraway and compost) were used at the rate of 10 mt ha^{-1} yr^{-1} for the study. ERP and HERP were separately mixed with soil at two levels (100 μg P g^{-1} soil and 200 μg P g^{-1} soil). A control treatment was also included. All treatments were replicated four times arranged in a complete randomized design. The treated soils were incubated in a glasshouse at the Institute at 60% field capacity, for three months.

The addition of organic amendments provided available N in the form of NH_4^+-N and NO_3^--N through mineralization. Subsequent nitrification of ammonium in the soil helped dissolution of ERP and HERP. The concentration of borax-extractable P was found to be greater in HERP-treated soil than that in ERP - treated soils at the lower rate of P, namely 100 μg P g^{-1} soil (as compared to 200 μg P g^{-1} soil). The dissolution of PR increased with the addition of organic amendments, causing an increase in borax-extractable P in the soil.

b) Influence of land management on soil quality indicators in a tea plantation of Low country wet zone.

About 52% of the tea cultivation in Sri Lanka is in the low-country wet zone. Most of these lands are situated in slopey areas, and are subject to high erosion and gradual degradation owing to intensive management practices. Thus, assessment of soil quality in tea lands is important for sustainable tea cultivation.

Representative soil samples were collected from depths of 0-15 cm from selected fields in the Hathhaula Division of Citrus Estate, and from an adjoining forest. The selected fields represent rehabilitation, fallow, three year-old tea, seven year-old tea and 11 year-old tea.

Soils were analyzed for texture, wet aggregate stability, pH, total organic C, total N, extractable P, Ex. K, soil microbial biomass, water soluble organic C, and potentially-mineralizable C and N. The length of tea cultivation after rehabilitation showed an impact on soil quality of the tea fields. Soil-bulk density and C content can be used to assess land degradation. Substantial amount of C was lost from tea fields after rehabilitation. It was found that wet aggregate stability is potentially a good indicator of soil quality in tea lands. Plant nutrient concentrations cannot be considered as a robust indicator of soil quality.

c) Evaluating soil test methods for assessing bio-availability of sulphur.

A glasshouse trial was conducted using six soils representative of the major tea-growing regions of Sri Lanka. Soils were treated with six rates of sulphur, and the tea cultivar, TRI 4052, was grown for one year, at the end of which soils were dismantled. Soils and plant samples were analyzed, and an attempt was made to choose a suitable and easy method to extract plant-available S by using seven extractants, namely water, potassium dihydrogen orthophosphate, NaCl, ammonium acetate, sodium acetate, HCl and LiCl. The trial was completed and the data will be published in due course.

d) Thrust B 35. Establishment of critical nutrient levels for better growth of clonal tea.

Six months-old nursery tea plants (cultivar 4052) were planted in metal pots containing quartz sand. Hewitt nutrient solution was provided to give three N levels (0, 52.5 $\mu g\ N\ ml^{-1}$ and 105 $\mu g\ N\ ml^{-1}$), three K levels (0, 42.5 $\mu g\ K\ ml^{-1}$ and 98 $\mu g\ K\ ml^{-1}$), and three Mg levels (0, 15 $\mu g\ Mg\ ml^{-1}$ and 30 $\mu g\ Mg\ ml^{-1}$). The treatments were replicated thrice in a completely randomized design. Growth assessments are being assessed. The trial continues.

e) Thrust B 15. Environmental studies.

Project B 15.1. Impact of changes in weather conditions on crop environment and productivity of tea: assessment of atmospheric wet- and dry-deposition.

The monitoring of rainwater quality continued with collaboration of the meteorological centres of the Institute's stations at Talawakelle, Ratnapura, Hantane, Passara, Kottawa and Deniyaya. The monitoring of rainfall, *in situ* pH, NO_3-N, SO_4-S, Mg and Ca are continuing.

f) Evaluation of the effect of fertilizer application in up-country tea estates on down-stream pollution of water bodies

A detail field study was commenced in February 2003 as a component of a post graduate study to assess the quality of water samples collected from different places of a stream running down from the jungle of Hortan plains to the tea plantations. The sampling sites cover the areas viz. Hortan plain jungle, tea estates in Diagama East and West, Sandingham, Waverly Estates. The objective of the study is to understand the effect of application of mineral fertilizers on pollution of down stream water bodies. Water sampling was conducted for 34 times and their analysis is continuing.

SUPPORTIVE PROJECTS

1) Adaptive fertilizer trials

a) TRI and TSHDA collaboration

A detailed description of the trials along with objective/s and some of important findings were published in Annual Reports of 1996 to 1999. Operations of some of the trials are still continuing.

b) TRI, and Balangoda and Madulsima Plantations collaboration, 2002

High (U877) and low potash (U709) mixtures on the soil/plant nutrient status, growth and yield of seedling and clonal tea (Eltab, Mahadowa, Wewessa, Telbedde, Kew, Kirkoswald, Cecilton, Balangoda estates and Gonakelle Estate, Passara.

The yield data of the trial plots are regularly recorded. The trials continue.

Thrust A 18. Development of regional analytical laboratories for soil, plant and fertilizer analysis

1) Analytical laboratory service

The total number of elements analysed for advisory purpose at Talawakelle, Walahanduwa and Hantane laboratories are 15747, 6184 and 210 respectively.

2) Analytical laboratory accreditation

The Division's Analytical Laboratory at Talawakelle participated in an International Laboratory Evaluation Programme on chemical analysis of soil (International Soil-Analytical exchange-ISE), and plants (International Plant-Analytical Exchange-IPE). Sixteen soil and 16 plant samples were received during the year. They were subjected to test methods, namely pH (water, $CaCl_2$ solution), % C (Walkley and Black), E.C, Na, K, Mg and Ca in soil samples, and Cu, Fe, Mn, Zn, Ca, K, Mg, Na, P, and Cd in plant samples. The results were submitted to the Wageningen University for evaluation.

Inventions and Patents

1. A method for composting waste tea to manufacture a compost material with a high content of humic substances.

This invention concerns the manufacture of high quality compost by humification of waste tea.

Waste tea is a by-product in tea manufacture. Generally 4-6% of waste is produced in black tea manufacture but, under conditions where unsuitable leaf is available for manufacture, the percentage of waste tea could increase even to a level of 8-10%. The estimated waste tea production in the country is about 20 – 25 million-kg yr^{-1}.

Recycling by composting of waste tea is one of the appropriate approaches in effective use of the material. It is known that application of compost offers immense benefits, which cannot be obtained by other means.

There are several common drawbacks in the current methods of composting waste tea. Traditional composting methods generally take more than 4-5 months for obtaining the final compost. Finding a quick composting method for waste tea is possible owing to the fact that waste tea materials are rich in organic C, N and micro-nutrients, which are important for plant health, nutrition and growth. The chemical process used in the present composting method uses chemical compounds called humic substances ('humates'), extracted from tea, to treat waste tea.

The composting method developed is low-cost and user-friendly, and produces a non-toxic compost material rich in high molecular humic substances, fulvic acids, a high content of dissolved carbon, plant-available N, and other macro- and micro-nutrients. Laboratory studies showed that that the formation of humic substances increase by three-fold within two weeks, compared to untreated waste tea. Unlike in other composting procedures, an increase in temperature of the composting material during composting process was not observed.

Some of the important chemical characteristics of the compost are given below.

Total C	36.5%
Total N	3.0%
Total P	0.4%
Total K	4.4%
Total Ca	1.01%
Total Mg	0.35%
Zn	81 ppm
Mn	521 ppm
C/N ratio	12.3
CEC	82 meq/100 g

Scientists from the Institute and the other scientists, who worked on the project, obtained patent rights for the development of this chemical process for composting waste tea.

2. A method for detoxification of pollutants in order to improve the quality of city solid-waste compost.

This invention involves detoxification of pollutants, binding of heavy metals, and removal of unpleasant odour, to improve the quality of compost made from city solid-waste compost.

One of the effective methods of re-cycling city solid-waste materials is to convert them into compost. The use of city solid-waste compost in agriculture has been a practice in some countries. However, there is evidence that this compost can harm crops and humans, directly or indirectly. Humans can be affected from living in the areas treated with city solid-waste compost, or by consuming the products that are grown using the compost. Owung to this reason, some restrictions exist for use of city solid-waste compost in crop production.

The risk and damage to the soil, environment and to humans, could be resolved by preventing the uptake of pollutants and heavy metals by detoxification, through binding and making them unavailable for plant uptake. A chemical method was developed to remove the bad smell, and to detoxify the pollutants in the city solid-waste compost. Laboratory trials were conducted, using short-term crops, to determine any possible phyto-toxicity effects on plants grown with the compost developed.

Scientists from the Institute and the other scientists, who worked on the project, obtained patent rights for the development of this chemical process for improving the quality of the compost made from city solid-waste materials.

3. Development of a user-friendly computer programme to estimate the fertilizer needs of tea estates.

Fertilization of tea fields with synthetic fertilizers is one of the most important activities in tea cultivation. It accounts for 10-12% of the total cost of production (COP). Application of fertilizer is known to improve yields and maintain sustainability.

The estimation of the fertilizer requirements for individual tea fields is done manually by estate managers on a yearly basis. Manual calculations are tedious and time-consuming. In order to assist plantation mangers, the Divisions of Soils and Plant Nutrition, and of Technology, of Institute jointly worked on a user-friendly tool to estimate fertilizer needs in tea estates.

This novel tool is a computer programme written in the Visual Basic Language. It consists of three sections.

The first window is dedicated to in-putting basic data of estates, such as name of the Estate, Divisions, Field Nos., extent, amount of mature and immature tea, nursery plants, yields, forest cover, etc. This section has a facility to delete, update and edit data previously entered from the database.

The second window is for the purpose of estimating the fertilizer needs of mature, immature, and nursery tea, and also of rehabilitation grasses. Additionally, it helps in estimating dolomite requirements, based on soil pH, ground application of kieserite, foliar application of Zn, Mn, Mg and urea, and spraying of K to mitigate drought effects.

The third window provides a facility for making general descriptions of nutrient-deficiency symptoms, with colour plates to help tea growers to compare abnormalities they observe in their tea fields.

A facility is also provided to work out the fertilizer requirements for individual fields, as well as for the whole estate, based on which the decisions could be made.

This computer programme will be made available to stakeholders in the near future.

TECHNOLOGY DIVISION

Officer-in-Charge – K. Raveendran

Research Activities (see Corporate Plan)

1. Project A 25.1. Reduction of cost of electrical energy in withering, using speed controllers.

The use of a variable speed drive (VSD) in the trough withering system had been recommended after testing. However, it was found that the system ejects harmonics to the power-supply system in the factory. Therefore, it was decided to purchase suitable harmonics filters for the variable speed drive. The filters called 'line chokes', which are available in the market, are not up to the requirement for speed controllers coupled to the withering troughs. Therefore, it was decided to develop harmonic filters for the troughs in the Division.

The new Research Assistant was required to study the VSD-coupled withering system in detail, and he started working on this. The theoretical background to VSDs was made available to the staff of Technology Division.

VSD-coupled withering systems were monitored and tested at two factories. It was found that the harmonics, ejected by VSD-coupled withering systems to the power system in tea factories, is considerable, and it was concluded that suitable harmonic filters needed to be coupled to the withering systems.

2. Project A 26.1. Developing and evaluating solar energy techniques for tea drying.

The booster fan of the solar collector system, coupled to the furnace/ air heater at the St Joachim factory, is under repair. As such, the performance of the system could not be monitored during the year. Messrs. CCC, Ratnapura, undertook the repair of the booster fan and they have been requested to complete the repairs early.

3. Project A 27.1. Evaluating new types of paper sacks.

The aim of this project is to test and recommend newly-produced low-cost packing materials for teas. The test includes moisture and odour-barrier properties, and the strength of the packing materials. During the period under review, three new packing materials were received for testing.

4. Project A 28.1. Optimum conditions for best grade mix in the Uva.

The teas produced in the Uva region are not fetching good prices at the auctions, especially during the off-quality season. This project was therefore designed to experiment with alternative methods of tea manufacture, suitable for the region.

The aim of the project includes optimizing the grade mix, in order to obtain better prizes for all the grades of teas. The manufacturing method selected for the experiments was Ortho-CTC, and during the year six trials were conducted at El Teb Estate, Passara.

5. B 47. Design and development of a tea bulking machine for leafy grade teas.

The teas of different grades produced in Low-Country have batch to batch variation in particle size distribution. Bulking the teas manually is not promising and could cause breakage of teas as well. The bulking machines that are in use at several factories have less features to provide reasonable bulking of teas. The new design has an improved tea bulking set up. This will be fabricated and tested in collaboration with University of Peradeniya.

6. Development of a moisture meter to measure moisture content.

A unit was designed to test the moisture content in made tea using the capacitance principle. This unit is different to the earlier unit developed in the Division.

A blender was used to grind tea samples within the new unit in order to have uniform packing. Variation between samples was thus avoided.

Tea samples were tested using this unit, and from the results no correlation was found between the moisture content in made tea and the measured capacitance. The unit will be developed further.

7. D 31. Computer-aided tea processing.

The withering process is the prime and most important process in tea manufacture, as far as quality of made tea is concerned. As there are several parameters involved in obtaining uniform withering, developing a computer-aided control system proved to be a time-consuming project requiring a high degree of skill.

It was decided to design a system to facilitate easy and simple control in the withering process, and such a system has now been designed. It will be fabricated, and tested with a commercial scale-withering trough at the St Coombs factory.

Other Divisional Research

1. ISO 9002 certification for tea processing at the St Coombs factory.

The implementation of a quality system was continued at the St Coombs factory.

The Consultant was requested to make necessary changes in the system, per the requirement for the new version ISO 9001.2000, as suggested by the certifying body. During the period under review, the Consultant obtained the necessary details, and conducted two training programmes for the staff.

The preparation of documents for the new version of the quality system at St Coombs factory is continuing.

2. Development of a sand separator.

The need for a suitable sand separator in the tea industry has been realized. The Department of Agricultural Engineering, Faculty of Agriculture, University of Peradeniya, Peradeniya, which has the patent for this unit, was contacted to design and develop a marketable model for use in tea factories.

3. Testing of a new moisture meter.

A meter called the Victory Digital Moisture meter from India, working on the capacitance principle, was tested. The performance of the meter was found to be unsatisfactory.

4. Classification of leafy grades of tea by particle-size analysis (ISO 11286).

The tests on recommended true-to-type tea samples from St Joachim estate were continued, and the results were published at the ISO Technical Committee on Tea.

5. Monitoring the standard of leaf at the St Coombs and the St Joachim factories.

The Division continued to monitor the standard of the leaves at the St Coombs and the St Joachim factories.

6. Miniature tea manufacture

Green-leaf samples from the Nematology and the Agronomy Divisions (80 in total) were manufactured, and the made teas were sent to professional tea tasters for evaluation.

7. Effect of removing coarse leaves, at an early stage of manufacture, on the quality of made tea.

The leaves coming to the factory is heterogeneous and mixed with coarse leaves. The coarse leaves affect the processing of the good leaves during tea manufacture. In this experiment, the coarse leaves were removed after the first rotorvane rolling. The made teas, both control and experimental, were sent to professional tea tasters for organoleptic evaluation. Chemical analysis was also conducted in the Division on the made tea samples.

8. The 'Nuwara-Eliya' tea character in Nuwara Eliya teas.

Certain teas produced in Nuwara Eliya were found to be lacking in the 'Nuwara Eliya' tea character. An experiment was therefore designed to improve the tea manufacture, with a view to obtaining this character, at the Concordia Estate factory.

A preliminary experiment was conducted at Concordia Estate and a few shortcomings in manufacture were pointed out to the factory management. Also, action was taken to repair the drier at this factory. However, the repair to the drier could not be completed and the experiments could not be continued.

9. Development of an electronic temperature-indicating and alarm unit for the FBD.

An electronic temperature indicator and alarm unit was designed to control the feeding rate of dhool to the FBD, in such a way as to allow the recommended weir-end temperature to be maintained.

10. Energy-related studies in tea factories.

A detailed study on energy-saving opportunities in tea factories has been started. Initially it was decided to develop a linear programme to optimize the usage of withering troughs. Also, a pamphlet was prepared to highlight energy-saving practices that could be followed in tea factories.

11. Study on the use of 'teazyme', a pectinase supplied by Forbes Services (Pvt) Ltd., on the quality of made tea.

'Teazyme', a pectinase supplied by Forbes Services (Pvt) Ltd., was tested with fermenting dhool at the Talawakelle Estate factory, and the made tea was tested for chemical quality parameters. A similar experiment was conducted using the miniature manufacturing unit in the Division.

It was found that the pectinace improves the TR/TF ratio in teas produced by commercial-scale manufacture.

12. A new and efficient approach for removing surface moisture from tea leaves.

A domestic washing machine was used to remove surface moisture from green tea leaves. The removal was found to be 85% and, interestingly, the green leaves were found not to be damaged in the process. The speed of the spinning system was 1380 rpm. Increasing the speed is expected to improve efficiency.

It has been decided to fabricate a prototype unit to test and develop the operation of the machine.

13. Factors affecting blackness and curliness of low-country teas.

Black teas, especially low-country teas, fetch good prices when it has the required blackness and curliness demanded by the customers. An experiment was designed to find the chemical factors, which affect the blackness and curliness of low-country teas.

This is a collaborative project with the Biochemistry Division.

14. Quality ranking of TRI cultivars in the up-country.

The Institute had developed several cultivars suitable for different tea-growing regions. The quality of made tea produced vary with the different cultivars. As such, it has been decided to carry out experiments to rank the cultivars, based on the quality of the made tea.

Eleven TRI clones have been selected, and four trials were conducted, to test the variation in made-tea quality during the year.

The results should prove useful for the tea industry, in selecting cultivars for planting, replanting and infilling.

15. A study on sorption isotherm in different parts of the tea shoot during withering.

The different parts of the shoots wither at different rates. A detailed study was initiated, to find the air quality required for withering the different parts of the shoots. The tea clones, TRI 3017 and TRI 777, were selected for this study. The equilibrium moisture content for each part of the shoots from the two clones was determined, using the saturated-salt solution method.

16. Collaborative projects with the National Engineering Research and Development (NERD) Centre.

16.1. Micro-controller application in the tea-withering process.

The engineers of the National Engineering Research and Development Centre were able to develop the software, and the auxiliaries for the withering-trough control system, to a certain degree. However, with a new engineer taking over the project, more information on the withering process had to be supplied to him, to enable him to proceed with the project. Once the control system is ready, it will be tested at the St Coombs factory.

16.2. Bio-gas and bio-fertilizer manufacture from refuse tea.

The engineer from the NERD Centre, after conducting appropriate experimentation, has found that refuse tea is not suitable for bio-gas and bio-fertilizer manufacture.

Seminars, Meetings, and Training Programmes

A training programme was conducted for St Coombs and St Joachim factory staff on "Finer Points in Black-Tea Manufacture".

Mr G L C Galahittiyawa made a presentation on tea manufacture at the RSC seminars held in Ratnapura and in Kandy.

Divisional staff continued supporting the NIPM, in conducting training programmes on tea manufacture, to estate managers and factory personnel.

Interaction with Factories

During the period under review, the staff made 52 advisory visits to factories with regard to various aspects of tea manufacture.

The number of samples received from estates for moisture determination was 328. These were reported on, together with advice for correction of defects, wherever necessary.

Personnel and Visitors

Mr V Dhaneskumaran, Electrical Engineer, joined the Division as a Research Assistant (on a contractual basis), and started work in August.

Mr M A Chamindra, Technical Assistant, continued his Advanced Certificate course in "Laboratory Technology" at the Open University of Sri Lanka.

The number of visitors to the Technology Division during the year, was 20 to Ratnapura, and five to Talawakelle.

AGRICULTURAL ECONOMICS DIVISION

Head - J. A. A. M. Jayakody

Research Activities (see Corporate Plan)

1. Thrust A 31. Identification of appropriate labour-use patterns to improve profitability in tea estates.

Project A 31.3. Identifying the factors that influence the out-migration of workers in the low country (Ratnapura, Kalutara and Kegalle Districts).

The study commenced in the 4th quarter of the year. A sample of sixteen estates was selected in the Ratnapura, Kalutara and Kegalle Districts, by the Advisory and Extension Division, Ratnapura.

The survey was completed for the Ratnapura and the Kegalla Districts.

Project A 31.4. Development of appropriate labour-use patterns for tea estates.

Development of monthly labour profiles for the up-, mid-, Uva and low elevations has been initiated.

2. Thrust A 35. Development of financial support systems for soil rehabilitation and conservation in tea estates.

A research proposal submitted to the South Asian Network for Development and Environmental Economics (SANDEE) was accepted for funding, and the grant was received by the Institute in December 2003.

3. Thrust A 36. Assessment of vulnerability, impact and adaptation to climate change in the tea industry of Sri Lanka.

The collection of primary data has been completed. Data analysis is continuing for the purpose of developing socio-economic models of the tea sector, with and without a scenario of climate change.

4. Project B 1. Establishment and maintenance of a micro-level tea information system in the Geographic Information System (GIS).

Use of the Global Positioning System (GPS) was initiated for fixing the geographic locations of tea estates. Information, collected by the Advisory and Extension

Division, will be stored in a database. So far, information has been received from 32 estates.

5. Project B 5. Estimation of the cost of tea cultivation.

6. Project D 35.1. Tea information.

National and International tea-data collection and computation were continued. The data were updated using available secondary sources for the year 2003.

7. Project D 35.2. Economic analysis of research recommendations.

Economic analysis of the following research recommendations was undertaken during the year.

Project D 35.2.1. Cost/benefit analysis of irrigation and fertigation of tea.

Project D 35.2.2. Cost-effectiveness of the nematode control methods recommended for tea nurseries.

Project D 35.2.4. Cost-effectiveness of different weed-control methods.

8 Project D 35.3. Project monitoring activities.

The INFORM database for the year 2003 was completed and submitted to the national INFORM Coordinator.

Publications

1. Ganewatte G, 2003. *Market for Value Added Tea Export of Sri Lanka: An Economic Analysis.* Ph. D. thesis.
   The thesis examines the determinant of the supply of value-added tea exports from Sri Lanka, and the present policy on tea imports for value addition.

2. The following research reports and articles were completed and submitted for publication during the year.

   (i) Waschik R, Jayasuriya S and Edwards G. Moving up the Processing Ladder in Primary Product Exports: Sri Lanka's 'Value Added' Tea Industry.

   (ii) Waschik R, Jayasuriya S and Edwards G. Regulation on Tea Imports for Value Addition: Is this a Realistic Policy?

(iii) Development Approach of the Sri Lanka Tea Industry.

(iv) Value Addition in Tea for the Export Market.

Record-books for small holders

Two booklets were prepared for the purposes of record-keeping by small holders. They include details of all the operations relevant to plucking, other field operations, nursery management, and new planting, replanting and infilling.

Seminars, Meetings and Training Programmes

1. Mrs J A A M Jayakody undertook two lecture hours on "Economics of Plantation Management", for the NIPM Diploma Programme, in January.

2. Mrs J A A M Jayakody presented a paper on "Economics of Fertilizer Application for Tea ", at the 206th E & E Forum, held at the Institute in Talawakelle on 31 st January.

3. Mrs J A A M Jayakody and Mr W S B Ariyapala attended the project progress meeting on "Assessment of the impact of an adaptation to climate change in the plantation sector in Sri Lanka", held on 3rd March at the Institute in Ratnapura.

4. Mrs J A A M Jayakody attended the RSC meeting held in Ratnapura on 13th March.

5. Mrs J A A M Jayakody attended the RSC meeting held in Passara on 14th March.

6. Mrs J A A M Jayakody attended a workshop on "Carbon Trading", held on 27th March at the Environment Ministry, Battaramulla, Colombo.

7. Mrs J A A M Jayakody attended a Plantation and Small Holder Sector Sub Committee meeting, held on 4th August at the Ministry of Plantation Industries Conference Hall.

8. Mrs J A A M Jayakody presented a lecture on "Ability to increase production by appropriate investment" at a Workshop, held on 3rd September at Ratnapura.

9. Mrs J A A M Jayakody and Mr W S B Ariyapala attended a project progress meeting on "Assessment of the impacts of an adaptation to climate change in the plantation sector in Sri Lanka", held on 17th August.

10. Miss R G N Rupasinghe attended a one-week training course on the use of statistics for research, held on 22nd September at the Postgraduate Institute of Agriculture, University of Peradeniya.

11. Mrs H W Shyamalie attended an annual training program for INFORM coordinators, organized by the Council for Agricultural Research Policy, on 13th and 14th November at the Postgraduate Institute of Agriculture, University of Peradeniya.

12. Mrs J A A M Jayakody attended the 7th Biannual Research and Training Workshop of the South Asian Network for Development and Environmental Economics (SANDEE), held at the Asian Institute of Technology, Thailand, from 27th October to 22nd November.

Personnel

Miss.R.G.N. Rupasinghe joined the Division as a Research Assistant (on a contractual basis), and started work in August.

Dr Gaminda Ganewatta, Research Assistant, returned to the Division in October, having completed his Ph D programme.

ADVISORY AND EXTENSION SERVICES

Head - B. A. D. Samansiri

1. Advisory Activities

The activities undertaken by the Advisory and Extension Services through its centres at Talawakelle, Ratnapura, Hantane, Passara, Kottawa and Deniyaya are summarized below:

1.1. Advisory Correspondence

A total of 2,335 letters was sent out to plantations, Regional Plantation Companies (RPCs), private estates, small holders, and others, on problem-solving, preparation of development programmes, and land-selection for replanting, and giving general information on tea and other matters.

1.2. Advisory Visits

A total of 798 routine and on-call advisory visits was made to company-managed plantations, private estates and small holdings.

The routine visits were made as a special activity, undertaken by the staff of the Advisory and Extension Services during April-September 2003, to cover all of the 304 tea estates managed by the RPCs.

The on-call visits were undertaken, as and when requests were received for problem-solving purposes, on all aspects of tea cultivation and plantation management.

A certain number of extension visits was also made, to estates and small holdings, for evaluating and monitoring mother-bush blocks of newly-released cultivars, and for fertilizer demonstration trials.

1.2.1. Routine Estate Visits

This activity was undertaken by the staff of the Advisory and Extension Services to cover all of the 304 tea estates managed by the 20 RPCs involved in tea, from April to September 2003. Advisory Officers visited these estates, scattered in all the tea-growing districts and elevation zones in Sri Lanka. These routine visits help to transform the approach of the Institute from a passive one to a pro-active one with a high degree of client focus.

In addition to giving advice during these visits, a mass of valuable information was collected by the Advisory Officers, initially in a pre-evaluation pro forma sent to the estates prior to the visit, and then by means of a through and detailed field-by-field evaluation during, and after, the visit.

2. Training Programmes

A total of 290 training programmes, seminars, group discussions, field-days, demonstrations, and education and familiarization programmes, was conducted. Field demonstrations were also conducted for small holders on cultural practices (harvesting, nursery management, etc.). Training was also conducted at the request of the NIPM for their various programmes.

3. Regional Scientific Committee Seminars

Seven Regional Scientific Committee seminars were organized for the plantation managerial staff of RPCs in the Dickoya, Kandy, Uva and Ratnapura regions.

4. Experiment and Extension (E & E) Forum for Smallholder Sector

The 11th and the 12th E & E forums, conducted in Sinhala for the smallholder sector, were held on 5th May and 13th October 2003 in the Institutes' Auditorium at Talawakelle.

5. Production of Advisory and Extension Material

5.1. Advisory Circulars

A total of 37 Advisory Circulars has been updated, and printed in the form of a new series on various subjects. Printing of a special folder (with a colour-coding system for different subject groups) has been completed.

The stakeholders have been informed about the issue of the new series of Circulars and the special folder. Out of 500 folders printed, 315 have been sold. Translation of the new-series Circulars into the Sinhala and the Tamil languages is in progress. Printing of the special Advisory Circular folder in the Sinhala and the Tamil languages is also in progress

5.2. Booklets, Newsletters, Leaflets and Reports

The following documentation was produced.

- A booklet entitled "Control of Stem and Branch Canker in the low Country and the Uva region".
- 'Te Thathu" (Volume 2, Issue 2), a newsletter on the latest tea technologies, written in Sinhala.
- A new Advisory Guideline on "Horse-Hair Blight", translated into Sinhala.
- A Sinhala version of "Tea Information" was updated.
- A leaflet on "Pruning" in Sinhala.
- A booklet on "Weed identification".
- A pamphlet on "Nutritional Deficiency Symptoms", submitted to the PPP for necessary action.
- "Te Thathu" (Volume 3, Issues 1 and 2),
- A report entitled "Agricultural Profile of the Corporate Tea Sector" which was the outcome of an 'agricultural census' undertaken by the Staff of the Advisory and Extension Services, covering all the 304 tea estates managed by the 20 RPCs involved in tea.
- Twenty reports on the "Agricultural Profile of Tea Estates managed by 20 RPCs", which were the outcome of the "agricultural census", undertaken by the Staff of the Advisory and Extension Services, were prepared and converted into digital format. The booklet, "Guide to the TRI", was revised: it includes a preface, an introductory section, the location of the TRI stations and estates, a brief history of the tea tndustry of Sri Lanka, the functioning of the Advisory and Extension Services and of the Research Divisions, etc.
- A revision of the booklet, "Guide to the TRI", which includes a preface, an introductory section, location of the TRI stations and estates, a brief history of the tea industry of Sri Lanka, functioning of the Advisory and Extension Services and the Research Divisions, etc.

5.3. Posters and Banners

Twenty-six posters and banners were prepared, and digitally printed, for display at exhibitions and in the Advisory Division's tea museum.

6. Mass-Media Activities

6.1. News Items

The following information was made available to newspapers and to the radio/ TV media.

- "New Planting Materials for the Tea Industry", broadcast on 17th January 2003 on the News Bulletins of SLBC, Sirasa, Hiru and Lakhanda.

- A report on the Seminar on Organic Tea Production held at the Tea Board Auditorium on 27th January 2003, broadcast on the News Bulletins of SLBC and Sirasa.

- A report on the Experiment and Extension Forum Seminar, held on 31st January 2003, broadcast on the News Bulletins of SLBC, Sirasa, Hiru and Lakhanda News.

- "Effect of Floods on Tea in Low Country Areas", broadcast on 22nd May 2003 on SLBC, Swarnawahini and Hiru.

- A report on the E & E (Sinhala) Forum seminar, held at the Institute's Auditorium on 5th May 2003, published in the Divaina newspaper of 13th May 2003.

- A report on the RSC seminar, held on 26th May 2003 at the Tourmaline Hotel, Kandy, published in the Silumina newspaper of 15th June 2003.

- The Head of the Advisory Division briefed media personnel on the "Role of the TRI in the ADB Tea Development Project", at the awareness workshop for media representatives on the Tea Development Project, organized by the Project Management Unit of the Project on 23rd April 2003. A news article was published subsequently in the Daily News of 28th April 2003.

6.2. Newspaper Articles

Twenty-two news and feature articles, on tea cultivation and related subjects, were published in the Sinhala and English languages in the national newspapers.

6.3. TV and Radio Programmes

Advisory and research staff coordinated and participated in 12 programmes of the "Ranpathaka Asiriya" TV programme series, telecast on Rupavahini every Tuesday at 6.30 pm to 7.00 pm.

Advisory and research staff coordinated and participated in 14 programmes of "Randallata Arunellak", broadcast on Ruhunu FM Radio and Kandurata FM Radio, conducted by the Tea Development Project.

7. Exhibitions

Advisory staff organised and participated in the following Exhibitions.

1. "Yali Pubudamu Sri Lanka" Agricultural Exhibition, held at the Research Station, Labuduwa, Galle from 06th to 11th August 2003 (coordinated by staff of the Kottawa station).

2. Tea Convention Exhibition held at the BMICH, Colombo in August 2003 (coordinated by Talawakelle staff).

3. Educational Exhibition held on 18th and 19th September 2003 at the Lindula Maha Vidyalaya (coordinated by Talawakelle staff).

4. The Jubilee Exhibition held at the University of Ruhuna, Matara, from 4th to 11th October (coordinated by Ratnapura and Kottawa staff).

5. Educational Exhibition held at the Eheliyagoda Maha Vidyalaya, Eheliyagoda from 29th August to 5th September 2003 (coordinated by Ratnapura staff).

6. "Nawa Dekma" Science and Technology Exhibition, held at the Viharamahadevi Park, Colombo from 12th to 23rd December 2003. (coordinated by Talawakelle staff).

8. Visitors

A total of 7,448 visitors were received at the Advisory and Extension Division, Talawakelle, and the Regional Extension Centers. These included persons seeking information on tea through informal discussions, as well as students on study tours for whom appropriate educational programmes were arranged.

9. Extension Services

9.1. Issuing of Publications

A total of 6,956 Advisory and Extension publications, pamphlets and leaflets were distributed.

9.2. Commercial Nursery Inspections

Three hundred and forty-four commercial tea nurseries were inspected in the small holdings and the private estates sectors, under the Tea Nursery Plant Certification Programme.

9.3. Soil Analysis

A total of 2,245 soil samples for pH, and 712 samples for soil carbon, were analyzed.

9.4. Sale of Planting Material

A total of 236,620 cuttings were issued to growers from the Regional Centres in Passara, Kottawa and Deniyaya.

9.5. Issuing of CDs

Sixteen CDs on "TRI Rolling Programmes" were copied and sold on requests from estate personnel.

10. Special Events

10.1. Establishment of Mother Bushes from new Cultivars

The establishment of 54 ha of clonal mother bushes under ADB funding is in progress. The planting of 34 ha has been completed at four extension centres and at two estates of the Institute. The coordinator of the project attended two meeting to discuss the progress of the activity. Two workshops were conducted on the management of mother bushes, at the Institute in Hantana, to educate Regional Managers of the TSHDA, Site Managers, and the two Superintendents of the Institute's estates.

10.2. Flood-Affected Tea Lands

As a result of the high rainfall received within a short period of time (more than 250 mm), some of the low-lying tea lands in the planting districts of Ratnapura, Kalutara, Morawak Korale and Galle were severely affected by floods and earthslips, on 17th May 2003.

A special educational campaign, group discussions and awareness programmes were conducted with a view to minimizing the effects of possible crop losses from flood damage. A documentary video film and a leaflet were prepared and distributed among the tea growers.

Staff of the Advisory Division of the Low-Country Station collected information on the levels of damage caused by the floods in the Ratnapura area. The Advisory Officer attended several meetings organized by the TSHDA to discuss possible assistance that could be extended to those who were affected by the floods.

10.3. Special Replanting Programmes in Ratnapura, Kandy and Gampola Regions

The Head of the Advisory Division participated in activities organized in connection with a special replanting programme of the TSHDA. Several smallholdings in the Gampola and Kandy regions were inspected to determine the possibility of replanting them without rehabilitation. It was found, however, that none of the lands inspected qualified for replanting without rehabilitation. The small holders in the area were apprised of the outcome of the study, and were educated on the advantages of soil rehabilitation before replanting.

11. Surveys and Collaborative Research Activities

11.1. Uva Region (Passara Station)

- Monitoring activities in the clonal observation trial 2/VP37/UVA are continuing.
- The field trial on evaluation of seed varieties has been initiated, and is being monitored by the Plant Propagation and Breeding Division.
- Monitoring of the drip-irrigation trial at Dammeria Estate is being continued jointly with the Agronomy Division.
- A field trial was initiated by the Soils and Plant Nutrition Division in order to evaluate high-potash fertilizer mixtures, in parallel with on-going estate trials in the region. This work is in progress.

- A trial was initiated at the Station, under the methyl-bromide project, to evaluate 300- and 400-series cultivars on their tolerance to nematodes (*P. loosi* and *R. similis*). The assessments are continuing.

- Establishment of tea germplasm was started in collaboration with the Plant Breeding Division.

- A trial was laid down at the Station, by the Plant Breeding Division, to evaluate the performance of polyclonal and biclonal seed stocks for the Uva region.

- Nursery experiments on alternatives to methyl bromide were started at the Station, in collaboration with the Entomology Division.

- An experiment was laid down to study the effect of Vermi-wash Spray on nursery plants, in collaboration with the Entomology Division.

- The Officer-in-Charge, Passara, participated in a fact-finding mission to Walapane tea small holder properties, along with the Officer-in-Charge, Hantane, in December in response to a request made by the TSHDA .

- Sulphur-deficiency symptoms were observed in a few smallholdings in the Passara and Pelgahatenna tea-inspector ranges, and indications are that these would become common in smallholdings that do not use zinc sulphate on mature tea.

- Widespread incidence of Shot-hole Borer infestation was reported from many plantations, especially in the Haputale-Koslanda area.

11.2. Kandy Region (Mid-Country Centre, Hantane)

- The adaptive trial on the use of the fertiliser mixtures, U 709 and VP/UM, was continued, in collaboration with the Soils and Plant Nutrition Division, at the Mid-Country Centre.

- Collection of field data from mid-country estates for the database was completed.

- Up-grading the museum at the Centre was continued, and construction work was initiated in the Institute's section of the National Tea Museum on Hantana Estate.

- Mother-bush blocks for the new 3000- and 4000-series were established, and the Advisory Officer gave the necessary assistance to the Officer-in-Charge in this regard.

- Surveys of the small holdings, collecting tea cuttings from the Centre, were completed.

- A set of nursery plants of the 4000- and 3000-series was raised in order to prepare a Growth Index.

- The Advisory Officer inspected the Clonal Mother Bush areas planted at the TRI and TSHDA centres, and on the land selected for planting the mother bushes in private estates. A report has been submitted.

11.3. Up-Country Region

- A field survey, conducted with the Soils and Plant Nutrition Division, on the use of high-potash fertilizer mixtures was completed. Analysis of the data is being undertaken.

- An adaptive trial on the use of the VP/UM fertilizer mixture vs U 709 was initiated, in collaboration with the Soils and Plant Nutrition Division. The collection of pre-treatment plucking data is in progress.

- Severe infestations of Shot-Hole Borer were reported from estates in the Maskeliya, Kotagala, Upcot, Watawala and Nawalapitiya regions, especially in the clones DT1 and TRI 2025.

- A new weed (*Commelina* spp.) was reported from Pedro Estate. The Advisory and Extension staff and the Agronomy staff investigated the level of spread, and the damage from the weed.

11.4. Ratnapura Region

- Monitoring of the observational trial on the comparison of the fertilizer mixtures, VP/LC-880 and U-709, in Field No. 1, St Joachim Estate, in collaboration with the Soils and Plant Nutrition Division and St Joachim Estate, was continued.

- An assessment of the nursery performance of the clones TRI 2025, 2027 and 4042, in a growth medium of refuse tea mixed with soil, in the Plant Breeding nursery, was continued.

- A study on the nursery performance of 3000- and 4000-series cultivars, under low-country conditions, was completed. The results reveal that the performance of TRI 4049, 4053, 4042, 4006 and 2026 is better than that of TRI 3014, 3025, 3055, 4061 and 2027, under low-country conditions.

- In order to popularise new cultivars among tea planters and small holders, monitoring of the clonal block established in Millakanda Estate, Bulathsinhala, was initiated, in collaboration with the Plant Breeding Division. These blocks consisted of 18 cultivars (3000- and 4000-series) in two replicates.

- Updating of databases for corporate-sector tea estates in the low country is in progress. The collection of basic information has been completed, and data entry has commenced.

- Expansion and upgrading of the tea museum are being carried out in the new Advisory Division premises. Arrangements have been made to start AV saloons so as to provide enhanced services to tea growers.

- Video programmes on shade management, organized by the Tea Reform Project, have been made, with the assistance of advisory and scientific staff.

- A survey to assess the severity and nature of damage by ticks, reported in small holdings in the Pelvadiya area of the Ratnapura AGA's Division, was carried out, with the assistance of a Diploma student. The results of the survey reveal that tick problems occur owing to the regular movement of wild boar in tea fields.

- Collection of weather and yield data, from tea estates in the low country. for a study on adaptation to climate change in the tea plantation sector, was initiated. This is a collaborative study with the Agronomy and Agricultural Economics Divisions, the SLAAS and the Meteorology Department, under an IACC Project on 'Assessment of Impact and Adaptation to Climate Change'.

- A research project on land-suitability assessment, mapping and classification, for tea planting in the Ratnapura District, was initiated in collaboration with the Agronomy Division.

- A detailed investigation on nematode infestation in high-yielding tea fields, in the Hapugastenna Tea Estate, was initiated in collaboration with the Entomology Division.

- A survey on labour productivity and migration was carried out in tea estates in the Ratnapura, Kegalle and Kalutara Regions, in collaboration with the Agricultural Economics Unit.

11.5 Galle Region

- The levels of Horse-Hair Blight damage were investigated by a team of advisory staff, in selected estates in the Galle region.

11.6 Deniyaya Region

- The trial designated as LVP 74 phase II, which commenced in August 1997, is in progress. It is being conducted in collaboration with the Plant Propagation and Breeding Division. The Physiology and Pathology Divisions also joined in the evaluation of growth performance and resistance to specific regional diseases.

- With regard to Thrust A 11 in the Corporate Plan ('Development of an economically viable system to eliminate/reduce the soil rehabilitation period prior to replanting tea in the low country'), the experiment, undertaken in collaboration with the Agronomy Division, continues in Handford Estate, Deniyaya.

- With regard to Project A 15.2 in the Corporate Plan on the effect of different rates of N and K, and Mg, on soil/plant nutrient status and yield, the experiment, undertaken in collaboration with the Soil and Plant Nutrition Division, continues in Lumbini Estate.

- The experiment on the effect of application of different levels of N, with different levels of compost manure, on growth, soil/plant nutrient status and yield, is being carried out in Anninkanda Estate, Deniyaya.

12. IT and Network Activities

A Technical Assistant was recruited on a contractual basis to attend to minor, computer-maintenance work, and network activities, in the institute. The company, East-West Information Systems, who established the Institute's network, attended to the major maintenance work on the networks, during the year.

Twenty new terminals were established, including the fibre-optics connection to the Technology Division.

13. Photography Services

The following services were rendered to the Research Divisions, the Advisory Division and the Institute's staff: colour photographs (3,819), colour slides (356), colour enlargements (22), B/W enlargements (55), B/W passport photographs

(155), preparation of former Directors' Photographs (20), preparation of Board Members' photographs (14) and preparation of photographs for the "Twentieth Century Tea Research" volume (215).

14. Audio-Visual Services

14.1 Video-Filming of Experimental Sites

Estates visits and activities at experimental sites were video-filmed for record purposes. The experimental sites were: Brunswick Estate (N and K trials); Pedro Estate (weed trials); Rattota Estate (soil-rehabilitation trials); Bambarakelle Estate (Tea Tortrix attack); Dammaria Estate (drip-irrigation); Somerset Estate (irrigation system trials); Talawakelle Estate (irrigation trials); High Forest Estate (experimental plots); and Dayagama Estate (Tea Borer damage).

14.2 Issuing of Video Films

Two hundred and sixty-four video films were copied and sent to various tea growers on request, and also to others involved in tea cultivation and training.

14.3. A video film on "Organic Tea Cultivation" was produced for the Tea Convention Exhibition.

Summary of Advisory and Extension Activities

No. Description	T'kelle	R'pura	Passara	Kottawa	Hantane	Deniyaya	Total
01 Advisory correspondence to estates/small holders	787	858	122	187	242	139	2335
02 Advisory visits (on-call and routine visits) to corporate sector and small holder sector.	216	193	92	47	176	74	798
03 Training programmes/ seminars/ NIPM programmes/group discussions/ field days/demonstrations/ educational programmes/ familiarization programmes	33	158	09	60	16	14	290
04 SC programmes	01	02	02		02		07
05 Visitors to the Division: estates/students/overseas/ small holders/others	4480	841	393	859	486	389	7448
06 Issue of publications/ leaflets/extension pamphlets	2669	3045	85	-	185	972	6956
07 Other activities-NIPM/ meetings	02	32	26		02	29	91
08 Exhibitions	03	02		02			
09 Soil samples tested for pH		367	1084	196	479	119	2245
10 Soil samples tested for C%			712				712
11 Issue of VP tea cuttings			45900	12570		178150	236620
12 Commercial nursery inspections	16	57	155	13		52	293
13 Green leaf harvested (kg)			36333	60121		37467	
14 Mature-tea extent (ha)			3.44	9.5		6.41	
15 Yield per hectare			2324	1392		1286	

MID-COUNTRY RESEARCH, ADVISORY AND EXTENSION CENTRE, KANDY

Officer-in-Charge – P. B. Ekanayake

1. General

There are 17 technical and 10 administration staff at the Centre. They conduct research in agronomy, entomology, plant-breeding, and soils- and plant-nutrition. The technical staff assist the Advisory and Extension Division in transferring technology to the plantation and small holder sectors.

Staff from the main station at Talawakelle are also involved in research activities in the mid-country.

2. Transfers

Ms P Marapana, stenographer/typist, was transferred to Talawakele in January, and then back to Hantane in April.

Ms D Kalikotuwe and Ms D Ratnayake, stenogrpahers, were transferred to Hantane in January, and then back to Talawakele in April.

Ms W R P de Silva, typist clerk, was transferred to Talawakele in February.

Mr S Abeysinghe, Experimental Officer, Entomology Division, was transferred to Talawakele in August.

Ms C N K Edirisinghe, Station Assistant, was transferred to Talawakele in January, and then back to Hantane in November.

3. Hectarage as at 31st December 2003

Type of land use	ha
Seedling tea	2.00
VP tea (mature)	5.50
VP tea (young)	3.50
Mother bushes	2.00
Nursery tea	0.20
Under mana grass	0.75
Cleared area for planting mana grass	0.50
Fruit trees	0.40
Coconut	0.81
Forestry	1.20
Marshy land	0.62
Buildings, gardens, paths and roads	5.77
Total	23.00

4. Crop

Green leaf harvested (kg)

Month	Crop harvested	Crop sold	Rate paid/kg Rs.cts	Total Rs.cts
January	2247	1893	14.64	26395.92
February	1824	1752	12.00	21024.00
March	1958	1818	12.38	23415.84
April	2558	2695	13.55	36517.25
May	2798	2798	15.26	42697.48
June	1995	1911	11.82	22508.02
July	2741	2445	11.00	26895.00
August	937	922	11.14	10271.08
September	2810	2556	15.08	38544.48
October	1743	1735	15.40	26719.00
November	2686	2678	16.21	43410.38
December	1770	1750	16.21	28367.50
Total	**26093**	**24953**		**346,645.95**

5. Income

No. of cuttings sold		1,057,250
Income from sale of cuttings	Rs.	264,312.50
No. of VP plants sold		22
Income from sale of plants	Rs.	154.00
Total crop harvested (kg)		26093
Income from sale of green leaf	Rs.	346,645.95
Guest-house occupation charges	Rs.	22,400.00
Soil testing (for pH) charges	Rs.	13,410.00
Sale of TRI publications	Rs.	9,170.00
Miscellaneous (sale of trees)	Rs.	49,770.00
Total income:	**Rs**	**705,862.45**

6. Training

Six NDT trainees were trained during the year.

One trainee from Tharuna Aruna was trained.

7. Meteorological Station

Recording and monitoring of meteorological data were done under the supervision of the Officer-in-Charge.

8. Experiments conducted by the Research Divisions

Agronomy Division

1. Effect of intercropping tea and coconut on productivity and land utilization: two experiments.
2. Effect of Intercropping tea and minor export crops in the mid-country: two experiments.
3. Effects of alternative methods of soil-reconditioning (in comparison to traditional methods) on the establishment and yield of tea: one experiment.
4. Effect of vermi-compost on growth and yield of tea: one experiment.
5. Effects of different formulations of glyphosate on weed control in mature tea.
6. Effects of surface application and incorporation of mulch materials on soil properties and growth of tea.
7. Comparison of manual and shear-harvesting of tea: demonstration block.
8. Demonstration of SALT hedgerows.

Entomology Division

1. Screening of insecticides to manage scavenging termites.
2. Screening of insecticides for control of Shot-Hole Borer.

3. A new Shot-Hole Borer trial: minimizing borer damage for short- and long-term benefits.

4. Testing of suitable dosages of the chemical, "Regent", in controlling Shot-Hole Borer.

5. Effect of the entomopathogenic fungus, *Beauveria bassiana*, on Shot-Hole Borer.

6. Survey of Shot-Hole Borer incidence in tea estates in the mid- country.

7. Assessment of Shot-Hole Borer incidence in seed stocks.

10. Screening of clones for resistance/tolerance and susceptibility to *R. similis:* two experiments.

11. Chemigation trial in glasshouse.

12. Nursery soil-substitute experiment: continuous assessments at field level.

Plant Breeding Division

1. Evaluation of bi-clonal and poly-clonal seed stocks in the mid-country, 2000.

2. Evaluation of cultivars for the mid-country.

3. Development of seed cultivars for the mid-country: hybridization of bi-clonal seed gardens.

4. Mutation breeding for crop improvement

5. Quantification of shoot multiplication.

Soils and Plant Nutrition Division

1. Estimating crop response to micro nutrients (Zn, B, Mn, etc.) at regional level: two experiments.

2. Farm-centered research on organic tea: soil fertility studies (collaborative research project with Gami Seva Sevana, Galaha).

3. Establishing critical nutrient levels for N, K, and Mg for better growth of clonal tea under glasshouse conditions.

4. Developing a fertilizer/dolomite applicator for improving broadcasting efficacy and overcoming the labour shortage.

5. Evaluating and improving the efficiency of fertilizer applicators.

6. Developing a regional analytical laboratory for soil, plant and fertilizer analysis.

7. Providing analytical laboratory services at the Mid-Country Centre.

9. New Constructions

An extension to the Advisory Building, and construction of a culture room for the Entomology Division and two store-rooms for research divisions, were completed.

Commenced laying tracks using paving-rubble, and applying a coat of premix, to the road leading from the Office to the Laboratory Complex and Auditorium.

Commenced fabricating doors for the garage.

10. Maintenance of Buildings, Roads and Water Supply

Colour washing was completed in 4 Nos. D type quarters; in the bathrooms and kitchens of 3 Nos. B type quarters; in 3 Nos. C type quarters; and in the Laboratory Complex, the Circuit Bungalow, and the Security guardrooms.

Re-tarring of part of the internal roads was completed.

Laid two tracks on the gravel road leading to the ARP type quarters.

Erected a name board at the hospital junction

Replaced one section of old GI pipe-line with S-lon pipes.

Fixed roof ceiling of the kitchen area of 4 Nos. D type quarters.

11. Transport

The vehicle fleet was increased by one, owing to allocation of the Panther jeep for coordinating work in the ADB-funded Mother Bush Project.

The Pajero, registration number 32–1809, was tinkered and painted, and a re-conditioned engine was fitted to it.

All the other vehicles had undergone various types of repairs during the year, so that, at end of the year, the vehicles were in good condition.

12. Security Services

Security was strengthened by employing watchers for the guardroom. This allowed operation of the barrier during the night, and at week-ends and public holidays.

13. Reading Room

At the request of the research staff, arrangements were made to use the Board Room as a Reading Room. Several accessions and publications were received from the main library at Talawakelle.

14. Special Scientific Visitors

1. Chaiwat Chumpun and Tirasak Wannawichit, Royal Project Foundation, Thailand, in February;
2. Naoki Toshioka, Japan in March;
3. Sh Shaijan, R Koansal and T E Nosratian, Tea Research Institute, Iran, in June;
4. Martin A Precious, Lipton Ltd., UK, in August;
5. A Assiriyage, CIC, in October;
6. S R Sharma, India, in November; and
7. Keron Budl, India, in November.

LOW COUNTRY RESEARCH, ADVISORY AND EXTENSION CENTRE, RATNAPURA

Officer-in-Charge – M. A. Wijeratne

1. Staffing

There are 41 permanent staff members attached to the Centre. Of them 25 are in the scientific Divisions, and 17 in the Administration Division.

2. Appointments, Transfers and Resignations

Dr M A Wijeratne, Senior Research Officer, was appointed as Officer-in-Charge of the Centre.

Mrs S I Vitarana, Head of the Entomology Division, was transferred to the main station at Talawakelle.

Mr D S EWeerasooriya was promoted to Grade II as the Administrative Officer.

Dr K G Prematilaka was promoted to the Grade I Selection Segment. Mr A K Mudalige was transferred to the Low Country Centre from Talawakelle.

Mr S R W Pathiranage and Mrs P H K Prathiraka have been appointed Research Assistants on a contractual basis.

Mrs Prathiraja resigned, and Mr A K M Jayasena retired, from the services of the Institute.

Training

Dr M A Wijeratne, Dr K G Prematilaka, Mr S L D Amarathunga and Mr K G J P Mahindapala participated in overseas training programmes and workshops.

Mr Chaminda Munasinghe followed an ACLT course, and Miss S M Samarasinghe continued her postgraduate studies.

Mr K Gunawardena and Mr U W K Munasinghe followed local training courses.

Mr D S E Weerasooriya followed a course relating to disciplinary procedure.

Training programmes for students from NAITA, and agricultural schools and the universities, were continued.

Civil and Electrical Work

The construction of the Hostel Complex for staff and trainees was completed and occupied in July 2003. A further ADB grant for Rs. 42 million was approved for further expansion of the Low Country Centre.

Some internal roads and D type quarters were damaged by the floods during May 2003.

Roof repairs, colour-washing, etc. of 2 Nos. B type quarters, 2 Nos. C type quarters, 2 Nos. D type quarters, and the Guest House, and organisation of the Information Room of the Advisory Division were completed.

The retaining wall for the new Administration Building, the water-supply system for the new Hostel Complex, and fencing of the field boundaries of the Plant Breeding nursery, were completed.

Re-wiring of the Guesthouse, quarters B-2 and C-1, and the workers' rest room, estate office, tea-room and information room of the Advisory Division, and erection of the lightning arrester, were effected.

LIBRARY

Librarian - Wasantha Illangantilake

The main function of the library is collection and dissemination of information on tea and allied subjects, and these activities were carried out throughout the year. The library provided regular and satisfactory services to the staff. In addition, the reference service was made available to students, scientists from outside the Institute, etc., on request.

The total number of new accessions of books during the year was 68. The library subscribed to 39 journals, and about 27 journals were received on a gift or exchange basis. The number of Annual Reports received was 16.

The library continued its normal routine work such as classification, cataloguing, indexing, and lending of materials. It also maintained a collection of news clippings relating to tea, and prepared an index for the collection. Five hundred and forty-nine copies of news clippings were distributed to the relevant Divisions and Centres of the Institute. The Cumulative Index of the Sri Lanka Journal of Tea Science, Vols. 52-65, 1983 –1997, was published.

In addition to quick reference queries made by the staff, 21 literature searches were made on the internet. Twelve CD-ROM searches were made from the Council for Agricultural Research Policy.

Inter–library loan activities continued satisfactorily. On request, 40 articles were sent to various agricultural libraries, while 41 articles were received for users at the Institute.

The library continued to maintain its relationship with AGRINET (the Agricultural Information Network) with a view to resource sharing. About 74 journal content pages were received according to Institute-user requirements, and 174 content pages were forwarded to AGRINET member libraries on the SDCP services. A further 25 articles were received from other libraries, and 23 articles were sent to other libraries through AGRINET. Computerized bibliographic data were sent to the CARP for compilation of the Sri Lanka National Agricultural Bibliography.

Firty-eight books and 139 journals were sent to the library of the Low Country Station, Ratnapura. Sixty publications were sent to the library of the Mid-Country Station, Hantana.

The Librarian visited the Low Country Station library, and 185 books were entered in the Accession Register. A catalogue was made of these accessions.

The Librarian attended the AGRINET meetings.

ST. COOMBS / LAMILIERE ESTATE

Superintendent - J. V. Hulangamuwa

1. Personnel

Mr S G Ekanayake resigned from the post of Superintendent on 31st March 2003.

Mr C Karunaratne, Superintendent, Waltrim Estate overlooked the estate from 1st April 2003 to 15th June 2003.

Mr J U Hulangamuwa assumed duties as Superintendent with effect from 16th June 2003.

Mr Mahen Madugalla was appointed Visiting Agent and visited the estate on 12th December 2003.

Mr S Fernando, Estate Medical Assistant, was re-instated with effect from 1st December 2003.

Mr S Rajapakse, Junior Assistant Field Officer, Passara Centre, was transferred to the estate on a temporary basis, with effect from 1st December 2003.

2. Brokers

Messrs. Forbes and Walker Tea Brokers (Pvt.) Ltd. continued as brokers to the estate. They were allocated 100% of the teas manufactured at St. Coombs for a trial period of six months.

3. Weather and Rainfall

Rainfall of 1,629.2 mm was recorded over 180 wet days, as against 1,708.3 mm over 171 days in 2003.

4. Field Works and Cultivation

4.1. Hectare Statement as at 31st December 2003

	St.Coombs	*Lamiliere*	*Total*
Old seedling tea in bearing	9.60	2.00	11.60
V.P. tea in bearing	78.32	44.50	122.82
V.P. tea immature	-	-	-
ADB Project	11.40	2.61	14.01
Nurseries	1.20	0.10	1.30
Experimental Area	4.90	1.00	5.90
Total in tea	**105.42**	**50.21**	**155.63**
Labour housing	1.09	-	1.09
Ravines and grassland	31.00	1.00	32.00
Buildings, roads, workers' gardens, etc.	34.28	14.70	48.98
Total	**171.79**	**65.91**	**237.70**

Crop and Yield

	2003		2002	
	Crop (kg)	Yield (kg/ha)	Crop (kg)	Yield (kg/ha)
St.Coombs	185,367	2,108	183,869	2,043
Lamiliere	103,230	2,220	111,331	2,369
Total	288,597	2,147	295,200	-
Bought Leaf	1,235	-	-	-
Grand Total	289,832	2,147	295,200	2,155

4.3. Cultural Operations

Regular upkeep of the work was done during the year.

4.4. ADB Mother Bush Project

The following fields were planted with 3000- and 4000-series plants for the ADB Mother Bush Project.

Field No. 4, St.Coombs Division 1.38 ha.
Field No. 11, Lamiliere Division 1.228 ha.

4.5. Nursery

46,625 plants were available in the estate nursery.

5. Factory and Manufacture

5.1 Top Prices

Silver Tips teas were sold at Rs.6,000.00 in October and December.

5.2. Working Results

The loss for the year is approximately Rs. 3,188,150.00

Factory and Manufacture

TABLE 1

Working Results of St.Coombs / Lamiliere Estate for 2003 compared to previous years

Year	Total Crop kg (MT)	Bought Leaf (kg)	Yield (MT kg/ha.)	Net Sale Average Actual (Rs/kg)	Cost of Production		+ Profit Loss Rs.
					Estimated Rs/kg	Actual Rs/kg	
1999	266,001	13,872	1,840	121.60	94.95	116.14	- 14,031,161.11
2000	288,058	-	2,036	148.50	103.29	115.74	+9,431,018.92
2001	272,060	8,369	1,986	160.00	108.31	130.00	+6,169,438.00
2002	295,200	-	2,155	141.18	118.78	146.78	-1,653,120.00
2003	289,832	1,235	2,147	140.00	143.75	151.00	-3,188,150.00

TABLE 2

Monthly Yield (kg/ha), Rainfall and Average 'N' applied from 1999-2003 St.Coombs Estate - St.Coombs Division

Month	1999	2000	2001	2002	2003
January	190	165	176	153	139
February	168	179	154	151	205
March	173	182	123	90	124
April	193	201	165	160	204
May	118	244	209	327	182
June	73	144	195	162	177
July	130	98	87	134	136
August	168	183	123	90	174
September	120	133	118	160	131
October	166	101	108	228	209
November	127	192	171	201	238
December	199	172	199	178	189
Total	1,825	1,994	1,828	2,034	2,108
Rainfall (mm)	2,032.0	1,887.6	1,949.3	1,708.3	1,629.2
No. of wet days	190	184	181	171	180
Average N ($kg\ ha^{-1}\ yr^{-1}$)	170	225	270	270	227

TABLE 3: Monthly Yield (kg/ha) of fields and amounts of "N" applied – St.Coombs Division (2003)

Field	Extent (ha.)	Total (N/ha.)	Mixture	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
1	6.5	235	VPUM	221	209	139	220	237	162	193	154	139	230	213	200	2317
1A	0.6	70	STUM	192	237	157	217	348	140	110	65	75	130	173	-	1844
1B	0.6	185	VPUM	0	105	145	133	208	132	120	88	102	127	195	55	1410
2	2.6	300	VPUM	143	322	108	203	299	267	168	262	90	213	279	115	2469
3A	7.0	68	VPUM	135	225	71	19	12	9	3	1	9	23	156	165	828
3B	6.7	240	VPUM	79	181	154	192	229	163	200	238	183	358	303	229	2509
4	9.1	240	VPUM	133	190	119	219	232	191	174	247	124	237	231	231	2328
5	7.4	330	VPUM	149	252	160	377	213	265	152	271	173	291	300	220	2823
6A	3.0	340	VPUM	245	293	216	430	206	328	134	231	192	365	283	231	3154
6B	2.5	263	VPUM	99	202	142	212	397	192	160	182	168	150	192	166	2262
7	4.7	250	VPUM	185	181	161	257	111	234	127	210	120	163	240	183	2172
8	5.2	230	VPUM	150	197	121	173	212	183	172	191	166	233	250	195	2243
9	7.8	260	VPUM	147	208	108	212	199	190	162	176	164	209	252	192	2219
10	2.0	240	VPUM	183	211	111	167	145	189	139	121	153	214	231	200	2064
11A	2.0	135	VPUM	84	66	52	54	-	4	3	-	20	30	194	138	645
11B	1.0	90	STUM	78	167	103	-	-	-	-	-	13	36	185	102	684
12A	1.2	185	VPUM	158	213	148	178	123	207	114	155	85	163	214	165	1923
12B	1.5	60	STUM	105	117	18	135	107	29	27	42	29	57	43	101	810
13	8.0	212	STUM	118	227	127	215	162	232	127	180	154	201	277	185	2205
13A	1.4	235	VPUM	134	120	79	136	135	165	104	127	114	184	226	151	1675
13NC	2.0	185	VPUM	47	51	79	90	169	141	117	125	112	282	235	159	1607
14	5.1	230	VPUM	116	217	109	203	166	154	131	161	148	196	196	184	1981

Table 4 : Cultural Operations - St. Coombs Division

Field No.	Seedling Tea (ha.)	V.P. Tea (ha.)	Clones	Last Pruned	Planting Year	Yield (kg/ha) 2002	Yield (kg/ha) 2003	Shade
1	-	6.5	TRI 2016,2023 2025 & DN	Sep. 1999	1953-1959	2734	2317	Dadaps , Gravellia
1A	0.6	-	-	Nov . 2003	Before 1935	1780	1844	Gravellia
1B		0.6	TRI 777	Sep. 1999	1993	-	1410	Dadaps
2	-	2.6	TRI 2043,2142 2025, DT1 & DT95	May 2001	1964	2710	2469	Dadaps , Gravellia & Calliandra
3A	-	7.0	TRI 2027, 2043 2025	June 2003	1965-1968	2244	828	Dadaps , Gravellia & Calliandra
3B	0.4	6.3	WT 26	Aug . 2002	1965-1968	1370	2509	Dadaps , Gravellia & Calliandra
4	-	9.1	TRI 62/9,2025 3016, DN, N2 CY 9	May 2000	1978-1981	2220	2328	Dadaps , Gravellia
5	-	7.4	TRI 2142,2025 2023, TC9, DT95 N2	May 2001	1970	2942	2823	Dadaps , Gravellia & Calliandra
6A	-	3.0	TRI 2025, DN	June 2002	1985-1986	510	3154	Dadaps , Gravellia
6B	-	2.5	N2 & TRI 4061	June 2002	1985-1986	569	2262	Dadaps , Gravellia
7	-	4.7	TRI 2024, 2025 62/9, DT1, DT95 3019	April 2000	1962-1964	2135	2172	Dadaps , Gravellia

Table 4 : Cultural Operations - St. Coombs Division (Contd.)

Field No.	Seedling Tea (ha.)	V.P. Tea (ha.)	Clones	Last Pruned	Planting Year	Yield (kg/ha) 2002	Yield (kg/ha) 2003	Shade
8	-	5.2	TRI 2024,2025 4052, 4072 DT1	June 99	1962-1964	2400	2243	Dadaps , Gravellia & Calliandra
9	4.8	3	TRI 3000 & 2043	2001	1986	2433	2219	Dadaps , Gravellia & Calliandra
10	-	2	SALT Area	Jun e 1999	1993	1550	2064	Dadaps , Gravellia & Calliandra
11A	-	2.0	TRI 2025, 62/9	June 2003	1988	1979	645	Gravellia & Calliandra
11B	1	-	-	Jun e 2003	1935	1784	684	Dadaps , Gravellia & Calliandra
12A	-	1.2	TRI 2025 KO 145	June 1999	1985	2515	1923	Dadaps , Gravellia
12B	-	1.5	-	-	1935	190	810	Gravellia
13	8.0	-	-	July 2001	1935	1777	2205	Dadaps , Gravellia & Calliandra
13A	-	14	TRI 2025 2043, DT 1	July 2001	1986	1314	1675	Gravellia & Calliandra
13NC	-	2	TRI 3000 Series 2025, DT1	Aug. 2001	1996	940	1607	Gravellia & Calliandra
14	-	5.1	TRI 777, 2023 2024, 3000 Series N2	Oct . 1999	1961	2012	1981	Dadaps , Gravellia & Calliandra

TABLE 5 : Monthly Yield (kg/ha) of fields and amounts of "N" applied - Lamiliere Division (2003)

Field No.	Extent (ha.)	Total (N/ha.)	Mixture	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
4A	5.1	253	VP/UM	199	164	142	342	178	241	193	242	175	394	309	268	2847
4B	1.9	68	VP/UM	118	193	99	328	46	-	-	-	-	-	96	83	963
5	0.5	90	ST/UM	222	486	194	350	202	332	64	222	70	-	-	-	2142
5NC	1.0	203	VP/UM	142	33	58	151	104	264	149	164	94	346	281	179	1965
6A	1.5	68	ST/UM	82	107	56	155	95	139	43	149	22	-	-	-	848
6B	2.0	202	VP/UM	-	-	16	68	164	165	77	90	122	181	280	194	1357
7	4.5	134	VP/UM	362	171	166	162	78	0	-	-	6	20	131	181	1277
8A	5.0	253	VP/UM	279	263	167	322	161	254	179	231	186	306	337	248	2933
8B	4.0	320	VP/UM	211	196	125	280	199	356	160	209	220	265	252	214	2687
9A	4.0	305	VP/UM	118	219	95	287	148	273	149	285	196	356	207	291	2624
9B	4.0	305	VP/UM	235	120	135	308	189	202	167	273	206	337	215	244	2631
10	6.6	185	VP/UM	176	96	105	100	106	180	162	159	148	234	215	230	1911
11	6.4	240	VP/UM	300	211	85	261	126	192	147	173	153	233	250	224	2355

TABLE 6

Monthly Yield (kg/ha), Average 'N' applied from 1999-2003 St.Coombs Estate – Lamiliere Division

Month	1999	2000	2001	2002	2003
January	176	175	230	220	215
February	178	174	206	134	169
March	196	203	197	103	117
April	174	200	185	214	241
May	139	261	280	355	139
June	84	125	244	180	198
July	126	93	113	141	133
August	134	193	128	119	178
September	131	133	161	199	144
October	172	127	137	262	241
November	134	218	213	236	228
December	227	220	214	204	217
Total	**1,871**	**2,122**	**2,308**	**2,367**	**2,220**
Average N ($kg\ ha^{-1}\ yr^{-1}$)	169	220	270	270	227

Table 7: Cultural Operations - St. Coombs Estate - Lamiliera Division

Field No.	Seedling Tea (ha.)	V.P. Tea (ha.)	Clones	Last Pruned	Planting Year	Yield (kg/ha) 2002	Yield (kg/ha) 2003	Shade
4A	-	5.1	TRI 2025	Jul 01	1984	2550	2847	Dadaps & Gravellia
4B	-	1.9	TRI 2025	Jul 03	1986	3001	963	Dadaps & Gravellia
5	0.5	-	-	Oct 03	1999	2784	2142	Dadaps & Gravellia
5NC	-	1.0	TRI 3041	-	-	4262	1965	Dadaps & Gravellia
6A	1.5	-	Mixed Clones	Aug 03	-	1667	848	Dadaps & Gravellia
6B	-	2.0	DT1, WT26 TRI 2025	Oct 02	1990-1991	1694	1357	Dadaps & Gravellia
7	-	4.5	TRI 2025	Jun 03	1983	2472	1277	Dadaps & Gravellia
8A	-	5	TRI 2025 & CY9	Jun 00	1979	2753	2933	Dadaps & Gravellia
8B	-	4	TRI 2025 DN, N2, WT26 CY9	Jun 01	1989-1990	2875	2687	Dadaps & Gravellia
9A	-	4	TRI 2025	May 02	1979	1117	2624	Dadaps & Gravellia
9B	-	4	TRI 2025, DN CY9	Jul 02	1980	1255	2631	Dadaps & Gravellia
10	-	6.6	DN, TRI 2025	Jun 99	1967-1969	2703	1911	Dadaps
11	-	6.4	DN, TRI 2025	May 00	1970 – 1971	2768	2355	Dadaps

ST. JOACHIM ESTATE

Superintendent - M. S. E. Perera

1. Personnel

Visiting Agent: Mr Lalin I de Silva, Manager, Aislaby Estate, Bandarawela, was appointed Visiting Agent, and made his first visit to the estate on 20th September, 2003.

2. Hectarage as at 31st December 2002

Mature tea	48.32
Nursery	1.58
Coconut	3.89
ADB Project	32 .19
Land under paddy	8.74
Tea/Rubber	3.68
Rubber	7.12
Mana grass	13.02
Total	**118.54**
Buildings, roads, ravines and jungle	23.44
Grand Total	**141.98**

3. Crop (made tea kg)

The production in 2003, compared to the previous year was:

Year	Estate Crop (Kg)	Bought Crop (Kg)
2002	65,071	658,619
2003	62,484	648,692

The production on the estate registered a decrease of 2,587 kg or 3.98 %, in comparison to that in the previous year, owing to the floods experienced in the month of May.

3.1. Bought Leaf

The bought leaf manufactured at the St. Joachim factory decreased by 9,927 kg or1.51 %, in comparison to that in previous year.

4. ADB Mother Bush Project

An extent of 5.95 ha was planted during the 2003 season, with 3000- and 4000-series clones, for the ADB Mother Bush Project.

A total extent of 27.5 ha has been completed to date out of the estimated 30 ha.

5. Prices

All teas produced at the St. Joachim factory are sold at the Colombo Auctions in the Low Grown Catalogue. Messrs Bartleet and Co. Ltd., and Forbes and Walker Tea Brokers (Pvt) Ltd., shared the sale of the teas equally.

Messrs De Silva, Abeywardena and Pieris sold St. Joachim teas up to August 2003. Their services were discontinued as from September 2003.

The Nett Sale Average for the year was Rs.142/92. The working of the St. Joachim estate resulted in a profit of Rs.712,233/- (as at 30th November 2003).

6. Nursery

The supply of planting materials to small holders in the District continued during the year.

Sale of Planting materials compared to the previous year was as follows.

Year	Shoots sold Rs.	Shoots Proceeds Rs.	Profit Rs.	Plants sold	Plants Proceeds Rs.	Profit Rs.
2002	432,475	108,119/=	79,205/=	80,082	585,813 /=	176,213/=
2003	769,775	192,443/-	171,896/=	44,012	352,096/=	94,531/=

7. Floods

Owing to the heavy rains in May, a flood-water level of up to 10 ft. was experienced. This resulted in new clearings in Field Nos. 1 and 5, and in the nursery, being submerged, with resultant damaged to the clearings and the nursery plants.

Table 1

Working Accounts, 2003 St. Joachim Estate In Comparison with Previous Years

YEAR	TOTAL CROP SOLD MADE TEA, KG	YIELD (MADE TEA), KG/HA	NET SALE AVERAGE, RS/KG	ESTIMATED C.O.P RS/KG	ACTUAL C.O.P RS/KG	.+ PROFIT .- LOSS, RS
1997	* 996106 # 66847	1236	120/61	98/24.30	111/60	+19,325,357/=.
1998	890,131 73,473	1359	133/64	94/25.00	87/43	+16,605,650/=
1999	746,768 78,197	1446	120/22	100/30.00	117/33	+8,262,014/=
2000	711,325 75,336	1393	138/70	82/98.00	75/62	+ 9,360,576/=
2001	609,732 66,459	1140	137/23	89/48	89/13	- 424,423/=
2002	658,619 65,071	1358	147/84	96/26	100/56	-1,306,425/=
2003	648,692 62,484	1293	142/92	130/09	92/11 *	+ 712,233/= *

* To end November 03

* Bought crop made tea
# Estate crop made tea

Table 02

St. Joachim Estate
Monthly yield (kg/ha) Rainfall and Average N applied

	1998	1999	2000	2001	2002	2003
January	146	122	117	123	102	106
Februay	99	94	105	115	81	88
March	81	132	139	122	109	105
April	131	133	141	113	109	131
May	104	108	143	118	127	116
June	123	113	118	87	130	112
July	103	102	95	86	116	124
August	98	101	100	88	130	95
September	120	135	101	56	104	100
October	127	121	100	88	113	112
November	107	138	110	78	105	107
December	120	147	124	90	85	
Total	**1359**	**1446**	**1393**	**1140**	**1358**	**1196**
Total rainfall (mm)	4579.9	4526.4	3740.6	3593.5	3194.8	3984.6
No of wet days	220	224	211	189	206	227
Average "N" (kg/ha/yr)	158	164	162	163	162	124

Table 3

St. Joachim Estate

Monthly Yeild (Kg / Ha), 2003
Fertilzer mixture used and amounts of "N" Applied

Field No.	Extent ha	Total N.	Fertilizer Mixture	MONTH												
				Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Total
1	2.68	180	VPLC/880	203	182	134	159	178	145	179	234	209	284	263	192	2362
1B	0.80	300	VPLC/880	362	344	390	549	356	445	687	340	351	286	469	464	4953
2A	0.93	320	VPLC/880	264	222	223	300	265	294	426	354	336	260	456	241	3641
02F	7.18	140	VPLC/880	41	27	41	36	38	50	56	24	50	44	38	67	512
3	8.40	140	VPLC/880	105	81	82	109	78	75	88	74	70	39	2	–	803
4	5.85	140	VPLC/880	83	78	79	87	108	106	107	86	89	108	78	93	1102
6	1.50	360	VPLC/880	63	21	87	85	120	144	179	85	132	131	141	74	1262
6B	1.10	200	VPLC/880	–	13	55	114	227	118	182	260	169	296	194	183	1811
6C	2.00	140	VPLC/880	13	61	124	173	145	89	233	177	184	330	303	189	2021
08A	6.00	210	VPLC/880	177	1`34	151	205	151	149	21	–	–	17	20	43	1068
08B	2.02	220	VPLC/880	227	209	279	295	247	284	352	280	204	270	290	282	3219
08C	1.90	2200	VPLC/880	62	45	47	17	–	–	–	–	10	45	43	34	303
02 (TRI)	4.12			35	25	30	61	13	10	13	11	53	8	25	27	311
3 A (TRI)	3.34			90	58	60	74	106	89	76	72	90	92	72	56	935
06 A (TRI)	0.50			336	304	500	434	40	104	58	34	116	94	224	240	2484
	48.32			**106**	**88**	**105**	**131**	**116**	**112**	**124**	**95**	**100**	**112**	**107**	**97**	**1293**

METEOROLOGICAL OBSERVATION - 2003
ADVISORY AND EXTENSION CENTRE, DENIYAYA

(Elevation 250 m. amsl)

Month	Mean Temperature		Soil Temperature at 30 cm		Rainfall (mm)	Wet Days	Total Wind (km)	Total Evaporation (mm)	Mean Sun Shine (hrs/day)
	Min. (°C)	Max. (°C)	9.00 h	16.00 h					
January	21.00	30.53	28.0	28.32	110.70	10	607.0	2.41	5.98
February	21.40	31.52	28.7	28.94	167.50	12	820.0	2.93	6.85
March	21.60	31.57	29.62	29.15	431.70	21	77.9	3.01	6.27
April	22.50	31.54	28.57	29.66	451.60	16	800.0	2.61	5.52
May	23.51	30.52	28.2	28.85	909.98	20	2002.0	NA	4.97
June	23.00	28.87	28.07	28.95	209.00	22	2000.0	NA	5.52
July	23.40	29.62	27.50	27.80	274.40	19	2443.0	2.86	5.73
August	23.94	29.76	27.90	28.30	168.30	16	2983.0	3.21	6.56
September	23.40	29.60	27.60	29.60	249.50	23	2230.0	3.04	6.36
October	22.87	29.90	28.98	28.40	324.70	19	1443.0	2.92	6.51
November	22.99	29.77	27.68	27.77	482.00	17	741.0	2.05	4.31
December	20.89	30.70	28.02	28.09	307.00	11	785.0	2.91	7.59
Total					4086.30	206	17633.0		
Mean	22.50	30.30	28.30	28.60			1469.4	2.79	6.09

NA - Not available

METEOROLOGICAL OBSERVATIONS - 2003

MID-COUNTRY RESEARCH, ADVISORY AND EXTENSION CENTRE, KANDY

(Elevation 762 m amsl)

Month	Mean Temperature (^{0}C)		Relative Humidity %		Mean Sunshine (hrs/day)	Rainfall (mm)	No:of Wet days	Evaporation (mm/day)
	Min	Max.	8.30h	15.30h				
January	18.9	25.9	99.0	99.2	4.9	171.4	08	2.17
February	20.5	25.4	99.3	98.9	7.1	41.3	05	3.39
March	20.0	30.0	99.5	98.9	7.3	110.6	09	3.29
April	20.2	29.6	99.6	99.0	6.4	231.8	13	2.28
May	21.7	28.7	99.4	99.4	6.3	108.7	09	2.92
June	21.2	28.9	99.0	99.0	6.8	92.4	11	3.14
July	19.8	27.6	99.1	99.3	5.5	149.4	09	2.12
August	20.6	27.0	99.3	98.9	5.4	108.6	15	2.26
September	19.7	27.8	99.3	98.9	6.7	82.5	09	2.52
October	19.0	28.2	99.0	98.9	6.4	100.7	15	2.52
November	20.0	26.0	99.4	99.0	3.6	180.5	22	1.75
December	18.6	27.7	99.1	98.7	7.3	4.5	01	3.06
Mean	20.0	27.7	99.3	99.0	6.14	-	-	-
Total	-	-	-	-	-	1382.4	126	31.42

METEOROLOGICAL OBSERVATIONS - 2003

UVA ADVISORY AND EXTENSION CENTRE, PASSARA

(Latitude 6^0 56'N, Longitude 81^0 07'E, Elevation 1120 m amsl)

Month	Mean Temperature (°C)		Mean Relative Humidity (%)		Mean Sunshine $(hrs/day)^{-1}$	Mean Wind Speed km / h	Total Rainfall (mm)	Evaporation (mm/day)
	Max. Dry	Min Dry	9.00 A.M.	4.00 P.M.				
January	23.5	16.6	82	83	4.1	3.37	213.3	1.90
February	25.1	16.3	79	76	4.7	2.48	95.9	2.63
March	26.5	18.1	77	78	5.9	1.34	220.3	2.62
April	26.8	21.4	73	77	5.6	0.77	188.1	2.70
May	28.7	20	77	77	5.2	2.29	121.9	3.21
June	28.4	19.5	77	78	5	1.36	134.8	2.92
July	27.3	19	81	83	4.5	1.86	78.7	2.94
August	27.3	18.7	77	78	4.6	1.65	88.9	2.73
September	27.7	18.3	76	74	4.8	1.38	159.9	2.83
October	26.8	18.2	75	77	5.2	0.96	189.6	2.72
November	23.9	18	89	89	2	2.95	461.4	1.25
December	24.4	16.7	78	80	5.0	4.28	63.7	2.38
Total							2016.5	30.83
Mean	26.4	18.4	78	79	4.7	2.06		

METEOROLOGICAL OBSERVATIONS - 2003

TRI-LOW COUNTRY STATION RESEARCH, ADVISORY & EXTENSION CENTRE, RATNAPURA

(Lat 6°41'N, Long 80°-40°E, 29 m amsl)

Month	Temperature (°C)		Relative Humidity %		Mean Sunshine	Rainfall Total	Difference from	Wet Days	Difference from	Pan Evaporation
	Mini: dry	Max: dry	9.00 hrs	16.00 hrs	H' Day	mm	30 years		30 years	(mm/day)
January	22.32	32.84	89	64	4.56	128.6	+17.5	11	+2	3.06
February	22.96	34.73	88	63	6.07	122.7	–14.3	8	–1	3.31
March	23.01	34.52	87	72	5.42	258.2	+46.0	18	+4	3.35
April	23.42	34.83	86	63	5.25	433.7	+94.8	20	-0	3.17
May	24.35	33.44	86	51	5.33	533.7	+57.8	19	–1	2.43
June	23.86	32.33	85	69	3.82	496.5	+84.3	24	+3	2.67
July	23.62	32.02	88	64	4.00	433.8	+59.0	24	+4	2.52
August	23.84	32.24	87	59	4.89	379.6	+75.0	21	+1	2.71
September	23.42	31.00	85	64	4.65	497.1	+75.7	25	+5	2.97
October	23.34	32.74	85	62	5.18	270.0	–166.8	26	+5	2.03
November	23.14	31.84	87	65	2.89	335.6	–35.8	25	+7	1.94
December	21.9	33.68	87	61	6.61	90.3	–145.0	7	–7	3.14
Total	—	—	—	—	—	3979.8	—	—	—	—
Mean	21.59	33.01	87	63	4.88	—	—	—	—	2.77

METEOROLOGICAL OBSERVATIONS - 2003

TRI - ST.COOMBS, TALAWAKELLE

(Lat.6"54768'n,Long.80"4239'e,1382m amsl)

Month	Mean Temperature (°C)		Soil Temperature (°C)		Rainfall Humidity (%)		Wind Travelled (miles)	Sunshine HRS (h/day)	EVAPO (mm)	RF (mm)	Wet Days
	Ambient Min.	Ambient Max.	9.00 am	16.00 pm	9.00 am	16.00 pm					
January	12.2	24.6	20.6	22.0	94.3	93.0	1852.82	5.4	2.29	114.0	12
February	11.9	26.4	21.1	23.0	92.8	86.8	1950.38	6.8	3.06	4.3	1
March	11.7	25.9	21.4	23.2	94.2	94.7	1770.07	7.6	3.10	145.7	12
April	13.7	26.8	22.3	23.8	95.7	91.3	1484.56	6.8	2.63	229.9	12
May	16.8	24.7	22.5	23.6	96.9	93.3	1593.00	5.5	2.22	153.7	11
June	15.8	24.7	22.7	23.7	96.1	94.0	1482.72	4.6	1.76	92.5	14
July	15.0	23.1	21.6	22.5	96.8	94.5	1990.96	3.8	1.91	205.2	18
August	16.1	22.5	21.5	22.4	97.0	94.7	1852.66	3.5	1.83	190.9	17
September	14.7	23.9	21.7	22.6	97.7	98.0	1448.37	3.6	1.59	112.6	21
October	13.7	25.2	21.9	23.0	96.0	95.1	1665.13	6.0	2.33	101.0	12
November	14.8	24.9	21.3	22.2	94.0	94.9	1852.53	3.9	2.16	183.0	16
December	11.4	26.2	20.9	22.5	92.6	91.5	1287.75	7.1	2.70	22.7	3
Average											
Total											

METEOROLOGICAL OBSERVATIONS - 2003

ADVISORY AND EXTENSION CENTRE, KOTTAWA, TALGAMPOLA

(Elevation-30m amsl)

Month	Mean Temperature (°C)		Relative Humidity (%)		Mean Sunshine (h day^{-1})	Total Rainfall (mm)	Rainfall difference from 20 years	Wet Days
	Min	Max	9.00 h	16.00 h				
January	21.3	30.9	88	83	5.5	83.2	–37.4	09
February	22.4	31.9	88	79	6.7	57.6	–34.5	04
March	22.4	31.8	90	83	6	297.8	+186.5	16
April	*	*	*	*	6.8	318.6	+66.7	11
May	23.8	30.8	89	83	5.0	490.0	+129.5	14
June	24.4	29.7	89	82	5.6	198.5	–58.2	24
July	24.4	29.9	89	78	4.2	329.1	+140.2	23
August	24.0	30.3	87	82	5.1	198.6	–11.8	21
September	23.8	30.2	89	80	5.8	557.2	+242.4	21
October	23.3	30.5	85	75	6.0	248.9	–115.0	17
November	23.3	30.8	86	79	4.0	312.1	+41.5	21
December	21.8	30.6	92	86	3.1	102.9	–63.6	07
Total						3194.5		188
Mean			88	81	5.9			