

ANNUAL REPORT – 2003



TEA RESEARCH INSTITUTE OF SRI LANKA

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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 its 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*, *Candida 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.

Felicitations 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
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8. Senior Management Staff as at 31st December

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

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

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
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Engineering Division

Ms D W Manawadu	-	Resident Engineer
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Library

Ms R W M W K Illangantilake	-	Librarian
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Publication Unit

Vacant	-	Publication/Publicity Officer
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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 Physiology and Plant Propagation Division

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

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 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
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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 K M 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
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Passara Station

Mr J C K Rajasinghe	-	Officer-in-Charge/Advisory Officer
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10. Other Administrative, Scientific, Research and Advisory Staff - Grades III-V, as at 31st December

Office of the Director

Ms S M Jeyasingham	-	Secretary to the Director
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Office of the Deputy Director Research (Production)

Ms D Ratnayake	-	Stenographer/Typist (English)
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Office of the Deputy Director (Administration)

Ms S Shanmuganathan	-	Stenographer/Typist (English)
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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
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Publication Unit

Ms A P V Kalyani	-	Stenographer/Typist (English)
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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 DarkRoom 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 Physiology Division

Ms V Sidhakaran	-	Experimental Officer
Ms D M S Navaratne	-	Experimental Officer
Mr H P Baddage	-	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 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 D 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 Palathanthirige	-	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
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Deniyaya Station

Mr O W Jayawardana	-	Station Assistant
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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

- (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

- (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 and Appointments

The following staff were recruited 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.
- (d) Dr M T Ziyad Mohamed was appointed Director on a contractual basis as from 04 August.
- (e) Mr W M P Wijekoon was appointed Deputy Director (Administration) as from 04 August.
- (f) 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) Network 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 Nematology 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 telephone 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		St. Coombs Estate 2003		St. Joachim Estate 2003		Total 2003	
			Rs.	Cts.	Rs.	Cts.	Rs.	Cts.	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				
(46,796,445)	CURRENT LIABILITIES									
	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.	INCOME	2003 Rs. Cts.				
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				
<u>245,222,652</u>		<u>213,235,248.94</u>				
(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)				
<u>237,660,096</u>	Total Income	<u>209,431,443.06</u>				
			Administration Finance and Common Service Rs. Cts.	Advisory, Extensions & Publicity Rs. Cts.	Research Rs. Cts.	Total Rs. Cts.
Total	EXPENDITURE					
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
	05 Transportation, Communication, Utility and Other Service		24,778,761.36	10,982,233.26	714,260.52	36,475,255.14
37,624,114			1,946,171.17	173,769.57	258,498.34	2,378,439.08
2,530,887	07 Contributions, Grants and Subsidies		2,162,485.32	1,012,441.58	3,113,908.80	6,288,835.70
5,951,630	08 Pensions and Retirement Benefits		6,745,895.50	-	-	6,745,895.50
1,972,306	08 Gratuity Provision		328,277.70	1,027,167.75	6,637.00	1,362,082.45
1,064,427	10 Media, Advertising, Publicity and Gifts		-	5,033,840.08	3,639,298.81	8,673,138.89
8,516,321	11 Cultivation and Field Trials		1,502,556.23	670,623.00	2,951,247.74	5,124,426.97
5,733,168	12 Miscellaneous (Annx. XVI)		<u>98,005,556.96</u>	<u>53,031,479.56</u>	<u>95,101,962.32</u>	<u>246,138,998.84</u>
<u>217,894,828</u>	Total Expenditure					
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	-				
<u>(33,612,703)</u>	Operating Surplus/(Deficit) transferred to Tea Research Fund	<u>(37,878,908.20)</u>				

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	Rs.	Rs.	Rs.	Rs.
Operating Activities				
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	
	<u>56,223,934</u>		<u>44,388,458</u>	
Less: Income from sale of fixed assets	(4,957,939)	51,265,995	(19,274)	44,369,184
		<u>7,889,606</u>		<u>57,401,340</u>
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		<u>7,889,606</u>		<u>4,954,436</u>
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		<u>(64,379,971)</u>		<u>128,390,873</u>

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	<u>16,764,937</u>	<u>(30,448,755)</u>
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	<u>318,000</u>	<u>329,278</u>
Cash generated from financing activities	<u>33,844,098</u>	<u>30,301,531</u>
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)	<u><u>61,908,500</u></u>	<u><u>156,661,988</u></u>
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
Cash 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
	<u><u>61,908,500</u></u>	<u><u>156,661,988</u></u>

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

Annex - XVII

The Tea Research Institute of Sri Lanka - Annual Report 2003

2002		INCOME			
Rs.	Kg.		Kg.	Rs.	
37,075,254.28	264,414	Tea Sales Gross Proceeds			
2,703,365.78	30,786	Tea Sales Ex Brokers (Gross)	254,711	38,828,691.43	(Note 1)
39,778,620.06	295,200	Tea Sales Local & Graties	32,776	3,283,299.76	
			<u>287,487</u>	<u>42,111,991.19</u>	
21,480.76		Less: Over valued Tea last year		63,086.91	
39,757,139.30		Add: Sale of green leaf		<u>42,048,904.28</u>	42,048,904.28
38,264.11		Miscellaneous Income		174,284.45	174,284.45
39,505.79		Total Income		-	<u>42,223,188.73</u>
39,834,909.20					
		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)		<u>179,729.80</u>	
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		<u>1,995,341.57</u>	
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		<u>914,438.65</u>	44,768,142.41
<u>(4,362,172.05)</u>		Profit/(Loss) transferred to TRI Operating A/c			<u>(2,544,953.68)</u>

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

Prepared by: S. G. Punchibanda

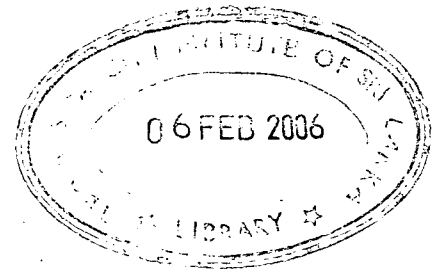
**TEA RESEARCH BOARD
ST. JOACHIM ESTATE WORKING ACCOUNT FOR THE
PERIOD 1ST JANUARY TO 31ST DECEMBER 2003**

Annex - XIII

2002		INCOME			
Rs.	Kg.		Kg.	Rs.	
107,197,333.70	717,388	Tea Sales Gross Proceeds	689,344	103,674,115.48	(Note 1)
511,891.13	6,302	Tea Sales Ex Brokers (Gross)	6,890	569,013.43	
<u>107,709,224.83</u>	<u>723,690</u>	Tea Sales Local & Graties	<u>696,234</u>	<u>104,243,128.91</u>	
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)	
<u>107,980,942.07</u>				<u>102,529,277.39</u>	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
<u>108,602,987.69</u>		Total Income		<u>103,641,727.76</u>	<u>103,641,727.76</u>
		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 (including transport charges)		73,704,510.75	
<u>105,961,253.78</u>				<u>99,314,750.91</u>	
		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	
<u>5,842,118.81</u>		Total Expenditure		<u>5,585,829.05</u>	104,900,579.96
111,803,372.59					
<u>(3,200,384.90)</u>		Profit/(Loss) transferred to TRI Operating A/c		<u>(1,258,852.20)</u>	<u>(1,258,852.20)</u>

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. Thrust A 9. Development of an economically viable system to eliminate/reduce the soil rehabilitation period, prior to replanting in the up-country.

1.1 Project A 9.1. Evaluating soil rehabilitation techniques.

Effect of direct planting *vis-à-vis* planting after soil reconditioning on yield; Concordia Estate, 1991.

The objective of this study is to compare the effect of soil reconditioning before replanting at a high altitude (>1800 m amsl) where soil fertility does not limit the establishment of tea. Five clones (PK 2, TRI 2024, DT1, NAY 3 and TRI 2025) are used in this study.

This experiment is now in the second year of the second cycle. The yield for the period, September 2002 to August 2003, is given in Table 1.

Table 1. Yield, kg made tea ha⁻¹

Clone	Reconditioning	Treatments	
		Direct Planting	Mean
TRI 2025	3518	3265	3391
TRI 2024	3509	3186	3347
NAY 3	3363	3058	3210
DT 1	3586	3070	3328
PK 2	3828	2966	3397
Mean	3561	3109	
LSD (P=0.05) for reconditioning		259	
LSD (P=0.05) for clones		NS	
CV (%)		12.0	

Soil reconditioning with grass improved the yield even during the second year of the second cycle.

U P Abeysekera

Assessment of techniques of soil reconditioning in seedling tea; Edinburgh Estate, 2002.

The objective of this study is to assess different techniques of soil reconditioning in a seedling tea field. In this study, two years of soil reconditioning with grass is compared with *in situ* soil-reconditioning for two years with grass before up-rooting the old seedling

tea. Mana grass was inter-planted with the seedling tea. In addition, rejuvenation pruning of existing bushes, with subsequent infilling after soil reconditioning, is also being tested.

The seedling tea was harvested at weekly intervals, and the soil-reconditioning grass was lopped at three-monthly intervals.

U P Abeysekara and A Anandacoomaraswamy

2. Thrust A 10. Development of an economically viable system to eliminate/reduce the soil rehabilitation period, prior to replanting in the mid-country.

2.1 Project 10.1. Evaluating soil rehabilitation techniques.

Effects of alternative methods of soil reconditioning on establishment and yield, compared with soil reconditioning by grass; TRI 3013, New Peacock Estate, 1991.

The objective of this experiment is to compare, with traditional methods, the alternative methods available for reducing the two-year soil reconditioning period. Compost and coir dust (with and without T200, a fertiliser mixture for young tea) were incorporated at the time of planting (July 1997). In another treatment, *Flemingia congesta* was used for *in situ* soil reconditioning after tea had been planted.

The control for this comparison was two years of soil reconditioning with mana.

This experiment is now in the second year of the second cycle. The yield, from October 2002 to September 2003, is given in Table 2.

Table 2. Yield, kg made tea ha⁻¹, with treatments T1 – T8.

T1 - Tea planted in soil reconditioned with mana	3488
T2 - Direct planting with compost, 3 kg per hole	1836
T3 - Direct planting with compost, 1.5 kg at the bottom of the hole with 20 g T200 per hole	1928
T4 - Direct planting with coir dust, 1.5 kg at the bottom of the hole and compost 1.5 kg at the top of the hole	2269
T5 – Direct planting with coir dust, 3 kg per hole and with 20 g T200 per hole	1979
T6 – Direct planting with coir dust, 3 kg per hole	2127
T7 – Direct planting with interplanted <i>Flemingia congesta</i> as a cover crop in the inter rows after planting of the tea	1957
T8 – Direct planting without any soil amendments but with 20 g T200 per hole	1668
LSD (P=0.05)	581
CV (%)	15.4

The benefits of soil reconditioning with grass was evident even during the second year of the cycle. Incorporation of coir dust in the planting hole also improved the yield, but not to the extent of soil reconditioning with grass.

A R Amerasekera

Effects of alternative methods of soil reconditioning on establishment and yield, compared with soil reconditioning by grass; TRI 2025, Ratwatta Estate, Ukuwela, 2000.

The objective of this experiment is to compare, with traditional methods, the alternative methods available for reducing the soil reconditioning period.

The yield for the second year of the cycle is given in Table 3.

Table 3. Yield, kg made tea ha⁻¹, with treatments T1 – T8.

T1 - Control (direct planting)	1071
T2 - Rehabilitation with mana for 2 years	1682
T3 - Rehabilitation with mana for 2 years, with cowpea in between the tea rows	1800
T4 - Compost with <i>Trichoderma</i> , 3 kg per hole	1489
T5 - Coir dust, 2 kg per hole	1835
T6 - Coir dust, 4 kg per hole	1981
T7 - Refuse tea 2 kg per hole	2064
T8 - Refuse tea, 4 kg per hole	1426
T9 - Coir dust, 2 kg per hole, and refuse tea, 4 kg per hole	1487
T10 - Mana <i>in situ</i> every row	972
T11 - Maize <i>in situ</i> every row	1406
T12 - 'Tur-dhal' <i>in situ</i> every row	783
LSD (P=0.05)	516
CV(%)	20.3

The results of the experiment indicate that comparable yields are obtained with the rehabilitation, coir-dust and refuse-tea treatments. All *in situ* rehabilitation treatments depressed the yield.

A Anandacoomarasamy, P B Ekanayake and A P D A Jayasekara

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3. Thrust A 11. Development of an economically viable system to eliminate/reduce the soil rehabilitation period, prior to replanting in the low country.

3.1 Project 11.1. Evaluating soil rehabilitation techniques; Balangoda Estate, 1999.

The objective of this study is to compare the effect of incorporating compost in trenches and planting-holes with direct planting, and with planting after rehabilitation with grass. The study was started in 1999. Planting of tea (TRI 2026) was done in September, 1999. Plants were brought into bearing in 2002. The yield from October 2002 to September 2003 is given in Table 4.

Table 4. Yield, kg made tea ha⁻¹, with girth and bush spread.

Treatments	Yield	Girth (cm)	Plant spread (cm)
Planting after rehabilitation	1578	4.79	120
Direct planting (in planting-hole)	1362	3.98	107
Planting with compost (in planting-hole)	1472	3.77	104
Planting with compost (in trenches)	1421	4.07	120
LSD (p=0.05)	NS	0.67	12.7
CV%		8.57	5.99

Rehabilitation and incorporation of compost into trenches gave satisfactory growth of the tea bushes. Although, there were marginal increases in yield after rehabilitation and incorporation of compost, these higher yields were not significantly different from yields given by direct planting ($p>0.05$).

M A Wijeratne, N P S N Bandara and D W Vithana

3.2 Project A 11.2. Evaluating soil rehabilitation techniques; St Joachim Estate, 2000.

This experiment was commenced in 2000. The treatments were as follows:

Rehabilitation with mana;
Compost in trenches;
Compost in planting holes;
Interplanting tea with mana;
Interplanting tea with 'Tur-dhal';
Interplanting tea with sweet corn.

The tea plants were brought into bearing in October 2002 and were lightly harvested. However, the experimental plots went under flood-water during the middle of the year 2003, and hence the bushes were rested for about three months.

The experiment is in progress.

M A Wijeratne and H S N Pieris

3.3 Project A 11.3. Determining the minimum period required for soil rehabilitation; St Joachim Estate.

Mana and citronella grasses were planted in two large blocks due for soil rehabilitation, in Field No. 1, St Joachim Estate, in August, 2001. Half of the blocks were uprooted and planted with tea, and the grasses in the other halves were maintained.

The tea plants have been centered, and the experiment is in progress.

N P S N Bandara

3.4 Project A 11.4. Evaluating soil rehabilitation techniques; Handford Estate, Deniyaya, 2000.

The objective of this experiment is to compare, with traditional methods, the alternative methods available for reducing the soil reconditioning period.

Compost with *Trichoderma*, refuse tea, and coir dust (with and without refuse tea), were incorporated at the time of planting (August, 2000).

Mana, maize and 'Tur-dhal' were used in other treatments for *in situ* soil reconditioning following the planting of tea. The other treatments were rehabilitation with mana grass for two years, and planting tea with and without cowpea. The controls were direct planting of tea after uprooting old seedling tea.

The yield for the period is given in Table 5

Table 5. Yield, kg made tea ha⁻¹, with treatments T1 – T13.

T1 - Rehabilitation with mana grass for two years	2469
T2 - Rehabilitation with mana grass plus green gram for two years	2422
T3 - Direct planting with mana grass in between the tea rows (<i>in situ</i> rehabilitation)	811
T4 - Direct planting with vettiver in between the tea rows (<i>in situ</i> rehabilitation)	1022
T5 - Direct planting with 'Tur-dhal' in between the tea rows (<i>in situ</i> rehabilitation)	758
T6 - Direct planting with green gram in between the tea rows (<i>in situ</i> rehabilitation)	828
T7 - Direct planting with fertiliser mixture T200, with no forking	686
T8 - Direct planting with fertiliser mixture T200, with forking down to 18" 710	
T9 - Direct planting with compost (3 kg per hole)	986

T10 - Direct planting with coir dust (3 kg per hole)	1272
T11 - Direct planting with <i>Trichoderma</i>	1043
T12 - Direct planting with refuse tea (3 kg per hole)	986
T13 - Direct planting with compost (1.5 kg per hole) and coir dust (1.5 kg per hole)	851
LSD (P=0.05)	394
CV (%)	20.5

Traditional soil reconditioning with grass for two years gave the highest yield. Addition of coir dust (T10) also improved the yield, but not to the same extent as with soil rehabilitation by grass (T1 and T2).

A R Amerasekara and U P Abeysekara

4. Thrust A 12. Development of intercropping systems (with pepper and coffee) for marginal tea lands in the mid-country smallholder sector.

4.1 Project 12.1. Evaluating the most compatible crop combinations.

Effect of intercropping minor export crops in a mid-country smallholder tea estate; Manikdewela, 2000.

This trial was terminated owing to change of ownership of the land.

P B Ekanayake and A P D A Jayasekara

Effect of intercropping minor export crops in a mid-country smallholder tea estate; Sunwin Hill Estate, Galaha, 2003.

This trial was initiated to study the effect of minor crops on yield of young tea.

The treatments are as follows:

Coffee

C1 - Catiemore

C2 - VP coffee

Pepper

P1 - Paniyur

P2 - Local

Spacing:

S1 - 4 m X 4 m

S2 - 6 m X 6 m

Plot size: 18 m X 18 m

No. of replicates: 03

Design: RCBD

This trial was initiated during the latter part of the year, and the planting of tea, pepper and coffee, in two replicates each, was completed during the year.

The experiment is in progress.

P B Ekanayake and A P D A Jayasekara

5. Thrust A 13. Development of intercropping systems (with pepper and coffee) for marginal tea lands in the mid-country estate sector.

Effect of intercropping minor export crops in a mid-country tea estate; New Peacock Estate, Pussallewa, 2002.

The treatments are as follows:

Coffee

C1 – Catiemore

C2 – IMY

Pepper

P1 – Paniyur

P2 – Local

Spacing:

S1 – 4 m X 4 m

S2 – 6 m X 6 m

Plot size: 18 m X 18 m

No. of replicates: 03

The yield of tea was monitored during the year. There was no difference between any of the treatments as the intercropped plants were still too small. The re-supplying of coffee and pepper plants was done after the drought period. Manuring and weeding of the intercrops were done during the year.

The experiment is in progress.

P B Ekanayake and A P D A Jayasekara

6. Thrust. A 14. Development of intercropping systems (with rubber and coconut) for the low country.

6.1 Project 14.1. Evaluating the most compatible crop combinations.

Effect of intercropping tea and rubber on productivity; RRI-Kuruwita, 1990.

This experiment is being conducted in collaboration with the Rubber Research Institute of Sri Lanka. There are six treatments in four replicates (blocks).

The treatments are as follows:

Monocropping of tea

Monocropping of rubber (18' x 12')

Tea (rehabilitated) under rubber (27' x 8')

Tea (rehabilitated) under rubber (40' x 8')

Tea (unrehabilitated) under rubber (27' x 8')

Tea (unrehabilitated) under rubber (40' x 8')

Unrehabilitated tea and rubber were planted in 1990, and rehabilitated tea was planted in 1992. Tea bushes planted without rehabilitation were pruned in 2003.

Table 6. Green-leaf yield of rehabilitated tea, kg/bush/yr, under different spacings of rubber.

Tea (as monocrop)	1.037
Tea under rubber (40' x 8')	0.480
Tea under rubber (27' x 8')	0.392
LSD (P=0.05)	0.411
CV (%)	19

The yield of rehabilitated tea under rubber was significantly lower than that of rehabilitated tea grown as a monocrop. There was no significant differences in tea yield under the two spacings of rubber. The yield of tea, planted without rehabilitation (four months only), showed no significant differences between the two spacings of rubber. The tea yield recorded was 0.222 kg/bush and 0.225 kg/bush for rubber spacings of 40' x 8' and 27' x 8', respectively. The weight of tippings from the unrehabilitated tea bushes was also not significantly different.

Effect of intercropping tea and rubber on productivity; St Joachim Estate, Ratnapura, 1990.

The feasibility of intercropping tea with rubber is being tested at St Joachim Estate. There are three treatments: tea (stand of tea 100%), tea under rubber (40' x 8') (stand of tea 75%), and rubber (20' x 12'), in three replicates. The rubber was planted in 1990, and the tea was introduced in 1993.

The yield of tea was significantly different ($P < 0.05$): 2.058 kg/bush/yr with tea as a monocrop, and 1.114 kg/bush/yr for tea under rubber.

The girth of the rubber trees at chest height was 79.8 (± 0.2) cm for rubber in tea, and 75.6 (± 2.1) for sole rubber treatments.

Effect of intercropping tea and rubber on productivity (demonstration plot); St Joachim Estate, Ratnapura, 1989.

Field practices in the demonstration plot were continued during the year 2002.

Effect of intercropping tea and rubber on productivity, (observation block); St Joachim Estate, Ratnapura, 1995.

There are four plots in this observation block: rubber (20' x 12'), tea, tea in rubber (40' x 8'), and tea in rubber (60' x 8' x 8'). Rubber rows were located in the east-west direction.

The harvesting of rubber and tea was continued. The tea bushes were pruned in June 2003, and harvesting was commenced in November 2003 after tipping in September.

There was no significant difference in the girth of the rubber trees in different treatments. Tipping assessments of the tea bushes (number of shoots, number of leaf/shoot and tipping weight) showed that the growth of tea bushes under rubber in both treatments were comparatively lower than with monocropped tea.

The recorded tipping weight was 580 g/bush for monocropped tea, 410 g/bush for tea under rubber at 60' x 8' x 8', and 245 g/bush for tea under rubber at 40' x 8'.

The rubber yield for the year (dry rubber) was estimated to be 2389, 2228 and 1844 kg/ha/yr, at spacings of 40' x 8', 60' x 8' x 8' and 20' x 12', respectively.

M A Wijeratne, P B Ekanayake and P Premathunga

Effect of intercropping tea and rubber on productivity; RRI, Kuruwita, 2003.

A new experiment was begun in collaboration with the Rubber Research Institute and the Department of Agriculture and Export Crops.

In this experiment, tea fruit crops (rambutan and durian) and cinnamon have been intercropped under four spacings of rubber (3 x 3 x 15 m, 3 x 3 x 18 m, 3.5 x 3.5 x 15 m and 3.5 x 3.5 x 18 m). There are nine rows of tea under rubber at a spacing of 15 m, and 12 rows under rubber at a spacing of 18 m. The tea areas are divided into two blocks, one for rehabilitation and the other for direct planting.

TRI 2027 was planted in 2001 (direct planting) and 2003 (after rehabilitation for two years). Tea planted without rehabilitation was brought into bearing in 2003; the yield of the bushes was 0.360, 0.326, 0.343 and 0.323 g/bush/year, for 3 x 3 x 15 m, 3 x 3 x 18 m, 3.5 x 3.5 x 15 m and 3.5 x 3.5 x 18 m, respectively.

There was no significant difference in yield between the treatments. Yield, shoot density and % of dormant shoots were recorded from tea bushes in different rows (near the rubber row, and in the middle), and were found not to be affected by treatments.

Effect of intercropping tea and rubber on productivity; RRI, Kuruwita, 1990 (see above).

As stated above, this experiment is being conducted in collaboration with the Rubber Research Institute of Sri Lanka. There are six treatments in four replicates (blocks).

The treatments are as follows:

Monocropping of tea

Monocropping of rubber (18' x 12')

Tea (rehabilitated) under rubber (27' x 8')

Tea (rehabilitated) under rubber (40' x 8')

Tea (unrehabilitated) under rubber (27' x 8')

Tea (unrehabilitated) under rubber (40' x 8')

Unrehabilitated tea and rubber were planted in 1990, and rehabilitated tea was planted in 1992. Tea bushes planted without rehabilitation were pruned in 2003.

Rehabilitated tea plots were pruned in May 2002 and tipped in August 2002.

Table 7. Green-leaf yield, kg/bush/yr, and tipping weights, g/bush, of rehabilitated tea, under different spacings of rubber.

Tea (as monocrop)	0.485	195
Tea under rubber (40' x 8')	0.282	150
Tea under rubber (27' x 8')	0.255	122
LSD (P=0.05)	0.198	51.9
CV (%)	25	

The yield of rehabilitated tea under rubber was significantly lower than that of rehabilitated tea grown as a monocrop. An analysis of the results on the yield of tea planted without rehabilitation showed that the 40' x 8' spacing gives a higher yield than 27' x 8', namely 0.420 and 0.282 kg/bush/yr, respectively. The weight of tippings was significantly higher in monocropped tea when compared with that of tea under rubber.

Effect of intercropping tea and coconut on productivity and land utilization.

Tea and coconut intercropping; Citrus Estate, Poddala, 2000.

In view of the unavailability of an adequate land area for treatment replication, this experiment is being conducted as an observation trial with the following treatments:

- T1 - Coconut alone at the recommended spacing
- T2 - Tea alone at the recommended spacing (with rehabilitation)
- T3 - Tea x coconut at 12' x 30' (without rehabilitation)
- T4 - Tea x coconut at 12' x 30' (with rehabilitation)
- T5 - Tea x coconut at 12' x 40' (without rehabilitation)
- T6 - Tea x coconut at 12' x 40' (with rehabilitation)

Planting the tea, soil sampling, re-supplying, and growth measurements were carried out during the year.

The trial is in progress.

P B Ekanayake, Jayantha Gunatilake and A P D A Jayasekara

Tea and coconut intercropping; Mawarala, *Shakti* Estate, Deniyaya, 2001.

This experiment is being conducted in collaboration with the Coconut Research Institute and the Tea Small Holding Development Authority.

The treatments are as follows:

- T1 – Coconut alone at the recommended spacing
- T2 – Tea alone at the recommended spacing (without rehabilitation)
- T3 – Tea alone at recommended spacing (with rehabilitation)
- T4 – Tea x coconut at 20' x 30' (without rehabilitation)
- T5 – Tea x coconut at 20' x 30' (with rehabilitation)
- T6 – Tea x coconut at 20' x 40' (without rehabilitation)
- T7 – Tea x coconut at 20' x 40' (with rehabilitation)
- T8 – Tea x coconut at 20' x 20' x 60' (without rehabilitation)
- T9 – Tea x coconut at 20' x 20' x 60' (with rehabilitation)

No. of replicates: 03

Design: RCBD

Re-supplying coconut and lopping mana were done during the year.

The experiment is in progress.

P B Ekanayake, Jayantha Gunatilake, A P D A Jayasekara and A Somaratne

7. Thrust A 19. Development of water management techniques for young and mature tea in drought-prone areas to minimize casualties and enhance yields.

7.1 Project 19.1 Determining quantity of water and frequency of application for drought-susceptible clones.

Project 19.2 Evaluating existing technologies for water application in tea.

Under this project, studies were undertaken in the low country, up-country and the Uva.

Evaluation of fertigation; St Joachim Estate, Ratnapura.

Study on drip-irrigation; St Joachim Estate, Ratnapura.

A feasibility study on the use of drip-irrigation for tea was begun in Field No. 1, St Joachim Estate. The irrigation system and the technical support were given free of charge by Messrs. Agriworld Pvt.Ltd., Colombo. The system covered an extent of about one acre.

The 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 tea planted at a spacing of 0.6 x 0.9 x 1.5 m. Two clones, TRI 2023 and TRI 3025, were used.

The results are given in Table 8.

Table 8. Yield, kg made tea ha⁻¹ yr⁻¹, under two systems of planting (raised beds and flat land).

Planting in raised beds

Treatment	TRI 2023	TRI 3025
1.	6768	5070
2.	7983	5728
LSD (P=0.05)	1040	442
CV (%)	9.7	5.6

Planting in flat land (as control)

Treatment	TRI 2023	TRI 3025
1.	5906	4206
2.	7889	4877

LSD (P=0.05)	1595	487
CV (%)	15.8	7.4

Effect of fertigation on the yield of tea (TRI 2025).

The fertilizer given was a U 709 equivalent in water-soluble form.

The yield for the period April to December 2003 is given in Table 9.

Table 9. Yield, kg made tea ha⁻¹, with and without fertigation.

Fertigation	2469
Without fertigation	2411
LSD (P=0.05)	432
CV (%)	18.1

There was no significant difference between the treatments with plants in the final year of the current cycle.

N P S N Bandara

Evaluation of fertigation; Somerset Estate, Nanu Oya, 2000 (TRI 2023).

In this study, previous treatments were modified to include nitrogen levels. Fertilizer was given with the irrigation water at rates of 180, 225 and 300 kg N ha⁻¹ as urea for 300 days. The annual yields are given in Table 10 (treatments 1. – 3.).

There was an additional treatment of the water application only but with surface broadcasting of fertilizer at the rate of 360 N kg ha⁻¹ in four splits. The yield for January to May 2003 is given in Table 10 (treatment 4.).

Table 10. Yield, kg made tea ha⁻¹, with and without fertigation inclusive of N.

1. Fertigation, 1 hr daily with 180 kg N ha ⁻¹	1952
2. Fertigation, 1 hr daily with 225 kg N ha ⁻¹	2015
3. Fertigation, 1 hr daily with 300 kg N ha ⁻¹	2047
• Water only, 1 hr daily with 360 kg N ha ⁻¹ as ground application 4 times per year	665
• Control (without fertigation)	1152
LSD (P=0.05)	145
CV (%)	7.8

Daily fertigation gave the highest yield.

A R Amerasekara, U P Abeysekara and A Anandacoomaraswamy

Evaluation of fertigation; Dammara Estate, Passara.

In this study, four treatments of varying fertigation frequencies 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.

The yield for January - December 2003 is given in Table 11.

Table 11. Yield, kg made tea ha⁻¹, with varying fertigation frequencies.

1	Fertigation, 1 hr daily	2865
2	Fertigation, once every two days (1.5 hr)	3465
3	Fertigation, once every three days (1.5 hr)	2989
4	Control (without fertigation)	2537

R M A C Rajakaruna, J C K Rajasinghe, A R Amerasekara and A Anandacoomaraswamy

Evaluation of fertigation; Talawakele Estate, Talawakele, 2003.

An experiment was initiated in May at Talawakele Estate, Talawakele to study the effect of fertigation on the yield of mature tea from three cultivars, TRI 3072, DN and DT1. Pre-treatment yield records were kept from May - October 2002. The following treatments were applied from November 2003.

1. Control (without fertigation)
2. Fertigation at 1.8 litres plant⁻¹ day⁻¹

Nitrogen, phosphorus and potassium nutrients were added through fertigation in treatment 2, while fertilizer was broadcast in treatment 1.

U P Abeysekara, A R Amerasekara and A Anandacoomaraswamy

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

8.1 Projects 20.2. Evaluating harvesting devices.

20.3. Modifying harvesting intervals.

20.5. Modifying bush management practices.

Raigama Estate, 2000.

This experiment was begun at Raigama Estate to test a motorized harvesting machine (Kawasaki NV 60 H), supplied free of charge by Messrs P P P Jinadasa Pvt. Ltd., on two clones planted as hedgerows. Two harvesting intervals, 14 and 21 days, were used, depending on the rate of shoot growth.

The following were the treatments:

Manual harvesting
Mechanical harvesting, interval of 14 days
Mechanical harvesting, interval of 21 days

Clones: TRI 2027 and H1/58

Harvesting commenced after tipping. The yield is given in Table 12.

Table 12. Yield, kg made tea ha⁻¹, using manual and mechanical harvesting.

	H1/58	TRI 2027
Manual harvesting	3236	3496
Mechanical harvesting (14 days)	2587	2644
Mechanical harvesting (21 days)	2322	2658
LSD (P=0.05)	456	661
CV (%)	10.3	13.8

The results show that the use of motorised machines reduced tea yield in both clones, irrespective of the changes in frequency of harvesting.

M A Wijeratne, N P S N Bandara and D W Vithana

Balangoda Estate, 1998.

This experiment was begun in 1998 under the Institute's Collaborative Research Programme with estates.

Four spacings of the tea bushes were tested using two clones, TRI 2026 and DG 39.

The different spacings are 0.6 x 1.2 m (100%), 0.6 x 0.9 x 1.5 m (100%), 0.6 x 0.6 x 1.5 m (114%) and 0.9 x 0.45 x 1.5 m (133%).

The tea plants were brought into bearing in the year 2000, and the bushes were pruned in November 2003. Statistical analyses of yield (January - August), and of weight of prunings, showed no significant difference between the spacings. However, TRI 2026 gave a yield about 20% higher than that given by DG39.

The highest ground cover was given by the 0.6 x 1.2 m spacing (76%), followed by the 0.6 x 0.6 x 1.5 m (72%) and the 0.6 x 0.9 x 1.5 (65%) spacings. The 0.9 x 0.45 x 1.5 m spacing gave the poorest ground cover (50%).

M A Wijeratne, H S N Peiris and the Superintendent, Balangoda Estate

**8.2 Projects 20.2. Evaluating harvesting devices.
20.4. Modifying fertilizer application.**

Galaboda Estate

A new experiment was begun to test the motorized harvesting machine (Kawasaki NV 60 H) at different levels of K application.

The following were the treatments:

Manual harvesting
Mechanical harvesting

Levels of K application: Normal rate (recommended K)
 Enhanced rate (1.5 x recommended K)

Replications: 04

Clone: TRI 2027

The plots were pruned in August 2003 and pruning assessments were made.

Analysis of the results showed that the yield of tea with mechanical harvesting was about 20% less than with manual harvesting. Enhancement of K application had no effect on yield.

The pruning assessments also gave similar results. In comparison with manual harvesting, the weight of the canopy leaves was significantly lower with mechanical harvesting. However, the tipping weights showed that recovery after pruning was not affected by different treatments, namely the harvesting methods and K application.

The use of machines on four other clones (TRI 3063, TRI 3041, TRI 2027 and TRI 3047), with enhanced K, also showed that yield was not affected by enhanced K application. This experiment was terminated.

M A Wijeratne and H S N Peiris

9. Thrust 21. Development of devices for improving pruning efficiency.

9.1 Project 21.1. Evaluating and improving the efficiency of pruning devices.

Improvements are being made to the design of the devices with the assistance of Messrs. Flowerland Lanka, and arrangements are being made for mass-scale production.

M A Wijeratne

9.2 Project 21.2. Assessing post-pruning vigour in mechanically-pruned bushes.

Field observations have shown that there are no variations in the recovery between mechanically- and manually-pruned tea bushes, provided careful attention is paid to cut branches achieving a sharp cut end, and manual cleaning is adopted wherever necessary.

M A Wijeratne

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

10.1 Project 24.1. Screening of new herbicides.

1.) A new product, Amiphosate (a granular formulation of glyphosate 50% and 70% w/w), was screened.

Although there was good control in the above-ground canopy of couch, root growth was not totally controlled by the new glyphosate formulations (Table 13). Illuk was also not properly controlled.

Table 13. Visual injury %, and weed fresh weight, as affected by new glyphosate formulations four months after application at St Coombs, Talawakelle.

Treatment	Spray volume	a.i. kg/ha	Injury %		Weight of couch (g/ft ²)	
			Couch	Illuk	Fresh	Dry
T1 - 50% Glyphosate	2.25 kg/ha	1.13	87	50	89.0	41.5
T2 - 70% Glyphosate	1.61 „	1.13	70	45	139.0	68.7
T3 - 41% Glyphosate	2.75 l/ha	1.13	97	68	40.5	19.5
T4 - 50% Glyphosate	4.50 kg/ha	2.25	98	68	107.0	46.0
T5 - 70% Glyphosate	3.22 „	2.25	95	42	138.0	64.0
T6 - 41% Glyphosate	5.55 l/ha	2.25	98	75	55.0	24.0
T7 - Control					110.0	52.6

There was good control of common weeds in all the plots with almost 90% control being observed visually, particularly with the double dosage (Table 14). However, the weed, amalai, was not controlled by any of the formulations.

Table 14. Visual injury %, and weed fresh weight, as affected by two new herbicide formulations after application at the TRI Mid-Country Station, Hantana.

	Spray a.i		Weed fresh weight	
	Volume (l/ha)	(kg/ha)	Application 1	Application 2
T1 - 70% Glyphosate	0.805	0.564	125.3	61.3
T2 - 70% Glyphosate	1.61	1.127	110.7	67.8
T3 - 50% Glyphosate	1.13	0.564	104.2	109.0
T4 - 50% Glyphosate	2.25	1.127	71.5	36.5
T5 - 41% Glyphosate	1.38	0.564	180.0	71.6
T6 - 41% Glyphosate	2.75	1.127	58.9	26.5

Amiphosate, the granular formulation of glyphosate, effectively controlled common weeds when applied at 0.8-1.6 kg/ha in the 70% w/w formulation, and when applied at 1.1-2.2 kg/ha in the 50% w/w formulation (Table 15).

Table 15. Visual injury %, and weed fresh weight, four weeks after application at St Joachim Estate, Ratnapura.

	Spray a.i		Visual injury %	weed fresh weight (g/0.09m ²)
	Volume (l/ha)	(kg/ha)		
T1 - 70% Glyphosate	0.805	0.564	53	65.6
T2 - 70% Glyphosate	1.61	1.127	70	30.8
T3 - 50% Glyphosate	1.13	0.564	78	58.9
T4 - 50% Glyphosate	2.25	1.127	68	60.6
T5 - 41% Glyphosate	1.38	0.564	58	40.0
T6 - 41% Glyphosate	2.75	1.127	78	16.7

2.) Deverinol (Napropamide 45% SC) was screened.

Weed weight was significantly reduced only with Deverinol at 16 ml/l at 7 and 12 WAA (Table 16). A higher dosage of Deverinol is required to suppress weed growth, and so this experiment was terminated.

Table 16. Weed fresh weight four weeks after application at St Joachim Estate, Ratnapura.

	a.i. (kg/ha) Spray			Weed fresh weight (kg/plot)* (g/ft ²)**
			volume (ml/l)	
T1 - Deverinol (45% SC)	1.98	8ml/l	2.15 a	127 ab
T2 - Deverinol (45% SC)	2.97	12ml/l	1.52 ab	129 ab
T3 - Deverinol (45% SC)	3.96	16ml/l	0.875b	106 b
T4 - Diuron 80%wp	0.88	2 g/l	0.975b	100 b
T5 - Oxyfluorfen	0.26	2 ml/l	1.675a	156 a

- Seven weeks after application (WAA); **12 WAA
- K G Prematilake and H Pretiraja

10.2 Project 24. 2. Management of problem weeds.

1. The Passali Kodi weed

a) Chemical control of Passali Kodi

Plots were subjected to the treatment combinations above twice, in January and April. The tea yield was not significantly affected by the herbicidal treatments (Table 17). However, Passali Kodi growth was suppressed significantly ($p < 0.05$) with Diuron + 2,4-D and Diuron + glyphosate combinations.

Table 17. Effect of various herbicide combinations on the growth of Passali Kodi.

	MT yield (kg/ha)	Fresh weight of Passali Kodi shoots (kg/m ²)
T1 - Glyphosate (36%) at 5.5 l + Ammonium sulphate 2.2 kg/ha	1139	0.266
T2 - Glyphosate (36%) at 5.5 l + Latron 0.55 l/ha	1364	0.173
T3 - Glyphosate (12%) at 6.6 l alone	1057	0.237
T4 - Diuron at 1.4 kg + 2,4-D at 1.2 l/ha	1267	0.107
T5 - Glyphosate (36%) at 5.5 l + Oxyfluorfen at 1.2 l/ha	1162	0.160
T6 - Glyphosate (36%) at 5.5 l + Diuron at 1.1 kg/ha	1361	0.144
T7 - Glyphosate (36%) at 5.5 l + Teepol 1.1 l/ha	1246	0.323
T8 - Regular manual removal	1103	0.167

b) Impact of growth of Passali Kodi on tea yield; Balangoda Estate.

The weight of Passali Kodi shoots was reduced significantly ($p < 0.05$) by treatments such as hand pulling of the shoots from the tea canopy every 10 and 12 weeks, and regular removal of yams/plants from the base of the tea plants, in comparison to hand pulling of shoots every two and four weeks (Table 18). Thus, regular removal of shoots does aggravate the growth of Passali Kodi. Hence, it is more appropriate to remove shoots from the tea canopy at 10-week intervals.

The tea yield was not significantly affected by the growth of Passali Kodi on the tea canopy for a longer duration.

Table 18. Effect of frequency of removal of Passali Kodi shoots from the tea canopy, on the growth and yield of Passali Kodi weed and tea.

Treatment	Fresh weight of Passali Kodi shoots (kg/plot)	Yield of tea	
		Flush weight (g/bush/yr)	MT yield (kg/ha/yr)
Every two weeks	15.30	638	1753
Every four weeks	15.10	646	1776
Every six weeks	12.50	693	1904
Every eight weeks	9.97	680	1869
Every ten weeks	5.64	663	1823
Every twelve weeks	8.64	729	2004
Regular removal of yams/plants from the base	7.53	729	2005
LSD	5.29	ns	ns

c) Impact of various leaf extracts, and incorporation of leaf materials into the soil, on germination of Passali Kodi bulbils and growth of the weed.

Germination was delayed until the 2nd week in bulbils dipped in *Eucalyptus* and *Brachiaria* leaf extracts for 24 hr (Table 19). Further, shoot growth was reduced significantly ($p < 0.05$) up to six weeks, when compared to that in *Pinus* and *Mucuna* leaf extracts. Although the lowest fresh and dry weights were recorded with *Eucalyptus* extracts, the differences are not significant.

Table 19. Shoot germination and growth of Passali Kodi as affected by leaf extracts.

	No. shoots/cup			Fresh weight Dry weight		
	1WA	2WA	4WA	6WA	6 WA (g/cup)	6 WA
T1 - <i>Pinus</i> lvs	2.0 a	5.0 a	38.0a	64.67 a	6.32a	0.69a
T2 - <i>Mucuna</i> lvs	0.67 b	4.33 ab	27.7ab	46.33 ab	6.16a	0.69a
T3 - <i>Eucalyptus</i> lvs	0 b	1.33 c	12.7 c	30.33 b	4.60a	0.46a
T4 - <i>Brachiaria</i> lvs	0 b	3.0 abc	19.7 bc	35.33 b	5.27a	0.58a
T5 - Control	0.67 b	2.0 bc	20.3 bc	36.33 b	6.07a	0.70a

Incorporation of chopped leaves of *Pinus* or *Eucalyptus* did not suppress the germination and growth of shoots from bulbils, except during the 1st week after incorporation of *Eucalyptus* (Table 20).

Table 20. Shoot germination and growth of Passali Kodi as affected by incorporation of leaf mulches into the soil.

	No. shoots/5 bulbils				Shoot dry weight (g/5 bulbils)			
	1 st	2 nd	3 rd	4 th	1 st	2 nd	3 rd	5 th
T1 - <i>Eucalyptus</i> lvs	7.0b	12.5a	15.2a	15.0a	0.31	0.35	0.27a	0.27
T2 - <i>Pinus</i> lvs	14.0a	16.8a	16.2a	17.8a	0.31	0.24	0.12b	0.30
T3 - Control	9.5ab	13.8a	12.8a	13.5a	0.17	0.38	0.13b	0.23

2. The Amalai weed

Management of the new Amalai weed; Pedro Estate, Nuwara Eliya.

Studies were commenced in August 2002. A series of herbicide applications was made for managing the Amalai weed during the year, and the following visual observations on injury levels were made after application.

No control	Partial control	Good control (75%)	Very good control (90%)
Basta at 1.5 l + 2,4-D amine salt at 2.2 l + Teepol 1 l/ha	2, 4 D- Amine salt at 2.2 l + Diuron at 1.1kg/ha	a) Paraquat at 2 l + MCPA 60% at 1.7-2.2 l + petrol at 1.1 l/ha - recovery commenced	When (a) was repeated with Paraquat at 2 l + MCPA 60% at 1.7-2.0 l + petrol at 1.1 l/ha
Paraquat at 2.2 l + MCPA 60% at 1.7 l + Surpol 1.2 l/ha	2, 4 D- Amine salt at 2.2 l + irex at 1.1 l/ha	b) Glyphosate at 5.5 l + ammonium sulphate at 5.5 kg + MCPA 60% at 2 l/ha - recovery is poor.	When (b) was repeated with glyphosate at 5.5 l + ammonium sulphate at 2.8 kg + MCPA 60% at 1.2 l/ha
	Diuron at 1.4 - 2.2 kg/l + Basta 1.5 l/ha	c) Paraquat at 2 l + 2,4-D amine at 2.2 l + petrol at 1.1 l/ha	When (c) was repeated with Paraquat at 2 l + 2,4-D amine at 2.2 l + petrol at 1.1 l/ha
	Basta at 1.5 l/ha + Potta. Sulphate 1.1 l/ha		

As shown, there was almost 90% control with repeated applications of the above three combinations.

2. *Commelina*

The following treatment combinations gave only a partial control of the *Commelina* weed.

Glyphosate at 2.7-4.4 l/ha + MCPA 60% at 1.1-1.7 l/ha + ammonium sulphate at 2.2-2.8 g/ha - 30%

Paraquat at 2.2 l + MCPA 60% at 1.7 l + Super Surfactant 0.55 l/ha

Glyphosate at 4.4 l + MCPA 60% at 1.7 l + petrol at 1.1 l/ha

Glyphosate at 4.4 l/ha + MCPA 60% at 1.7 l/ha + Latron at 1.2 l/ha

3. *Vel Kohola*

Chemical control of *Vel Kohola*; Matuagala Estate, Kiriella.

Field experiments were commenced in mid-September with the application of the following herbicide combinations.

T1 - Glyphosate (36%) at 10 ml + 2,4-D amine salt (73%) at 4 ml/l

T2 - Glyphosate (36%) at 10 ml + Latron at 0.5 ml/l

T3 - Glyphosate (36%) at 10 ml + Teepol at 2ml/l

T4 - Glyphosate (36%) at 10 ml + ammonium sulphate at 10 ml/l

T5 - Glyphosate (36%) at 8 ml + MCPA (60%) at 4 ml + ammonium sulphate at 5 g/l

T6 - Paraquat at 4 ml + MCPA (60%) at 3 ml/l

T7 - Paraquat at 4 ml + petrol at 2ml/l

There was very poor control of the weed with all the herbicides (Table 21).

Table 21. Visual observations on injury level (%) in weed following application of herbicides.

2 WAA	%
T1 - Leaf discolouration /wilting	20
T2 - Leaf discolouration /wilting	30
T3 - Leaf discolouration /wilting	20
T4 - Leaf discolouration	10
T5 - Totally discoloured leaves	45
T6 - Discoloured leaves	25
T7 - Leaves slightly wilted	10

The same treatments were repeated 4 WAA. Here again all the treatments performed poorly, and the recovery of growth commenced 5 WAA.

The weed was then treated, with the different herbicide combinations given below, 5 WAA.

- T1 - Glyphosate (36%) at 10 ml + MCPA (60%) at 4 ml + Latron at 0.5 ml/l
- T2 - Glyphosate (36%) at 10 ml + MCPA (60%) at 4 ml + Super Surfactant at 2 ml/l
- T3 - Glyphosate (36%) at 10 ml + MCPA (60%) at 4 ml + petrol at 2ml/l
- T4 - Glyphosate (36%) at 10 ml + ammonium sulphate at 10 ml/l
- T5 - Paraquat at 4 ml + MCPA (60%) at 4 ml/l + ammonium sulphate at 10 ml/l
- T6 - Paraquat at 4 ml + MCPA (60%) at 4 ml/l
- T7 - Paraquat at 4 ml + MCPA (60%) at 3 ml/l + petrol at 2 ml/l

Only the glyphosate + MCPA (60%) + petrol, and the glyphosate + ammonium sulphate, combinations gave a fair performance. Thus, all plots were treated only with these two combinations, two WAA.

The experiment is in progress. Laboratory studies on the morphological characteristics, particularly of the waxy cuticular layer of the leaf, are also in progress.

10.3 Project 24.3. Cost appraisal of different weed management practices; Hemingford Estate, 2003.

The following treatments were tested in a pruned tea field. Three applications, as given below, were made on 25 April, 24 July and 30 October.

- T1 - 2,4-D at 1.65 l + Diuron 1.1 kg/ha // MCPA 60% 1.65 l + ammonium sulphate 1.1 kg/ha // MCPA 60% 1.65 l + ammonium sulphate 1.1 kg/ha
- T2 - Diuron at 1.1 kg + Surpol 1.1 l/ha // 2,4-D 1.65 l + Paraquat 0.44 l/ha // MCPA 60% 1.65 l + Paraquat 0.44 l/ha
- T3 - Glufosinate ammonium 1.6 l + 2,4-D amine 1.65 l // MCPA 60% 1.65 l + Paraquat 0.44 l/ha glufosinate // glyphosate 1.65 l + MCPA 60% 1.7 l/ha
- T4 - 2, 4-D Amine 1.65 l + Surpol 0.825 l/ha // glyphosate 1.65 l + MCPA (60%) 1.7 l/ha // glyphosate alone 1.65 l/ha
- T5 - Paraquat at 1.1 l/ha + // Glyphosate 1.38 l + ammonium sulphate 1.1 kg/ha // glyphosate 1.38 l + ammonium sulphate 1.1 kg/ha
- T6 - Manual // Paraquat 0.44 l + MCPA (60%) 1.65 l // Paraquat 0.44 l/ha

	<u>Cost of weeding</u>	
	Rs/ha/yr	Rs/ha/month
T1	6780/-	565/-
T2	6040/-	583/-
T3	7250/-	604/-
T4	6642/-	554/-
T5	5038/-	420/-
T6	5074/-	423/-

Divisional activities

11. Project D/AGRY

1. Impact of CO₂ fertilization on growth and yield of tea in the low-country wet zone of Sri Lanka.

A new research project was initiated in collaboration with SLASS, CRI and the Meteorology Department. The collection of productivity and socio-economic data has been completed and the results are being analysed.

An experiment on the impact of enhanced CO₂ on the yield of mature tea was commenced at both St Joachim Estate and St Coombs Estate. Ambient CO₂ level was enhanced by supplying CO₂ 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 CO₂ was 3257 kg/ha/yr compared to 2393 kg/ha/yr under ambient CO₂.

M A Wijeratne and P Premathunga

2. Variation of yield components under different CO₂ concentrations.

This study was conducted in collaboration with the Faculty of Agriculture, University of Ruhuna, and the AIACC Project. The yield components of tea were measured under high (600-800 ppm) and ambient (350-400 ppm) CO₂ concentrations in experimental blocks maintained at the TRI Low-Country Station (AIACC Project).

The results showed that shoot density, mean shoot weight and shoot extension rates, were greater under the high CO₂ levels. The percentage of dormant shoots was low in the plot with enhanced CO₂. The tea leaves of the CO₂-enhanced plots had a high chlorophyll content, and were smaller than that of the ambient CO₂ plots. As a result, the tea yield of the CO₂-enhanced plots was higher than that of the control.

Dry weather reduced shoot density, extension rate and mean shoot weight. Further increase in dormant shoots was also observed during dry months contributing to a lower yield.

M A Wijeratne, and G V R Premalatha, Faculty of Agriculture, University of Ruhuna

3. Study on the factors associated with debilitation and death of tea bushes in the Deniyaya region.

This study was done in collaboration with the Faculty of Agriculture, University of Ruhuna.

Bush debilitation and death of bushes in many affected fields were reported to be due to nematode infestation. However, there were some areas without significant nematode infestation, but which had symptoms of bush debilitation. Hence, this study was done in localised patches in affected tea fields where nematode infestation was not found. Analysis

of soil samples, and observations of affected and healthy bushes, in some estates of the Deniyaya region showed that physical and chemical parameters of the soil (soil texture, pH and soil nutrients) had not contributed to bush debilitation. However, the soil organic-carbon level of affected areas was comparatively lower than in healthy areas.

Affected bushes also had Mg deficiencies. No visible pest and disease attacks were identified on the affected bushes. However, observations have revealed that many of the necessary agricultural practices had not been attended to, from land preparation to harvesting, in these affected fields. Hence, bush debilitation could have been largely due to poor cultural practices adopted in the past.

M A Wijeratne, Shantha Jayasinghe, and I P K S K Karunanayake, Faculty of Agriculture, University of Ruhuna

4. Growth of cuttings in the nursery under polythene tents of different colour and enhanced ambient CO₂.

Data collection on the growth of nursery plants was completed, and results were summarized for analysis.

M A Wijeratne and P Premathunga

5. A land-suitability mapping project for tea-growing lands in the Ratnapura District.

A new project for classifying tea lands in the Ratnapura District was commenced in September 2003. Dr C R Panabokke and Mr L Amarasinghe were appointed as the Senior Advisor and Consultant to the Project, respectively. Mr S R W Pathirana was appointed Research Assistant. The staff of the Agronomy Division and of the Advisory Division of the TRI Low-Country Station assisted in data collection, analysis and mapping.

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

Data compilation of existing tea lands, and extraction of other details from aerial photographs, are in progress, and these details were copied into the 1:50,000-scale ABMP maps with the help of an 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, transferring the AER boundaries on to provincial maps, identification and location of all available rain-gauge stations, and generalization of elevation boundaries of the up-, mid- and low country and their transfer onto Agro Ecological maps, have been completed.

A Productivity Index (VP yield per 100 mm of rainfall at 75 percent of expectancy) was generated. It was observed that the value of this Productivity Index could range from 40 to 150 for most of the estates studied. The Productivity 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.

M A Wijeratne, C R Panabokke, L Amarasinghe, S R W Pathirana and N P S N Bandara

6. Effect of different rates of earthworm casts, and T 200, on growth and yield of tea; Stelenberg Estate, Pussellawa, 1998.

This trial was initiated to investigate the effect of earthworm casts on growth and yield of tea.

The yield recorded during the 2nd year of the cycle is presented in Table 22

Table 22. Effect of earthworm casts and T 750 on yield of VP tea.

Treatments	Yield (kg made tea ha ⁻¹)
T1 - Earthworm casts 300 g per plant + T 750 (four applications of each per year)	3170
T2 - Earthworm casts 300 g per plant (six applications per year) + T 750 (two applications per year)	2806
T3 - Earthworm casts 300 g per plant (six applications per year)	1946
T4 - T 750 (six applications per year)	1606

The results indicate that earthworm casts, in combination with the inorganic fertilizer mixture T 750, give significantly higher yields than earthworm casts alone.

The experiment is in progress.

P B Ekanayake, S N Wijesekara and Janaka Jayawarna

7. SALT demonstration hedgerows

Three loppings were done during the year. *Calliandra calothyrsus* had given a higher biomass production than the other species. Biomass production of *Adathoda vasica* was very low. The biomass production is presented in Table 23.

Table 23. Biomass production of different hedgerow species.

Species	Biomass production (kg ha ⁻¹)
<i>Flemingia congesta</i>	2628
<i>Calliandra calothyrsus</i>	8158
<i>Cassia spectabilis</i>	3373
<i>Tecoma stans</i>	2483
<i>Adathoda vesica</i>	1033

This demonstration trial is being continued.

A P D A Jayasekara

8. Effect of mulching materials and soil acidity on the yield of tea; St Coombs Estate, Talawakele.

Two experiments were conducted with young and mature tea of the clone TRI 2025.

The following treatments were tested in combination. The pH amendments are on the cycle basis, applied in August 2000, and the mulch applications were done on the annual basis. After resting the mulch application for one year, the yield were recorded in the 3rd year for young tea, and in the 3rd year after pruning for mature tea.

Mulch treatments	Soil acidity
Control	1. Control
Refuse tea, 25 tons ha ⁻¹	2. Dolomite, 2500 kg ha ⁻¹
Mana (<i>Cymbopogon confertiflorus</i>), 35 tons ha ⁻¹	3. Minplus, 2500 kg ha ⁻¹
Dadap (<i>Erythrina lithersperma</i>), 35 tons ha ⁻¹ (Crushed basaltic rock)	
Pangirimana (<i>Cymbopogon nardus</i>), 35 tons ha ⁻¹	
<i>Trichoderma</i> fungi	

The yield for young and mature tea is presented in Tables 24 and 25.

Table 24. Yield of young tea.

Mulch	PH	Yield (kg made tea ha ⁻¹ yr ⁻¹)			Mean (mulch)
Control	2712	2767	2690	2723 bcd	
Refuse tea	2918	3107	3029	3018 a	
Mana	2768	2690	2675	2711 bcd	
Dadap	2909	2847	2770	2842 bc	
Pangirimana (live)	2485	2839	2625	2650 bd	
Mean (pH)	2759	2850	2758		

LSD (P=0.05) – Ns ns ns
 mulch 138
 LSD (P=0.05) – pH
 107
 CV = 6.8 %

Table 25. Yield of mature tea (kg made tea ha⁻¹).

Mulch	PH	Yield (kg made tea ha ⁻¹ yr ⁻¹)		Mean (mulch)
Control	2964	3737	3473	3391 ns
Refuse tea	3616	3816	3204	3545 ns
Mana	3823	3418	3300	3514 ns
Dadap	3185	3733	3297	3405 ns
<i>Trichoderma</i>	3531	3313	3201	3348 ns
Mean (pH)	3424	3603	3295	
LSD (P=0.05) – mulch				
LSD (P=0.05) – pH	Ns	ns	ns	

After the 3rd year of mulch application, a significant improvement of yield was observed in the young tea plots where refuse tea was applied. This was observed in the 1st and 2nd years as well. Dadap-treated plots also gave high yields, although not as high as in plots where refuse tea was applied.

Though there was no significant improvement of yield, dolomite-treated plots showed higher yields than control and Minplus-treated plots.

In mature tea, though there was no significant improvement of yield in the 3rd year, higher yields were recorded in refuse tea-treated plots and dolomite-treated plots.

This experiment involving mulch application is in progress.

M S D L De Silva

9. Study on biodynamic farming; Stassen Tea Project, Haldumulla

Biodynamic farming is one of the organic farming systems. It is based on the application of organic amendments and biodynamic preparations, based on the lunar calendar, to get maximum benefits from cosmic radiation in stimulating energy and nutrient recycling.

An investigation, the Stassen Bio Tea Project, was begun at Haldumulla, in the year 2000, for comparing the results of traditional organic farming with biodynamic farming, on tea yield. The biodynamic preparations used are designated as BD 500 - 507. The preparations consist of specific minerals, or plants, treated or fermented with animal organs, water and/or soil. The treatments are combinations of burial of prunings or no

burial of prunings, two levels of organic amendments giving 60 or 120 kg N ha⁻¹ annum⁻¹, and conventional (non-lunar) or lunar-based applications of the preparations.

There was a control in which no biodynamic preparations were applied.

The treatments, and the yields obtained, are given in Table 26.

Table 26. Yield made tea (kg ha⁻¹).

Treatments	1 st year	2 nd year	3rd year
Burial of prunings	1442	1926	1982
No burial of prunings	1368	1906	1925
Conventional organic farming	1335	1768	1843
Biodynamic organic farming	1474	2065	2064
Organic amendments			
60 kg N ha ⁻¹ year ⁻¹	1475	1991	2067
120 kg N ha ⁻¹ year ⁻¹	1334	1842	1840
LSD, burial of prunings	NS	NS	NS
LSD, farming	NS	280.2	NS
LSD, N	NS	NS	NS
CV (%)	24.0	19.9	22.9

The biodynamic farming gave a significantly higher yield only during the 2nd year of the current cycle.

A R Amerasekara, U P Abeyssekara and A Anandacoomaraswamy

Staff

New Appointments

- 1). Dr M A Wijeratne was appointed Officer-in-Charge, TRI Low-Country Station, Ratnapura, with effect from January 1st 2003, in addition to his substantive post of Senior Research Officer in Agronomy.
- 2). Two Research Assistants, Mr S R W Pathirana and Mrs P H K Pathiraja, were recruited on a casual basis. They were attached to the Agronomy Division to work on weed management and on the land-suitability classification project. Mrs Pathiraja resigned from the Institute with effect from 3rd December 2003.

Staff Activities

- 1). Dr M A Wijeratne participated in a regional workshop on impact of, and adaptation to, climate change (AIACC) held in Bangkok, Thailand during March 2003.
- 2). Dr M A Wijeratne was appointed to the Faculty Board, Faculty of Agriculture, University of Ruhuna, and was also appointed Visiting Lecturer to the same Faculty.
- 2). Dr M A Wijeratne addressed estate managers and smallholders at RSC seminars and at E & E forums.
- 3). Dr M A Wijeratne continued to train tea estate workers and field staff on mechanical harvesting, with special emphasis on the use of the TRISTH.
- 4). Dr M A Wijeratne supervised the research projects of two undergraduates, Miss G V R Premalatha and Mr I P K S K Karunanayake, from the Faculty of Agriculture, University of Ruhuna.
- 5). Dr M A Wijeratne participated in a TV programme on post harvest losses in tea, and in a radio programme on rush crop management organized by the Tea Development Project.
- 6). Mr N P S N Bandara addressed tea growers and stakeholders, on tea irrigation and water management for higher productivity, at the Sinhala-language E & E forum at Talawakelle, and at discussions held at the TRI Low-Country Station.
- 7). Mr N P S N Bandara successfully completed two on-line training courses on Digital Literacy for Agriculture Professionals and Integrated Soil Fertility Management, conducted by the Asia Pacific Regional Technology Center.
- 8). Trainees from NAITA completed their training in the Division.
- 9). Arrangements were made with Messrs Flowerland Lanka, Makola, for further development, mass-scale production and sale of both the collapsible plucking-basket and the hand-pruner, invented by Dr M A Wijeratne.
- 10). Dr K G Prematilake presented a paper on the management of the problem weed, Gatakola, at the 19th Asian-Pacific Weed Science Conference held in Manila, Philippines, during the period 17th-21st March.
- 11). Dr K G Prematilake participated in a short-term training programme on Research Management held in the National Academy of Agricultural Research Management (NAARM), Hyderebad, India, during the period 11th -30th November.

- 12). Dr K G Prematilake was appointed a Moderator, as well as a member of the Faculty Board, in the Sabaragamuwa University.
- 13). Dr K G Prematilake was elected a Committee Member, Section B of the SLAAS, for the year 2003/04.
- 14). Dr K G Prematilake supervised the final year projects of three university students.
- 15). Dr K G Prematilake trained six NDT trainees from the Naiwala and Hardy Institute, Ampara.
- 16). Dr K G Prematilake delivered lectures to the Superintendents and Assistant Superintendents of Kotagala Plantations Ltd. in a programme organized by the NIPM.
- 17). Ms M S D L Silva participated in a workshop on Effective Proposal Writing, sponsored by the National Science Foundation, on 6th June.
- 18). Ms M S D L Silva participated in a workshop on the Status of Plant Protection and Research in the National Agricultural Research System, and Future Needs, sponsored by CARP, on 28th November.
- 19). Ms M S D L Silva addressed the Managers and Assistant Superintendents of Maskeliya Plantations Ltd. on Integrated Weed Management in Tea, at a workshop on Crop Protection and Fertilizer Management in Tea, organized by the CIC on 27th November.
- 20). Ms M S D L Silva addressed the Assistant Superintendents and Field Officers of Watawala Plantations on Problem Weeds and their Management in Tea Cultivation, on 13th November.

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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.

Currently chemical control by the application of fungicides is at present the only available method to control the disease. The main disadvantage of the continuous use of fungicides is that the fungus could develop resistance to the fungicide. The development of biochemical control methods, based on natural resistance mechanisms, has therefore become important in the control of fungal diseases.

The work carried out up to 2002, on the levels of flavanol, flavonol and anthocyanins in both healthy and infected tissues, showed that epicatechin and anthocyanin could play a significant role in the resistance mechanism. It is also reported that, following blister blight infection, the activity of five enzymes, chalcone synthase (CHS), flavanone-3-hydroxylase (F3H), dihydroflavonol-4-reductase (DFR), leucoanthocyanidin-4-reductase (LAR) and flavanone-4-reductase (FNR), are enhanced. This denotes an up-regulation of flavonoid biosynthesis during the infection. It was further confirmed that tea anthocyanidin reductase could convert cyanidin and delphinidin to (-)-epicatechin and (-)-epigallocatechin, respectively.

These investigations suggest that the formation of proanthocyanidins is via epicatechin and involves leucoanthocyanidins (flavan-3,4-diols).

As a consequence of these findings, the work carried out during 2003 focused on the identification and characterisation of proanthocyanidins (PA) in both healthy and infected leaf tissues.

Proanthocyanidins from healthy and infected leaves were isolated and subjected to several methods of characterization. Acid hydrolysis in the presence of phloroglucinol was used to determine the initiating and extension units of the PA polymer.

Purified PA from both healthy and infected leaves were hydrolyzed in 2M HCl, and the products resolved by HPLC. The hydrolysed products were identified by comparing with them with the authentic cyanidin or delphinidin, and this confirmed that tea leaf contains only procyanidin and prodelphinidin.

Matrix-assisted laser desorption ionization time-of-flight mass spectrometry (MALDI-TOF-MS) was also used to characterize the PA from healthy and infected tea leaves. There were clearly more of the gallated oligomers in the proanthocyanidins from diseased leaves than from healthy leaves.

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 gallo catechin) and towards 2,3-*cis* stereochemistry (e.g. epicatechin and epigallocatechin). In addition, infection also resulted in increased gallic acid esterification of the initiating subunits of proanthocyanidins in these tissues.

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.

It was previously reported that tea cultivars resistant to blister blight showed a higher level of (-)-epicatechin, and it is known that epicatechin is a potent inhibitor of pectolytic enzymes secreted by fungi. Trials have been initiated to study the pectolytic enzymes of *E. vexans*. The results from preliminary trials showed that pectin lyase activity could be detected when blister spores are germinated *in vitro*.

Work is in progress to detect the activity of other enzymes such as polygalacturonase and pectate lyase.

P A N Punyasiri, A D M Damayanthi, A Balasooriya (Pathology Division), V Kumar (University of Peradeniya), and I S B Abeysinghe.

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

Shot-hole borer (SHB) is a major insect pest of tea in Sri Lanka, and SHB infestation is a serious problem affecting 30% of the land under tea cultivation in the country. Continuing SHB depredations, and the resulting debilitation of the tea bushes, lead to loss of yield and exposure to attack by secondary pests, fungi and termites.

A new strategy for integrated pest management could be developed for minimal environmental impact, and also for limiting the development of resistance, by studying certain components of the chemical ecology of pests. 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. The work carried out so far on this project has established the flavanol profiles of SHB-resistant and -susceptible cultivars, and their changes upon SHB infestation. Twenty-five volatile compounds present in the leaves and the 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 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 belong to the orders Diptera, Hymenoptera and other Coleoptera.

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

G de Silva, A D M Damayanthi and I S B Abeysinghe

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

The recently completed study on RAPDs (Random Amplified Polymorphic DNA) generated useful information on the genetic diversity of tea cultivars. The development of more specific and highly reproducible markers, such as SSRPs (Simple Sequence Repeat Polymorphisms) and AFLPs (Amplified Fragment Length Polymorphisms), is important for further studies. Therefore, a more informative and accurate AFLPs technique was initiated, in addition to the SSRPs technique, for characterising tea clones. The technique is at present in the developmental stage.

A tea genomic library has been constructed to screen for SSRPs markers which are used for molecular characterisation. A few cultivars that are thought to be positive have been identified. These cultivars have been prepared for long-term storage. Secondary screening of these clones is being carried out at present.

Phase II of the RAPDs study with 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.

Blister blight study

In order to develop a putative marker for blister blight resistance, RAPDs reactions were carried out with DNA bulks. The results showed that markers developed by the RAPDs technique is inadequate for this purpose. Hence the AFLPs technique is also suggested for this study.

A C Liyanage, K M Mewan, E Karunanayake (University of Colombo), T L S Tirimanne (University of Colombo), J M D T Everard (Coconut Research Institute), M T K Amarakoon (Division of Plant Breeding), W A S N S T Goonetilleke and P G C Priyantha

4. Project B 19.

(a) Effect of black tea on oral micro-organisms.

Studies to find the effect of tea extract, and components isolated from tea, on oral micro-organisms were continued. 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 *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.

The catechin and theaflavin fractions of tea were the most effective components in the tea extracts. The results, using the standard gel diffusion method for catechin and theaflavin fractions, for 19 strains of MRSA are given in Table 1.

Table 1. Effect of catechin and theaflavin fractions of Sri Lankan black tea against MRSA, using the standard gel diffusion method.

Average scavenging area diameter (cm)		
MRSA Strain number	Catechin	Theaflavin
1	6.3	5.9
2	6.6	5.6
3	5.7	4.4
4	6.8	5.2
5	6.8	6.0
6	5.7	5.5
7	5.5	5.3
8	6.7	5.9
9	5.5	5.0
10	6.4	5.8
11	5.9	5.2
12	5.5	5.0
13	5.2	4.9
14	6.2	5.5
15	7.0	6.0
16	5.5	5.7
17	6.4	6.8
18	6.8	6.1
19	7.7	7.3

R W Thanuja Dharshani, H N Fernando*, G J Panagoda, B R P Ananda and A M T Amarakoon.

*Faculty of Dental Sciences, University of Peradeniya.

(b) Chemical properties of teas produced in different regions of Sri Lanka.

Different manufacturing procedures, which produce different types of teas, are adopted in the differing regions and climates of Sri Lanka.

A study was initiated in October to determine the chemical composition of teas produced in six tea-growing regions of Sri Lanka (Dimbulla, Nuwara Eliya, Uda Pussellawa, Uva, Kandy and Ruhuna). Data generated from this study could be useful in marketing these teas.

C D Jayasinghe, R W Thanuja Dharshani and A M T Amarakoon

(c) Antioxidant activity of Sri Lankan teas under different conditions.

The antioxidant activity of tea could vary with different brewing methods, grades of tea, addition of flavours, milk, sugar, etc. Quantitative data are not available for the different types of commercially-available teas, although consumers often request such information. A study was therefore initiated to find the antioxidant activity of Sri Lankan teas under different conditions.

B R P Ananda and A M T Amarakoon.

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.

J Jayasundara and I S B Abeysinghe.

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, which may contribute to the redness of the liquor. Therefore, in addition to the investigations on TP, TF, TR, B, TC and fluoride content, Fe, Al, Cu, Mn, were also included in the analysis. Teas from Dimbulla region were used as controls.

Results of the analysis are given in Table 2.

Table 2. Results of chemical analyses of Bogo Valley and Dimbulla teas.

Region	TF%	TR%	TC%	B%	TR/T F	TP	F(pp m)	AL(pp m)	Zn(ppm)	Cu(pp m)	Fe(ppm)
Bogo (mean)	1.07	14.62	4.32	25.03	14.65	13.73	1.57	882.05	40.03	42.23	134.82
Dimbulla (mean)	1.01	14.89	4.29	21.81	14.97	16.82	1.50	792.86	43.09	52.59	137.88

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

M L D P Gunatilake, A D M Damayanthi, A M T Amarakoon and I S B Abeysinghe

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.

Therefore, it is necessary that pre-export testing for residues in made tea be carried out, in order to ensure their acceptability in destination markets, tea exports being highly important in the national economy. To address this issue, the development of reliable and economical methods for pesticide-residue analysis in tea is being carried out.

Twenty one pesticides, recommended by the Institute or used in the country, were selected for this study. They are: DDT, Bitertanol, Carbofuran, Carbosulfan, Chloropyrifos-ethyl Chloropyrifos-methyl, Copper Oxychloride, Cypermethrin, Diazinon, Dicofol, Dimethoate, Diuron, Endosulfan, Ethion, Fenthion, Fenvalarate, Glyphosate, HCH, Monocrotophos, Propagite and Propiconazole.

Initially two different solvent systems, and two clean-up methods, were tested on five pesticides to develop multi-residue methods for these pesticides, namely:

1. extraction with acetone: hexane (1:4) and alumina activity 5 or GPC clean-up; and
2. extraction with ethyl acetate and GPC clean-up.

In 2002, a multi-residue method for the analysis of chloropyrifos-ethyl, dimethoate 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 chloropyrifos-ethyl, diazinon and chlorfluazuron.

J M D Abeysinghe and I S B Abeysinghe.

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. For each organic estate, two conventional estates in the same locality producing the same grade of tea were selected for comparison. Accordingly, six clusters were formed, each consisting of one organic and two conventional estates. Four of the clusters produced BOP, one BOPF and the other FBOP. In order to maintain a common particle size among and between clusters for a specific grade, BOPs were sieved through meshes 12-18, BOPFs through meshes 14-22, and FBOPs through meshes 8-12.

All 16 samples were analysed for flavour, TF/TR, caffeine, catechins, total polyphenols, soluble solids, crude fibre and moisture, and subjected to tasters' evaluation.

This exercise was initiated in June 2003, and was carried out until December 2003, for periods of six months at two-weekly intervals, amounting to a total of 12 trials. The results are being statistically analysed.

A C Liyanage, J Jayasundara, A D M Damayanthi, and W S C Ranasinghe (undergraduate trainee)

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.

Green-leaf samples were supplied by the Plant Breeding Division, and manufacture of the samples were carried out using an environmentally-controlled miniature manufacturing facility. Made-tea samples were evaluated by three professional tea tasters, and ranked on the basis of quality, using the hedonic scale procedure.

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.

A Muthukumarana and I S B Abeysinghe

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.

Six samples of carbonated tea were treated in duplicate as follows.

<u>Sample No.</u>	<u>Treatment</u>
1.	With the clarifying agents, bentonite and aluminium sulphate (control)
2.	Without the clarifying agents, bentonite and aluminium sulphate
3.	Filtered through Whatman No. 5 filter paper
4.	Filtered through a 0.45 μm filter
5.	Filtered through a 0.30 μm filter
6.	Filtered through a 0.22 μm filter

The samples are being observed visually for clarity periodically 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 three months. The observations will be continued up to a period of 12 months.

A C Liyanage, G A A R Perera, A. Muthukumarana and M W Silva

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 the samples to interested parties.

G A A R Perera, A Muthukumarana, M W Silva and I S B Abeysinghe

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

(a) 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, when compared with DT1 and TRI 777 (which are cultivars with good manufacturing properties), the pH of the leaf juice is lower in TRI 2025. The pH is further reduced during fermentation, bringing it below the optimum range for polyphenol oxidase (PPO). PPO is the enzyme responsible for the conversion of catechins in fresh flush to theaflavins and thearubigins in black tea.

It was also observed that PPO activity further decreased during fermentation. Therefore, the poor fermentation property of TRI 2025 seems to be an inherent character of the cultivar.

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 (Table 3), and this results in poor withering.

Table 3. Mean stomata density of leaf (mm^2) in three cultivars.

Cultivar	Mean stomata density (mm^2)
TRI 2025	120
DT 1	141
TRI 777	205

K Nishantha Kumara*, S P Rebeira (contract RA), M A B Ranathunga, A M T Amarakoon

* Department of Chemistry, University of Ruhuna

(b) 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 teas with high amounts of theaflavins (TF) take milk well. Further, teas processed from flush containing high amounts of total polyphenols also take milk well. Results indicate further that teas made from some cultivars (e.g. K 145) do not take milk well, while tea made from some other cultivars do (e.g. DT 1). Further studies indicate that the problem is aggravated in hard-withered, short-fermented teas made from cultivars which take milk poorly.

The study will be continued in 2004.

H G P Kumara*, S P Rebeira (Contract Research Assistant) and A M T Amarakoon

* Department of Food Science and Technology, University of Ruhuna

(c) 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 (bud, 1st leaf, 2nd leaf, etc.) of the fresh tea flush, and their contribution to made tea.

Notable findings were that the content of aluminium and fluoride increased with leaf maturity, while total polyphenol and caffeine content decreased with leaf maturity (Table 4). 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.

Table 4. Chemical constituents in different part of fresh tea flush.

	Bud	1 st Leaf	2 nd Leaf	3 rd Leaf	Stalk	Flush (3+Bud)
Aluminium (mg/l)	1.5	2.7	5.3	7.7	4.2	6.8
Fluoride (mg/l)	0.12	0.39	0.74	1.19	0.21	0.69
Total polyphenols (% dry wt.)	29.6	26.0	25.3	23.1	18.2	23.5
Caffeine (% dry wt.)	5.7	4.9	4.3	3.8	3.1	4.2

S P Rebeira (Contract Research Assistant) and A M T Amarakoon

Staff

New Appointments

Dr I S B Abeysinghe was appointed Head of the Division with effect from 1st January 2003.

Mr P A N Punyasiri was promoted to Grade 1 with effect from 18 April 2003.

Miss B R P Ananda, Miss W A S N S T Goonetilleke, Miss S P Rebeira and Mr C D Jayasinghe were appointed Contract Research Assistants with effect from 23 July 2003.

Staff Activities

Mr G A A R Perera completed the course work component of his post-graduate studies leading to a M.Sc. degree in Food Science and Technology at the University of Sri Jayawardenepura, and started his research project in November 2003.

Dr I S B Abeysinghe and Dr A M T Amarakoon were members of the Sri Lankan delegation for the Fifteenth Session of FAO's Inter-Governmental Group on Tea, held in Colombo from 18 to 20 August 2003.

Dr I S B Abeysinghe presented a paper entitled "Identification of volatile compounds in shot-hole borer-susceptible and -resistant Sri Lankan tea cultivars", at the IVth Asia Pacific Crop Protection Conference held in New Delhi, India from 18 to 19 September 2003.

Dr I S B Abeysinghe attended a project-planning meeting of the SAREC-supported Asia Swedish Research Partnership programme in Uppsala, Sweden from 28 September to 4 October 2003.

Mr M D L P Gunathillake has successfully completed the UNESCO-funded Post Graduate Diploma course in Chemistry and Chemical Engineering at the Tokyo Institute of Technology, Japan, and resumed duties in October 2003.

Dr I S B Abeysinghe was a member of the Sri Lankan delegation at the 20th Meeting of the International Standards Organisation Sub Committee on Tea, held in Hangzhou, China, from 21 to 23 October 2003.

At the invitation of the Regional Scientific Committees (RSCs) in Uva and the mid-country, Dr I S B Abeysinghe addressed the RSC seminars on "Pesticide residues in made tea" and "Tea aroma profiles", held on 14 July and 28 November 2003, respectively.

Dr A M T Amarakoon was a guest speaker in seminars on 'Tea and Health' for medical professionals, organised by the Sri Lanka Tea Board. Six seminars were held in Colombo, Kandy (two seminars), Galle, Kurunegala and Jaffna.

Dr (Mrs) A C Liyanage served on the Comprehensive Examination Committee (MSc, Biotechnology) of the Post Graduate Institute of Agriculture, University of Peradeniya.

Dr I S B Abeysinghe continued to serve as a member of the Board of Studies in Chemical Sciences at the Post Graduate Institute of Science, University of Peradeniya.

Dr I S B Abeysinghe was appointed a member of the National Technical Committee on Tea by the Sri Lanka Standards Institution (SLSI). He continues to serve as an assessor for laboratory accreditation for the SLSI.

Dr I S B Abeysinghe served as a member of the Committees on "Interest Subsidiary Scheme for Manufacture of Ready-to-Drink (RTD) Teas" and "Upgrading of the Analytical Laboratory of the Sri Lanka Tea Board", on appointment by the Sri Lanka Tea Board.

External Collaborators

1. Prof. V Kumar and Prof. (Mrs) S Kumar, Department of Chemistry, Faculty of Science, University of Peradeniya, on the Biological Pest Control Project.
2. Prof. E Karunanayake, Department of Molecular Biology and Biochemistry, Faculty of Medicine, University of Colombo, on the Use of DNA Markers for Molecular Characterisation of Tea.
3. Mr J M D T Everard, Geneticist/Plant Breeder, Coconut Research Institute, Lunuwila, on the Use of DNA Markers for Molecular Characterisation of Tea.

4. Dr G J Panagoda, Faculty of Dental Science, University of Peradeniya, on the Effect of Black Tea on Oral Health.

Students/Trainees

Miss S P Rebeira, an undergraduate trainee from the Department of Food Technology, University of Peradeniya, completed her project on "Chemical composition of different parts of fresh tea flush and their contribution to the quality of made tea" in March.

Mr H G P Kumara and Mr K Nishantha Kumara from the University of Ruhuna completed their undergraduate projects on "Interaction of tea with milk" and "Manufacturing properties of TRI 2025", respectively.

Miss W S C Ranasinghe from the University of Sabaragamuwa began her undergraduate research project on "Comparison studies on organic and non-organic teas" in May.

Meetings and Seminars

Mr P A N Punyasiri attended the Professor R S Ramakrishna Memorial Training Seminar on Modern Analytical Methods, organised by the Institute of Chemistry, Ceylon, on 3 January.

Mr P A N Punyasiri attended a seminar on "Application of good laboratory practices (GLP) for efficient laboratory management", organised by the Institute of Chemistry, Ceylon, on 23 May.

Mr K M Mewan attended a training programme on Plant Transformation from 22 to 23 December, at the Agricultural Biotechnology Centre, Faculty of Agriculture, University of Peradeniya.

Mr G A A R Perera attended a seminar on " Food safety for the food-processing industry", organised by the Institute of Chemistry, Ceylon, on 14 November.

Miss R W Thanuja Dharshani attended a training seminar on "Safety in microbiological laboratories", conducted by the Institute of Chemistry, Ceylon, in August.

Miss A D M Damayanthi attended a training programme on "Laboratory quality management" at the ITI, Colombo, on 26 July.

Publications

Amarakoon, A M T, 2003 a. Tea drinking and oral health. News Letter, Sri Lanka Tea Board, Vol. 1, No. 1, 13-14.

Amarakoon, A M T, 2003 b. Tea and health. News Letter, Sri Lanka Tea Board, Vol.1, No. 2, 3-8.

Punyasiri, P A N, Abeysinghe, I Sarath B and Kumar, Vijay, 2003. Changes in catechin, methylxanthine and proanthocyanidin content of tea leaf on blister blight infection (Submitted to Phytochemistry).

Thanuja Dharshani, R W, Fernando, H N, Panagoda, G J and Amarakoon, A M T, 2003. Antibacterial activity of tea: Inhibition of methicillin resistant *Staphylococcus aureus* (MRSA). TRI Update 8, 4.

Donors

1. Sida/SAREC and the International Programme in the Chemical Sciences, Uppsala University, Sweden, for the Biological Pest Control Project.
2. Sida/SAREC, Grant for Capacity Building in Biotechnology.
3. National Research Council (NRC), for Biochemical and Chemical Methods in the Control of Blister Blight Leaf Disease of Tea caused by *Exobasidium vexans*.

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 live wood termite.

Field and laboratory assessments on shot-hole borer and live wood termite infestations were made from the Phase II trials of the Plant Breeding Division which were established at Passara (cultivar VP 37) and St Coombs (cultivars VP 75 and VP 76).

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 test cultivars, VP 80/40, 80/5, 80/225, 80/20, 80/53, 80/39, 80/49, 80/21, 80/43, 80/35, 80/22, 80/24, 80/30, 80/99, 80/230 and 80/216, were established in the nursery for evaluations scheduled for 2006.

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 shot-hole borer infestation, were carried out. Periodic evaluations will be conducted in the new two years.

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 cultivars 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 (Fig. 1).

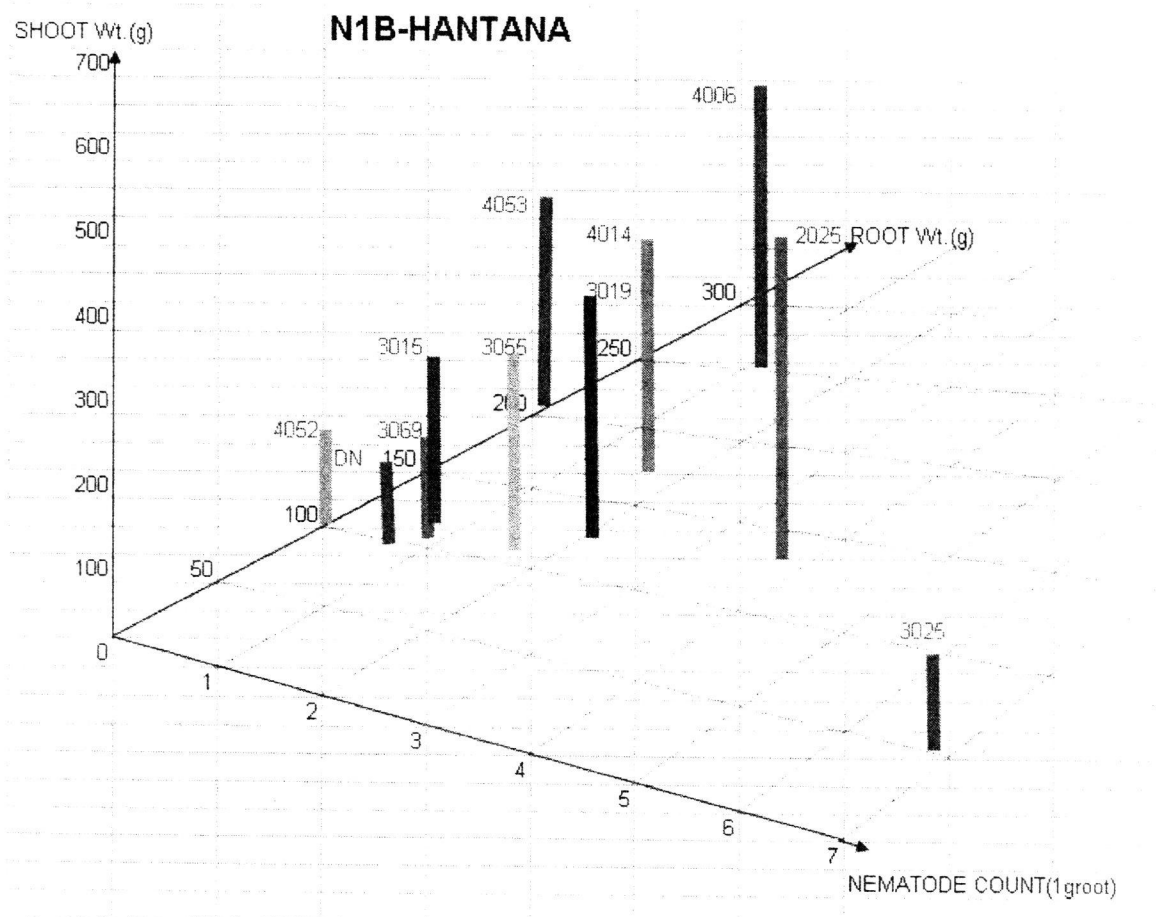


Fig. 1. Test cultivars: shoot growth and nematode infestations.

5 Project A 3.2. Screening lines for shot-hole borer.

Periodic assessments of shot-hole borer infestations in the LVP 74 trial of the Plant Breeding Division at Deniyaya are being monitored.

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 populations in screening tanks is on-going.

7 Project A 4.2. Screening lines for resistance to the low-country live wood termite.

LE 83. Observation blocks of 34 selections from Maratenna Division of Balangoda Estate, L.P.G Division (planted in 1999).

Growth assessments of 34 selections from the observational blocks, in the Maratenna L. P. G. Division of Balangoda Estate, planted in 1999, were carried out. The overall observations are given in Table 1.

Table 1. Performance of the progeny of Maratenna selections from Balangoda Estate, 2003. (non parametric).

Label of the selection	Growth
MT 101	Fair
MT 102	Poor
MT 104	Poor
MT 105	Fair
MT 114	Good
MT 165	Fair
MT 158	Poor
MT 138	Poor
MT 122	Good
MT 131	Fair
MT 116	Poor
MT 141	Poor
MT 133	Poor
MT 153	Fair
MT 150	Fair
MT 166	Poor
MT 119	Good
MT 108	Poor
MT 106	Poor
MT 170	Poor
MT 168	Poor
MT 126	Fair
MT 127	Fair
MT 142	Fair
MT 121	Fair
MT 128	Poor
MT 117	Poor
MT 143	Poor
MT 162	Poor
MT 163	Poor
MT 171	Poor
MT 157	Poor
MT 156	Poor
TRI 2025 (the standard)	Fair

Dry powder from stem materials of the tested cultivars was bio-assayed in a four-channel perspex olfactometer. Out of the 15 cultivars tested, cultivars MT 131, MT 105, MT142, MT 128 and MT165, were found to be resistant to live wood termite.

These six clones were pruned in October in order to take cuttings for further experimentation.

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

Plants of the 26 selected cultivars, with no live-wood termite damage and good branching (after 12-20 years), were raised in the Plant Breeding Division nursery at St. Joachim Estate for further studies.

The selected cultivars were H27, H41, H71, H101, H102, H108, H117, H119, H122, H134, H153, H188, H211, H310, H314, H354, H374, H402, H424, H427, H467, H472 and H482, and former estate selections, Pettigala PET 142, Tocklai TV 09 and Y2.

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

Thirty-seven clones, selected from field No. 4 of Hadaraganga Division, were screened.

Assessments at pruning time, carried out with the 37 selections, are given in Table 2.

Table 2.

Cultivar line	Average branching	Average girth	Average pruning weight (kg)
HG 17	16.9	5.50	2.41
HG 1	9.9	4.15	1.49
HG2	13.3	5.25	1.79
HG 3	17.5	5.55	2.00
HG 6	12.4	4.75	1.04
HG 4	10.2	4.50	1.04
HG 8	9.5	4.15	1.18
HG 10	9.9	4.9	1.54
HG11	15.4	4.75	1.6
HG 13	10.2	4.60	1.21
HG 24	7.5	3.85	0.93
HG15	10.6	4.2	1.40
HG 14	9.1	4.25	1.15
HG 9	9.9	4.00	0.54
HG 7	12.0	4.7	1.69
HG 5	13.1	5.45	1.50
HG20	9.1	4.0	1.11
HG 21	8.3	4.5	2.24
HG 23	8.6	5.3	2.45
HG28	14.7	5.15	2.38
HG37	11.2	4.55	1.48
HG 48	12.6	5.15	1.70
HG12	10.5	4.55	1.27
HG16	10.3	4.15	1.12

HG49	10.6	4.2	1.71
HG 42	12.6	4.9	1.8
HG43	6.8	2.1	0.75
HG44	4.6	2.2	0.47
HG35	8.9	4.1	1.2
HG33	10.9	4.15	0.72
HG32	9.1	4.85	1.57
HG30	7.4	3.80	1.15
HG19	15.6	6.05	2.68
HG27	7.3	3.15	1.00
HG45	10.5	4.65	1.02
HG47	13.5	5.05	1.95
HG50	12.2	5.05	1.73

None of the cultivars was found to be susceptible to live wood termite-damage. Also, there were no significant differences between clones based on yield data.

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

Several TRI 4000-series cultivars (TRI 4089, 4003, 4088, 4053, 4015, 4024, 4036, 4004, 4019, 4046, 4052 and 4020) were screened for resistance to low country live wood termite. Data will be generated at the time of the second prune.

7 Project A 16.5.

N 384. Studies on nematicidal action following planting *Arachis pintoi* in tea soils.

In order to study chemical extracts from soils planted with *A. pintoi*, cement-lined tanks infested with the nematodes, *P. loosi*, *R. similis* and *Meloidogyne* spp., respectively, were maintained at the Mid-Country Station, Hantane.

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

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

In response to a decision not to allow the use of pyrethroids on tea, the spraying of Bulldock (T 3) was omitted from the trial. The plots were kept unsprayed, but other chemicals were sprayed at intervals of three months, commencing from February.

The CATMOD Procedure was used for statistical analysis of the data which was collected from January to December 2003.

Table 3 summarizes the results.

Table 3

Treatment	Open	Healed	Larvae	Pupae	Male	Female
T1 & T5	*	NS	*	*	NS	*
T2 & T5	*	NS	*	*	NS	NS
T4 & T5	*	NS	*	*	NS	*
Likelihood Ratio	<0.0001	<0.0001	<0.0001	0.0005	0.1921	0.0328

* P < 0.05, NS - Not significant

Assessments showed that Regent, Laybacid and Trebon are significantly different from the untreated controls, in lowering the population and the number of galleries in the branches.

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

Since the use of pyrethroids are not allowed in Sri Lanka, spraying of Buldock (T 4) was suspended. The plots were kept unsprayed, but the other chemicals were sprayed in February.

Treatments

- T1 - Laybacid @ 3500 ml/ha
- T2 - Regent @ 1 litre/ha
- T3 - Regent @ 1.25 litre /ha
- T4 - Buldock @ 750 ml/ha (not sprayed)
- T5 - Trebon @ @ 750 ml/ha
- T6 - Untreated control

Cultivar - TRI 2025

Design - RCBD

No. of replicates - 3

No. of bushes per plot - 70

Branch sampling for shot-hole borer incidence was done at two-month intervals. The CATMOD Procedure was used for statistical analysis of the data collected from January to December 2003.

Table 4

Treatment	Open	Healed	Larvae	Pupae	Male	Female
T1 & T6	NS	NS	*	NS	*	NS
T2 & T6	*	*	*	*	NS	*
T3 & T6	NS	NS	*	*	NS	*
T5 & T6	*	*	*	*	NS	*
Likelihood ratio	0.0014	0.3388	0.0061	0.0002	0.82203	0.0375

P* < 0.05, NS - Not significant

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.

Treatments

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

Cultivar - TRI 2025,
No. of replicates – 3
Design – RCBD

Spraying of chemicals was carried out at three-month intervals, commencing from January. Monthly assessments of shot-hole borer incidence, and weekly plucking records, were maintained.

There was a significant difference in borer population and galley counts in the Regent and Trebon treatments, when compared to the treatments testing other chemicals and to the control. Plucking data indicated that there is no significant difference between the treatments in relation to yield in the same period, when compared to the control. In terms of number of galleries and live stages, there were significant differences between the untreated control and the treatments, Regent @ 1 litre and Trebon.

Confirmation trials on the use of Regent and Trebon in the management of SHB

To confirm the results from ME 14, ME 15 and LE 87, two experiments were initiated with DT 1 and TRI 2025, at Brunswick Estate, Maskeliya and at Levellon Estate, Pupuressa, respectively.

Treatments

T1 - Fenthion - 3500 ml/ha
T2 - Regent - 1000 ml/ha
T3 - Regent - 1250 ml/ha
T4 - Trebon - 750 ml/ha
T5 - Control

ME 26. Colgrain Division, Levellon Estate, Pupuressa

Cultivar - TRI 2025 (1st year after pruning)
No of treatments - 5 No of replicates - 3
No of bushes/plot - 60 Design - RCBD

E 320. Brunswick Division, Field No. 2, Brunswick Estate, Maskeliya.

Cultivar – DT 1 (two years after planting)

Periodic branch sampling at monthly intervals were monitored since the first chemical application which was given in October. This experiment is 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, was 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 (1st year after pruning)
No. of treatments - 2 No. of replicates - 4
No. of bushes/plot - 60

Treatments

T1 – Sprayed
T2 - Unsprayed

Assessment of SHB incidence:

Branch sampling was carried out at monthly intervals. The CATMOD procedure was used for statistical analysis of the data collected from January to December 2003.

This data are presented in Table 5 and Figs. 2-5.

Table 5

Treatment	Open	Healed
T1 and T2	NS	NS
Likelihood ratio	0.0425	0.0067

P < 0.05, NS - Not significant

Fig 2

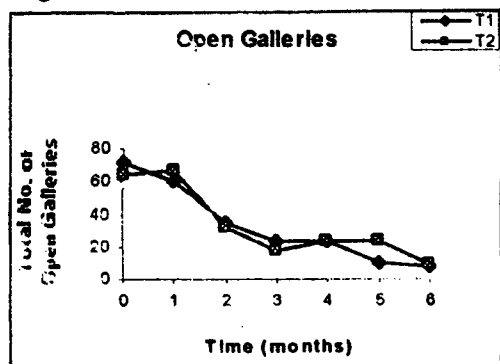


Fig 3

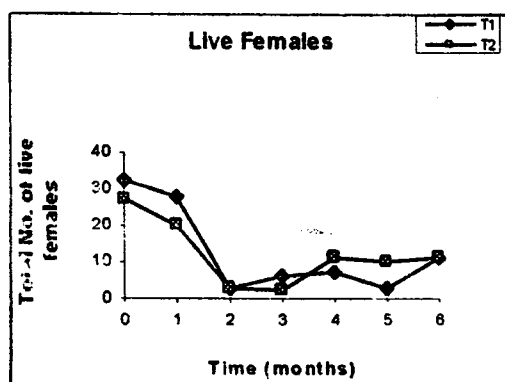
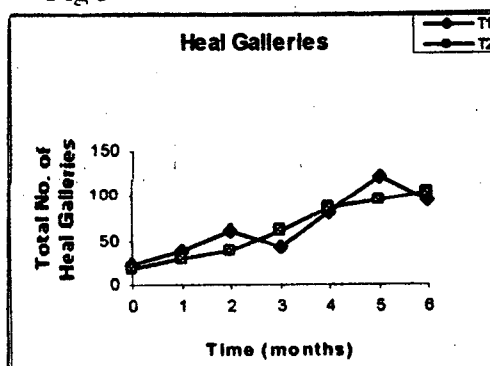


Fig 4

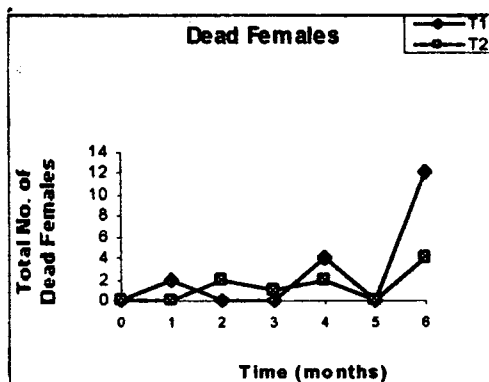


Fig 5

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 (one year from prune).

Cultivar - TRI 2025, No of replicates - 4

Treatments

- T1 - Sprayed
- T2 - Unsprayed

Branch sampling was carried out at monthly intervals. The CATMOD procedure was used for statistical analysis of the data collected during June - December 2003.

The data are presented in Table 6 and Figs. 6-9.

Table 6

Treatment	Open	Healed
T1 and T2	*	NS
Likelihood ratio	0.8719	0.7717

P* < 0.05, NS- Not significant

Fig 6

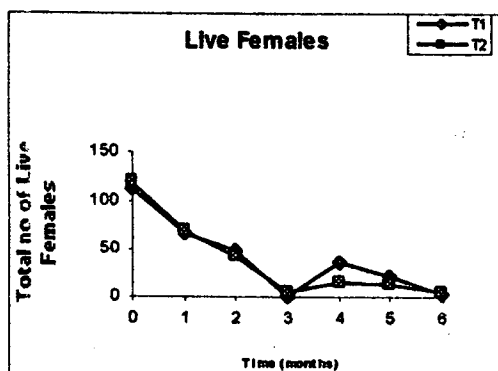


Fig 7

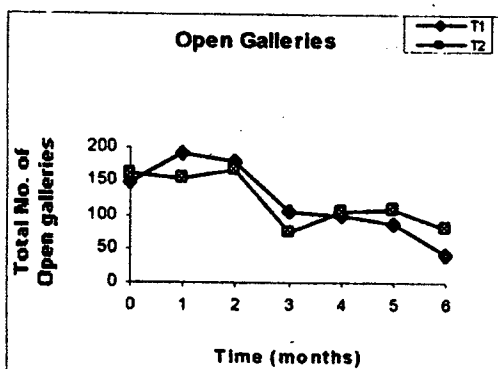
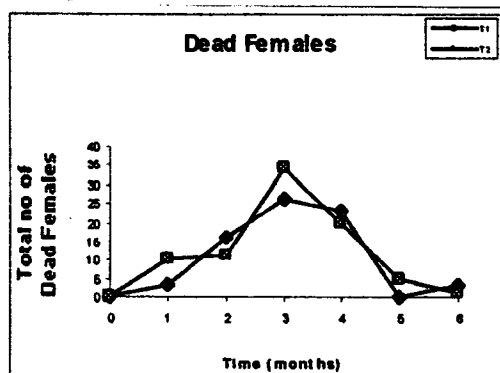


Fig 8

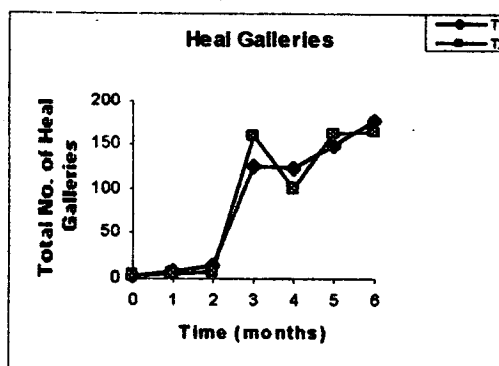


Fig 9

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

To evaluate the feasibility of using the fungus, *Beauveria bassiana*, in the field, together with three conventional insecticides for comparative purposes, the trials were initiated, in 2002, at the following locations.

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

E 311. Templestowe Estate, Field No. 12 A

These two trials were 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 fungal agent could be air-borne and transmitted in that fashion.

A new experiment was laid out in Haputale Estate.

**E 313. Haputale Estate, Haputale Division, Field No.7
(two years after pruning).**

Plots were laid out with a distance of 75 bushes between each plot.

Treatments

1. Treated with *B. bassiana*
2. Untreated

No. of replicates : 4

First spraying was carried out on 13th August, and the 2nd spraying on 24th November.

Table 7

	29.09.2003		18.11.2003		01.01.2004	
	Live/ dead beetles	Infected	Live/ dead beetles	Infected	Live/ dead beetles	Infected
A1 Treated	31	10	41	5	36	5
A2 Untreated	67	-	74	-	50	-
B1 Treated	21	21	22	12	27	21
B2 Untreated	66	-	63	-	48	-
C1 Treated	47	10	46	8	23	12
C2 Untreated	69	-	53	1	49	-
D1 Treated	15	9	63	10	33	19
D2 Untreated	72	-	*		68	2

- All the beetles died; reason unknown.

The experiment is in progress.

Evaluation of application methods of *B. bassiana* spore suspensions.

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

To test the methods of application, an observation trial was initiated.

Treatments

1. *B. bassiana* suspension applied by a knapsack sprayer
2. *B. bassiana* suspension applied by a mist blower
3. Untreated (control)

The experiment is in progress

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

There are no differences between treatments, but there are differences between the cultivars. The SHB assessments will be continued periodically until 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 and 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 (15⁰C to 32⁰C). The development parameters form the basis for the life-cycle module of DYMEX.

The life-cycle stages (eggs, larvae and pupae) were obtained by splitting open the tea stems (variety TRI 2025) brought from Attampaitia Estate, Attampitia (Badulla District). The eggs and pupae were removed from the galleries, and placed on moist filter paper in a Petri dish which was then placed in an incubator set at the required temperature. The temperatures selected covered the beetles' active range, namely 15⁰C - 32⁰C.

Observations were taken regularly on egg hatching, mortality and pupal emergence and mortality.

Initial attempts to rear shot-hole borer larvae on ambrosia cultures in Petri dishes, to determine the development time, were not successful as the cultures were frequently contaminated and the larvae were unable to develop.

A different approach was therefore adopted for determining the duration of the larval stage indirectly, under the same temperatures that the eggs and the pupae were subjected to. Beetles recovered from the galleries were introduced singly into freshly-prepared diet tubes, in order to track the performance of individual beetles (Sivapalan, P and Shivanandarajah, V, 1977).

Diet tubes were observed regularly for signs of adult emergence, and the first appearance of daughter beetles were noted. The time lapse between introducing the mother beetle and the appearance of daughter beetles is taken as the duration for the total life cycle. The combined durations of eggs and pupal stages were then subtracted from the total to obtain the larval duration, at a particular temperature.

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 the development data well, 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.

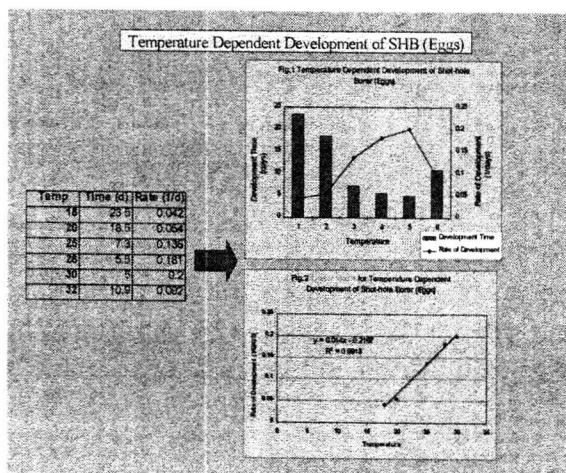


Fig. 10

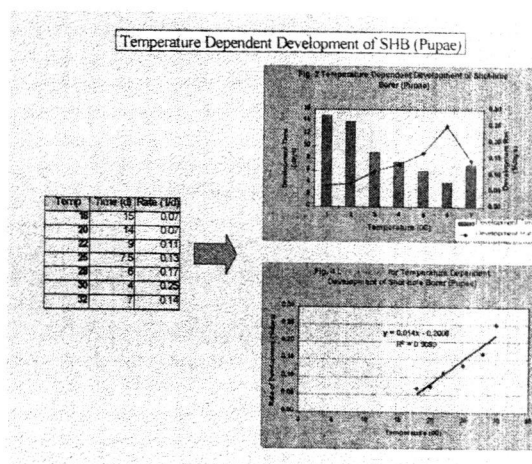


Fig.11

The data for the duration of eggs at these temperatures are yet to be subjected to analysis.

The average fecundity of a female under different temperature can also be determined from the rearing experiments in the diet tubes. The diet-tube method proved to be a good tool to obtain generations of beetles for other laboratory purposes as well.

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

Introduction to the problem

Shot-hole borer, *Xyleborus fornicatus* Eichh. (Coleoptera: Scolytidae), is one of the serious pests in tea in Sri Lanka. The pest is known to occur in tea-growing areas at elevations between 150 and 1500 m. The damage caused by the beetle is twofold: the primary damage (the mechanical damage) is mainly due to the boring activity of the beetle, and the secondary damage is due to wood rot which leads to debilitation of the bush. There is a growing concern that shot-hole borer might extend its range and become a threat to areas currently free of the problem. Under the climate-change scenario, the possible effect could be that global warming would perceptibly increase temperatures resulting in range extensions of major pests like shot-hole borer. Therefore, the present study was initiated in order to determine the present distribution and the degree of infestation of shot hole borer, in the tea-growing areas.

Objectives

1. To map the present distribution of the borer and the level of infestation in the tea-growing areas in order to obtain a complete database for future reference.
2. To predict the changes in distribution under the climate-change scenario, and compare the changes in distribution, if any. Modelling the effects of changing temperature will also be done after the population model is built.
3. To see whether the present recommendations need revision in order to make their application suitable for local climatic conditions.

Methodology

1. Visits to estates. All the estates in the tea-growing areas (Fig. 1) will be visited for information relating to the presence or absence of shot-hole borer and for sampling.
2. The sampling method. Sampling will be carried out according to the method described in the Institute's Advisory Circular PM 1, issued in February 2003, with a slight modification. Sampling will be done in one-hectare blocks of tea known to be infested with shot-hole borer. This information will be obtained with the help of the estate superintendents.

Having selected a bush at random, a branch of the primary type, 30 cm in length, will be removed. The selection of the branch from the bush will also be at

random. The number of bushes, and therefore the number of branches removed, will be 100. Wherever possible, the clone TRI 2025 will be sampled, as it is the most susceptible clone for shot-hole borer. If the clone is not available in a particular estate, another susceptible clone from the list of cultivars, will be selected for sampling.

3. Involvement of personnel. As there are a large number of estates to be covered (see Annexure), people at different TRI stations will be entrusted with covering the estates under the jurisdiction of each of the stations.

Fig. 12

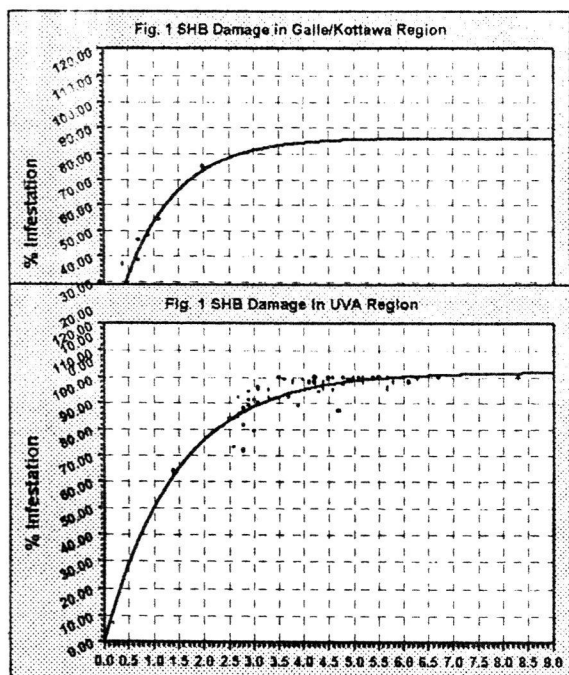


Fig. 13

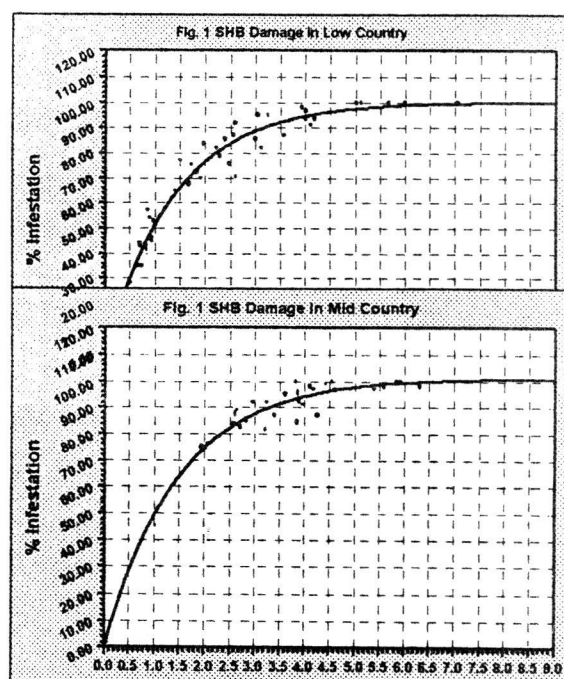
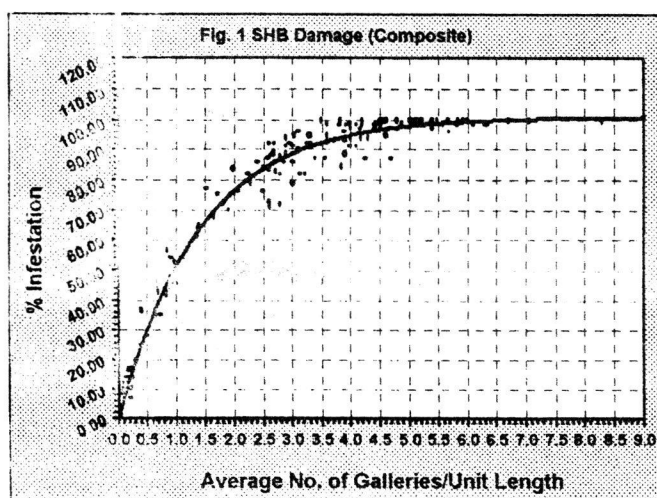


Fig. 14



The two damage components fitted well into the exponential curves for these two parameters (Curve Expert 1.3 - a curve-fitting expert for Windows; $y = a(1 - e^{-bx})$, with a high correlation (R^2 in the range 0.96 to 0.99) considering data from different isolated areas (SE in the range 3.5 to 4.5).

The composite graph also yielded a high correlation ($R^2 = 0.99$ with $SE = 4.2$), with the same type of curve. This composite curve is being used to categorize shot-hole borer damage on a scale of 0 to 10, in terms of the average number of galleries/unit length of tea stem. The 10 categories would also be placed into three groups. This would form the basis for different control measures or packages to be adopted.

The following personnel carried out the survey.

1. Uva Region (number of estates = 66)
R S Walgama, C De Seram, M M Jayathilake, L S Abeysinghe and D D Liyanage
2. Low Country (number of estates = 70)
A K Prematunge, M M Jayathilake and R Perera
3. Mid-Country (number of estates = 60)
R M D T Pallemulla, B Sureshkumar and U B Herath
4. Deniyaya and Kottawa Region (number of estates = 30)
R S Walgama, C de Seram, M M Jayathilake and P K Jayawickrama

ME 24. Survey on SHB incidence in tea estates in the mid-country.

A survey was completed to assess SHB incidence in tea estates in the mid-country.

Table 8

	Estate	Avg.	Infestation, %
1	Kellebokke	2.73	83
2	Mahaousa	2.63	84%
3	Madulkelle	6.32	98%
4	Duckwari	5.59	98%
5	Hantane	2.08	76%
6	Nicholoya	3.97	91%
7	Midland	5.4	97%
8	Pitakanda	3.24	82%
9	Levellon	4.44	99%
10	Rangala	3.84	100%
11	Mooloya	0.07	4%
12	Hunnasgiriya	2.84	86%
13	Opalgala	3.4	87%
14	Bandarapola	4.62	97%
15	Galpehela	1.94	75%
16	Allakolla	2.95	92%

17	Goomera	4.55	100%
18	Hagalle	3.25	92%
19	Rothschild	3.61	92%
20	Melfort	3.88	96%
21	Delta	5.92	100%
22	Geragama	2.67	89%
23	Rookwood	0.04	3%
24	Loolecondera	5.84	100%
25	Hope	0.02	1%
26	Rahatungoda	3.89	93%
27	Lanternhill	4.11	98%
28	Monte Cristo	3.61	95%
29	Craighead	3.85	85%
30	Westhall	2.59	84%
31	Kataboola	4.17	97%
32	Imboolpitiya	4.25	87%
33	Greenwood	2.62	88%
34	Elpitiya	1.04	45%
35	Sanquar	3.5	99%
36	Kaloogalla	4.04	100%
37	Beaumont	3.51	87%
38	Sogama	2.1	79%
39	Deltota	4.2	100%
40	Galaha	4.22	100%
41	Great Valley	4.95	99%
42	Kandaloya	5.99	99%
43	Nagastenna	5.01	100%
44	Dotaloya	3.15	73%
45	Hunugala	5.29	99%
46	Ratwatte	4.48	96%
47	Cooruduwatte	5.27	100%
48	Nayapane	4.68	97%
49	New Peacock	4.13	97%

12 Project A 23.5. Effect of soil pesticides on soil biomass and productivity of tea.

N 417. Semen quality of men in organic and conventional tea plantations, in comparison with an urban population in Sri Lanka.

Among the environmental pollutants, synthetic agro-chemicals are known to affect male fertility. However, no proper studies have been performed to evaluate the effect of these compounds on the status of fertility among the agricultural populations in Sri Lanka.

The organic system of management totally replaces the use of all kinds of synthetic agro-chemicals with natural inputs. Therefore the aerial, soil and water environment is expected to be maintained at healthy levels, compared to a conventional area. An urban environment expresses other kinds of pollution.

The results of the quality of semen in three groups of men in Sri Lanka, including workers occupationally exposed to (i) organic, and (ii) conventional, tea production systems for nearly 18 years, and (iii) men from an urban population, are discussed.

Semen samples from volunteer donors, representing age groups varying from 18-58 years in organic (n = 30), and in conventional (n = 23), tea plantations, and in an urban population (n = 50), were subjected to semen-fluid analysis according to WHO criteria. Data analysis was done using the Mann Whitney U test. Food and behavioural patterns, life-style practices, and the clinical history data of the subjects, were also considered for the study.

Workers exposed to agro-chemicals (in conventional plantations) had a significantly greater percentage ($P < 0.0001$) of morphologically abnormal spermatozoa than men in both organic plantations and in the urban population (Table 9). On the other hand, motility and viability of the spermatozoa were lower in semen of men both in conventional plantations and in the urban population ($P < 0.05$ and 0.001 , respectively).

Table 9. Semen parameters of workers from organic and conventional tea plantations, and from an urban area in Sri Lanka (mean \pm SEM)

Parameter	Population			Normal values (WHO, 1999)
	Organic	Conventional	Urban	
Age	37.2 \pm 1.2	37.0 \pm 1.7	35.4 \pm 0.9	
Volume (ml)	1.7 \pm 0.2	1.9 \pm 1.7	2.2 \pm 0.33	2.0 - 5.0
Concentration (million/ml)	59.8 \pm 2.1	56.4 \pm 1.1	53.8 \pm 1.7	20 - 160
Motility (%)	49.1 \pm 0.7	39.6 \pm 0.22 *	40.3 \pm 0.29 *	>50
Viability (%)	64.1 \pm 0.42	39.6 \pm 0.23	55.1 \pm 0.28	>50
Morphology (%)	56.2 \pm 1.1	39.6 \pm 0.24 **	53.1 \pm 0.52	>30

* $p < 0.05$ ** $p < 0.001$

From the preliminary results, it may be concluded that exposure to pollutants, regardless of the type, is reflected in the fertility parameters of males. The agro-chemicals have shown to be detrimental to semen quality (both at testicular and post-testicular levels), and likely to impair fertility. This is similar to what is observed in conditions of urban pollution.

Having developed a data base of this nature for worker health, the beneficial, practical implication would be in exploiting certain international tea markets influenced by fair-trade practices, organic agricultural practices and health considerations.

Further, the results of this study highlight the importance of strengthening field safety measures to ensure the welfare of estate workers, while at the same time increasing their efficiency and productivity. More experimentation is therefore in progress to determine the presence of adverse chemical substances, such as pesticide residues, heavy metals, etc., in body fluids of males, females and children associated with the tea community.

13. Project A 23.6.

N 398. Effect of local and imported biodynamic preparations on microbial activity in soil and in compost.

Biodynamic preparations ('vitalizers') are reported to affect crop nutrition and yield, pest and disease management, etc., through influences on soil microbial activity, the science of which has not been studied as yet. Local preparations (Stassens, Haldummulla Bio Tea Project), and foreign preparations (from the UK), used in biodynamic tea cultivation were tested for their biological activity in tea soils, and in compost under laboratory conditions.

The results of the preliminary study indicate that local preparations have a more positive influence on soil microbial activity than on that in compost. Further studies are in progress to assess the nutrient composition and quality of the biodynamic preparations. Also, alternative local raw materials are being tested to replace any costly, imported inputs.

N 426. Biological performance of different compost materials in tea soils.

The biological performance in tea soils, resulting from the incorporation of six bio-compost samples used in the TRI-ORCON trial at the TRI, one market waste compost sample, and ten municipal solid waste (MSW) samples from different sources in the country, was tested *in vitro*. Soil microbial biomass, germination of beans and microbial growth in laboratory cultures of the samples were assessed and compared. The data are being analyzed.

14 Project A 32.3.

The growth, health and quality of tea- and soil parameters of the TRI-ORCON trial, established in Field No. 13 at St Coombs, and of the BIDORCON trial, established in the Nematology experimental area, were periodically monitored. The Nature Farming Demonstration and Research Area, established in the Nematology experimental area, was also maintained for field use and demonstration purposes.

N 370. Influence of nematode-suppressive organic tea soils on nematode-cyst incidence.

Agricultural soils, with sufficient densities of naturally-occurring biological control agents or antagonists of nematodes, which would help maintain parasitic nematode populations below the economic threshold, are considered as 'nematode suppressive' soils (Ns).

The present study re-investigated the 'nematode suppressiveness' (Ns), already established with the root-lesion and the root-knot nematodes, in tea soils of the TRI-ORCON trial, using the potato golden cyst (PCN) nematode (*Globodera rostochiensis*). The original, sterilized soils of Ns tea, which included (i) Ns TW, (ii) Ns NOC, and (iii) Ns COM and NNs (non suppressive) tea (NNs CONV), were screened under glass-house conditions for nematode establishment, damage, and plant- and tuber growth of potato.

The Ns tea soils exhibited a significantly minimum PCN cyst recovery, compared to the maximum number of PCN recovered from NNs tea soils ($P > 0.0217$). Also, the sterilized Ns tea- and NNs tea soils exhibited maximum number of cysts compared to the original soils. The shoot biomass of potato in the presence of PCN was significantly higher in all the original tea soils than in sterilized soils ($P > 0.0195$). The root biomass production was also high in the original Ns tea soils, although not statistically significant. There was a significant inverse relationship between tuber biomass production and the number of recovered PCN in original tea soils ($r = - 0.9068$, $P > 0.0339$). All tea soils possessed C:N ratios between 14 and 20, which are desirable for beneficial microbial activity.

It may be concluded from these results that Ns in tea soils, resulting from organic agricultural practices, could suppress not only lesion- and root-knot nematodes of tea, but also nematode-cyst numbers. Therefore, the study indicated the importance of developing Ns agricultural soils in order to minimize crop damage by nematodes. The existence of Ns would be cost-effective, environmentally- and user-friendly, in addition to improving the health and the productivity of soil. Therefore, it is advisable to exploit Ns through beneficial means in low input and sustainable agricultural systems.

N 369. Mass propagation of nematode biocontrol agents.

For the purposes of field dissemination, laboratory- and pot cultures of different isolates of *Pastueria penetrans* and nematode-trapping fungi species, *Arthrobotrys musiformis*, *A. oligospora*, *Arthrobotrys* spp., *Dactylella* spp. and *Monacrosporium* spp., were maintained.

N 371. Monitoring naturally-occurring nematode antagonists of tea nematodes.

The densities of nematode biocontrol agents, and soil populations of *P. loosi* and *Radopholus similis* in Needwood Estate, Haldummulla, and at the TRI Station, Kottawa, respectively, were periodically monitored.

N 375 a. Soil-less media for tea propagation as alternatives to chemical treatments in tea nurseries.

Rubber latex-coated soil-less media of compatible size to conventional tea nursery bags, using tea waste, coir dust and sugarcane bagasse, were prepared at the Rubber Research Institute laboratories, Ratmalana. The nursery performance of the media is being assessed in the Protected Tea Nursery at Great Western Estate.

N 375 b. Nursery performance of tea in soils from different sources.

Suitable soil in ample amounts for tea nurseries is becoming a scarce resource in most of the estates. As alternative sources, *Eucalyptus* soil, *Pinus* soil, mana soil, old tea soil and forest or jungle soil, were tested for their performance in callus formation and rooting of nursery plants.

Formation of callus, root dry-weight and total root-length of tea plants was higher in forest soil than in the other media tested. *Pinus* and *Eucalyptus* soils were equally good in performance, while mana and old tea soils performed less well in callus formation (Fig. 15).

No parasitic nematodes were found in *Pinus* and *Eucalyptus* soils. Only free-living nematodes were found. The nutrient composition of the soils seemed to be quite satisfactory for tea propagation. Studies are in progress to elucidate any allelopathic or stress factors in these soils that may cause early callusing in tea.

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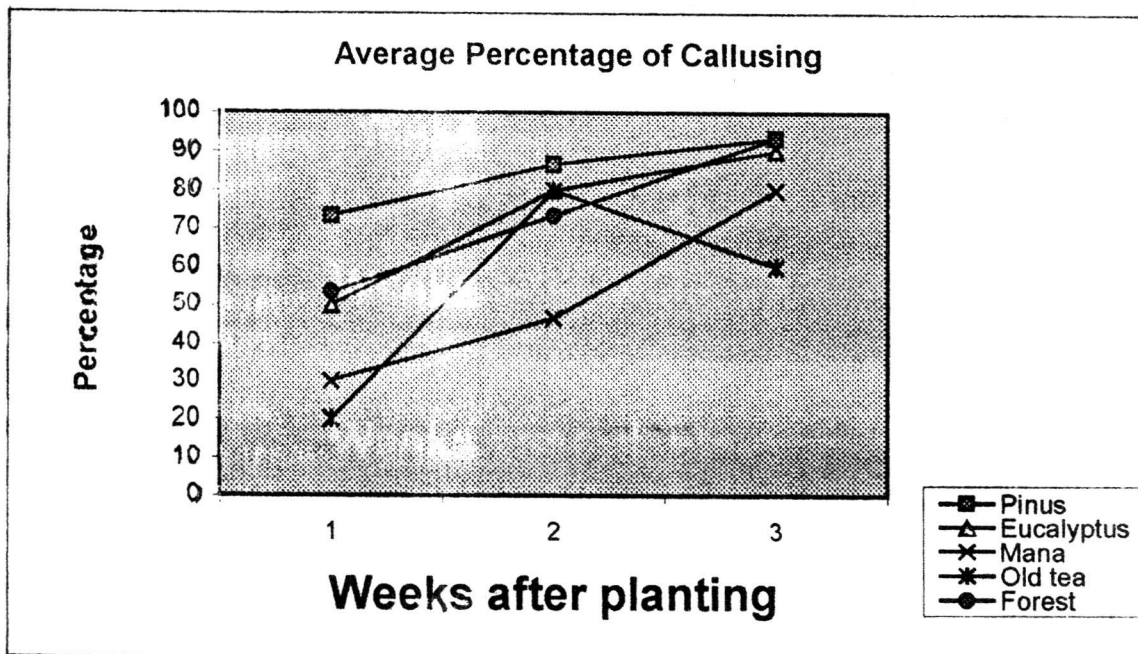


Fig. 15. Callus formation of tea cuttings (cultivar TRI 2043) grown in soils from different sources.

In order to harness *Pinus* and *Eucalyptus* soils as alternative soil sources for mass-scale tea propagation, experiments have been set up at Great Western Estate.

N 399 b. Field performance of tea planted in mechanically- and manually-uprooted tea lands.

In order to evaluate the growth and establishment of young tea (cultivar DT 1), planted in mechanically- and manually-uprooted lands in Great Western Estate, data on root biomass in different soil layers, girth, height, number of branches and shoots of plants were monitored. The significant differences ($p=0.05$) in root- and shoot promotion in mechanically-uprooted soils were noted. Data are being correlated with the nematode incidence in soil under two different practices.

N 423 a. Nematicidal properties of the *Toona* plant.

The chemical extraction of leaves, flowers and seeds of the *Toona* plant was completed at the ITI laboratories, Colombo for use in laboratory- and field bioassays with tea nematodes.

In order to evaluate the nematicidal properties the *Toona* plant, a pot experiment was established at the Nematology Experimental Area at TRI. The experiment is in progress.

N 422. Evaluation of vermi-wash application in tea nurseries.

An experiment was set up at the TRI Station, Passara to compare the performance of vermi-wash applications with that of conventional nursery applications on growth, establishment and resistance to pests and diseases of nursery tea plants of the cultivar TRI 4071. Data on the callusing of cuttings and the rooting of plants were collected periodically. The experiment is in progress.

N 400 a and b. Effect of biodynamic agriculture on growth, establishment, and pest- and disease incidence in tea.

Biodynamic applications and practices were adopted for (a) tea in the BIDORCON field trial, and (b) African violet and anthurium in the Nematology glasshouse, as per the Sri Lankan biodynamic planting- and application calendar. For comparison, organic and conventional treatments were monitored as per IFOAM and TRI recommendations, respectively.

Growth, development and quality and pest- and disease incidence of plants, and soil parameters, were periodically monitored for scientific validation of the biodynamic practices.

N 425. Development of bio-fumigation methods

Laboratory studies were initiated to develop bio-fumigation methods from materials of animal and plant origins. Several experiments are in progress.

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

Time-saving techniques for screening newly-released TRI 5000-series cultivars against low country livewood termite (LCLWT).

Preliminary laboratory bioassays were carried out with rotted wood materials at prune cuts of 25 cultivars. The results showed that the following are LCLWT-resistant.

Bioassays I and II (Olfactometry/Petri C. A.)

Cultivar

Code

26/4	significant repulsion	a
68	significant repulsion	a

62	significant attraction	e
22/11	significant repulsion	a
163	significant repulsion	a
145	significant repulsion	a
379	significant repulsion	a
23/5	significant repulsion	a

Bioassay III (Glass-Plate Method)

<u>Code</u>		
379	significant repulsion	a
23/5	significant repulsion	a

Bioassay IV

No significant results could be obtained from the bioassay with fresh stems. Consequently, the studies are to be repeated for further generation of data.

CH₂Cl₂ extracts of the cultivar TRI 2016 were fractioned using MPLC chromatography. Initial bioassays revealed that among the 22 fractions obtained, the following fractions significantly repelled termites (LCLWT).

S/16/4/11-	significant repulsion (P<0.001)
S/16/4/2-	significant repulsion (P<0.005)
S/16/4/9-	significant repulsion (P<0.001)

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

In stage II of the studies to develop a short-cut method to screen tea cultivars for nematode resistance and susceptibility, eight-month old closely-raised nursery plants of the cultivars DN, DT 1, K 145 and TRI 2142 known to be tolerant, and KEN 15/7, TC 9, TRI 1526, TRI 2024, TRI 2026 and TRI 2043 known to be susceptible to *P. loosi*, were used in the experiments designated as N 386 a and b.

N 386 a. Biochemical resistance of tea cultivars known to be tolerant and susceptible to *P. loosi*.

Periodic biochemical investigations on the amino acid and polyphenol content in the roots of the tea cultivars, exposed to nematode infestation, were made.

N 386 b. Root morphology of tea cultivars known to be tolerant and susceptible to *P. loosi*.

Morphometric and morphological differences in (a) thickness of epidermis and cortex, and (b) xylem diameter, wall thickness, area and density, of the feeder roots of the tea cultivars were studied.

Statistical analyses of biochemical parameters, and morphology and morphometrics of feeder roots, along with root populations of *P. loosi*, are being undertaken in order to determine the potential for exploiting such parameters in nematode-screening protocols in tea. Molecular data are also being used for further understanding the resistance mechanisms of tea, against different nematode groups and isolates.

N 386 c. Nutrient composition of the different plant parts of young tea exposed to isolates of *P. loosi*.

Different plant parts of young tea of the susceptible cultivar, TRI 2024, grown in micro plots heavily infested with four *P. loosi* isolates (isolate 1: Talawakele, isolate 2: Delmar, isolate 3: Hantane, and isolate 4: Passara), were subjected to analyses for N, P and K, in order to study the damage caused by the nematode isolates.

Highly significant differences in plant growth were observed with the different nematode isolates. However, the symptomatological measurements with regard to pre-mature flowering and fruiting were not significant. The most and least damage to tea was caused by isolates 1 and 4, respectively. A significantly low partitioning of dry matter in leaves, stems and roots was evident with isolate 1.

Total root length was also significantly affected by the nematode isolates. The root- and shoot dry weights were highly correlated ($P < 0.0001$). The uptake of nutrients by the affected root biomass was reflected in the nutrient composition and the poor productivity in different parts of the plant. The plants subjected to isolate 4 had a significantly greater content of N, P and K in their leaves, stems and roots than those subjected to the other isolates.

17 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.

18 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.

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

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

Treatments

- 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.

Table 10

Treatments	1 st assessment		2 nd assesment		3 rd assessment		4 th assesment	
	Pre-count	Post-count	Pre-count	Post-count	Pre-count	Post-count	Pre-count	Post-count
T1 - R1	500	25	300	0	200	0	100	0
	300	279	300	9	1000	0	500	85
	100	0	500	0	200	0	1000	197
R2								
R3	200	50	2000	1876	200	76	-	-
	500	100	500	424	300	150	-	-
	1500	425	500	483	1000	689	-	-
T2- R1								
R2								
R3	+	0	+	60	+	0		
T3- R1	+	179	+	42	+	168		
R2	+	132	+	18	+	129		
R3	+	0	+	0	+	51		
T4- R1	+	0	+	0	+	0		
R2	+	0	+	0	+	0		
R3	500	398	500	200	1000	763		
T5- R1	500	252	2000	1050	1000	105		
R2	200	306	1000	824	100	98		
R3								

+ Termites present in the branches

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

LE 88. Panambalana Estate, Kahatapitiya, Horana.

Treatments

3 M x 6 C, where M= rooting medium; C=cultivar

Media:

M1 - Soil and coir dust (in layers)

M2 - Soil and paddy husk (1:1 mixture)

M3 - Soil only

Cultivars: TRI 4046, 4006, 3014, 4042, 4049 and 2027

Two hundred plants were planted in a sub-plot in one replicate, with three replicates making up the trial.

Final assessments were carried out November at 10 months.

There were no differences between the 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.

Objectives

1. To study the feasibility of using easily-available agricultural by-products as partial soil substitute in tea nurseries.
2. To determine whether coir dust and paddy husk can be used in low-country tea nurseries where scavenging termites are active in the soil.

Final assessment was carried out 10 months from planting.

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

Objective

To study the feasibility of using easily-available materials such as paddy husk, tea waste, etc., as partial soil substitutes in tea nurseries, and so reduce the usage of soil alone as the rooting medium.

This trial was initiated in December. There are seven treatments x two replicates (250 plants/replicate).

21 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.

Treatments

- T1 - Regent (granular formation), 30 kg /ha
- T2 - Regent (liquid suspension), 3.5 liters/ha
- T3 - Regent (liquid suspension), 2 liters/ha
- T4 - Control

Observations were taken at two-month intervals.

It was observed that there was no difference between the control and the other treatments. Previous observations had shown that there was much reduced termite activity even in the control plots. This may have been due to the small size of the plots because the effect of chemicals could be seen on other plots. As the underground nests of the termites may sometimes be found far away from the bushes, termites may forage for food in one plot and have their nests in another plot.

Since these results were inconclusive, the experiment will be repeated in large plots.

Publications

Mohotti A J, Damayanthi N, Tennakoon K T, Mohotti K M and Sangakkara U R, 2003. Anatomical differences in 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; p. 77.

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; Perth, Australia; p. 151.

Mohotti K M, Elliyadde R V P K N, Ekanayake E M R K and Thiruchelvum S, 2003. Import and export of biotic materials with special reference to conservation and utilization of soil biodiversity components: a case study in the Sri Lankan tea industry. Proceedings, 23rd Annual Sessions, Institute of Biology, Colombo; p. 9.

Walgama R S and Zalucki M P, 2003. Modelling in insect pest management: a case study in a tree crop. Abstract of Proceedings, 23rd Annual Sessions, Institute of Biology, Colombo.

Wijeratna S, Mohotti K M, Seneviratne H R, Premakumara G A S and Ratnasooriya W D, 2003. Semen quality of men in organic and conventional tea plantations and in an urban population of Sri Lanka. Proceedings, 23rd Annual Sessions, Institute of Biology, Colombo; p.17.

Staff Training:

Mr R S Walgama, Research Assistant, left for Australia in December to continue with the final segment of his training in Computer Simulation Modelling for Pest Management, leading to a Ph. D., at the Department of Zoology and Entomology, University of Queensland, Australia.

Miss S M Samarasinghe, Research Officer, commenced her postgraduate studies on biochemical resistance of tea against the low country livewood termite at the Postgraduate Institute of Science, University of Peradeniya.

Undergraduate Supervision

Dr Mohotti supervised the final-year research projects and theses of the following undergraduate students.

- a) N. I. Suwandarathne, Faculty of Agriculture, University of Ruhuna,
- b) K. G. R. G. R. Wickramawardana, Faculty of Agricultural Sciences, University of Sabaragamuwa,
- c) K. M. W. G. Kandawinna, Department of Environment and Forestry, University of Sri Jayawardanapura, and
- d) C. N. Herath, Faculty of Agriculture, University of Peradeniya.

Research Collaboration

Dr Mohotti collaborated in research projects with the Industrial Technical Institute, Colombo; Medical and Science Faculties, Colombo; Agriculture and Science Faculties, Peradeniya; and the Agriculture Faculty, Ruhuna.

Dr Mohotti served as:

- a member and Visiting Lecturer in Nematology of the Board of Studies, Plant Protection, Post Graduate Institute of Agriculture, Peradeniya;
- a Visiting Lecturer in Organic Agriculture of the Board of Studies, Agricultural Engineering, Post Graduate Institute of Agriculture, Peradeniya;
- a Visiting Lecturer in Export Agriculture of the Faculty of Agricultural Sciences, Sabaragamuwa University, Belihuloya;
- the Country Coordinator of the Asian Research Network of Organic Agriculture (ARNOA);
- the general secretary of the Lanka Organic Agriculture Movement (LOAM);
- the joint-secretary, National Agricultural Society of Sri Lanka (NASSL);

- a resource person in Indigenous Knowledge in Agriculture, Sri Lanka Resource Centre for Indigenous Knowledge (SLARCIK), University of Sri Jayawardenapura, Colombo;
- a resource person and member of the expert committee on Organic Products Promotion Programme of the Ministry of Environment and Natural Resources;
- a resource person in Nematology and Environmentally-Friendly Tea Cultivation for the NIPM;
- a resource Person for the development of databases and documentation of Traditional Knowledge in Agriculture in Sri Lanka for CARP and IUCN;
- the team leader of the Task Force Committee on preparation of organic standards on Pest and Disease Control in the Asian context, coordinated by ARNOA; and
- a member of the Organic Agriculture Cluster of the University Grants Commission.

Seminars, Conferences and Workshops

Dr Mohotti made presentations on

- 'Importance of Organic Agriculture in Sri Lanka' at the national workshop organized by the Organic Product Promotion and Development Center in Colombo;
- 'Nematode Management in Tea' and 'Organic Tea Cultivation', for Iranian tea delegates, coordinated by NIPM;
- 'Nursery management in tea' to the planters coordinated by NIPM

Dr Mohotti participated in the Outward Bound Training Programme conducted by Outward Bound Trust of Sri Lanka, during 18-20 July, in Dambulla.

Dr Mohotti attended:

- the International Workshop on Technology of Application of Pesticides, held at the PGRC, Peradeniya during 23-26 June;
- the workshop on Indigenous Knowledge and People held in Sigiriya during 8-10 August;

- the General Convocation of the Sabaragamuwa University of Sri Lanka; and
- RSC IV held in Kandy on 25 May;
- the E & E (Sinhala) on 5 May;
- the 23rd Annual Sessions of the Institute of Biology Sri Lanka held in Colombo on 25 - 27 September.

Dr Mohotti participated in:

- the '*Te Dallaka Asiriya*' of two Rupahavini programmes on 'Environmental Tea Cultivation' and 'Organic Tea Cultivation'; and
- the '*Kamatha*' programme of Sirasa on 'Organic Tea Cultivation'.

Video Film

Dr Mohotti jointly composed the video on 'Organic Tea Cultivation being in Harmony with Nature' with J C K Rajasinghe and A J Mohotti.

PLANT BREEDING DIVISION

Head - M.T.K.Gunasekare

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 17 January, 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 progress of research during the last year, and a detailed activity plan of revised plant breeding programmes on hybridization, and evaluation and screening of new accessions, were presented to the Consultative Committee on Research (CCR) in July.
- Achievements made in plant breeding research activities during last five years were presented at a special meeting with CEOs of Plantation Companies.
- The “Tea Reserve” concept was introduced to the plantation sector aiming at preserving valuable genetic material *in situ* (that is, on-estate).
- A study was commenced in collaboration with Agronomy Division to evaluate the suitability of new cultivars for mechanical harvesting.
- 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.
- A segregating population to identify molecular markers linked to the blister-blight trait was established in a field trial on St Coombs.
- 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 Upcot area.
- A preliminary selection of potential seed cultivars for 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.
- An inventory of germplasm accessions at three regional stations and at St Coombs were taken, and all available information on evaluated accessions were documented in a preliminary form.
- 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)

Towards meeting the objectives of the TRI Corporate Plan 1999 – 2003, the following activities were undertaken by the Division in the year 2003.

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 (Table 1).

VP 75 and 76 trials were terminated after selecting promising accessions for establishment in the Phase II trials, based on their average cycle yield recorded during the first pruning cycle (Table 2).

Table 1. Plant Breeding accessions under evaluation in the up-country, Phase I.

Trial No.	Year of planting	Origin	Location	No. of accession tested	Standard cultivars	Remarks
VP 75	1995	N	Field No. 14, St Coomb	27		First cycle yield recording was complete and bushes were pruned in May. Promising accessions were identified for evaluation in Phase II.
VP 76	1995	O		48		-do-
VP 77	1996	P	Field No.12, St Coomb	101	2025, 400 DT1	First cycle yield recording was completed. Rested bushes were pruned in September after recording yield.
VP 82	1998	F		46	2025 4052	Recording of yield continued. Based on annual yield, 2 accessions yielded more than the control, TRI 2025. Of those accessions, 21 yielded more than the control, TRI 4052.
VP 84	2001	R	Field No.10, St Coomb	44	2025	First and second centering were done, and the weights and bush counts were recorded.
VP 88	2002	S	Field No.9, St Coomb	22	2025 3072 4052	Infilling of the vacancies was done in May. First centering was carried out in June and weights were recorded
VP 90	2003	U	Field No. 13, St Coomb	10	2025 PK 2	New evaluation trial
Total				298		

For origin of accessions: refer footnote under Table 3.

Table 2. Cycle yields of completed Phase I trials: cultivars VP 75 and 76.

VP 75 accessions selected for Phase II	Average cycle yield (2000 – 2002), kg MT/ha	% Yield increase compared to control	VP 76 accessions selected for Phase II	Average cycle yield (2000 – 2002), kg MT/ha	% Yield increase compared to control
07	4920	39	05	4408	25
55	3734	6	18	4388	24
265	3708	5	17	4331	23
<i>TRI 2025</i>	<i>TRI 3538</i>		21	4130	17
			07	4127	17
			23	3830	9
			08	3749	6
			<i>TRI 2025</i>	<i>TRI 3525</i>	
CV %	28.0			19.08	

Apart from the above accessions, another 10 accessions were also propagated in the nursery. The selection of these 10 accessions (given below) were mainly based on average annual yield and growth performance.

VP 75 - 45, 49, 248

VP 76 - 14, 16, 22, 25, 26, 30, 39

Evaluation of Accessions: Phase II

One hundred and seventy accessions are currently under evaluation in Phase II trials in the up-country region (Table 3).

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

Table 3. Accessions under evaluation in the up-country, Phase II.

Trial No.	Year of planting	Origin [#]	Location	No. of accessions tested	Standard cultivars	Remarks
VP 80	1996	D	St. Coombs Field No.12	32	DN, 2025	Shoots of promising selections were propagated in the Plant Breeding Division, Hantane. Pruning was carried out in August after completion of 1 st cycle yield. The trial is ready for propagating promising accessions for Phase III trials.
VP 81	1998	E		21	2024, 2025, 3016, 3072, 3073, 4052	Recording of yield continued. Based on annual yield, four accessions were found to yield more than the control, TRI 3072.
VP 83	2001	A	St. Coombs Field No.10	20	2025, 4006, 4052, 4053	First centering was done in May. Second centering was carried out and the weights and bush counts were recorded.
VP 85	2000	G	St. Coombs Field No.6	18	2025, 3072, 4052	Yield recording is being continued. Based on annual average yield, 5 accessions are yielding more than control, TRI 3072 and 4 accessions over TRI 2025
VP 86	2000	D	St. Coombs Field No.12	14	This trial was handed over to the estate as no promising accessions were identified.	
VP 87	2001	T	Pedro Estate Field No. 12 B	27	2025, PK 2	First centering was carried out, and weights and the vacancy count were recorded. Infilling was done. Plucking was commenced end of November, and yield recording will be commenced in January, 2004.
VP 89 (New)	2003	A,B,C	St. Coombs Field No. 13	38	2025, DT 1	Promising selections were made from VP 71, 72 and 73 (see Annual Report 2001)
Total				170		

[#] For origin of accessions: refer footnote under Table 3.

Footnote: Origin of the accessions under evaluation.

- A VP 39 selections (crosses made in 1980/1981 using clones TRI 777, TRI 2025, TRI, 2026, ASM 4/10, DT1 and DN)
- B VP 43 selections (crosses made in 1982/1983 using clones TRI 777, TRI 2025, TRI 2024, TRI 2023, TRI 2043, TRI 2142, TRI 62/9, ASM 4/10, DT1, DN, CY9, DT 95, H 1/58, DG 39 and China types)
- C VP 44 selections (crosses made in 1984, using clones TRI 777, TRI 2025, TRI 2142, TRI 2143, ASM 4/10, DN, CY9, DT1 and DG 39)
- D VP 37 selections (obtained after open pollination of clones TRI 777, TRI 2025, DT1 and TRI 2043)
- E VP 38 selections (bi-clonal seed selection of Aislaby (2025 X 2024), Hugoland (2025 X 2024) and Hantane (2025 X 2023) stocks)
- F VP 65 selections (polyclonal seed selections of Urumiwela and Karandupona stocks at Carolina Estate, Watawala,1992)
- G LVP 30 selections (bi-clonal seed selections of Aislaby (2025 X 2024) and Hugoland (2025 X 2024) stocks)
- H LVP 42 selections (polyclonal seed selections of Urumiwela and Karandupona stocks at Parambe Estate, Kegalle,1989)
- I LVP 28 selections (bi-clonal seed selections of Aislaby (2025 X 2023) stock, at St Joachim Estate, Ratnapura, 1992)
- J Pettigala selections (bi-clonal seed selections of Vykumbura (2025 X DN) stock, at Pettigala Estate, Balangoda)
- K LVP 49 selections (polyclonal seed selections of Urumiwela and Karandupona stocks, at St Joachim Estate, Ratnapura, 1991)
- L LVP 45 and 46 selections (polyclonal seed selections of Urumiwela and Karandupona stocks, at St Joachim Estate, Ratnapura, 1989 and 1990)
- M Introduction from Assam, India, in 1988
- N VP 45 selections (seed stocks obtained from the crosses of 1985 using TRI 777, 2024, 2025, 2142, DT 95)
- O VP 52 selections (polyclonal seed selections of Urumiwela and Karandupona stocks, Field No. 9, St Coombs Estate, 1990)

- P VP 58 selections (polyclonal seed selections of Urumiwela and Karandupona stocks, Field No. 9, St Coombs Estate, 1991)
- Q LVP 69 selections (polyclonal seed selections of Urumiwela and Karandupona stocks, Field No. 2 A, St Joachim Estate, 1994)
- R VP 74 selections (biclinal seeds selections of El Teb (DN X 2025) and polyclonal seeds selections from Sapumalkanda S106)
- S Pedro Estate seedling selections, 2001, Field No. 8, Scrub Division
- T St Coombs seedling selections, 2000, Field No. 8
- U Seedling selections from Labukelle Estate, 2002, Field Nos. 7 and 12, Bambarakelle Division

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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 standard cultivar, TRI 2025, while TRI 3069, 3015, 3017, 4063, 3020 and 3073 recorded higher yields than the standard cultivar, N2 (Norwood 2).

B A Rathnagoda, R Pakaradevan and J D Kottawa Arachchi

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. (*Vide* relevant sections in Plant Pathology Annual Report for details.)

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, 4078.

Remarks on Project A 1.2.

A detailed action plan was prepared for evaluating and planning the early screening of new tea cultivars, aimed at achieving a more systematic evaluation procedure and reducing the time taken to release new cultivars to the end-users. Discussions were made with relevant subject specialists in order to improve the screening procedures for evaluating breeding accessions. They all agreed to adopt a scale of 0-9 in their screening procedures from 2003 onwards. Although the screening of accessions in Phase I was introduced for early evaluations, and the Plant Breeding Programme accordingly revised for improving efficiency and shortening the time taken for developing cultivars, it was concluded that there were deficiencies in the procedures being employed.

Screening for SHB. It became clear that the current method used for field categorization in order to apply control measures is not suitable for screening breeding accessions. The correlation established between per cent gallery (% G) and degree of infestation do not tally with the scores obtained for accessions evaluated this year, with regard to SHB. Hence, screening carried out this year was not considered for evaluating accessions.

The Entomologist agreed to work out a more appropriate method to suit the needs of screening accessions in Plant Breeding trials (Phase I and Phase II).

Screening for blister blight. According to the Pathologist, the first round of assessments for blister blight needs to be confirmed subsequently by another assessment, before any final conclusion is made on the resistance or susceptibility of the accessions evaluated.

1.3. Project A 1.5. Screening accessions for quality.

VP 77. The Biochemist agreed to analyze the accessions in Phase I from this year onward, provided that 400 g samples can be issued.

Thirty-six accessions, representing high- and moderate-yielding lines, were selected for testing quality against a standard cultivar, DT 1. One round of quality assessment was completed during March – May, for 35 accessions, which are likely to be selected for Phase II. However, it was realized that testing for quality of accessions from Phase I is not possible, owing to difficulties in providing adequate amounts of green leaf with acceptable leaf standards. Therefore, it was decided to discontinue quality assessments in the Phase I trials.

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 12 March to 30 June.

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

(*Vide* relevant sections of Biochemist's report for more details on this project.)

Some fields in Pedro Estate were visited in order to assist the Biochemistry Division in identifying seedlings and some VP cultivars for analysis. This analysis would facilitate the study on quality decline in the Nuwara Eliya region.

K Gunasekare, M A B Ranatunga, B A Rathnagoda, R Paskarathevan, J D Kottawa Arachchi and A K Mudalige.

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. These shoots were issued from the VP 80 Phase I trial.

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

B A Rathnagoda and K Gunasekare.

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.

A summary of the yield data, gathered over two cycles and the 1st year of the 3rd cycle, with regard to promising cultivars compared to the standard cultivar, TRI 2025, is given in Table 4.

Table 4. Mean yield of outstanding cultivars of the TRI 3000- and 4000-series in the first and second pruning cycles, and the first year of the third pruning cycle.

Cultivar	Yield- 1 st cycle Average (kg MT ha ⁻¹)	% yield increase or decrease over control (1 st Cycle)	Yield 2 nd cycle average (kg MT ha ⁻¹)	% yield increase or decrease over control (2 nd Cycle)	Yield 3 rd cycle 1 st year
4046	5922	34	6474	22.2	6882
3018	4918	11	5180	-2.23	5326
4006	4792	8	5326	0.53	5903
2025	4417	0	5298	0	5002

U Sritharan

No evaluation trials are being conducted, except 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, respectively, 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.

T M Sarathchandra and U Sritharan

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 Uva, six were found to be promising when compared to standard cultivars (Table 5).

Table 5. Accessions under evaluation in the Phases I and II trials in the mid-country semi-dry zone (Uva).

Trial No.	Year of planting	Origin #	Location	No. of accessions tested	No. of promising accessions	Yield range (kg MTha ⁻¹)	Yield of the standard cultivars (kg MT ha ⁻¹)	Remarks
Phase I Trials								
UVP 10	1998	F	Field No. 4 Passara station	37	3 (Acc. Nos 73, 122, 72)	4095 - 3779	2025 -3768	Yield recoding continued
Total				37				
Phase II Trials								
UVP 9	1998	D	Field No. 4 Passara station	20	3 (Acc. Nos. 208, 210, 211)	5540 - 5387	2025 -5236	Sampling for SHB screening was done by Entomology Division
Total				20				

Origin of accessions: Refer footnote under Table 3

J C K Rajasinghe, K Gunasekare and M Ratnayake

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 low country has been continued (Table 6 and 7).

Evaluation of Accessions, Phase I

Table 6. Accessions under evaluation for the low country

Trial No.	Year of planting	Origin #	Location	No. of accessions tested	Standard cultivars	Remarks
LVP 84	2000	Q	Field No.1 St. Joachim estate	190	TRI 2026, 2027	First cycle yield recording was commenced in May
Total				190		

Origin of accessions: Refer footnote under Table 3

4.1.1 Evaluation of Accessions: PHASE II

One hundred and eighty seven accessions are currently being evaluated in Phase II trials in the low country (Table 7).

TABLE 7 – Accessions under evaluation in phase II trials in the low country

Trial No.	Year of planting	Origin #	Location	No. of accessions tested	Standard cultivars	Remarks
LVP 74	1997	G	Deniyaya Station	35		Of the 13 promising accessions (LVP 74/01, 59, 68, 72, 85, 93, 122, 124, 157, 166, 168, 195, 178) propagated last year, 7 were established as large scale observation trial at Kottawa
LVP 75 [I]	1997	D	Field No 1 St. Joachim Estate	45		Shoots of 22 promising accessions were issued to Hantana, Plant Breeding Division for propagation. Cutting of the same selections were propagated at the Plant Breeding nursery, Ratnapura to establish phase III trials.
LVP 75 [II]	1997	H				
LVP 75 [III]	1997	I				
LVP 75 [IV]	1997	J				
LVP 76	1999	H		22	2023, 2025, 2027	Yield recording continued for the 2 nd year of the first cycle.
LVP 77	1999	L		13	2023, 2025, 2027	-do-
LVP 78	1999	J		21	2023, 2025, 2027	-do-
LVP 79	1999	M		6	2023, 2025, 2027	-do-
LVP 80	2000	A		13	2023, 2026, 4042	Yield recording commenced in May.
LVP 81	2000	B		14	2025, 2027, 4046	-do-
LVP 82	2000	C		11	2026, 2027, 3055, 4006, 4061	-do-

LVP 83	2000	L		18	2023, 4042	-do-
LVP 85	2001	A		20	2026, 2027, 4042	Centering was done in June. Due for commencement of recording yield in early 2004
LVP 86	2002/03	K	Field No.8 St. Joachim	49	2026, 4042	New trial
Total				267		

[#] *Origin of accessions: Refer footnote under Table 3*

K Gunasekare, P D Upali, A K M Jayasena, J H N Piyasundara, A K Mudalige, J A S K V Jayasinghe

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.

K D Dahanayake, M Ratnayake, P D Upali, A P Kumara, A K Mudalige, J D Kottawa Arachchi and K Gunasekare.

1.7. 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 (relevant sections in Plant Pathology Annual Report for details.)

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.

1.8. 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 biclinal and polyclonal seed cultivars.

Projects A 5.1 - 8.1. 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 up country.

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

R Paskarathevan

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.

U Sritharan and N Karunatilake.

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.

K Gunasekare, M Ratnayake, R Paskarathevan, J K C Rajasinghe and
A H Chamara Nissansala

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.

M Ratnayake, M A B Ranatunga, P D Upali, J C K Rajasinghe and A S Jayasekare.

Evaluation of the performance of seed stocks planted by estates

Aislaby Estate

A detailed inspection of the demarcated seedling blocks on Field Nos. 2 and 12 on 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.

R Paskarathevan, M Ratnayake and Superintendent, Aislaby Estate.

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 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.

The following measurements were also taken to evaluate the yield components of individual genotypes in each seed progeny in order to assess their uniformity.

Shoot density. Number of harvestable shoots per unit area of bush. Measurements were taken on the day prior to plucking, using a 30 cm x 30 cm quad rode. The number of pluckable shoots in the quad rode samples were counted. Measurements were repeated three times over a period of one month.

Percentage of active shoots. After harvesting the shoots, the total number of active shoots were counted in the harvest and expressed as a percentage of the total number of harvested shoots. Measurements were repeated three times over a three-month period.

Dry weight of harvested shoots. Oven-dry weights of the harvested shoots from each bush of each progeny were recorded. Measurements were repeated three times to obtain the average dry weights of the harvested shoots per bush in all progenies.

Analysis of the data to predict uniformity of seed progenies is being done.

J H N Piyasundara, P D Upali, A K Mudalige and K Gunasekare.

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.

U Sritharan, H Jayaweera, K Sarathchandra and N Karunatilake.

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. The percentage of aseptic cultures in the initial culture period was 8-10%. However, an increase of contamination was noticed in the 3rd and 4th sub-cultures, leading to unacceptable rates of multiplication possibly owing to inefficient HEPA filters in the laminar flow.

T M Sarathchandra

Production of artificial seeds

A protocol was perfected for encapsulation of isolated zygotic embryo axes, with alginic acid as a matrix in combination with CaCl₂. 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*.

T Seran * and K Gunasekare.

(*Post-graduate candidate from the Eastern University)

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.). Of those accessions some have been replicated in several gene banks.

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.

A P Kumara, M Ratnayake and K Gunasekare.

(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. Ten plants of each accession in two replicates were evaluated against the standard cultivar, TRI 2025.

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. This is to increase the genetic diversity of the base population. Germinated seedlings were transferred to polythene sleeves.

M Ratnayake and J D Kottawa Arachchi.

(c) New genetic materials were introduced to the existing germplasm. These were received from a former member of the International Camellia Society. The following seedling sources were planted in Field 10, St Coombs in November: *Camellia sinensis* var. *macrophylla* collected from Vietnam (one plant), *Camellia sinensis* collected from Malaysia (nine plants), and *Camellia sinensis* from Korea (three plants).

M A B Ranatunga and R Paskarathevan

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

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

J H N Piyasundara, P D Upali and A K Mudalige

2.2. Controlled-Hybridization Programmes Up-Country

Over 200 of the following crosses were carried out, commencing in December this year.

TRI 3013 x PK 2
 TRI 3019 x TRI 777
 TRI 3017 x PK 2
 TRI 3016 x PK 2
 TRI 3013 x KEN 16/3
 TRI 3025 x NAY 3

All Divisional Staff, Talawakelle

Low Country

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 crosses were carried out using selected parental combinations, depending on their desirable characteristics, aimed at generating improved VP cultivars for future plant breeding programmes.

Details of the crosses carried out are given in Table 8.

Table 8. Controlled hybridization programme, Ratnapura: progenitors and number of crosses per combination.

Progenitors	No. of Crosses	Progenitors	No. of Crosses
TRI 3051 X H1/58	1094	TRI 3047 X TRI 62/6	21
TRI 3052 X TRI 62/9	1398	TRI 3052 X TRI 3055	335
TRI 4047 X H1/58	365	TRI 3052 X TRI 62/1	57
TRI 3047 X TRI 4053	1247	TRI 4053 X TRI 3055	77
TRI 3051 X TRI 62/9	33	TRI 3051 X TRI 3055	44
TRI 4006 X TRI 62/6	02	TRI 3052 X TRI 4053	10
TRI 4014 X TRI 62/6	227	TRI 3051 X TRI 4053	05
TRI 2027 X H1/58	56	TRI 3058 X H1/58	10
TRI 2022 X H1/58	354	TRI 2016 X TRI 4053	110
TRI 3025 X TRI 4053	34	TRI 3052 X TRI 62/6	100
TRI 4014 X TRI 62/9	16	TRI 3058 X TRI 4053	425
TRI 4041 X TRI 62/6	15	TRI 3055 X KEN 16/3	147
TRI 2025 X TRI 4014	10	TRI 3055 X S-106	03
TRI 3025 X TRI 62/9	10	TRI 3055 X DG 39	22
TRI 62/9 X TRI 4053	20	TRI 2016 X KP 204	57
TRI 4053 X TRI 3047	65	TRI 2016 X KEN 16/3	43
TRI 3047 X H1/58	40	TRI 62/9 X CY 9	06
TRI 3047 X TRI 62/1	25	TRI 3052 X TRI 3055	120
TRI 3052 X TRI 62/6	08		
Total No. of crosses		6586	

The following poly-crosses were also carried out:

Progenitors	No. of Crosses
TRI 3052 X TRI 62/9 + TRI 4053	20
TRI 3047 X TRI 62/9 + TRI 4053	55
TRI 3052 X TRI 62/9 + H 1/58	10
TRI 3047 X TRI 4053 + H 1/58	10
TRI 2022 X TRI 62/9 + H 1/58	10
TRI 3047 X TRI 4053 + TRI 62/6	20
TRI 2022 X TRI 62/6 + H 1/58	35
Total	160

P D Upali, A K Mudalige, J H N Piyasundara and K Gunasekare

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.

Twenty-three cultivars available in *ex-situ* gene banks were used in the study. Counts were taken from randomly-selected bushes of the cultivars to score the availability of different stages: flower buds, flowers and pods. The results were subjected to average linkage cluster analysis.

The cultivars studied were clustered into three broad categories, based on similarities in the presence of specific stages. From the dendrogram, it was observed that there is high variability among the cultivars studied in terms of their flowering and fruit-set patterns.

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

Experiments were carried out to determine the optimum anther dehiscion stage of flowers, and different flower bud stages, of ten cultivars. A variable response, in terms of the *in vitro* germination of pollen collected from various stages, from mature unopened flower buds to open flowers, was found.

Significant variations were observed in pollen viability among different cultivars, as well as among their developmental stages. The 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. Further, the stage of flowers currently being used for controlled pollination (namely, flowers just after opening) is not the optimum when different cultivars are used. 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.

None of the pollen collected from four different stages of *C. sasanqua* germinated *in vitro* in the present study, although the concentration of sucrose in the germination medium was changed to 15 and 20% (w/v).

K Gunasekare, M A B Ranatunga and P S Dhaweddana*.

(*An undergraduate student from the Sabaragamuwa University)

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.

<u>Trial No.</u>	<u>Correlation Coefficient</u>
VP 80	0.785 ($p \leq 0.0001$)
LVP 75	0.540 ($p \leq 0.0001$)

The tipping weights from the above two trials are being used to determine the correlation between all the aforementioned parameters.

M A B Ranatunga, K Gunasekare, N Piyasundara and R Paskaradevan.

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 therefore 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, internodal 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 located 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.

K Gunasekare, M Ratnayake, R P Jayantha Kumara* and D M U M Dissanayake*.

(* Students from the Hardy Advanced Technical Institute)

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.

A sample from the above population at the nursery stage was used to evaluate the quantitative, genetic parameters of both progenies. The data are being analyzed.

In collaboration with the Pathology Division, seedlings derived from the segregating population for the blister-blight trait were screened at the nursery stage.

K Gunasekare, M A B Ranatunga and J D Kottawa Archchige.

2.6. Polyploid Breeding

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

M A B Ranatunga and K Gunasekare.

2.7. Mutation Breeding

Open-pollinated seeds were irradiated at dosage rates of 0.5 kr, 1kr, 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.

T M S Sarathchandra and R Pieris*
(*Horticultural Research and Development Institute).

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. 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. Selection was based on the manageable number of estates in the Uva region to which planting materials of the particular cultivars were issued by the Institute during 1979–2000. A questionnaire was prepared and circulated among 58 estates in the region belonging to the Agarapathana, Balangoda, Hapugastenne, Madulsima, Maskeliya, Malwatta Valley and Namunukulla Plantations. Of the 58 estates, only 14 responded by sending back duly-filled questionnaires. The survey data were analyzed and documented.

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' still preferred 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 Institute's Passara Centre.

K Gunasekare, J C K Rajasinghe, R M A C Rajakaruna and J D Kottawa Arachchi.

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 selection in two replicates, with TRI 2025 and PK 2 as control cultivars).

(2) Liddesdale Estate

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

M A B Ranatunga, M Ratnayake, J D Kottawa Arachchi, and Managers, Labukelle and Liddesdale Estates.

(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.

All divisional staff, and Manager, Fairlawn Estate.

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 belonging to Horana Plantations Ltd., were identified, and measures taken to preserve valuable germplasm on these estates (Bambarakelle, Eildon Hall, Tillicultry, Gouravilla, Stockholm, Mahanilu, Fairlawn, 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.

K Gunasekare, M Ratnayake and B A Ratnagoda
(CEO, Horana Plantations Ltd and estate managers)

5. Seed Gardens

Seed gardens in the low country

Most of the seed gardens established previously in 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 respective estates. Follow-up visits were made to monitor the seed-setting of parental cultivars and to collect seeds from different sources.

Activity	Flowering & Fruit set assessment	Removal of unproductive branches [+] & Weeding using Brush Cutter [*]	Fertilizer application	Remarks
Seed Garden				
Polyclonal				
Karandupona Estate #, Kegalle	+	+ *	+	Seeds were collected from each parent separately for seed stocks trial at Passara
Halpe Estate, Tummodera	+	+ *	+	
Salawa Estate, Hanwella	+	+ *	+	
Anhettigama Estate, Deraniyagala	+	+	+	
Sorana Estate, Horana	+	+ *	+	
Sapumalkanda Estate, Dehiowita	+	+	+	--
Kiriporuwa Estate, Yatiyantota	+	+ *	+	Seeds were collected from each parent separately for seed stocks trial at Passara
Rambukkanda Estate, Ratnapura	+	+ *	+	
Peenkanda Estate, Nivitigala	+	-	-	--
Bi-clonal				
Maliboda Estate, Deraniyagala	+	+ *	+	Seeds were collected from each parent separately for seed stocks trial at Passara
Reucastle Estate, Dehiowita	+	+ *	+	
Rambukkanda Estate, Ratnapura	+	+ *	+	--
Peenkanda Estate, Nivitigala	+	-	-	--
Raigama Estate Ingiriya	+	+	+	--

- Infilling with four cultivars, DG 39, DN, TRI 2023 and TRI 2025.

P D Upali, A K Mudalige, J H N Piyasundara and estate managers.

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.

P D Upali, J D Kottawa Arachchi, K D Dahanayake and K Gunasekare.

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.

B A Ratnagoda and K Gunasekare.

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 during the year from the Plant Breeding Division's mother-bush blocks at St Coombs Estate. Issuing of shoots for the Tea Development Project, funded by the ADB (Asian Development Bank), was almost completed according to schedule. The balance was issued to some estates and smallholders as indicated below.

(a) Issue of shoots for estates and small holders

Date of issue	Issued to	TRI 3000 Series	No. of shoots	TRI 4000 Series	No. of shoots
24.2.03	Diyagama West Diyagama			4052	200
				4071	200
				4079	60
24.2.03	Glasgow Estate Agarapatana	3018	270	4052	200
				4071	200
24.2.03	Dambetenne Estate Haputale			4042	150
				4046	140
				4052	400
2.4.03	Kew Estate Bogahawatta	3016	75	4052	100
		3018	100	4071	200
				4079	25
8.4.03	Craigie Lea Estate Patana	3013	20	4052	20
		3014	20	4053	20
		3015	20	4067	20
		3016	20		
		3017	20		
		3018	20		
		3019	20		
3020	20				

29.5.03	Kelaniya Est (Pvt) Maskeliya			4052 4053	500 500
19.6.03	N.K.S.G. Naragala Ruwanwella	3014 3020 3052 3053	75 125 50 100	4006 4052	100 200
14.7.03	M. Nazeem Manikwatta Nawalapitiya			4006	200
Total			945		2925

Low Country

Issue of shoots for estates and smallholders

About 1,800 shoots (approximately 9,000 cuttings) of TRI 3000- and 4000-series clones were supplied to the smallholders 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.

(a) Issue of shoots to estates and smallholders

DATE	NAME & ADDRESS	TRI 3000 series	No of Shoots	TRI 4000 series	No of Shoots
5-11-2003	The Manager, Millakande Estate, Bulathsinghala	3041 3051 3052 3058 3069	50 50 50 50 50	4059	50
7-10-2003	The Manager, Millakande Estate, Bulathsinghala	3014 3055	50 50	4004 4006 4042 4049 4053 4061	50 50 50 50 50 50
8-10-2003	P. Pussalla, 2/4, Panaluwa, Padukka	3025	150	4042 4046 4052 4053 4054 4059 4061	200 100 50 50 50 50 100

22.5.03	Talawakelle Estate	3015	60	4071	60
	Talawakelle	3016	60	4079	60
		3018	60		
29.5.03	Meddakumbura Estate			4052	2000
	Watagoda			4053	2000
14.7.03	Dunsinane Estate			4052	4000
	Pundaluoya			4053	1000
30.12.03	Waverley Estate	3020	250	4052	1000
	Agarapatana	3072	250	4071	500
				4078	500
Total			1285	13055	

(b) Issue of shoots for the ADB Mother Bush Project

Date of issue	Issued to	TRI 3000 Series	No. of shoots	TRI 4000 Series	No. of shoots
29.5.03	TSHDA, Walahanduwa	--	--	4052 4053	1500 1500
Total					3000

(c) Issue of shoots to smallholders

Date of issue	Issued to	TRI 3000 Series	No. of shoots	TRI 4000 Series	No. of shoots
7.4.03	M. Nazeem Manikwatta Nawalapitiya			4042	300
				4046	600
9.4.03	N.K.S.G. Naragalla Ruwanwella	3014	50	4006	100
		3019	50	4042	30
		3020	100	4043	75
		3025	20	4046	75
		3052	125	4052	20
		3055	100	4053	75
			4055	100	
5.5.03	A.K. Ratnayake Nawalapitiya	3017	50	4006	50
		3018	100		

29.5.03	Kelaniya Est (Pvt) Maskeliya			4052 4053	500 500
19.6.03	N.K.S.G. Naragala Ruwanwella	3014 3020 3052 3053	75 125 50 100	4006 4052	100 200
14.7.03	M. Nazeem Manikwatta Nawalapitiya			4006	200
Total			945		2925

Low Country

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About 1,800 shoots (approximately 9,000 cuttings) of TRI 3000- and 4000-series clones were supplied to the smallholders 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.

(a) Issue of shoots to estates and smallholders

DATE	NAME & ADDRESS	TRI 3000 series	No of Shoots	TRI 4000 series	No of Shoots
5-11-2003	The Manager, Millakande Estate, Bulathsinghala	3041 3051 3052 3058 3069	50 50 50 50 50	4059	50
7-10-2003	The Manager, Millakande Estate, Bulathsinghala	3014 3055	50 50	4004 4006 4042 4049 4053 4061	50 50 50 50 50 50
8-10-2003	P. Pussalla, 2/4, Panaluwa, Padukka	3025	150	4042 4046 4052 4053 4054 4059 4061	200 100 50 50 50 50 100

8-10-2003	U.K. Ajith Priyantha, Udukandana, Karangoda, Rathnapura			4006	50
				4042	50
				4046	50
				4049	50
				4052	50
				4059	50
				4061	50
Total Number of shoots		500		1300	

(b) Issue of shoots for the ADB Mother Bush Project

DATE	NAME & ADDRESS	TRI 3000 series	No of Shoots	TRI 4000 series	No of Shoots
7.11.03	Indika Rajapaksha			4006 4042 4052	100 800 50
27.11.03	Indika Rajapaksha	3025	600	4042 4046	200 200
16.12.03	TRI, Kottawa	3014 3025 3055	70 60 60	4006 4042 4049 4052 4061 4063	100 560 50 60 100 50
Total Number of shoots			790		2270

P D Upali, A K Mudalige and J H N Piyasundara

7. Other Divisional Activities

7.1. Review of Research Programmes

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

7.2. Meetings, Training Programmes, Workshops, Fellowship and Appointment

B A Ratnagoda and N Piyasundara attended a workshop on Effective Proposal Writing and Conducting and Publishing Academic Research in the Biological Sciences at the SLAAS auditorium on 31 January.

M A B Ranatunga was awarded a fellowship, to follow a 10-weeks training programme on Sustainable Agricultural Development at Wageningen, the Netherlands, starting from 28 April.

J D Kottawa Arachchi followed a three-days course on Computer Applications and Statistics at the PGIS, Peradeniya from the 9 to 11 May.

R Paskarathevan attended a workshop on Effective Proposal Writing and Conducting and Publishing Academic Research organized by the NSF on 6 June.

M A B Ranatunga participated in a short course on Sampling Techniques, Survey Design and Analysis at the PGIA from 22 to 26 September.

M T K Gunasekare attended the following meetings.

A meeting with the CEOs and the Consultant of TASL to discuss issues related to usage of pesticides on tea in Sri Lanka, held at the Institute in Talawakelle, on 23 April.

A meeting on a Common Research Programme for the Plantation Sector at the CRI, Lunuwilla on 6 June.

A meeting at the CRI, Lunuwilla to explore the possibility of sharing resources for molecular biological studies among Institutes of the Ministry of Plantation Industries, on 25 August.

A meeting on a Common Research Programme for the Plantation Sector at the RRI, Agalawatta, on 29 August.

A meeting on Private Sector Participation in Planting Material Production, at the Hector Kobbekaduwa Agricultural Training Center, organized by the Ministry of Plantation Industries, on 10 November.

A meeting on a Common Research Programme for the Plantation Sector at the TRI, Talawakelle, on 14 October.

A workshop on the ADB Mother Bush Project at the TRI, Hantane, on 21 November.

M T K Gunasekare was appointed to the National Committee on Plant Breeders and Biotechnologists, by the CARP, with effect from 1 January. She attended five Committee meetings, and a special group meeting on Prioritization of National Plant Breeding Programmes for funding.

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. Tea Sci. 68, 12-19.

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

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. Tea Sci.68 (in press).

7.4. Presentations

M T K Gunasekare made the following presentations.

“Plant Breeding: major thrust areas and achievements made in the last five years” at meeting with the CEOs of RPCs Forum, 19 May.

“The Importance of proper establishment of mother bushes” at workshop on ADB Mother Bush Project, held at TRI Hantana, on 24 June.

M Ratnayake made a presentation at the E & E (Small Holder) Forum on “New cultivars for the future: their availability and identification”.

M A B Ranatunga made presentations at the Institute, Talawakelle and NSF, Colombo on the training programme he followed at the IAC, Wageningen.

7.5. Training Programmes

Ms T H Seran, Lecturer, Faculty of Agriculture, Eastern University, continued her Ph.D. programme in the Division under the supervision of Dr (Ms) M T K Gunasekare

Mr P P Jayantha Kumara, National Diploma in Agriculture trainee from the Technical College, underwent his three-months In-Plant Training Programme from March.

Ms P S Dhaweddana, undergraduate, Sabaragamuwa University, underwent a six-months Industrial Training Programme from April.

Ms K G W Maduwanthi, Diploma student, School of Agriculture, Kundasale, underwent a six-months Special Training Course from April.

Ms Iresha Nilanthi, Agriculture School, Kundasale, commenced a training programme in April.

Mr D M U M Dissanayake, National Diploma in Agriculture trainee from the Technical College, underwent his three-months In-Plant Training Programme from July.

Ms K M L Kulasekara, undergraduate, Faculty of Agriculture, University of Peradeniya, commenced her final-year research project in October.

Messrs Dinusha Tilanka, Ruwan Chinthaka, K R S Wijesiri and R Jayasinghe underwent one month's training at the Plant Breeding Division, Ratnapura.

7.6. Familiarization Programmes on Plant Breeding Activities.

These were conducted for the following:

Assistant Superintendent, SPC, Mid-Country; 23 April.

Assistant. Superintendent, Kegalle Plantations; 4 August.

Six Trainee Assistant Superintendent from St Coombs; 10 December.

Planter trainees from Udapussellawa Plantations; 12 August.

28 Assistant Tea Field Officers, job-oriented training; 20 August.

7.7. Discussions and Demonstrations on Plant Breeding Activities.

Discussions and demonstrations were conducted for the following:

A group of final-year students from the Faculty of Agriculture, University of Peradeniya; 8 January.

A group of students from the Department of Microbiology and Biochemistry, Faculty of Science, University of Peradeniya; 23 January.

A group of students from the University of Jaffna; 17 March.

A group of undergraduate students from the Faculty of Agriculture, University of Peradeniya; 23 July.

A group of M. Sc. Biotechnology students from the PGIA, Peradeniya; 23 July.

A group of undergraduate students from the Faculty of Agriculture, Eastern University; 24 July.

Planter trainees from Mayfield Estate (on a familiarization programme); 26 May.

A delegation from the Tea Research Institute, China; 7 March.

A group of 26 tea professionals from Germany; 24 March.

A group of tea specialists from Germany; 3 April.

Three Iranian tea experts; 18 and 30 June.

The following visited the Division:

The CEO, Horana Plantations Ltd., to see the seed garden and germplasm on St Coombs; 5 March.

Dr M Krishnamurthi, Plant Breeder from India, to discuss the Tea Breeding Programme; 28 – 31 March.

Prof. Ranjan Ramasawmy, Chairman, NSF, for a discussion on biotechnology-related research undertaken in the Division.

Prof. A K Dutta, Actg. Director, Tocklai Tea Research Association.

7.8. Services

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

Rutland Estate, Hewaheta,
Mawita Estate, Neluwa,
Panawatta Estate, Yatiyantota,
Smallholders at Batapola.

7.9. Correspondence

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

7.10. Retirement and New Appointment

Mr A K M Jayasena, Experimental Officer, retired from the service of the Institute with effect from 7 September.

Mr D A P Kumara joined the Division as a Research Assistant (on contract) with effect from 23 July.

7.11. Re-structuring of the Division

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

PLANT PATHOLOGY DIVISION

Head – A Balasuriya

Research Activities (see Corporate Plan)

Applied Projects

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 hypolateritia* 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%) (Table 1).

Table 1

	TRI 2023 parent	TRI 2043 parent
Total no. of plants assessed	165	169
Range of blisters/plant	0 – 57	0 - 61
Average blisters per plant	7.3	4.8
% extremely resistant	33.9	54.4
% extremely susceptible	7.3	4.8

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 the second leaves in four Phase I trials (VP71, VP72, VP73 & VP82) and two Phase II trials (VP80 & VP81) (Table 2).

Table 2

Trial	Phase	Extremely resistant	Highly resistant	Resistant	Moderately resistant	Moderately susceptible.	Susceptible.	Highly Susceptible.	Extreme Susceptible.
VP71	I	-	4	22	26	8	11	9	1
VP72	I	2	16	18	15	13	16	10	5
VP73	I	-	11	14	27	21	20	14	6
VP80	II	-	11	8	6	6	1	1	2
VP81	II	-	7	4	6	3	4	3	4
VP82	I	-	3	8	13	11	5	6	4

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

- 0 to 20% - for blister-prone areas
- 21 to 40% - for blister-prone areas with some control measures
- 41 to 65% - for blister-prone areas with adequate control measures
- > 65% - for not planting in blister-prone 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 resistance 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 our supervision.

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 results were communicated to the Plant Breeding Division (Table 3).

A slightly expanded scale to denote the rates of disease was used, in order to bring uniformity to all the related disease assessments.

- 0 - No cankers
- 1 - Up to 3 healing canker scars
- 2 - More than 3 healing cankers
- 3 - Up to 3 healing and up to 3 small (< 2 cm) cankers, with some callusing
- 4 - Up to 3 healing and more than 3 small cankers, with some callusing
- 5 - Up to 3 small and large (>2 cm) cankers, with some callusing
- 6 - Up to 3 small and large cankers, without any sign of callusing
- 7 - More than 3 small and large cankers
- 8 - Canker/s spreading up to the base or collar
- 9 - Death due to canker

Plants were assessed individually by using the above scale of rating, and an initial value was given to each plant. A series of weightings were also used, when appropriate, for each variable aspect, in order to ensure that each line gets the fairest possible score. These variables are the number of plants per replicate, the status of the soil, and the level of shade in which the replicate is located in the field.

The final categorization was done on the following basis:

- < 1.00 - Extremely resistant
- 1-1.99 - Highly resistant
- 2-2.99 - Resistant
- 3-3.99 - Moderately resistant
- 4- 4.99 - Moderately susceptible
- 5-5.99 - Susceptible
- 6-6.99 - Highly susceptible
- 7-7.99 - Very highly susceptible
- >8 - Extremely susceptible

Table 3

Trial	Phase	Extremely resistant	Highly resistant	Resistant	Moderately resistant	Moderately susceptible.	Susceptible	Highly Susceptible.	Extremely susceptible.
LVP30	II	-	2	-	4	4	19	10	1
LVP75	II	-	2	3	8	7	9	9	11

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.

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 (Table 4).

Table 4

	<i>E. coracana</i>	<i>P. miliaceum</i>
Time taken to flowering (months)	2	3
Root infections by VAM (%)	40	77
Spore counts/100g of soil	1196	508

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.

Supportive Projects

6 Project D 21 (D/LEAFDC). 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).

Table 5 Percent infection using second leaf count

Treatment	Assessment No										
	Pre	1	2	3	4	5	6	7	8	9	10
1	55.54	68.05	54.45	31.06	13.75	12.49	26.05	0.5	7.16	12.4	29.8
2	49.81	56.23	54.75	22.75	16.75	20.0	18.82	1.25	6.25	11.25	25.02
3	52.87	47.67	33.25	14.75	6.5	9.75	12.29	0.75	1.51	4.37	10.94
4	64.42	56.19	63.62	29.70	28.72	18.5	22.79	4.75	12.58	21.47	38.5
Average	55.66	57.04	51.52	24.57	16.43	15.19	19.99	1.81	6.88	12.37	26.07

Table 6 Number of blisters per second leaf

Treatment	Assessment No										
	Pre	1	2	3	4	5	6	7	8	9	10
1	1.46	1.95	1.04	0.53	0.22	0.20	0.32	0.00	0.09	0.18	0.42
2	1.26	1.47	1.19	0.49	0.24	0.27	0.26	0.01	0.08	0.18	0.37
3	1.22	1.09	0.34	0.22	0.11	0.10	0.17	0.00	0.01	0.04	0.13
4	2.15	1.56	1.47	0.72	0.50	0.29	0.32	0.05	0.15	0.32	0.73
Average	1.52	1.52	1.01	0.49	0.27	0.22	0.27	0.02	0.08	0.18	0.41

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 (D/STEMDC). 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 *Hypoxyton*, 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 *Hypoxyton* stem blight infections as yet.

8 Project D 23 (D/ROOTDC). 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.

The programme of study, undertaken by a postgraduate student, was completed. During the eight months under investigation in the Nuwara Eliya Estate, the affected area expanded by 129.75 m². 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/MS/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 digitaliae*, 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

During Mr Jayasundara's training programme with the Kelaniya University, he was able to complete 80 samples for total plate counts. 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.

9.4.1 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 *Paecilomyces variotii*), and four up to genus level.

Divisional Activities

10 Project D/PLPA

Estate Visits

The following estate visits were undertaken during the year.

Several visits were made to Nuwara Eliya in connection with the die-back syndrome affecting TRI 2025, and *Hypoxylon* stem blight; Hanford in Deniyaya in connection with treatments on the Deniyaya problem; Hulandawa in Akuressa in connection with the screening of bushes resistant to canker or wood rot; Diyagama East in connection with the screening of bushes resistant to blister blight and general debilitation of old teas; Lankaberiya in Ittakanda in connection with the *Poria* control trial activities; several visits to Thangakelle in Lindula in connection with the TRI 2025 die-back syndrome; Helbodde in Katukitula in connection with general bush debilitation; Koslanda on a reconnaissance survey of N-fixing bacteria in organic tea fields; Mousakelle in connection with the low productivity of TRI 2024.

Other Visits

Visits were made to the Microbiology Department of Kelaniya University to work out a project proposal on biological control of root diseases using bacterial microbes; to the University of Peradeniya to assess a presentation by an undergraduate trainee; to the University of Ruhuna to discuss the work/study programme of the contractual RA; to the Chemistry Division of the RRI in Ratmalana in connection with a collaborative project for developing a protective paint.

Seminars, Workshops and Lectures

Dr Balasuriya attended and participated in RSC seminars in Kandy and Badulla as a panel member; delivered a special lecture on blister blight control at Alagolla Estate, by invitation; addressed three Iranian lady-visitors sponsored by the NIPM; participated in a 10-minute radio programme on *Ruhunu Sevaya*, and two 5-minute TV programmes on *Ruhunu Sevaya*.; attended the 59th Annual Session of the SLAAS in the capacity of Vice President, Section B, spanning over one week.

Discussions and Meetings

Dr Balasuriya continued to convene HOD meetings with the Director. He was involved in the revision of the Institute's Corporate Plan as coordinator. (The first revision was published in September 2003.)

He attended six committee meetings of the SLAAS, Section B, in the capacity of its Vice President, and three ACMSC (Agricultural Chemicals and Machinery Screening Committee) meetings

Staff Training

Dr Balasuriya attended a two-day Outward-Bound Training Programme in Dambulla.

Mr J W K K Jayasundara (EO) completed an on-the-job training programme, at the Microbiology Department of the Kelaniya University, with the aim of establishing benchmarks on microbial contaminations of made teas produced in Sri Lanka.

Visitors/Trainees

A group of managers from Namunukula Plantations Ltd. spent one morning on a familiarization visit.

Dr Monica Beutgen of the German Tea Association visited in the company of Mr Nishantha Wickramasinghe, following the Tea Convention in Colombo.

New Capital Items

A Biological Safety Cabinet was purchased.

Publications

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.

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.)

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).

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

4. General (Administration)

The staff position as at 31st December, 2003 was:

Dr A Balasuriya	Head
Ms N H L Pradeepa	Research Assistant
Ms B A P Cooray	Research Assistant
Ms W G S M Kumari	Research Assistant (Contractual)
Mr J W K K Jayasundara	Experimental Officer (Graduate)
Mr R M A Ratnayake	Experimental Officer
Ms W G N Udayangani	Technical Assistant
Ms J A V J Jayasinghe	Technical Assistant (Contractual)

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

Mr C P Ranasinghe, postgraduate student (MSc) from the Kelaniya University (Department of Microbiology), Ms Sujeewa Ratnayake, undergraduate student from the Peradeniya University (Faculty of Agriculture) and Mr Chaminda Edirisinghe, undergraduate student from the 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, Messrs H M Dumindu and 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 in January and July, respectively.

PLANT PHYSIOLOGY AND PROPAGATION DIVISION

Head - V Shanmugarajah-

Research Projects in Plant Physiology

Basic Research Projects

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)

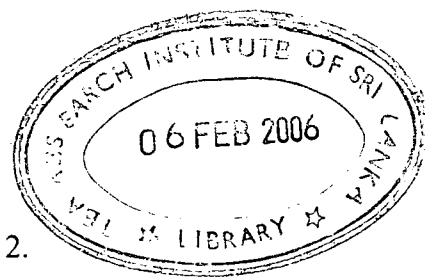
Variation of yield with age was investigated for two cultivars, TRI 2025 and DT 1, which have a different canopy architecture and leaf morphology. In addition, leaf area index (LAI) and rate of photosynthesis were measured, and the chlorophyll content of the leaves determined. Leaf fall was also monitored.

The annual yield of clones TRI 2025 and DT1 with their age is presented in Table 1.

Table 1. Effect of age of bushes on yield (kg MT ha⁻¹)

Year after prune	TRI 2025	DT 1
1	2760	2317
2	3004	2434
3	2932	2649
4	2167	1903
LSD (P = 0.05)	353.7	331.8
SE	256.8	241.5
CV (%)	9.6	10.5

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.



Measurements of the Leaf Area Index (LAI) are given in Table 2.

Table 2. Effect of age of bushes on Leaf Area Index

Year after Prune	TRI 2025	DT 1
1	4.1	4.1
2	5.9	6.6
3	7.0	7.6
4	6.4	6.7
LSD (P = 0.05)	0.98	0.81
SE	0.702	0.588
CV (%)	12.0	9.4

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.

The rate of photosynthesis of the bushes in the different years is given in Table 3.

Table 3. Effect of age on rate of photosynthesis ($\mu\text{mol m}^{-2} \text{s}^{-1}$)

Year after prune	TRI 2025	DT 1
1	11.86	15.34
2	12.64	15.66
3	13.30	15.42
4	12.08	15.66
LSD (P = 0.05)	1.25	NS
SE	0.908	1.567
CV (%)	7.3	10.1

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.

The chlorophyll content of the leaves of these cultivars in the different years is given in Table 4.

Table 4. Effect of age on the chlorophyll content of leaves (SPAD)

Year after prune	TRI 2025	DT 1
1	60.62	66.78
2	59.08	62.74
3	58.02	62.66
4	60.50	63.76
LSD (P = 0.05)	NS	NS
SE	2.363	3.614
CV (%)	4.0	5.6

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.

The leaves fallen from the bushes in the different years were collected. Their weight is given in Table 5.

Table 5. Effect of age on quantity (kg ha⁻¹) of fallen leaves

Year after prune	TRI 2025	DT 1
1	773	497
2	1336	1073
3	1591	1019
4	1085	707
LSD (P= 0.05)	280.7	314.6
SE	203.7	228.4
CV (%)	17.0	27.7

In TRI 2025, the amount of leaves fallen during the first year is significantly lower than that during the other years. The amount of leaves fallen during the fourth year is significantly less than that of the third year. 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.

D M S Navaratne, A Anandacoomaraswamy and V Sidhakaran

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 are presented in Table 6. There were no statistically significant differences in the yield between treatments.

Table 6. Yield of mature tea under different shade treatments

Treatment	Yield (kg ha ⁻¹ year ⁻¹)
Unshaded	3377
30% shade	3098
60% shade	2908
Shaded with <i>Grevillea robusta</i> L.	3396
CV%	18.6

A J Mohotti and V Sithakaran

2.2. Photoinhibition of photosynthesis in tea

Physiological parameters were monitored in order to assess the photoinhibition in shaded and unshaded treatments.

The results of some of the measurements, taken for a M. Phil. Project, were presented at the 15th Annual Congress of the Post Graduate Institute of Agriculture, University of Peradeniya, and were published in Tropical Agricultural Research (Vol. 15). A summary is given below.

The effect of Photosynthetically Active Radiation (PAR) on the rate of photosynthesis and chlorophyll fluorescence of field-grown mature tea bushes (*Camellia sinensis* L. O. Kuntze) was extensively studied at a high elevation in Sri Lanka.

The tea bushes were subjected to three shade treatments over a two-year period: in artificial shade (30% shade, provided by black-nylon netting), in the shade of trees (*Grevillea robusta* L.), and unshaded. The rate of photosynthesis and the chlorophyll fluorescence of healthy, mature leaves were related to the environmental conditions over the course of the day. The effect of radiation on productivity was assessed by shoot growth and dry matter yield.

Measurements were taken from dawn to dusk on bright, clear days and on cloudy days with two different patterns of cloud covers. On clear days, the rate of photosynthesis was greatest in the morning between 8:00 and 10:00 h local time. A mid-day drop in rate of photosynthesis was observed, which could be attributed to photoinhibition of photosynthesis (PI). The rate of photosynthesis was significantly lower ($p < 0.05$) in unshaded plants than in shaded plants. Moreover, unshaded leaves had a significantly lower ($p < 0.05$) fluorescence ratio (F_v/F_m), around 09:00 to 11:00 h local time compared to shaded plants, clearly indicating 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 with the drop in rate of photosynthesis and leaf temperature, stomatal conductance and leaf water potential. The yield, which is indicative of the ultimate effect of all the conditions throughout the year, however, was significantly higher in the shade tree treatments. Although under unshaded conditions PI was observed, only 4.6% of the total number of days distributed throughout the year had bright and clear days. The rest of the period comprised days receiving light intensities below the saturation intensity, and days with intermittent cloud cover.

These data confirm the importance for higher productivity of correct adherence to the recommended shade-tree management practices in tea.

The experiment is in progress.

Asha Karunaratne, A J Mohotti and S P Nissanka

2.3 Possible alternative shade tree species

A comprehensive database of about 200 possible species that can be used as alternative shade species was developed based on canopy, leaf and root characteristics. The species included many native to Sri Lanka as well as introduced species. They also had many other uses apart from being used as shade *per se*. A questionnaire was sent to Plantation Companies and tea small holders, in order to collect additional information regarding such species.

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.

A model nursery and an experimental area are also being developed near the laboratory premises of the Institute in Talawakelle.

The experiment is in progress.

H P Beddage and A J Mohotti

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 plants around the shade trees, *Erythrina lithosperma* and *Grevillea robusta* L., and in unshaded plots, were monitored.

The yields from January to December 2003 are presented in Tables 7 and 8. There was no statistically significant differences in yield between treatments.

Table 7. Yield of tea under shade trees (kg made tea ha⁻¹)

Treatment	Yield (kg ha ⁻¹ year ⁻¹)
Tea under <i>Grevillea robusta</i> L.	3603
Control (unshaded)	3444
CV%	7.8

Table 8. Yield of tea under shade trees (kg made tea ha⁻¹)

Treatment	Yield (kg made tea ha ⁻¹ year ⁻¹)
Tea under Dadaps (<i>Erythrina lithosperma</i>)	3377
Control (unshaded)	3349
CV%	4.9

The experiment was terminated.

V S Sithakaran and A J Mohotti

3. Tea root physiology

Under this project, 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 and 2 were presented as a poster presentation at the "The Third International Symposium on Dynamics of Physiological Processes of Woody Roots", held in Perth, Australia in September-October 2003.

The results are summarized below.

In field-grown plants (Experiment 2), the fresh- and dry weights of roots and total root length were measured separately at 15 cm depths of soil, up to a total of 45 cm. The soil at each depth was analysed for macro-nutrients, N, P, K, Mg and Ca. Starch reserves and respiration in roots were measured. In addition, yield, rate of photosynthesis, and leaf nutrient contents, were measured.

In young tea plants (Experiment 1), grown in rhizotrons for five months, root elongation rate, root depth, fresh- and dry weights, and shoot fresh- and dry weights, were measured.

More roots penetrated into the deeper layers of soil with organic management systems. In all organically-treated plants, a higher percentage (>42%) of roots were present in the 15-30 cm depth than in the 0-15 cm depth (about 32%) but, in conventionally-grown plants, more roots (>42%) were present in the 0-15 cm depth as shown by measurements of fresh weight, dry weight and total root length.

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.

Similar observations were made with young tea. Shoot growth did not show significant differences between treatments but root growth was affected. Root elongation rate, fresh- and dry weights, and total root length were significantly smaller in conventionally-grown tea than in tea grown with all organic treatments.

These differences will have an impact under adverse conditions such as droughts. Organically-grown tea will have more chances of survival than conventionally-grown tea. This information can be considered of vital importance in modifying current management practices to ensure a sustainable agro-ecosystem.

Mahesha Vajirakanthi, J Mohotti, K Mohotti and D C Bandara

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.

Some preliminary results of a comparison of the root system of field-grown seedlings and that of cultivars are shown in Tables 9 -12.

Table 9. The length of tea roots (cm) in 1000 cm³ soil. Seedlings and cultivars (>50 years old), St Coombs Estate, Talawakele (n=8).

Depth (cm)	15 cm away from the base of bush				45 cm away from the base of bush			
	Seedling		Cultivar		Seedling		Cultivar	
	Mature roots	Feeder roots	Mature roots	Feeder roots	Mature roots	Feeder roots	Mature roots	Feeder roots
0-15	103.6	307.8	53.3	214.4	84	271	112.8	519.9
15-30	27.9	103.4	30.1	95.7	46.7	96.1	44.4	195.3
30-45	14.8	24.7	15.9	85.9	50.3	53.2	22.4	82.6
45-60	41.6	21.1	3.8	17.8	18.1	57.4	22.1	44.4

Table 10. The fresh weight of tea roots (cm) in 1000 cm³ soil. Seedlings and cultivars (> 50 years old), St Coombs Estate, Talawakelle (n=8)

Depth (cm)	15 cm away from the base of bush				45 cm away from the base of bush			
	Seedling		Cultivar		Seedling		Cultivar	
	Mature roots	Feeder roots	Mature roots	Feeder roots	Mature roots	Feeder roots	Mature roots	Feeder roots
0-15	13.00	2.44	10.31	1.87	10.6	1.5	7.1	4.7
15-30	3.49	1.11	9.49	0.46	13	1.3	4.9	1.1
30-45	2.61	0.28	1.44	0.24	2.8	0.8	1.3	0.6
45-60	3.33	0.06	0.07	0.08	1.1	0.5	0.6	0.1

Table 11. The dry weight of tea roots (cm) in 1000 cm³ soil. Seedlings and cultivars (>50 years old), St Coombs Estate, Talawakele (n=8).

Depth (cm)	15 cm away from the base of bush				45 cm away from the base of bush			
	Seedling		Cultivar		Seedling		Cultivar	
	Mature roots	Feeder roots	Mature roots	Feeder roots	Mature roots	Feeder roots	Mature roots	Feeder roots
0-15	5.2	0.7	4.06	0.46	3.30	0.56	3.27	0.79
15-30	1.3	0.4	3.46	0.23	4.24	0.41	1.30	0.26
30-45	1.0	0.06	0.54	0.09	0.93	0.21	0.58	0.15
45-60	0.5	0.8	0.04	0.03	0.39	0.25	0.10	0.31

Table 12. The lateral root spread and depth of the active root zone, Seedlings and cultivars (>50 years old), St Coombs Estate, Talawakele (n=13)

	Seedling	Cultivar
Lateral root spread (cm)	104.3354	110.1969
Depth of active root zone (cm)	54.90307	55.48923

R Kudahettige, J Mohotti and Nalika Damayanthi

Root windows, and a low-cost minirhizotron system are being constructed and installed in the field, in order to study the tea root system. The experiment is in progress.

R Kudahettige, J Mohotti, Nalika Damayanthi and K Mohotti

Experiment 3. Anatomical studies of tea roots.

Periodic root samples were taken from the 'TRI-ORCON' organic vs inorganic field experiment, in order to study possible anatomical changes in roots of field-grown tea with organic and inorganic treatments. The organic treatments included plants grown with tea waste, neem (*Azadirachta indica*) oil cake, and compost, which were compared with plants grown with recommended conventional practices including synthetic fertilizer and other agro-chemicals.

Two different sizes of roots, with diameters of 1-2 mm (small) and 2-5 mm (large), were examined. Sections of 15-20 μm thickness were cut, slides were prepared, and the following measurements were made: the thickness of the epidermis, cork, and xylem-vessel wall, and the diameter of the xylem vessel.

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 according 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.

These results were presented as an oral presentation at the "The Third International Symposium on Dynamics of Physiological Processes of Woody Roots", held in Perth, Australia in September-October 2003.

Nalika Damayanthi, J Mohotti, K U Tennakoon, K Mohotti and U R Sangakkara

Root samples of different sizes were taken from the 'TRI-ORCON' trial in the dry- and the wet seasons. The anatomical parameters are presented in Tables 9 - 13.

Table 13. Thickness of the epidermis of roots sampled in the dry season; 'TRI-ORCON' trial, TRI, Talawakelle

Treatment	Root diameter (mm)			
	1-2	2-5	5-7	7-12
TW	3.6	5.8	6.8	8.1
NOC	4.1	4.9	6.3	7.6
COM	3.5	4.4	6.1	7.7
CONV	3.6	5.1	6.2	7.6
CV%	15.4	13.6	9.1	5.4

(TW – Tea waste, NOC – Neem oil cake, COM – Compost, CONV – Conventional)

Table 14. Thickness of the cork of roots sampled in the dry season; 'TRI-ORCON' trial, TRI, Talawakelle

Treatment	Root diameter (mm)			
	1-2	2-5	5-7	7-12
TW	16.1	23.9	12.5	16.6
NOC	13.5	23.7	12.4	15.9
COM	14.7	19.9	12.7	15.9
CONV	10.9	21.0	12.5	14.99
CV%	19.6	9.0	6.3	6.2

Table 15. Thickness of the ray parenchyma of roots sampled in the dry season; 'TRI-ORCON' trial, TRI, Talawakelle

Treatment	Root diameter (mm)			
	1-2	2-5	5-7	7-12
TW	1.7	1.7	2.0	2.7
NOC	1.9	2.3	2.5	2.4
COM	1.1	1.7	2.4	2.6
CONV	1.4	1.9	2.2	2.5
CV%	10.5	12.2	8.3	2.8

Table 16. Diameter of the xylem vessels of roots sampled in the dry season; 'TRI-ORCON' trial, TRI, Talawakelle

Treatment	Root diameter (mm)			
	1-2	2-5	5-7	7-12
TW	4.0	4.8	4.7	5.6
NOC	4.4	4.9	4.6	5.7
COM	4.8	4.8	4.9	6.1
CONV	4.2	5.6	5.3	4.9
CV%	13.5	3.6	4.3	7.7

Table 17. Thickness of the xylem-vessel walls of roots sampled in the dry season; 'TRI-ORCON' trial, TRI, Talawakelle

Treatment	Root diameter (mm)			
	1-2	2-5	5-7	7-12
TW	0.7	0.8	0.9	0.9
NOC	0.6	0.7	0.8	0.9
COM	0.6	0.6	0.8	0.9
CONV	0.6	0.7	0.8	0.9
CV%	10.8	9.7	6.4	4.7

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

Nalika Damayanthi, J Mohotti, K Mohotti and U R Sangakkara

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.

The experiment is in progress.

Nalika Damayanthi and J Mohotti

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 (Table 18).

Table 18. Yield (kg made tea ha⁻¹ year⁻¹) from the 'TRI-ORCON' trial, TRI, Talawakelle

Treatment	Yield (kg ha ⁻¹ year ⁻¹)	
	2002	2003
Tea Waste	2147	2424
Neem oil cake	2095	2267
Compost	2113	2368
Conventional	1917	2246
CV%	9.57	9.8

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.

The experiments are in progress.

K. Mohotti and J Mohotti

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.

The experiment is in progress.

T Pathirana, J Mohotti, U R Sangakkara and K Mohotti

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 K₂SO₄ and KCl spraying. One each of a drought-susceptible cultivar (TRI 2026), and a drought-tolerant cultivar (TRI 4046), were selected. KCl and K₂SO₄ were sprayed and the physiological changes monitored.

The experiment was conducted in a growth cabinet using approximately one year-old tea plants of cultivars TRI 2026 (drought-susceptible) and TRI 4049 (drought-tolerant). There were three spraying treatments: 2% K₂SO₄, 2% KCl, and no spraying. These plants were either exposed to a drying cycle or no-water stress was given. Leaf photosynthetic rate, stomatal conductance, leaf water potential (LWP), maximum efficiency of energy capture of the photosystem II (measured as Fv/Fm using fluorescence), and the efficiency of the same under actinic light (fluorescence yield), were measured. The leaves were also analyzed for total soluble-sugar content.

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 K₂SO₄-sprayed plants. The decrease in photosynthesis in KCl-sprayed plants was less than that in K₂SO₄-sprayed plants.

The highest total soluble-sugar content was observed with K₂SO₄ 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.

These results were presented and published at the 23rd Annual Sessions of the Institute of Biology, Sri Lanka, held in 25-27 September 2003.

S Wickremaratne, A J Mohotti, S Munasinghe, S P Nissanka and L S K Hettiarachchi

Development of selection criteria for drought tolerance in tea

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

The experiment is in progress.

R Kudahettige and A J Mohotti

Research Projects on Plant Propagation

7. 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.

V Shanmugarajah

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

8.1. 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.

V Shanmugarajah, K D Dahanayake and P K Jayawickrema

8.2. 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 three and six months, and the growth of the scions at six months after planting the graft combinations, were assessed. Casualties at six months after planting were slightly more than at three months, and are given in Table 19.

Table 19. Casualties at the end of six months

% Casualties	No. of combinations	Combination No..
0	3	10, 11, 13
<10	5	4, 6, 8, 14, 15
11 – 20	4	2, 3, 7, 12
21 – 30	2	5, 9
> 50	1	1

Observations on the growth of scions, at six months after planting, are given in Table 20.

Table 20. Plants with satisfactory shoot growth at six months after planting

Percent of plants alive	Combinations	Combination No
> 80 %	3	12, 13, 15
71 – 80	3	2, 6, 14
61 – 70	2	3, 4
50 – 60	2	8, 10
< 50	5	1, 5, 7, 9, 11

V Shanmugarajah

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 few casualties when a count was made at the end of the first and second months.

The trial is in progress.

V Shanmugarajah

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.

V Shanmugarajah and Superintendents of Mattakelle and St Joachim Estates

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.

V Shanmugarajah and Superintendent, St Joachim Estate

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.

V Shanmugarajah

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 J, Sithakaran V and Ananthcoomaswamy A, 2003. Physiological studies on the tea plant: Sri Lankan contributions. In: *Twentieth Century Tea Research in Sri Lanka* (ed. W W D Modder), Tea Research Institute of Sri Lanka; p. 21-35.

Seminars and Workshops

1. V Shanmugarajah and A J Mohotti attended the Outward Bound Training Programme, 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

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.

Project A 15.1. Characterization of soils to series level in the tea-growing areas of Sri Lanka.

A detailed description of the objectives, the previous work carried out, the outcomes, publications etc., was 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, was completed, and the results are now in the process of being produced as a publication.

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

A description of the work carried out, and the objectives of the work, were reported in the Annual Reports of 1996 to 2001. The incorporation of data on soil physico-chemical parameters of soil series into maps is in progress.

W M S Wijayatunga, G P Gunaratne, A K N Zoysa, L S K Hettiarachchi and J A A M Jayakody.

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.

1) Effect of different rates of N (240, 420 and 600 kg N ha⁻¹ yr⁻¹), K (120, 210 and 300 kg K₂O ha⁻¹ yr⁻¹) and Mg (60, 105 and 150 MgO kg ha⁻¹ yr⁻¹) on growth, soil- and plant-nutrient status, and yield of tea.

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

The yield data obtained in the 5th year following pruning are presented in Table 1. There is no significant increase in yield from increasing rates of N even in the 5th year, as also observed in the last two years. As in the past, no significant effect was found due to increasing rates of K and Mg. No significant interaction was found between N and K, between N and Mg, and between K and Mg, treatments in the trial.

Table 1 - Effect of different rates of N, K and Mg on the yield of tea in the 5th year (made tea kg ha⁻¹); main effects only.

N level (kg ha ⁻¹ yr ⁻¹)	K ₂ O level (kg ha ⁻¹ yr ⁻¹)			Mean	
	120	210	300		
240	3006	3022	2983	3003	
420	3043	2981	2941	2989	SE 28.3
600	2986	3053	3001	3013	
Mean	3012	3019	2975	3002	
		SE 28.3			SE 48.9

N level (kg ha ⁻¹ yr ⁻¹)	MgO level (kg ha ⁻¹ yr ⁻¹)			Mean	
	60	105	150		
240	2982	3052	2977	3003	
420	2958	3036	2972	2989	SE 28.3
600	2977	3002	3061	3013	
Mean	2972	3030	3003	3002	
					SE 48.9

K ₂ O level (kg ha ⁻¹ yr ⁻¹)	MgO level (kg ha ⁻¹ yr ⁻¹)			Mean	
	60	105	150		
120	3002	2971	3062	3012	
210	2952	3089	3015	3019	SE 28.3
300	2962	3029	2933	2975	
Mean	2972	3030	3003	3002	
					SE 48.9

Soil pH, Ex. K and Ex. Mg concentrations in 0-15 and 15-30 cm depths of the soil, in the 5th year (July, 2003) after pruning, are presented in Table 2, 3 and 4, respectively. As in previous years, the soil pH values at 0-15 and 15-30 cm depths in the 5th year significantly decreased with increasing rates of N. No variation in pH was found due to increasing rates of K or Mg.

As in the previous years, the soil Ex. K concentration in the 5th year also increased significantly with increasing rates of K, at both depths. However, N and Mg levels did not show any significant effect on Ex. K in the soil, at both depths. At both depths, the soil Ex. Mg concentration significantly decreased due to increasing rates of N and K at their highest rates. The application of Mg at its highest rate significantly increased the Ex. Mg concentration in the soil.

Table 2 - Effect of different rates of N, K and Mg on soil pH status; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	4.40	4.41	4.31	0.034
15-30 cm	4.39	4.39	4.26	0.043
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	4.39	4.37	4.35	0.034
15-30 cm	4.34	4.37	4.33	0.043
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	4.45	4.30	4.36	0.034
15-30 cm	4.45	4.28	4.30	0.043

Table 3 - Effect of different rates of N, K and Mg on soil Ex. K status (mg kg⁻¹) ; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	506	498	483	25
15-30 cm	771	772	772	24
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	416	525	546	25
15-30 cm	685	803	828	24
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	499	471	517	25
15-30 cm	781	767	769	24

Table 4 - Effect of different rates of N, K and Mg on soil Ex. Mg status (mg kg⁻¹); main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	198	200	161	17
15-30 cm	219	204	197	18
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	176	219	164	17
15-30 cm	215	220	186	18

<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	165	169	226	17
15-30 cm	181	182	258	18

The leaf N, K, Mg and Ca concentrations, determined in the 5th year, is shown in Table 5. An increase in N rate significantly increased leaf N only at its highest rate, but a significant reduction in leaf K and Mg concentration was found only at the highest rate of N application. With increasing rates of K fertilizer, N, K, Mg and Ca concentrations reduced, but it was significant only at the highest rate of K application. With increasing rates of Mg fertilizer, leaf Mg and N concentrations significantly increased, but it did not significantly change the K and Ca concentration in the leaf. The experiment continues

Table 5 - Effect of different rates of N, K and Mg on leaf nutrient concentration (%); main effects only.

Leaf nutrient (%)	<u>N level (kg ha⁻¹ yr⁻¹)</u>			SE
	240	420	600	
N	3.02	3.01	3.10	0.041
K	1.25	1.29	1.24	0.015
Mg	0.25	0.24	0.23	0.005
Ca	1.34	1.31	1.32	0.030

	<u>K₂O level (kg ha⁻¹ yr⁻¹)</u>			
	120	210	300	
N	2.99	3.13	3.01	0.041
K	1.27	1.27	1.24	0.015
Mg	0.25	0.24	0.23	0.005
Ca	1.35	1.32	1.30	0.030

	<u>MgO level (kg ha⁻¹ yr⁻¹)</u>			
	60	105	150	
N	2.98	3.12	3.03	0.041
K	1.26	1.25	1.27	0.015
Mg	0.23	0.24	0.25	0.005
Ca	1.30	1.32	1.36	0.030

The effect of increasing rates of N, K and Mg on pruning weights is given in Table 6. The increasing rates of N showed an increase in pruning weights of the trial plots, but an increase in the K and Mg rates did not have any significant effect on pruning weights. The trial continues.

Table 6 - Effect of different rates of N, K and Mg on pruning weight (kg); main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)			Mean	
	120	210	300		
240	128	101	117	116	
420	131	127	127	128	SE 4.3
600	141	142	128	137	
Mean	134	123	124	127	
		SE 4.3			SE 7.5

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)			Mean	
	60	105	150		
240	112	115	119	131	
420	139	122	125	126	SE 4.3
600	142	140	129	125	
Mean	131	127	125	127	
		SE 4.3			SE 7.5

<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)			Mean	
	60	105	150		
120	137	132	132	134	
210	128	118	124	123	SE 4.3
300	128	127	117	124	
Mean	131	127	125	127	
		SE 4.3			SE 7.5

T C N Peries, S Anandacoomaraswamy, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi.

2) Effect of different rates of N (240, 420 and 600 kg N ha⁻¹ yr⁻¹), K (120, 210 and 300 kg K₂O ha⁻¹ yr⁻¹) and Mg (60, 105 and 150 kg MgO ha⁻¹ yr⁻¹) on growth, soil- and plant-nutrient status, and yield of tea.

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

The yields obtained in the 3rd year (May 2002 to April 2003) are presented in Table 7. No significant increase in yield was found due to increases in the N, K and Mg treatments in the trial.

Table 7 - Effect of different rates of N, K and Mg on the 3rd year yield of tea (made tea kg ha⁻¹); main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)			
	120	210	300	Mean
240	3850	3829	3761	3813
420	3486	4203	3573	3754
600	4098	3544	3401	3681
Mean	3811	3859	3578	3749
		SE 100		SE 173

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)			
	60	105	150	Mean
240	4002	3755	3682	3813
420	3799	3651	3813	3754
600	3774	3588	3681	3681
Mean	3858	3665	3725	3749
		SE 100		

<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)			
	60	105	150	Mean
120	3968	3665	3800	3811
210	3981	3955	3640	3859
300	3625	3375	3735	3578
Mean	3858	3665	3725	3749
				SE 173

The effect of increasing rates of N, K and Mg fertilizer on soil pH, Ex. K and Ex. Mg concentrations, at 0-15 cm and 15-30 cm depths, are presented in Tables 8, 9 and 10, respectively.

Table 8 - Effect of different rates of N, K and Mg on soil pH status; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	4.79	4.56	4.56	0.062
15-30 cm	4.53	4.51	4.45	0.094

<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	4.69	4.64	4.59	0.062
15-30 cm	4.56	4.49	4.44	0.094
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	4.58	4.59	4.74	0.062
15-30 cm	4.42	4.45	4.62	0.094

Table 9 - Effect of different rates of N, K and Mg on soil Ex. K status (mg kg⁻¹); main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	76	63	67	4.63
15-30 cm	64	55	59	4.16
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	52	74	80	4.63
15-30 cm	45	66	68	4.16
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	66	75	65	4.63
15-30 cm	57	64	58	4.16

Table 10 - Effect of different rates of N, K and Mg on soil Ex. Mg status (mg kg⁻¹); main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	124	110	117	13
15-30 cm	101	87	101	13
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	117	129	106	13
15-30 cm	94	110	85	13
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	95	114	142	13
15-30 cm	78	92	119	13

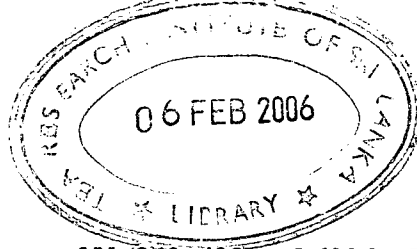
The soil pH decreased significantly when the N and K rates increased to the highest rate at the 0-15 cm depth. This could be due to acidification of added nitrogen fertilizer, and also replacement of H⁺ ions in the soil solution from soil colloids caused by mass action of K ions at their highest rates. The increasing rates of N and K did not significantly reduce the 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 effect of N, K and Mg fertilizer rates on leaf N, K, Mg and Ca concentrations are presented in Table 11.

Table 11 - Effect of different rates of N, K and Mg on leaf nutrient concentration (%); main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
<u>Leaf nutrient (%)</u>				
N	3.32	3.33	3.29	0.031
K	0.96	0.96	0.96	0.014
Mg	0.29	0.28	0.27	0.006
Ca	1.11	1.06	1.06	0.036
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
N	3.35	3.34	3.24	0.031
K	0.93	0.96	0.99	0.014
Mg	0.29	0.28	0.28	0.006
Ca	1.09	1.05	1.09	0.036
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
N	3.33	3.30	3.30	0.031
K	0.96	0.96	0.93	0.014
Mg	0.27	0.28	0.29	0.006
Ca	1.10	1.09	1.04	0.036

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

J R Y Abeywardane, W T B D Priyantha, M A Wijedasa, R P Kulatunga, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi.



3) Effect of different rates of N (240, 420 and 600 kg N ha⁻¹ yr⁻¹), K (120, 210 and 300 kg K₂O ha⁻¹ yr⁻¹) and Mg (60, 105 and 150 kg MgO ha⁻¹ yr⁻¹) on growth, soil- and plant-nutrient status, and yield of tea.

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

The effect of increasing rates of N, K and Mg on yield is presented in Table 12.

Table 12 - Effect of different rates of N, K and Mg on yield (2nd year) (made tea kg ha⁻¹); main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)			Mean	
	120	210	300		
240	8500	8604	8418	8507	
420	8505	8423	8580	8503	SE 75
600	8587	8428	8636	8548	
Mean	8531	8485	8543	8519	
		SE 75	SE 130		

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)			Mean	
	60	105	150		
240	8477	8578	8467	8507	
420	8511	8501	8495	8503	SE 75
600	8544	8457	8644	8548	
Mean	8511	8512	8536	8519	
			SE 130		

<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)			Mean	
	60	105	150		
120	8488	8499	8605	8531	
210	8461	8490	8504	8485	SE 75
300	8583	8546	8498	8543	
Mean	8511	8512	8536	8519	
					SE 130

The data show that increasing rates of N, K and Mg do not increase tea yields significantly, in the first year after pruning.

J R Y Abeywardane, W T B D Priyantha, M A Wijedasa, R P Kulatunga, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi.

4) Effect of different rates of N (240, 420 and 600 kg N ha⁻¹ yr⁻¹), K (120, 210 and 300 kg K₂O ha⁻¹ yr⁻¹) and Mg (60, 105 and 150 kg MgO ha⁻¹ yr⁻¹) on growth, soil- and plant-nutrient status, and yield of tea.

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

The effect of increasing rates of N, K and Mg on yield in the 2nd year after pruning is presented in Table 13.

Table 13 - Effect of different rates of N, K and Mg on yield (2nd year) (made tea kg ha⁻¹); main effects only

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>K₂O level (kg ha⁻¹ yr⁻¹)</u>			Mean	
	120	210	300		
240	3120	3257	3275	3217	
420	3230	3301	3240	3257	SE 41
600	3178	3176	3206	3186	
Mean	3176	3245	3246	3220	
		SE 41			SE 72

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>MgO level (kg ha⁻¹ yr⁻¹)</u>			Mean	
	60	105	150		
240	3270	3205	3177	3247	
420	3266	3213	3291	3206	SE 41
600	3204	3199	3157	3208	
Mean	3247	3206	3208	3220	
					SE 71

<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	<u>MgO level (kg ha⁻¹ yr⁻¹)</u>			Mean	
	60	105	150		
120	3168	3142	3216	3176	
210	3293	3313	3128	3245	SE 41
300	3279	3161	3281	3240	
Mean	3247	3206	3208	3220	

The increasing rates of N and Mg did not increase yields significantly. However, an increase in K application from 120 to 210 kg ha⁻¹ yr⁻¹ increased yield, although a further increase in K fertilizer to 300 kg ha⁻¹ yr⁻¹ did not increase yield significantly.

The effect of increasing rates of N, K and Mg on soil pH, Ex. K, Mg and Ca are presented in Table 14, 15, 16 and 17 respectively.

Table 14 - Effect of different rates of N, K and Mg on soil pH; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	5.27	5.16	5.18	0.072
15-30 cm	5.27	5.12	5.06	0.071
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	5.24	5.16	5.22	0.072
15-30 cm	5.08	5.17	5.20	0.071
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	5.22	5.21	5.19	0.072
15-30 cm	5.09	5.21	5.16	0.071

Table 15 - Effect of different rates of N, K and Mg on soil Ex. K'; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	163	145	145	7
15-30 cm	134	123	126	6
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	132	145	176	7
15-30 cm	114	121	149	6
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	143	158	151	7
15-30 cm	125	130	128	6

Table 16 - Effect of different rates of N, K and Mg on soil Ex. Mg; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	197	202	196	6
15-30 cm	188	153	160	10
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	202	195	199	6
15-30 cm	163	154	185	10
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	200	199	196	6
15-30 cm	151	176	174	10

Table 17 - Effect of different rates of N, K and Mg on soil Ex. Ca; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	332	279	258	23
15-30 cm	268	271	293	22
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	281	281	307	23
15-30 cm	264	276	291	22
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	286	308	276	23
15-30 cm	268	278	285	22

The increasing rates of N fertilizer decreased soil pH significantly at both soil depths. However, the increase of K and Mg fertilizer rates did not show 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 effect of N, K and Mg fertilizer rates on leaf nutrient status is presented in Table 18.

Table 18 - Effect of different rates of N, K and Mg on leaf nutrient concentration (%); main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
<u>Leaf nutrient (%)</u>				
N	3.57	3.60	3.56	0.034
K	1.65	1.61	1.65	0.032
Mg	0.27	0.29	0.27	0.006
Ca	0.69	0.68	0.69	0.017
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)				
	120	210	300	
N	3.58	3.61	3.53	0.034
K	1.58	1.63	1.70	0.032
Mg	0.28	0.28	0.27	0.006
Ca	0.70	0.68	0.68	0.017
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)				
	60	105	150	
N	3.62	3.56	3.54	0.034
K	1.62	1.65	1.64	0.032
Mg	0.27	0.29	0.27	0.006
Ca	0.67	0.70	0.69	0.017

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5) **Effect of different rates of N (240, 420 and 600 kg N ha⁻¹ yr⁻¹), K (120, 210 and 300 kg K₂O ha⁻¹ yr⁻¹) and Mg (60, 105 and 150 kg MgO ha⁻¹ yr⁻¹) on growth, soil- and plant-nutrient status, and yield of tea.**

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

The effect of increasing rates of N, K and Mg fertilizer on yield of tea in the 2nd year of the trial is presented in Table 19.

Table 19 - Effect of different rates of N, K and Mg on yield (2nd year) (made tea kg ha⁻¹); main effects only.

N level (kg ha ⁻¹ yr ⁻¹)	K ₂ O level (kg ha ⁻¹ yr ⁻¹)			Mean	
	120	210	300		
240	5028	4635	5072	4912	
420	5117	5061	5000	5059	SE 87
600	4779	4805	4846	4810	
Mean	4975	4834	4972	4927	
		SE 87			SE 150

N level (kg ha ⁻¹ yr ⁻¹)	MgO level (kg ha ⁻¹ yr ⁻¹)			Mean	
	60	105	150		
240	5052	4887	4795	4911	
420	4900	5019	5258	5059	SE 87
600	4860	4875	4696	4810	
Mean	4938	4927	4916	4927	
		SE 87			SE 150

K ₂ O level (kg ha ⁻¹ yr ⁻¹)	MgO level (kg ha ⁻¹ yr ⁻¹)			Mean	
	60	105	150		
120	4963	5088	4894	4975	
210	4834	4899	4769	4834	SE 41
300	5016	4794	5017	4972	
Mean	4938	4927	4916	4927	
		SE 87			SE 150

There was no significant effect of increasing rates of N, K and Mg fertilizers on yield of tea.

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6) **Effect of different rates of N (240, 420 and 600 kg N ha⁻¹ yr⁻¹), K (120, 210 and 300 kg K₂O ha⁻¹ yr⁻¹) and Mg (60, 105 and 150 kg MgO ha⁻¹ yr⁻¹) on growth, soil- and plant-nutrient status, and yield of tea.**

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

The effect of increasing rates of N, K and Mg fertilizer application on the 2nd year yield of tea plants are given in Table 20.

Table 20 - Effects of different rates of N, K and Mg on yield (2nd year) (made tea kg ha⁻¹); main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)			Mean	
	120	210	300		
240	3855	4114	3751	3907	
420	3920	3925	3860	3902	SE 99
600	4219	4195	3823	4079	
Mean	3998	4078	3811	3963	
		SE 99			SE 172

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)			Mean	
	60	105	150		
240	3838	3838	4044	3907	
420	4112	3761	3833	3902	SE 99
600	3959	4072	4206	4079	
Mean	3970	3890	4028	3963	
					SE 172

<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)			Mean	
	60	105	150		
120	3992	3986	4017	3998	
210	4017	4038	4179	4078	SE 99
300	3901	3648	3886	3811	
Mean	3970	3890	4028	3963	
					SE 172

The increasing rates of N application increased tea yields up to the highest rate, but the increasing rates of K and Mg did not show any significant effect on yield.

The increasing rates of N, K and Mg fertilizer on changes in soil pH, Ex. K, Mg and Ca are presented in Tables 21, 21, 23 and 24, respectively.

Table 21 - Effect of different rates of N, K and Mg on soil pH; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	4.85	4.79	4.67	0.062
15-30 cm	4.87	4.85	4.71	0.072
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	4.73	4.71	4.87	0.062
15-30 cm	4.80	4.69	4.93	0.072
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	4.80	4.74	4.77	0.062
15-30 cm	4.83	4.80	4.80	0.07

Table 22 - Effect of different rates of N, K and Mg on soil Ex. K; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	168	154	148	7
15-30 cm	171	162	154	7
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	141	166	162	7
15-30 cm	147	166	174	7
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	159	157	154	7
15-30 cm	164	165	158	7

Table 23 - Effect of different rates of N, K and Mg on soil Ex. Mg; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	110	101	90	9
15-30 cm	127	119	100	9
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	92	97	112	9
15-30 cm	114	105	126	9
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	89	106	105	9
15-30 cm	113	113	120	9

Table 24 - Effect of different rates of N, K and Mg on soil Ex. Ca; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	234	255	234	25
15-30 cm	297	314	266	25
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	216	229	278	25
15-30 cm	282	259	336	25
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	244	249	229	25
15-30 cm	297	289	290	25

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.

Table 25 - Effect of different rates of N, K and Mg on leaf nutrient concentration; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
<u>Leaf nutrient (%)</u>				
N	3.73	3.76	3.73	0.039
K	1.36	1.33	1.24	0.023
Mg	0.37	0.36	0.37	0.005
Ca	1.34	1.30	1.32	0.029
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
N	3.76	3.70	3.76	0.039
K	1.32	1.34	1.36	0.023
Mg	0.37	0.37	0.36	0.005
Ca	1.34	1.32	1.34	0.029
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
N	3.75	3.74	3.74	0.039
K	1.32	1.34	1.36	0.023
Mg	0.36	0.37	0.37	0.005
Ca	1.30	1.31	1.36	0.029

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7) **Effects of different rates of N (240, 420 and 600 kg N ha⁻¹ yr⁻¹), K (120, 210 and 300 kg K₂O ha⁻¹ yr⁻¹) and Mg (60, 105 and 150 kg MgO ha⁻¹ yr⁻¹) on growth, soil- and plant-nutrient status, and yield of tea.**

Clone TRI 2025, Field No. NC New Division, Rangala Estate, Karaliyadda (2002).

The effect of increasing rates of N, K and Mg fertilizer on the 1st year yield of tea plants after pruning are presented in Table 26.

Table 26 - Effect of different rates of N, K and Mg on 1st year yield (made tea kg ha⁻¹); main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)			Mean	
	120	210	300		
240	2001	1985	1920	1969	
420	1977	2072	1932	1994	SE 55
600	2190	2151	1905	2082	
Mean	2056	2069	1919	2015	
		SE 55			SE 96

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)			Mean	
	60	105	150		
240	1944	2037	1926	1969	
420	2092	1871	2018	1994	SE 55
600	2069	2083	2094	2082	
Mean	2035	1997	2013	2015	
			SE 55		SE 96

<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)			Mean	
	60	105	150		
120	2065	1985	2119	2056	
210	2189	2018	2000	2069	SE 55
300	1851	1988	1919	1919	

The increasing rates of N fertilizer increased yields up to the highest N rate, but increasing rates of K and Mg did not show any significant improvement in yield.

Table 27 - Effect of different rates of N, K and Mg on soil pH; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	4.64	4.58	4.42	0.04
15-30 cm	4.21	4.22	4.05	0.055
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	4.43	4.63	4.60	0.04
15-30 cm	4.01	4.23	4.24	0.055

<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	4.54	4.55	4.56	0.04
15-30 cm	4.15	4.16	4.16	0.055

Table 28 - Effect of different rates of N, K and Mg on soil Ex. K; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	88	94	88	8
15-30 cm	81	94	86	7
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	84	87	99	8
15-30 cm	86	78	97	7
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	87	108	76	8
15-30 cm	79	96	85	7

Table 29 - Effect of different rates of N, K and Mg on soil Ex. Mg; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	102	105	85	9
15-30 cm	98	106	101	7
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	79	112	101	9
15-30 cm	92	112	102	7
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	91	107	94	9
15-30 cm	93	113	100	7

Table 30 - Effect of different rates of N, K and Mg on soil Ex. Ca; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	96	108	71	13
15-30 cm	130	137	118	13
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	71	118	85	13
15-30 cm	100	156	129	13
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	102	90	82	13
15-30 cm	140	131	114	13

The increasing rates of N decreased soil pH significantly, but the application of K and Mg 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.

Table 31 - Effect of different rates of N, K and Mg on leaf nutrient concentration; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
<u>Leaf nutrient (%)</u>				
N	3.80	3.77	3.83	0.071
K	1.05	1.01	1.02	0.035
Mg	0.34	0.34	0.34	0.009
Ca	0.76	0.80	0.77	0.027
<u>K₂O level (kg ha⁻¹ yr⁻¹)</u>	120	210	300	
N	3.81	3.74	3.85	0.071
K	1.02	0.98	1.08	0.035
Mg	0.34	0.34	0.34	0.009
Ca	0.79	0.76	0.76	0.027

	<u>MgO level (kg ha⁻¹ yr⁻¹)</u>			
	60	105	150	
N	3.76	3.83	3.83	0.071
K	1.04	1.05	0.99	0.035
Mg	0.34	0.35	0.34	0.009
Ca	0.77	0.76	0.77	0.027

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8) Effects of different rates of N (240, 420 and 600 kg N ha⁻¹ yr⁻¹), K (120, 210 and 300 kg K₂O ha⁻¹ yr⁻¹) and Mg (60, 105 and 150 kg MgO ha⁻¹ yr⁻¹) on growth, soil- and plant-nutrient status, and yield of tea.

Clone TRI 2025, Field No. NC 5, Midlands Estate, Ratthota (2000)

The effect of increasing rates of N, K and Mg fertilizer application on 1st year yield of tea plants are shown in Table 32.

Table 32 - Effect of different rates of N, K and Mg on 1st year yield (made tea kg ha⁻¹); main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>K₂O level (kg ha⁻¹ yr⁻¹)</u>			Mean
	120	210	300	
240	2398	2472	2258	2376
420	2572	2294	2605	2490 SE 74
600	2607	2434	2622	2554
Mean	2526	2400 SE 74	2495	2474 SE 128

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>MgO level (kg ha⁻¹ yr⁻¹)</u>			Mean
	60	105	150	
240	2541	2324	2262	2376
420	2500	2397	2575	2490 SE 74
600	2573	2590	2501	2554
Mean	2538	2437	2446	2474 SE 128

<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	<u>MgO level (kg ha⁻¹ yr⁻¹)</u>			Mean	SE 74
	60	105	150		
120	2635	2550	2392	2526	
210	2433	2402	2364	2400	
300	2545	2359	2581	2495	

The increasing rates of N fertilizer significantly increased tea yields, but the increase in K and Mg fertilizer rates did not show any significant improvement in yield.

The effect of increasing rates of N, K and Mg rates on soil pH, Ex. K, Mg and Ca are presented in Table 33, 34, 35 and 36, respectively.

Table 33 - Effect of different rates of N, K and Mg on soil pH; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	4.37	4.31	4.21	0.05
15-30 cm	4.32	4.21	4.19	0.05
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	4.31	4.33	4.26	0.05
15-30 cm	4.25	4.26	4.21	0.05
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	4.32	4.29	4.29	0.05
15-30 cm	4.31	4.22	4.20	0.05

Table 34 - Effect of different rates of N, K and Mg on soil Ex. K; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	64	67	63	7
15-30 cm	52	99	56	13

<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	53	65	76	7
15-30 cm	59	81	67	13
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	73	47	75	7
15-30 cm	62	75	70	13

Table 35 - Effect of different rates of N, K and Mg on soil Ex. Mg; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	58	64	62	5
15-30 cm	70	77	63	5
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	64	56	65	5
15-30 cm	72	71	69	5
<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	59	61	66	5
15-30 cm	67	68	77	5

Table 36 - Effect of different rates of N, K and Mg on soil Ex. Ca; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
0-15 cm	171	213	162	21
15-30 cm	155	192	139	22
<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	120	210	300	
0-15 cm	176	160	211	21
15-30 cm	162	159	165	22

<u>MgO level</u> (kg ha ⁻¹ yr ⁻¹)	60	105	150	
0-15 cm	191	178	177	21
15-30 cm	179	147	160	22

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 increased Ex. K and Mg, respectively.

The effects of increasing rates of N, K and Mg are presented in Table 37.

Table 37 - Effect of different rates of N, K and Mg on leaf nutrient concentration; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	240	420	600	SE
<u>Leaf nutrient (%)</u>				
N	3.54	3.67	3.82	0.08
K	2.03	2.11	2.06	0.05
Mg	0.30	0.33	0.32	0.01
Ca	2.16	2.43	2.24	0.06
<u>K₂O level (kg ha⁻¹ yr⁻¹)</u>				
	120	210	300	
N	3.64	3.84	3.55	0.08
K	2.01	2.12	2.07	0.05
Mg	0.32	0.32	0.31	0.01
Ca	2.21	2.30	2.33	0.06
<u>MgO level (kg ha⁻¹ yr⁻¹)</u>				
	60	105	150	
N	3.69	3.64	3.69	0.08
K	2.09	2.02	2.09	0.05
Mg	0.32	0.31	0.32	0.01
Ca	2.29	2.28	2.26	0.06

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

1) Effects of different rates of N (100, 200, 300, 400 and 500 kg N ha⁻¹ yr⁻¹) and K (in 100, 300 and 500 kg K₂O ha⁻¹ yr⁻¹) on soil- and plant-nutrient status and yield of tea.

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

The increasing rates of N and K on tea yield are presented in Table 38.

Table 38 - Effect of increasing levels of potash and nitrogen yield of tea.

Treatments N (kg ha ⁻¹ yr ⁻¹)	Yield (made tea kg ha ⁻¹)			Mean	
	K ₂ O (kg ha ⁻¹ yr ⁻¹)				
	100	300	500		
100	2193	2354	2296	2281	
200	2197	2278	2368	2281	
300	2300	2389	2230	2306	SE 58
400	2313	2394	2428	2378	
500	2407	2414	2309	2377	
Mean	2282	2366	2326	2325	
		SE 45			SE 100
		CV 6.2%			

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 yield. This experiment continues.

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9) Effects of different rates of N (240, 420 and 600 kg N ha⁻¹ yr⁻¹), K (120, 300 and 480 kg K₂O ha⁻¹ yr⁻¹) and frequencies (6, 8 and 12 weekly intervals) on growth, soil- and plant-nutrient status and yield of tea.

Clone TC9, Brunswick Estate, Maskeliya (1998)

The effect of increasing rates of N and K fertilizer, and the frequency of application, on the 1st year yield is shown in Table 39.

Table 39 - Effect of different rates of N and K applied at different frequencies on yield (1st year) (made tea kg ha⁻¹); main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>K₂O level (kg ha⁻¹ yr⁻¹)</u>			Mean	
	120	300	480		
240	2574	2621	2602	2599	
420	2623	2673	2582	2626	SE 28
600	2591	2689	2652	2644	
Mean	2596	2661	2612	2623	
		SE 28			SE 48

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>Frequency (weeks interval)</u>			Mean	
	6	8	12		
240	2517	2639	2642	2599	
420	2535	2628	2714	2626	SE 28
600	2613	2710	2609	2644	
					SE 48

<u>K₂O level</u> (kg ha ⁻¹ yr ⁻¹)	<u>Frequency (weeks interval)</u>			Mean	
	6	8	12		
120	2589	2583	2617	2596	
300	2508	2779	2696	2661	SE 28
480	2568	2616	2653	2612	

The increasing levels of K and N did not show any significant improvement in yield (Table 39).

Table 40 - Effects of different rates of N and K applied at different frequencies on soil pH (1st year) at 0-15 cm depth; main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>K₂O level (kg ha⁻¹ yr⁻¹)</u>			Mean	
	120	300	480		
240	4.94	4.99	5.10	5.01	
420	4.89	4.87	4.84	4.89	SE 0.044
600	4.81	4.82	4.79	4.81	
Mean	4.88	4.90	4.91	4.90	
		SE 0.044			SE 0.077

The increase in N rate significantly reduced soil pH, but the K rate had no significant influence on soil pH (Table 40).

Table 41 - Effects of different rates of N and K applied at different frequencies on soil Ex. K (mg kg⁻¹) (1st year) at 0-15 cm depth; main effects only.

N level (kg ha ⁻¹ yr ⁻¹)	K ₂ O level (kg ha ⁻¹ yr ⁻¹)			Mean	
	120	300	480		
4 th year					
240	281	374	378	344	
420	274	334	321	309	SE 19
600	288	281	299	289	
Mean	281	329	333	314	
		SE 19			SE 33

The application of increasing rates of K significantly increased Ex. K in the soil, and the increase in the N rate significantly decreased Ex. K in the soil (Table 41).

Table 42 - Effects of different rates of N and K applied at different frequencies on soil Mg (mg kg⁻¹) (1st year) at 0-15 cm depth; main effects only.

N level (kg ha ⁻¹ yr ⁻¹)	K ₂ O level (kg ha ⁻¹ yr ⁻¹)			Mean	
	120	300	480		
240	94	79	81	85	
420	75	81	70	75	SE 6.4
600	69	84	72	75	
Mean	80	81	74	78	
		SE 6.4			SE 11

The increasing rates of both N and K fertilizer did not significantly affect Ex. Mg status in the soil (Table 42).

Table 43 - Effects of different rates of N and K applied at different frequencies on leaf N (%) (1st year); main effects only.

N level (kg ha ⁻¹ yr ⁻¹)	K ₂ O level (kg ha ⁻¹ yr ⁻¹)			Mean	
	120	300	480		
240	3.04	3.04	3.00	3.03	
420	3.10	3.11	3.08	3.10	SE 0.022
600	3.15	3.13	3.18	3.15	
Mean	3.10	3.10	3.09	3.09	
		SE 0.022			SE 0.037

The increasing rates of N significantly increased the leaf N concentration (Table 43).

Table 44 - Effects of different rates of N and K applied at different frequencies on leaf K (%) (1st year); main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>K₂O level (kg ha⁻¹ yr⁻¹)</u>			Mean	
	120	300	480		
240	1.50	1.60	1.65	1.58	
420	1.58	1.59	1.59	1.59	SE 0.012
600	1.55	1.60	1.57	1.57	
Mean	1.54	1.60	1.61	1.58	
		SE 0.012			SE 0.022

The increasing rates of K showed a highly significant increase in K concentration in the leaf (Table 44).

Table 45 - Effects of different rates of N and K applied at different frequencies on leaf Mg (%) (1st year); main effects only.

<u>N level</u> (kg ha ⁻¹ yr ⁻¹)	<u>K₂O level (kg ha⁻¹ yr⁻¹)</u>			Mean	
	120	300	480		
240	0.31	0.29	0.26	0.29	
420	0.29	0.29	0.29	0.29	SE 0.003
600	0.29	0.30	0.28	0.29	
Mean	0.30	0.29	0.28	0.29	
		SE 0.003			SE 0.007

The increase in K rate significantly decreased Mg concentration in the leaf, but it was not affected by the N rate (Table 45).

T C N Peries, O G K A Gunaratne, S Ananthacoomaraswamy, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi.

(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) **Effects of seven different levels of N (0 to 720 kg N ha⁻¹ yr⁻¹) with compost manure (at 0 and 5 t ha⁻¹ yr⁻¹) on growth, soil- and plant-nutrient status and yield of tea.**

Clone DT1, St Coombs Estate, Talawakelle (1992)

The yield obtained during 5th year of the current cycle (August 2002 to July 2003) is presented in Table 46.

As observed in previous years, the yield in the 5th year 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 had not made any significant influence on the tea yields.

Table 46 - Effect of different levels of nitrogen, with and without compost, on tea yield.

<u>Treatments</u>		<u>Yield (made tea kg ha⁻¹)</u>	
N level (kg ha ⁻¹)		Compost	
N	Nil	5t	Mean
0	1927	2124	2025
120	2273	2160	2216
240	2267	2345	2306
360	2522	2527	2524 SE 102
480	2254	2290	2272
600	2255	2279	2267
720	2328	2264	2296
Mean	2261	2284	2012
		SE 55	SE 145
CV% 0.5			

The experiment continues.

R G A Wijayawardhana, D M B N Dissanayake, O G K A Gunaratne, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi.

2) Effects of three different levels of N (200, 400 and 600 kg N ha⁻¹ yr⁻¹) with different levels of compost manure (at 0, 10, 20 and 30 t ha⁻¹ yr⁻¹) on growth, soil- and plant-nutrient status and yield of tea.

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, is presented in Table 47. The data shows that neither N rate, nor compost application, showed any significant impact on yield.

Table 47 - Effect of different levels of nitrogen, with and without compost, on 1st year yield of tea.

	<u>Treatments</u> N level (kg ha ⁻¹)		<u>Yield (made tea kg ha⁻¹)</u>			Mean	
	Nil	10t	Compost				
			20t	30t			
200	1321	1097	1216	1180	1204		
400	1181	1184	1375	1243	1246	SE 51	
600	1051	1368	1327	1244	1248		
Mean	1184	1216	1306	1223	1232	SE 89	
			SE 45				
			CV% 4.1				

Table 48 - Effect of different levels of nitrogen, with and without compost, on soil pH at 0-15 cm depth.

	<u>Treatments</u> N level (kg ha ⁻¹)		<u>Soil pH</u>			Mean	
	Nil	10t	Compost				
			20t	30t			
200	5.43	5.00	4.90	5.89	5.31		
400	5.35	5.37	4.98	5.18	5.22	SE 0.188	
600	6.06	5.27	5.17	5.46	5.49		
Mean	5.62	5.21	5.02	5.51	5.34	SE 0.376	
			SE 0.217				
			CV% 2.2				

Table 49 - Effect of different levels of nitrogen, with and without compost, on soil C (%) at 0-15 cm depth.

	<u>Treatments</u> N level (kg ha ⁻¹)		<u>Soil C (%)</u>			Mean	
	Nil	10t	Compost				
			20t	30t			
200	1.42	1.64	1.54	1.73	1.58		
400	1.51	1.60	1.56	1.61	1.57	SE 0.059	
600	1.70	1.67	1.51	1.64	1.63		
Mean	1.54	1.64	1.54	1.66	1.59	SE 0.119	
			SE 0.069				
			CV% 4.8				

A clear relationship between compost and N rates could not be observed on pH and C levels in the soil (Tables 48 and 49).

J R Y Abeywardane, W T B D Priyantha, M A Wijedasa, R P Kulatunga, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi.

3) Effects of three different levels of N (200, 400 and 600 kg N ha⁻¹ yr⁻¹) with different levels of compost manure (at 0, 10, 20 and 30 t ha⁻¹ yr⁻¹) on growth, soil- and plant-nutrient status and yield of tea.

Clone TRI 2026, Anninkande Estate, Deniyaya (2001)

The yield information collected following imposition of treatments, during the period January 2002 to end December 2003, are given in Table 50. The experiment continues.

Table 50 - Effect of different levels of nitrogen, with and without compost, on yield of tea.

	<u>Treatments</u> N level (kg ha ⁻¹)		<u>Yield (made tea kg ha⁻¹)</u>			Mean	
	Nil	10t	Compost		30t		
			20t				
200	5541	6270	5676		5258	5686	
400	5968	5660	5598		6119	5836	SE 275
600	6597	5547	6375		5776	6074	
Mean	6035	5826	5883		5718	5866	SE 476
			SE 238				
			CV% 11.3				

A significant increase in yield could not be observed from either N or compost rates.

Table 51 - Effect of different levels of nitrogen, with and without compost, on soil pH at 0-15 cm depth.

	<u>Treatments</u> N level (kg ha ⁻¹)		<u>Soil pH</u>			Mean	
	Nil		Compost		30t		
			10t	20t			
200	4.48		4.50	4.50	4.52	4.50	
400	4.25		5.03	4.36	4.37	4.50	SE 0.141
600	4.51		4.74	4.36	4.39	4.50	
Mean	4.41		4.76	4.41	4.43	4.50	SE 0.282
				SE 0.162			
				CV% 5.2			

The increasing rates of N, or compost, rates did not show any significant effect on soil pH (Table 51).

Table 52 - Effect of different levels of nitrogen, with and without compost, on soil C (%) at 0-15 cm depth.

<u>Treatments</u> N level (kg ha ⁻¹)		Soil C (%)				
N	Nil	Compost			Mean	
		10t	20t	30t		
200	1.67	1.54	1.33	1.27	1.45	
400	1.40	1.83	1.27	1.49	1.50	SE 0.134
600	1.41	1.65	1.41	2.18	1.66	
Mean	1.49	1.67	1.34	1.65	1.54	SE 0.269
			SE 0.155			
			V% 5.1			

A clear result could not be obtained in the trial from the application of compost with regard to soil C levels (Table 52).

J R Y Abeywardane, W T B D Priyantha, M A Wijedasa, R P Kulatunga, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi.

(d) Effect of application of different rates and proportions of urea and sulphate of ammonia on growth, soil- and plant-nutrient status and yield.

The following trials, explained in 1 to 7 are to investigate the S nutrition of tea.

1) Effects of application of different rates of N as urea and sulphate of ammonia (240 and 360 kg ha⁻¹ yr⁻¹), and their proportions (urea:SA = 100:0, 75:25, 50:50, 25:75 and 0:100), on growth, soil- and plant-nutrient status and yield of tea.

Clone TRI 2025, St Coombs Estate, Talawakelle (May 1979)

The yield obtained during the 4th year of the 6th cycle is given in Table 53.

Table 53 - Effect of different proportions of urea: S/A at 240 and 360 N (kg ha⁻¹ yr⁻¹) on yield (made tea kg ha⁻¹ yr⁻¹) of mature tea.

<u>Proportions (%)</u> <u>Urea: S/A</u>	<u>Level of N (kg ha⁻¹ yr⁻¹)</u>			
	240	360	Mean	
100:0	2427	2575	2501	
75:25	2303	2513	2513	
50:50	2365	2626	2495	SE 52.2
25:75	2424	2500	2462	
0:100	2220	2806	2513	
Mean	2348	2646	2497	
	SE 82.6			SE 117 (18 df)
	CV 5 %			

The increase in the N application rate significantly increased the yield, but there was no significant effect on yield 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 SO₄-S levels (at depths of 0-15 and 15-30 cm), and leaf sulphur concentrations, are given in Tables 54, 55, 56 and 57, respectively.

Table 54 - Effect of application of different proportions of S/A: urea at 240 and 360 N (kg ha⁻¹ yr⁻¹) on soil pH at 0-15 cm depth.

<u>Proportions (%)</u> <u>Urea: S/A</u>	<u>Level of N (kg ha⁻¹ yr⁻¹)</u>			
	240	360	Mean	
100:0	4.56	4.22	4.23	
75:25	4.02	4.15	4.09	
50:50	4.10	3.91	4.00	SE 0.047
25:75	3.99	3.73	3.86	
0:100	3.91	3.59	3.75	
Mean	4.12	3.92	4.02	
	SE 0.075			SE 0.105 (18 df)
	CV 3.5%			

The N rate, and the ratio of N sources, showed a significant influence of soil pH. An increase in the rate of N 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.

Table 55 - Effect of application of different proportions of urea: S/A at 240 and 360 N (kg ha⁻¹ yr⁻¹) on soil pH at 15-30 cm depth.

<u>Proportions (%)</u> <u>Urea: S/A</u>	<u>Level of N (kg ha⁻¹ yr⁻¹)</u>		
	240	360	Mean
100:0	4.49	4.09	4.29
75:25	3.90	4.16	4.03
50:50	4.01	3.90	3.96
25:75	3.98	3.76	3.87
0:100	4.03	3.66	3.84
Mean	4.08	3.91	4.00
	SE 0.032		SE 0.072 (18 df) CV 2.5%

Table 56 - Effect of application of different proportions of urea and S/A at 240 and 360 N (kg ha⁻¹ yr⁻¹) on soil SO₄-S levels at 0-15 and 15-30 cm depths.

<u>Proportions (%)</u> <u>Urea:S/A</u>	<u>(SO₄)-S (mg kg⁻¹)</u>	
	0-15 cm	15-30cm
100:0	63	127
75:25	240	297
50:50	253	347
25:75	254	351
0:100	255	335
SE	28	47
	<u>Level of N (kg ha⁻¹ yr⁻¹)</u>	
	240	223
	360	203
SE	13	27
CV%	23	16

The increasing proportion of ammonium sulphate, as the source in the total N rate, significantly increased the SO₄-S at both soil depths.

Table 57 - Effect of application of different proportions of urea and S/A at 240 and 360 N ($\text{kg ha}^{-1} \text{ yr}^{-1}$) on total leaf S concentration.

<u>Proportions (%)</u> <u>Urea:S/A</u>	<u>Total S in leaf (%)</u>
100:0	0.28
75:25	0.30
50:50	0.32
25:75	0.29
0:100	0.34
SE	0.014
<u>Level of N ($\text{kg ha}^{-1} \text{ yr}^{-1}$)</u>	
240	0.30
360	0.31
SE	0.006
LSD (0.05)	NS
CV %	8.3

The increase in the proportion of ammonium sulphate in the N source increased the total S concentration in the leaf tissues.

The experiment continues.

O G K A Gunaratne, S Ananthacoomaraswamy, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi.

2) Effects of application of different rates of N as urea and sulphate of ammonia (200, 300, 400 and 500 $\text{kg N ha}^{-1} \text{ yr}^{-1}$), and their proportions (urea: SA = 100:0, 75:25, 50:50, 25:75 and 0:100), on growth, soil- and plant-nutrient status and yield of tea.

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

Table 58 - Effect of different proportions of urea: S/A at 200, 300, 400 and 500 N (kg ha⁻¹ yr⁻¹) on yield (kg made tea ha⁻¹ yr⁻¹) of mature tea.

<u>Proportions (%)</u> <u>Urea: S/A</u>	<u>Level of N (kg ha⁻¹ yr⁻¹)</u>				Mean
	200	300	400	500	
100:0	8389	8208	8274	8266	8284
75:25	8076	8353	8523	8289	8310
50:50	8587	8131	8138	8252	8277 SE 84
25:75	8525	8197	8158	8383	8316
0:100	8202	8649	8429	8365	8411 SE 168
Mean	8356	8308	8304	8311	8320
	SE 75.2				SE 168 (18 df) CV 3.5 %

The yield obtained during the 2nd year (September 2002 to September 2003) is given in Table 58. The increasing rates of N nor the proportions of N showed no significant effect on tea yield.

The experiment continues.

J R Y Abeywardane, W T B D Priyantha, M A Wijedasa, R P Kulatunga, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi.

3) Effect of application of different rates of N as urea and sulphate of ammonia (200, 300 and 400 kg N ha⁻¹ yr⁻¹), and their proportions (urea: SA = 100:0, 75:25, 50:50, 25:75 and 0:100), on growth, soil- and plant-nutrient status and yield of tea.

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

Table 59 - Effect of different proportions of urea: S/A at 200, 300 and 400 N (kg ha⁻¹ yr⁻¹) on 2nd year yield (kg made tea ha⁻¹ yr⁻¹) of mature tea.

<u>Proportions (%)</u>		<u>Level of N (kg ha⁻¹ yr⁻¹)</u>			Mean
		200	300	400	
Urea: S/A					
100:0	3395	3629	3290	3438	
75:25	3389	3472	3789	3550	
50:50	3434	3972	4059	3821	SE 142
25:75	3810	3248	3559	3539	
0:100	3060	4037	4423	3840	
Mean	3417	3671	3824	3638	
		SE 110		SE 245 (42 df)	
				CV 14 %	

The increasing rates of N increased tea yield significantly in the second year but showed no significant effect on yields from the proportions of N fertilizer (Table 59).

T C N Peries, D M B N Dissanayake, O G K A Gunaratne, S Ananthacoomaraswamy, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi.

4) Effect of application of different rates of N as urea and sulphate of ammonia (200, 300, 400 and 500 kg N ha⁻¹ yr⁻¹), and their proportions (urea: SA = 100:0, 75:25, 50:50, 25:75 and 0:100), on growth, soil- and plant-nutrient status and yield of tea.

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

The yields obtained in the 1st year of the trial is given in Table 60.

The increasing rates, or the proportion of the source of N, did not show any significant influence on yields.

The trial continues.

Table 60 - Effect of different proportions of urea: S/A at increasing rates of N (200, 300, 400 and 500, kg N ha⁻¹ yr⁻¹) on yield (kg made tea ha⁻¹ yr⁻¹) of mature tea.

<u>Proportions (%)</u>	<u>Level of N (kg ha⁻¹ yr⁻¹)</u>					
	<u>Urea: S/A</u>	200	300	400	500	Mean
100:0		4248	4751	4178	3870	4262
75:25		4425	4453	3973	4331	4295
50:50		4606	4125	4110	4339	4339 SE 105
25:75		4339	4408	4377	4347	4368
0:100		4270	4652	4637	4385	4486
Mean		4378	4478	4255	4254	4341
				SE 94		SE 209 (38 df)
						CV 8.4 %

W M S Wijayatunga, P L K Tennakoon, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi.

5) Effect of application of different rates of N as urea and sulphate of ammonia (200, 300, 400 and 500 kg N ha⁻¹ yr⁻¹), and their proportions (urea: SA = 100:0, 75:25, 50:50, 25:75 and 0:100), on growth, soil- and plant-nutrient status and yield of tea.

Clone TRI 2026, Field No. 7, St Francis Division, Millakande Estate, Horana (2001)

The yields obtained before and after imposing treatments, during the 3rd year, showed that there was no significant increase in yield due to the N rate or to the proportion of the source of N (Table 61).

The experiment continues.

Table 61 - Effect of different proportions of urea: S/A at increasing rates of N (200, 300, 400 and 500, kg N ha⁻¹ yr⁻¹) on yield (kg made tea ha⁻¹ yr⁻¹) of mature tea.

<u>Proportions (%)</u>	<u>Level of N (kg ha⁻¹ yr⁻¹)</u>					Mean
	<u>Urea: S/A</u>	200	300	400	500	
100:0		6654	6395	6661	6485	6549
75:25		6391	6736	6652	6409	6547
50:50		6509	6811	6475	6137	6547 SE 147
25:75		6305	6524	6479	6831	6535
0:100		6323	6486	6826	6523	6542
Mean		6436	6590	6619	6499	6531
				SE 132		SE 295 (38 df)
						CV 7.8 %

T C N Peries, D M B N Dissanayake, O G K A Gunaratne, S Ananthacumaraswamy, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi

6) Effect of application of different rates of N as urea and sulphate of ammonia (200, 300, 400 and 500 kg N ha⁻¹ yr⁻¹), and their proportions (urea: SA = 100:0, 75:25, 50:50, 25:75 and 0:100), on growth, soil- and plant-nutrient status and yield of tea.

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

No significant effect on yield was observed in the 2nd year due to increase in the rate of N or to the proportion of the source of N (Table 62).

The experiment continues.

Table 62 - Effect of different proportions of urea: S/A at increasing rates of N (200, 300, 400 and 500, kg N ha⁻¹ yr⁻¹) on 2nd year yield (kg made tea ha⁻¹ yr⁻¹) of mature tea.

<u>Proportions (%)</u>	<u>Level of N (kg ha⁻¹ yr⁻¹)</u>					Mean
	<u>Urea: S/A</u>	200	300	400	500	
100:0		5403	5220	5057	5396	5269
75:25		5156	5431	5242	5173	5251
50:50		4968	5138	5419	5262	5197 SE 76
25:75		5489	5375	5083	5534	5370
0:100		5402	5194	5566	5428	5398
Mean		5284	5272	5273	5359	5297
				SE 68		SE 151 (38 df)
						CV 4.9 %

J R Y Abeywardane, W T B D Priyantha, M A Wijedasa, R P Kulatunga, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi

7) Effect of application of different rates of N as urea and sulphate of ammonia (200, 300, 400 and 500 kg N ha⁻¹ yr⁻¹), and their proportions (urea: SA = 100:0, 75:25, 50:50, 25:75 and 0:100), on growth, soil- and plant-nutrient status and yield of tea.

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

The yield data collected in the immature phase of the trial is presented in Table 68.

No significant impact due to increasing rates of N or to the proportion of the source of N could be observed in yields (Table 63).

The trial continues.

Table 63 - Effect of different proportions of urea: S/A at increasing rates of N (200, 300, 400 and 500, kg N ha⁻¹ yr⁻¹) on yield (kg made tea ha⁻¹ yr⁻¹) of mature tea.

<u>Proportions (%)</u> Urea: S/A	<u>Level of N (kg ha⁻¹ yr⁻¹)</u>				Mean
	200	300	400	500	
100:0	2553	2517	2469	2530	2517
75:25	2516	2578	2585	2550	2557
50:50	2444	2490	2446	2568	2487 SE 37
25:75	2510	2486	2580	2458	2483
0:100	2425	2771	2530	2562	2572
Mean	2490	2568	2502	2534	2523
			SE 33		SE 73 (38 df)
					CV 5.0 %

T C N Peries, O G K A Gunaratne, S Ananthacumaraswamy, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi

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

The information from field trials, comparing the efficiency of conventional zinc sulphate and/or commercial Epsom salt in foliar spray solutions with commonly-used foliar spray formulations, is presented below.

1) Effect of application of micro-nutrient foliar feeds, such as Multiplex and Kiecite, along with two conventional zinc sulphate solution combinations (11 kg Zn ha⁻¹ yr⁻¹) on growth, soil- and plant-nutrient status, quality and yield of tea.

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

Spraying of foliar fertilizers following the ground fertilizer application was carried out. N and K₂O were supplied at the rates of 300 and 150 kg ha⁻¹ yr⁻¹ respectively.

The yields obtained in the 5th year is given in Table 64.

Table 64 - Effect on yield of conventional zinc sulphate and/or commercial Epsom salt foliar spray solutions, along with two commonly used foliar spray formulations.

Foliar Fertilization Formulation	Yield (kg made tea ha ⁻¹ yr ⁻¹)
Water (control)	2668
Kiecite	2956
Zinc sulphate	2897
Zinc sulphate + CES	2728
Multiplex	3149
SE	91
CV %	3.2

Compared to the control treatments, all the micro-nutrient foliar sprays showed a higher yield. Multiplex-treated plots gave the highest yields.

The experiment continues.

T C N Peries, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi

2) Effect of application of micro-nutrient foliar feeds, such as Multiplex and Kiecite, along with two conventional zinc sulphate solution combinations (11 kg Zn ha⁻¹ yr⁻¹) on growth, soil- and plant-nutrient status, quality and yield of tea.

Clone TRI 2025, Field No. 9, Madulkelle Estate, Madulkelle (2000)

The experimental plots were pruned. The trial is in progress.

W M S Wijayatunga, P L K Tennakoon, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi

3) Effect of application of micro-nutrient foliar feeds, such as Multiplex and Kiecite, along with two conventional zinc sulphate solution combinations (11 kg Zn ha⁻¹ yr⁻¹) on growth, soil- and plant-nutrient status, quality and yield of tea.

Clone TRI 2025, Field No. 3 B, Greenwood Estate, Nawalapitiya (2000)

Spraying of foliar fertilizer following the ground fertilizer application was carried out. Nitrogen from U 709 was supplied at the rate of 320 kg N ha⁻¹ yr⁻¹.

The yield obtained in the 4th year is given in Table 65.

Table 65 - Effect on yield of conventional zinc sulphate and/or commercial Epsom salt foliar spray solutions, along with two commonly used foliar spray formulations.

Foliar Fertilization Formulation	Yield (kg made tea ha ⁻¹ yr ⁻¹)
Water (control)	3986
Zinc sulphate	4221
Zinc sulphate + CES	4272
Zinc sulphate + CES + Urea	4165
Multiplex	4112
Kiecite	4196

SE 156
CV % 7.5

No significant increase in yield due to foliar treatments was found.

The experiment continues.

W M S Wijayatunga, P L K Tennakoon, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi

4) Effect of application of micro-nutrient foliar feeds, such as Multiplex and Kiecite, along with two conventional zinc sulphate solution combinations (11 kg Zn ha⁻¹ yr⁻¹) on growth, soil- and plant-nutrient status, quality and yield of tea.

Clone TRI 2025, Field No. 3, Upper Division, Indola Estate, Deniyaya (2000)

Basal soil fertilizations along with foliar fertilizations were carried out. N and K₂O were supplied at the rates of 320 and 100 kg ha⁻¹ yr⁻¹ respectively.

The yield obtained in the 1st year is given in Table 66.

No significant variation in yield was found due to foliar spraying of the different formulations.

The experiment continues.

Table 66 - Effect on yield of conventional zinc sulphate and/or commercial Epsom salt foliar spray solutions, along with two commonly used foliar spray formulations.

Foliar Fertilization Formulation	Yield (kg made tea ha ⁻¹ yr ⁻¹)
Water (control)	2115
Zinc sulphate	2292
Multiplex	2286
Kiecite	2208
Chelamin	2155
SE 86.1	
LSD (0.05) NS	
CV % 7.7	

J R Y Abeywardane, W T B D Priyantha, M A Wijedasa, R P Kulatunga, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi

Project A 15.4. Evaluating the effects of foliar application of macro- and micro-nutrients on colour and strength of tea liquor.

1) The effect of foliar application of phosphorus (0, 1, 2, 3 and 4% DAP and TSP) on plant P status, quality (biochemical parameters), and yield of tea.

Clones DT 1 and CY 9, St Coombs Estate, Talawakelle (1992)

The nutrients were provided by soil fertilisation. Yield records were maintained and soil- and plant-nutrient status was assessed.

The experiment continues.

Table 67 - Effect of foliar applications of phosphate fertilizer on yield of clone CY 9.

Treatments P concentration (%)	Yield (kg made tea ha ⁻¹ yr ⁻¹)		
	Type of P fertilizer		
	TSP	DAP	Mean
1	2126	2155	2140
2	2123	2169	2146 SE 53
4	2105	2092	2098
Mean	2113	2120	2117
		SE 37	SE 75

Table 68 - Effect of foliar application of phosphate fertilizer on yield of clone DT1.

Treatments	Yield (kg made tea ha ⁻¹ yr ⁻¹)		
	Type of P fertilizer		Mean
P concentration (%)	TSP	DAP	
1	2005	2110	2057
2	1998	2015	2006
3	2010	2061	2035
4	2070	2002	2036
Mean	2113	2120	2117
		SE 33	SE 66

Table 69 - Effect of foliar application of phosphate fertilizer on yield of clone TRI 2025.

Treatment	Yield (kg made tea ha ⁻¹ yr ⁻¹)		
	Type of P fertilizer		Mean
P concentration (%)	TSP	DAP	
1	2377	2278	2327
2	2177	2081	2390
3	2269	2203	2236
Mean	2286	2255	2270
		SE 61	SE 122

The increasing rates of foliar P spraying did not significantly increase made tea yields in any of the clones tested (Table 67, 68 and 69).

R G A Wijayawardhana, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi

Project A15.6. An island-wide survey on identifying factors affecting response to applied potash (K) and sulphur (S).

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

G P Gunaratne, S M Dissanayake, W M S Wijayatunga and L S K Hettiarachchi

2. Thrust A 16. Development of regional and site-specific dolomitic limestone recommendations for amelioration of soil acidity and enhancement of soil productivity.

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

1) Effect of application of increasing levels of dolomitic limestone at three frequencies (cycle, mid- and yearly basis) on growth, soil- and plant-nutrient status, and yield of tea

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

The yield obtained in the 4th year of the cycle is given in Table 70.

The increasing rates of dolomite showed a significant effect on yield.

The experiment is in progress.

Table 70 - Effect of increasing levels of dolomitic limestone applications on yield (kg made tea ha⁻¹ yr⁻¹).

Rate of dolomite application (kg ha ⁻¹ pruning cycle ⁻¹)	Frequency of dolomite application			
	Cycle	Mid-cycle	Yearly	Mean
Control	3057	-	-	-
1250	3075	3079	3199	3118
2500	3017	3158	3198	3124 SE 52
5000	2857	2869	2935	2887
10000	2732	2912	-	2822 SE 64
Mean	2920	3005	3111	
SE	45	45	52	SE 90 (44 df)
CV % 6.7				

R G A Wijayawardhana, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi

3. Thrust A17. Development of fertilizer and/or dolomite applicators for improving broadcasting efficacy and overcoming labour shortage.

Some of the physical properties of tea fertilizer mixtures, and their component fertilizer materials, were tested. It was found that the bulk density, repose angle and friction angle intervene directly in the free flowing nature of the 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. They also provide a smooth surface for fertilizer materials to flow freely on the surface. When mature tea fertilizer is moist, it creates problems in the applicator, such as 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 certain volume of fertilizer confined in a cavity, and allows 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 (rpm), pitch size and diameter are being evaluated.

C S K A. Ratnayake, N P S N Bandara, W M S Wijayatunga, B F A Basnayake, S M Hulangamuwa, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi

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

1) Field trials at Gemi Seva Sevana

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

(a) Farmer-centered 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 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.

W M S Wijayatunga and A K N Zoysa

2) 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 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 were chemically-treated waste-tea compost at 5 mt and at 10 mt, and a control. The treatments were replicated thrice.

The first fertilizer treatment application to the soil was carried out in October 2003.

J R Y Abeywardana, S M Disanayake, P S Munasinghe and A K N Zoysa

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

A field trial was started in June 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 per plot of cultivar TRI 2027.

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 ZnSO₄ 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.

J R Y Abeywardana, S M Disanayake, P S Munasinghe and A K N Zoysa

Basic Research

a) Effect of mixing organic amendments on the dissolution of EPR and high-grade EPR (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, kapok, rubber, black caraway and compost) were used at the rate of 10 mt ha⁻¹ yr⁻¹ for the study. EPR 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 and 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 NH₄⁺-N and NO₃⁻-N through mineralization. Subsequent nitrification of ammonium in the soil helped dissolution of EPR and HERP. The concentration of borax-extractable P was found to be

greater in HERP-treated soil than that in EPR-treated soils at the lower rate of P, namely $100 \mu\text{g P g}^{-1}$ soil (as compared to $200 \mu\text{g P g}^{-1}$ soil). The dissolution of PR increased with the addition of organic amendments, causing an increase in borax-extractable P in the soil.

S. R. Amarasinghe and A. K. N. Zoysa

b) Influence of land management on soil quality indicators in a tea plantation in the 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 sloped 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 Hathhuala 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 amounts of C were 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 D Malmala Arachchi, S D Wanniarachchi and A K N Zoysa

c) Evaluating soil test methods for assessing bioavailability 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.

G P Gunaratne

5. 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 , $52.5 \mu\text{g N ml}^{-1}$ and $105 \mu\text{g N ml}^{-1}$), three K levels (0 , $42.5 \mu\text{g K ml}^{-1}$ and $98 \mu\text{g K ml}^{-1}$), and three Mg levels

(0, 15 $\mu\text{g Mg ml}^{-1}$ and 30 $\mu\text{g Mg ml}^{-1}$). The treatments were replicated thrice in a completely randomized design. Growth assessments are being assessed. The trial continues.

P L K Tennakoon, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi

6. 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, $\text{NO}_3\text{-N}$, $\text{SO}_4\text{-S}$, Mg and Ca are continuing.

P L K Tennakoon, S M Dissanayake, O G K A Gunaratne, W M S Wijayatunga, G P Gunaratne, A K N Zoysa, L S K Hettiarachchi, S L D Amaratunge, P B Ekanayake, S T Yatawatte, K D Dahanayake, J. A. S. K. V Jayasinghe and J C K Rajasinghe

7. Thrust B New. Evaluation of the effect of fertilizer application in up-country tea estates on down-stream pollution of water bodies.

A detailed field study was started in February 2003 as one component of a postgraduate study to assess the quality of water samples, collected from different places in a stream running down from the jungles of Horton Plains to tea plantations. The sampling sites covered the areas of the Horton Plains jungle, tea estates in Diyagama East and West, and the Sandringham and the Waverly Estates.

The objective of the study is to understand the effect of application of mineral fertilizers on pollution of downstream water bodies. Water sampling was done 34 times. The analysis continues.

R G A Wiyawardhane, H A Dharmagunawardhana and A K N Zoysa

Supportive Projects

1) Adaptive fertilizer trials

a) TRI and TSHDA collaboration

A detailed description of the trials along with objective/s and some of the important findings were published in the Annual Reports of 1996 - 1999. The operations of some of the trials continues.

S M Dissanayake, W M S Wijayatunga, G P Gunaratne, A K N Zoysa, L S K Hettiarachchi, S L D Amarathunge, P B Ekanayake, S T Yatawatte, K D Dahanayake and J A S K V Jayasinghe

b) TRI and Balangoda/Madulsima Plantations collaboration, 2002

High- (U 877) and low-potash (U 709) mixtures on the soil- and plant-nutrient status, growth and yield of seedling and clonal tea (El Teb, Mahadowa, Wewessa, Telbedde, Kew, Kirkoswald, Cecilton, Balangoda Estates, and Gonakelle Estate, Passara).

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

P S Munasinghe, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi

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

1) Analytical laboratory services

(a) Routine analytical work, SPND laboratories

The number of analysis routinely carried out on soil-, leaf- and fertilizer samples at the Talawakelle, Walahanduwa and Hantane laboratories are given in Tables 71, 72 and 73, respectively.

Table 71 – Routine analyses carried out at the SPND laboratory, Talawakelle.

Element	Soil	Leaf	Fertilizer	Organic	Total
Nitrogen	978	69	546	30	1623
Phosphorus	1732	368	495	18	2613
Potassium	1959	376	-	20	2355
Magnesium	2166	378	272	11	2827
Zinc	183	28	18	3	232
PH	2622	-	-	28	2650
Carbon	1996	-	-	26	2022
Particle size	-	-	83	-	83
100mesh	-	-	82	-	82
30 mesh	-	-	-	-	-
Calcium	326	178	-	3	507
Manganese	88	9	-	2	99
Iron	60	-	-	2	62
E.C	26	-	-	3	29
Sulphur	132	12	-	-	144
Copper	60	-	-	1	61
Ammonium-N	67	-	-	-	67
Nitrate-N	67	-	-	-	67
Sodium	60	-	-	3	63
Aluminium	161	-	-	-	161
Total	12683	1418	1496	150	15747

Table 72 - Routine analyses carried out at the SPND laboratory, Walahanduwa.

Element	Soil	Leaf	Fertilizer	Organic	Total
Nitrogen	380	83	263	28	754
Phosphorus	655	82	238	20	995
Potassium	759	83	256	21	1119
Magnesium	573	82	172	7	834
Zinc	13	9	6	-	28
PH	1170	-	-	23	1193
Carbon	759	-	-	23	782
Particle size 100mesh	-	-	37	-	37
30 mesh	-	-	37	-	37
EC	15		-	4	19
Boron	19	29	-	-	48
Zinc	13	9	6	-	28
C.E.C.	231	-	-	23	254
Calcium	37	17	-	2	56
Total	4624	394	1015	151	6184

Table 73 – Routine analysis carried out at the SPND laboratory, Hantane.

Element	Soil	Leaf	Fertilizer	Organic	Total
PH	97	-	-	-	97
Carbon	113	-	-	-	113
Total	210	-	-	-	210

Y D Kumarasiri, K K V A Premaratne, T C N Peries, S M Disssanayake, R G A Wijayawardhana, M A Wijedasa, J R Y Abeywardane, B D Priyantha, R P Kulatunga, W M S Wijayatunga, P L K Tennakoon, P S Munasinghe, S Ananthacoomaraswamy, G P Gunaratne, A K N Zoysa and L S K Hettiarachchi

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, CaCl₂ 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 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.

A K N Zoysa, A C R de W Wickramaratne, P S Munasinghe and S M Dissanayake

2. A method for detoxification of pollutants in order to improve the quality of city solid-waste compost.

This invention concerns detoxification of pollutants, binding of heavy metals and removal of unpleasant odour to improve the quality of compost made of 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. Owing 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.

A K N Zoysa, A C R De W Wickramaratne, P S Munasinghe, S M Dissanayake and D M B N Dissanayake

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 managers, 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.

A K N Zoysa, U Alagiyawadu, G P Gunaratne and M T Ziyad Mohomad

Publications

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General

Dr L S K Hettiarachchi left the island on February 4, 2003 for 11 months on sabbatical leave to pursue his post-doctoral research at Aberdeen University, United Kingdom.

Mr R G A Wijayawardhana commenced his field research work in early February to pursue his postgraduate training in Environmental Science at the University of Peradeniya.

Appointments

Dr A K N Zoysa was appointed as the Acting Head of the Soils and Plant Nutrition Division with effect from February 4, 2003. He continued his services in the Acting Head position until the end of December, 2003.

Mr Y D Kumarasiri and Miss K K V A Premaratne were appointed as contractual Technical Assistants from 4th August and 1st September, 2003, respectively.

Promotions

Messrs M A Wijedasa and W T B Priyantha were promoted to Grade III of the TRI service with effect from 1st June 2003.

Mrs S Ananthcoomaswamy and Mr G P Gunaratne were promoted to the Recruitment Segment of Grade I of the TRI service with effect from 1st October 2001 and 14th April 2003, respectively.

Mr S M Dissanayake was transferred to the SPND Laboratory, Walahanduwa with effect from 1st December 2003.

Dr A K N Zoysa served as:

- (a) a member of the Board of Studies in Environmental Science, in the Postgraduate Institute of Science, University of Peradeniya, Peradeniya;
- (b) a Visiting Lecturer in the Faculty of Agriculture, University of Ruhuna; and
- (c) a member of the Publications and Presentations Panel of the Institute.

Meetings and Seminars

Drs L S K Hettiarachchi and A K N Zoysa, Messrs G P Gunaratne, P S Munasinghe and Mrs S Ananthacumraswamy attended the 206th and 207th E & E meeting, where Dr L S K Hettiarachchi and Mr G P Gunaratne presented a paper: "Outcome of a collaborative trial on nitrogen and potassium, and classification, characterization and management of soils in the tea-growing areas of the wet zone of Sri Lanka". The meetings were held in the TRI Auditorium, Talawakelle, on 31st January and 26th July, respectively.

Dr A K N Zoysa attended the RSC VI (Ratnapura) meeting, held in the Low-Country Station, Ratnapura, on 13th March.

Dr A K N Zoysa attended the RSC II (Dickoya District) meeting, held at the Darrowela Planters Club on 11th April.

Dr A K N Zoysa attended a seminar on Promotion of Canadian GIS Project at Hotel Renuka, Colombo, on 6th May.

Dr A K N Zoysa attended a meeting with the Honourable Minister of Agricultural Research and Crop Productivity on the formation of the Agriculture and Plantation Development Council, Walahanduwa, at the Walahanduwa Plantation Human Development Trust Auditorium on 11th May.

Dr A K N Zoysa, Mr G P Gunaratne, Mr P S Munasinghe and Mrs S Ananthacoomaraswamy attended the 11th and 12th E & E (Sinhala) meeting, held at TRI Auditorium, Talawakelle, on 5th and 13th May and October, respectively.

Dr A K N Zoysa and Mr G P Gunaratne attended the RSC (Kandy) meeting, where Mr G P Gunaratne delivered a lecture on "classification and characterization of soils in the tea-growing areas of the mid-country", held at the Hotel Tourmaline, Kandy, on 26th May.

Dr A K N Zoysa attended the RSC III (Badulla District) meeting, held at the Uva Management Training Centre, Passara, on 14th July.

Mr G P Gunaratne attended a seminar on Plant Protection and Fertilizer Use in Tea, where he gave a lecture entitled "Soil-test based fertilizer recommendations: a tool for optimizing the nutrient supply to tea", held at the TRI Auditorium, Talawakelle, on 27th November.

Training Programmes and Workshops

Dr A K N Zoysa attended a workshop on "The use of phosphorus and potassium fertilizers in Sri Lankan Agriculture", in July.

Mr D M B N Dissanayake attended a three-day short course on Computer Applications and Statistics, organized by the Post Graduate Institute of Science at Peradeniya, from 9th to 11th May.

Dr A K N Zoysa and Mrs S Ananthacoomaraswamy attended a three-day Outward Bound Training Programme at Dambulla, from 18th to 20th July.

Mr P S Munasinghe attended a training programme and workshop on Laboratory Accreditation and ISO 17025:2000, organized by the Sri Lanka Standards Institution at the SLSI auditorium, Colombo, from 16th to 19th October.

Dr A K N Zoysa attended an International Training Programme on “Agricultural Research Management for Scientists from Sri Lanka”, held at the National Academy of Agricultural Research Management, Hyderabad, India, during 11th to 30th November.

Trainees

Miss S R Amarasinghe and Mr C D Malmala Arachchi (final-year Agriculture undergraduate students) from the University of Ruhunu successfully completed their six-month research projects in July, under the supervision of Dr A K N Zoysa.

Mr H W J P Amarasekera, an NDT trainee from the School of Agriculture, Kundasale, and Messrs C S Madarasinghe, O L A Abesinghe, NDT trainees from the Hardy Advanced Technical Institute, Ampara, successfully completed their five-months training programme in August, October and November, respectively.

Trainee Assistant Superintendents from Kegalle, Udapussellawa Plantations Ltd. and St Coombs Estate underwent a familiarizing programme on some aspects of soil fertility and tea plant nutrition, on 13th August and 3rd December, respectively.

Assistant Field Officers underwent a familiarizing programme on some aspects of soil fertility and tea plant nutrition”, on 20th August.

Visitors

Two officers from the Institute of Policy Studies, Colombo, visited the Division to familiarize themselves with soil fertility and nutritional aspects of tea, on 23rd January.

Messrs David Bromilow, Carl Barry, D K Nawaratne and M B A Perera of Flowerland, Hydroponics Cut Flower Growers and Agriculture Consultants visited the Division and discussed the challenges in soil fertility improvements and alteration of microenvironments, on 9th April.

A group of students from the University of Peradeniya and the Eastern University visited the Division to familiarize themselves with aspects of soil fertility and tea plant nutrition, on 23rd and 24th July, respectively.

Dr A C R de W Wickramaratne, Senior Lecturer from Tula University, Russia, participated in collaborative work with Dr A K N Zoysa and staff of the Division and Institute on the use of Humic substances (humates) in research and development work, from 24th April to 30th July.

Dr A K Dutta, Acting Director of the Tea Research Association, Tocklai, India, had discussions with staff of the Division regarding on-going projects and future needs for tea research, on 4th December.

TECHNOLOGY DIVISION

Actg Head – 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 ten trials were conducted at El Teb Estate, Passara.

Table 1. shows the details of the grade mix produced in the trial. The teas manufactured were sent to professional tea tasters for evaluation. The results of the evaluation are given in the Table 2. The teas manufactured in these trials were chemically analyzed. The results are given in the Table 3.

Table 1. The grade mix produced in orthodox rotorvane and orthodox-CTC tea manufacture

Trial No	Date	GL mc%	LS %	Wither	Dhool percentages						Grade percentages - Control						Grade percentages - Treatment					
					CTC	1st	2nd	3rd	4th	BB	Pekoe	BOP	BOPF	Dust	Off	RT	Pekoe	BOP	BOPF	Dust	Off	RT
3	17.06.2003	76.01	71	41.7	69.1	30.9	38.1	16.8	9.6	4.6	5.2	21.1	35.9	18.6	8.1	10.9	13.4	21.6	22.6	18.4	10.9	12.9
4	18.06.2003	77.88	85	40.4	68.2	31.8	46.7	14.2		7.3	11.9	23.2	28.5	14	6.9	15.5	10.3	21.4	32.6	23.2	5.2	7.3
5	23.06.2003	78.18	63	39.1	86	14	12.2	20.9	21.8	31.2	11.9	19.8	33.9	12.9	3.7	17.8	11.3	26.2	29.2	14.9	12.7	5.6
6	24.06.2003	79	79	37.3	85.6	14.4	20.7	21.3	21.6	22	5.7	25.8	36.1	13.4	9.9	9.1	7.6	19.6	30.2	22.7	14.2	5.6
7	07.07.2003	76.15	86	37.9	55.5	44.5	47.1			8.4	6.8	22.1	36.4	21.3	5.6	7.9	6.8	18.7	29.2	30.3	8.9	5.9
8	13.10.2003	77.42	76	36.1	73.9	26.1	36	21.1		16.9	13.6	23.1	29.7	9.9	17.6	6.1	7.4	25.2	31.1	18.1	4	14.2
9	14.10.2003	76.76	54	37.6	62	37	27	17		18	12.1	25.5	27.6	9.7	15.3	9.8	11.7	24.1	31.6	20.3	8.2	4.1
10	10.11.2003	79.82	42	31.2	57.7	42.3	19.6	21.2		16.9	19.6	23.1	16.5	7.7	15.1	18	11	23.9	25.8	15.7	6.9	16.4
11	12.11.2003	77.49	54	36.2	60	40	37	14.5		8.5	13.7	26.8	30.6	12.4	3.6	12.9	10.3	27.1	21.3	13.9	7.1	20.1
12	13.11.2003	76.61	36	34.5	58.1	41.9	32.6	13.2		12.3	14.9	34.4	28.3	13.9	6.6	1.8	11.7	21.8	24.2	14.8	14.3	13.3

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Table 2. The scores obtained through evaluation of test tea samples by professional Tea Tasters.

Trial	3 Taster 1		3 Taster 2		4 Taster 1		5 Taster 1		6 Taster 1		7 Taster 1		8 Taster 1		9 Taster 1		10 Taster 1		11 Taster 1		12 Taster 1	
	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T
Pekoe	17	15	16	18	12	17	13	13	14	12	12	15	13	16	17	16	13	15	13	17	12	16
BOP	16	19	16	18	13	14	14	13	15	14	9	13	15	16	18	18	14	17	16	17	13	17
BOPF	17	19	18	16	18	18	13	13	16	12	14	15	15	16	18	20	16	18	16	18	13	16
Dust	17	20	19	19	18	16	14	15	18	14	14	19	18	16	19	20	20	17	18	16	17	20
Off	16	10	18	16	17	21	14	14	13	13	11	18	17	17	19	21	15	No	16	No	16	21

Total score	83	83	87	87	78	86	68	68	76	65	60	80	78	81	91	95	78	67	79	68	71	90
TS - main	67	73	69	71	61	65	54	54	63	52	49	62	61	64	72	74	63	67	63	68	55	69
Off	16	10	18	16	17	21	14	14	13	13	11	18	18	21	16	10	18	16	17	21	14	14

Table 3. Results of the chemical analysis on test tea samples.

After 1st dhool extraction

Trial No		TF	TR	TC	BR	TR/TF	Water Extract
3	Control	0.8235	13.4704	4.31	17.39	16.36	44.01
	Treatment	0.7965	15.1079	4.83	14.77	18.97	43.58
4	Control	0.7695	13.2627	4.06	17.10	17.24	44.51
	Treatment	0.7762	13.6618	4.38	16.29	17.60	43.65
5	Control	0.6610	15.2894	5.13	11.34	23.13	44.82
	Treatment	0.7878	15.7685	5.04	13.63	20.02	46.03
6	Control	0.7807	16.1764	5.43	12.77	20.72	45.69
	Treatment	0.9022	16.2041	5.38	15.21	17.96	45.73
7	Control	0.6390	13.9310	4.26	13.21	21.80	43.75
	Treatment	0.6930	13.1289	4.86	12.36	18.95	44.16
8	Control	0.6637	15.0135	4.80	11.20	22.62	41.27
	Treatment	0.7897	14.4374	4.03	16.61	18.28	41.76
9	Control	0.8010	14.5255	4.27	16.25	18.13	40.37
	Treatment	1.0125	15.3458	5.33	16.76	15.16	41.09
10	Control	0.6818	13.6400	4.10	15.55	20.01	37.29
	Treatment	0.7268	13.3100	4.35	15.23	18.31	37.19
11	Control	0.6413	13.0200	4.64	12.52	20.30	38.71
	Treatment	0.7380	14.6700	4.62	14.88	19.88	37.26
12	Control	0.5940	12.5100	3.95	13.77	21.06	36.51
	Treatment	0.7470	14.2800	4.31	15.97	19.12	37.15
13	Control	0.7065	15.2600	4.61	15.31	21.60	43.11
	Treatment	0.7808	15.1300	5.13	15.49	19.38	29.61

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 test results (see the Table 4.) shows that the performance of the meter is unsatisfactory.

Table 4. Comparison of Victory Digital Moisture meter reading with the standard oven method reading.

Tea/ grade	Sample No.	Std Oven M.C reading (%)	Meter M.C reading (%)				Difference in M.C (%)
			Sample 1	Sample 2	Sample 3	Average M.C	
Fired dhool	1	7.8	8.6	8.5	8.6	8.6	0.8
	2	8.7	9.6	9.7	9.8	9.7	1.0
	3	2.7	6.2	6.1	6.0	6.1	3.4
	4	7.4	8.2	8.2	8.4	8.3	0.9
	5	4.8	6.4	6.6	6.7	6.6	1.8
	6	3.4	6.2	6.1	6.0	6.1	2.7
	7	4.6	6.6	6.6	6.6	6.6	2.0
	8	3.0	5.9	5.9	6.0	5.9	2.9
	9	5.1	6.3	6.6	6.5	6.5	1.4
	10	1.9	5.4	5.3	5.4	5.4	3.5
	11	1.8	5.5	5.6	5.6	5.6	3.8
	12	4.5	6.0	6.0	6.0	6.0	1.5
	13	2.1	5.4	5.3	5.3	5.3	3.2
	14	5.4	6.5	6.3	6.5	6.4	1.0
BOP	1	2.9	5.9	5.7	5.6	5.7	2.8
	2	7.0	6.9	6.9	7.1	7.0	0.0
	3	4.7	5.8	5.8	5.9	5.8	1.1
	4	3.6	5.4	5.2	5.4	5.3	1.7
	5	4.4	5.6	5.4	5.5	5.5	1.1
	6	4.7	5.5	5.7	5.7	5.6	0.9
	7	4.8	5.8	5.8	5.8	5.8	1.0
BOPF	1	4.4	5.4	5.4	5.4	5.4	1.0
	2	8.3	9.6	9.5	9.2	9.4	1.1
	3	3.7	6.0	6.0	6.0	6.0	2.3
	4	5.5	6.3	6.4	6.3	6.3	0.8
	5	4.0	6.2	6.2	6.2	6.2	2.2
	6	4.6	7.0	7.0	7.0	7.0	2.4
	7	3.6	6.0	6.0	5.9	6.0	2.4
Dust 1	1	3.2	7.2	7.0	7.0	7.1	3.9
	2	5.4	8.1	8.0	8.1	8.1	2.7
	3	4.0	7.6	7.5	7.7	7.6	3.6
	4	4.2	6.9	6.8	7.0	6.9	2.7
	5	4.3	6.7	6.9	6.9	6.8	2.5
	6	4.5	6.9	6.9	6.9	6.9	2.4
	7	6.2	8.6	8.5	8.5	8.5	2.3

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. The results of the sieve analysis carried out on Leafy type of tea are given in the Table 5.

Table 5. Results of sieve analysis of true to type grades

Sieve No.		3	3 ⁻	4 ⁺	4	5	6	7	8	10	12	14	16	18	22	25	BP
Grade	Rep	Weights (%) retained on B.S.sieves															
OPA	R1	0.61	3.49	14.96	24.45	34.62	13.15	4.29	2.33	1.06	0.84						0.20
	R2	0.81	4.09	17.16	26.42	29.32	13.32	4.03	2.33	1.30	0.94						0.27
OP	R1	0.00	0.02	0.20	0.46	7.92	41.90	24.92	13.68	6.85	2.70						1.36
	R2	0.06	0.04	0.36	0.43	6.25	45.61	22.75	14.21	6.15	2.60						1.55
OP1	R1					0.35	1.32	7.66	29.11	30.91	18.05	6.94	4.84	0.67	0.12		0.02
	R2					0.31	0.84	7.10	27.39	31.31	18.13	8.10	5.80	0.77	0.18		0.06
BOP1	R1				0.01	0.06	0.16	0.33	1.68	39.42	21.83	16.13	15.88	3.24			1.26
	R2				0.01	0.04	0.17	0.45	2.33	34.37	26.09	16.61	14.80	3.53			1.61
FBOP1	R1				0.04	0.00	0.09	0.22	1.79	24.34	30.91	15.36	17.98	5.77			3.50
	R2				0.01	0.02	0.10	0.23	1.57	22.44	33.99	15.06	17.53	5.86			3.18
FBOP	R1					0.00	0.07	1.07	6.91	29.74	32.94	10.44	13.15	3.73	1.35		0.60
	R2					0.02	0.27	4.72	19.26	30.47	20.16	10.97	10.10	2.78	0.86		0.39
Pekoe	R1	0.00	0.01	0.55	3.91	16.91	36.81	28.23	10.13	2.38	0.65						0.41
	R2	0.00	0.01	0.05	3.45	13.73	35.20	28.44	13.34	4.27	0.99						0.54
Pekoe1	R1	0.00	0.01	0.01	0.08	1.44	11.01	29.62	42.65	12.32	1.78						1.07
	R2	0.00	0.01	0.06	0.05	1.99	12.86	26.33	33.97	15.81	4.60						4.32
FBOPF	R1						0.00	0.01	0.01	0.23	3.31	21.31	28.01	20.73	14.79	6.63	4.99
	R2						0.00	0.01	0.01	0.22	2.87	18.81	27.95	20.55	15.53	7.99	6.06
FBOPF1	R1						0.00	0.05	1.19	9.16	37.57	19.29	19.20	8.42	3.52	1.21	0.40
	R2						0.02	0.19	1.99	11.84	34.59	20.46	19.08	7.40	3.08	1.04	0.33

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. The standard of leaves tested at St.Joachim Estate is given in the Table 6 – 18. The standard of leaves tested at St.Coombs Estate is given in the Table 19.

Table 6. Standard of leaf at St.Joachim Estate

LEAF STANDARD AND MOISTURE CONTENT OF GREEN LEAF (St. JOACHIM TEA FACTORY - 2003)

Item	2003.02.13		2003.02.14		2003.02.17		2003.02.18		2003.02.24		2003.02.26	
	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %
Standard Leaf	82.92	14.44	134.13	37.79	80.25	17.02	1219.02	75.96	141.37	30.64	128.78	27.43
Coarse Leaf	389.91	67.92	130.30	36.32	65.01	13.36	185.03	7.01	30.97	5.42	15.57	2.67
Damage Leaf	101.27	17.64	90.50	25.50	326.21	69.19	200.86	12.52	289.08	62.65	325.17	69.26
Sub Standard Leaf	491.18	85.56	220.80	62.21	391.22	82.98	385.89	24.04	320.05	69.36	340.74	72.57
Total Weight of the sample	574.10		354.93		471.47		514.91		461.42		469.52	
Moisture Content of GL	80.47%		79.54%		80.18%		78.95%		79.19%		75.83%	
Surface Moisture	Yes		No		Yes		No		No		No	

Table 7. Standard of leaf at St.Joachim Estate

Item	2003.02.27		2003.03.03		2003.03.12		2003.03.13		2003.03.14		2003.03.17	
	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %
Standard Leaf	177.91	38.81	135.73	28.63	216.72	45.97	174.35	36.29	161.88	34.11	144.80	30.65
Coarse Leaf	36.70	8.00	15.07	3.18	12.14	2.58	10.78	2.24	28.42	4.67	14.82	2.46
Damage Leaf	243.86	53.19	323.33	68.19	242.58	51.46	295.33	61.47	284.34	59.91	312.75	66.21
Sub Standard Leaf	280.56	61.19	338.40	71.37	254.72	54.03	306.11	63.71	312.76	65.89	327.57	69.35
Total Weight of the sample	458.47		474.13		471.44		480.46		474.64		472.37	
Moisture Content of GL	78.59%		77.54%		80.67%		81.92%		81.59%		78.06%	
Surface Moisture	No		No		Yes		Yes		Yes		No	

Table 8. Standard of leaf at St.Joachim Estate

Item	2003.03.19		2003.03.20		2003.03.21		2003.03.24		2003.03.25		2003.03.26	
	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %
Standard Leaf	111.97	23.88	171.84	35.55	121.10	25.45	138.90	29.40	140.90	30.26	103.44	21.91
Coarse Leaf	28.79	6.14	11.44	2.37	6.87	1.44	11.88	2.51	26.98	4.66	14.86	2.65
Damage Leaf	328.22	69.99	300.04	62.08	347.90	73.11	321.74	68.09	297.72	63.94	353.88	74.95
Sub Standard Leaf	357.01	76.12	311.48	64.45	354.77	74.55	333.62	70.60	324.70	69.74	368.74	78.09
Total Weight of the sample	468.98		483.32		475.87		472.52		465.60		472.18	
Moisture Content of GL	79.09%		80.59%		80.85%		79.40%		78.86%		80.39%	
Surface Moisture	Yes		Yes		Yes		Yes		No		Yes	

Table 9. Standard of leaf at St.Joachim Estate

Item	2003.04.04		2003.04.22		2003.04.23		2003.04.24		2003.04.29		2003.05.07	
	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %
Standard Leaf	198.47	40.91	197.03	41.85	117.84	24.80	138.43	28.60	125.37	26.82	106.89	22.97
Coarse Leaf	1.17	0.24	1.22	0.26	49.19	10.35	13.95	2.88	10.20	1.75	7.91	1.40
Damage Leaf	285.53	58.85	272.55	57.89	308.07	64.84	331.70	68.52	331.92	71.00	350.58	75.33
Sub Standard Leaf	286.70	59.09	273.77	58.15	357.26	75.20	345.65	71.40	342.12	73.18	358.49	77.03
Total Weight of the sample	485.17		470.80		475.10		484.08		467.49		465.38	
Moisture Content of GL	76.18%		78.06%		80.17%		78.86%		80.87%		8158.00%	
Surface Moisture	No		No		Yes		No		Yes		Yes	

Table 10. Standard of leaf at St.Joachim Estate

Item	2003.05.26		2003.05.29		2003.06.02		2003.06.03		2003.06.04		2003.06.05	
	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %
Standard Leaf	154.98	34.76	103.84	26.65	168.10	37.33	124.14	32.69	94.67	23.01	214.51	46.52
Coarse Leaf	22.06	4.95	6.12	1.57	9.73	2.16	8.39	2.21	12.26	2.48	29.60	4.58
Damage Leaf	268.86	60.30	279.62	71.77	272.43	60.51	247.22	65.10	304.49	74.01	217.00	47.06
Sub Standard Leaf	290.92	65.24	285.74	73.35	282.16	62.67	255.61	67.31	316.75	76.99	246.60	53.48
Total Weight of the sample	445.90		389.58		450.26		379.75		411.42		461.11	
Moisture Content of GL	77.51%		79.54%		77.65%		79.26%		79.28%		79.83%	
Surface Moisture	No		Yes		No		Yes		Yes		Yes	

Table 11. Standard of leaf at St.Joachim Estate

Item	2003.06.11		2003.06.12		2003.06.17		2003.06.19		2003.06.24		2003.06.25	
	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %
Standard Leaf	160.20	33.82	183.93	42.60	135.32	32.79	54.22	13.41	120.03	26.85	203.44	51.07
Coarse Leaf	10.83	2.29	7.88	1.82	1.70	0.41	1.36	0.34	5.64	1.00	4.62	0.77
Damage Leaf	302.67	63.89	239.99	55.58	275.63	66.80	348.88	86.26	321.45	71.89	190.27	47.77
Sub Standard Leaf	313.50	66.18	247.87	57.40	277.33	67.21	350.24	86.59	327.09	73.15	194.89	48.93
Total Weight of the sample	473.70		431.80		412.65		404.46		447.12		398.33	
Moisture Content of GL	80.17		79.44		78.31		81.12		77.94		78.13	
Surface Moisture	Yes		Yes		No		Yes		No		No	

Table 12. Standard of leaf at St.Joachim Estate

Item	2003.06.26		2003.06.30		2003.07.01		2003.07.02		2003.07.03		2003.07.08	
	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %
Standard Leaf	220.77	51.91	68.66	15.05	122.81	26.90	214.80	46.98	100.86	20.37	131.24	37.73
Coarse Leaf	11.07	2.60	4.21	0.92	2.48	0.54	3.75	0.82	11.33	1.94	5.07	1.07
Damage Leaf	193.42	45.48	383.35	84.03	331.25	72.56	238.62	52.20	382.83	77.34	211.57	60.82
Sub Standard Leaf	204.49	48.09	387.56	84.95	333.73	73.10	242.37	53.02	394.16	79.63	216.64	62.27
Total Weight of the sample	425.26		456.22		456.54		457.17		495.02		347.88	
Moisture Content of GL	79.24		82.69		80.24		79.44		80.9		79.58	
Surface Moisture	No		Yes		Yes		No		Yes		No	

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Table 13. Standard of leaf at St.Joachim Estate

Item	2003.07.15		2003.07.18		2003.07.22		2003.07.23		2003.07.24		2003.07.29	
	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %
Standard Leaf	207.42	50.27	144.97	35.14	108.06	48.44	259.73	55.18	219.50	49.21	206.46	52.00
Coarse Leaf	6.71	1.63	11.00	2.67	21.35	9.57	7.80	1.66	22.21	4.98	12.63	3.18
Damage Leaf I	152.20	36.89	189.38	45.90	70.08	31.41	154.81	32.89	113.72	25.50	149.74	37.71
Damage Leaf II	46.29	11.22	67.21	16.29	23.60	10.58	48.35	10.27	90.61	20.31	28.21	7.11
Sub Standard Leaf	205.20	49.73	267.59	64.86	115.03	51.56	210.96	44.82	226.54	50.79	190.58	48.00
Total Weight of the sample	412.62		412.56		223.09		470.69		446.04		397.04	
Moisture Content of GL%	81.0		81.69		81.78		80.8		78.89		78.12	
Surface Moisture	Yes		Yes		Yes		No		No		No	

Table 14. Standard of leaf at St.Joachim Estate

Item	2003.07.30		2003.07.31		2003.08.04		2003.08.05		2003.08.13		2003.08.14	
	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %
Standard Leaf	190.12	47.46	168.65	40.57	229.70	50.38	157.93	36.83	147.25	35.06	128.18	29.39
Coarse Leaf	28.41	7.09	63.60	15.30	40.72	8.93	34.61	8.07	26.76	6.37	52.10	11.95
Damage Leaf I	122.86	30.67	100.87	24.26	111.44	24.44	162.08	37.80	176.42	42.01	203.85	46.74
Damage Leaf II	59.16	14.77	82.63	19.87	74.08	16.25	74.20	17.30	69.54	16.56	51.98	11.92
Sub Standard Leaf	210.43	52.54	247.10	59.43	226.24	49.62	270.89	63.17	272.72	64.94	307.93	70.61
Total Weight of the sample	400.55		415.75		455.94		428.82		419.97		436.11	
Moisture Content of GL%	77.9		79.2		80.6		80.3		79.9		81.0	
Surface Moisture	No		No		Yes		Yes		Yes		Yes	

Table 15. Standard of leaf at St.Joachim Estate

Item	2003.08.18		2003.08.19		2003.09.09		2003.09.15		2003.09.16		2003.09.18	
	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %
Standard Leaf	181.22	41.54	77.97	18.90	136.24	29.05	115.52	27.29	136.60	34.01	111.90	23.75
Coarse Leaf	21.02	4.82	82.57	20.01	16.63	3.55	238.05	56.24	11.18	2.78	19.55	4.15
Damage Leaf I	150.94	34.60	98.63	23.91	231.83	49.43	59.42	14.04	200.79	49.99	302.24	64.16
Damage Leaf II	83.06	19.04	153.38	37.18	84.32	17.98	10.29	2.43	53.08	13.22	37.37	7.93
Sub Standard Leaf	255.02	58.46	334.58	81.10	332.78	70.95	307.76	72.71	265.05	65.99	359.16	76.25
Total Weight of the sample	436.24		412.55		469.02		423.28		401.65		471.06	
Moisture Content of GL%	78.92		67.01		80.02		79.4		78.84		79.02	
Surface Moisture	No		No		Yes		No		No		Yes	

Table 16. Standard of leaf at St.Joachim Estate

Item	2003.09.29		2003.09.30		2003.10.06		2003.10.07		2003.10.08		2003.10.14	
	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %
Standard Leaf	330.02	70.37	175.68	36.21	135.22	34.68	129.54	35.26	111.87	26.88	127.46	32.66
Coarse Leaf	13.43	2.86	252.61	52.07	15.12	3.88	13.97	3.80	2.79	0.67	16.61	4.26
Damage Leaf I	106.61	22.73	46.57	9.60	214.05	54.90	201.24	54.78	242.57	58.29	181.80	46.58
Damage Leaf II	18.93	4.04	10.29	2.12	25.49	6.54	22.59	6.15	58.92	14.16	64.40	16.50
Sub Standard Leaf	138.97	29.63	309.47	63.79	254.66	65.32	237.80	64.74	304.28	73.12	262.81	67.34
Total Weight of the sample	468.99		485.15		389.88		367.34		416.15		390.27	
Moisture Content of GL%	78.43		78.97		79.07		79.34		82.37		78.19	
Surface Moisture	No		No		Yes		No		Yes		No	

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Table 17. Standard of leaf at St.Joachim Estate

Item	2003.10.15		2003.10.27		2003.10.28		2003.10.29		2003.10.30		2003.10.31	
	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %
Standard Leaf	213.16	55.13	123.57	34.00	161.48	38.18	120.20	29.50	148.14	35.13	118.04	28.27
Coarse Leaf	6.25	1.62	7.16	1.97	9.85	2.33	9.22	2.26	2.21	0.52	14.68	3.52
Damage Leaf I	131.61	34.04	106.68	29.35	204.08	48.25	188.72	46.32	198.94	47.17	239.23	57.29
Damage Leaf II	35.62	9.21	126.07	34.68	47.57	11.25	89.26	21.91	72.42	17.17	45.64	10.93
Sub Standard Leaf	173.48	44.87	239.91	66.00	261.50	61.82	287.20	70.50	273.57	64.87	299.55	71.73
Total Weight of the sample	386.64		363.48		422.98		407.40		421.71		417.59	
Moisture Content of GL%	80.70		80.93		79.66		79.46		79.42		80.91	
Surface Moisture	Yes		Yes		No		No		No		Yes	

Table 18. Standard of leaf at St.Joachim Estate

Item	2003.11.04		2003.11.05		2003.11.06		2003.11.10		2003.11.17		2003.11.18	
	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %	Weight	Weight %
Standard Leaf	151.72	38.05	128.99	28.69	107.03	25.35	78.93	21.64	126.60	30.94	151.25	34.86
Coarse Leaf	21.76	5.46	28.83	6.41	17.83	4.22	34.20	9.38	25.28	6.18	34.87	8.04
Damage Leaf I	191.21	47.96	35.31	7.85	268.54	63.60	218.96	60.03	222.12	54.29	215.16	49.60
Damage Leaf II	34.00	8.53	256.46	57.04	28.84	6.83	32.69	8.96	35.17	8.60	32.55	7.50
Sub Standard Leaf	246.97	61.95	320.60	71.31	315.21	74.65	285.85	78.36	282.57	69.06	282.58	65.14
Total Weight of the sample	398.69		449.59		422.24		364.78		409.17		433.83	
Moisture Content of GL%	78.57		80.89		82.2		79.33		78.64		77.62	
Surface Moisture	No		No		Yes		No		No		No	

Table 19. Standard of leaf at St.Coombs Estate

Month	Leaf Standard 2003			
	St. Coombs		Lamilere	
	Count %	Weight %	Count %	Weight %
January	49	55	46	53
February	60	63	60	65
March	51	57	56	63
April	58	62	59	66
May	52	59	55	57
June	56	59	54	60
July	59	61	55	56
August	67	69	56	53
September	63	62	51	54
October	68	69	64	70
November	50	53	54	55
December	55	58	56	60

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 withered leaves were first rolled in orthodox roller and then rolled in 8" size rotorvane. The rolled leaf discharged from the rotorvane was passed through a roll breaker consisting of meshes No.6, 7 & 4. The dhool which were collected from No.6 & No.7 meshes were taken as 1st dhool. The leaves which passed through No.4 mesh were rolled again in rotorvanes and 2nd dhool, 3rd dhool, 4th dhool and big bulk were produced. Coarse leaves which come over the mesh No.4 were collected separately and rolled once in rotorvane to produce dhool (2nd dhool) and big bulk.

In the control the meshes which were used in the first roll breaker were No.6, 7 & 7 and dhools were produced without separating the coarse leaves.

The Table 20. shows the experimental data.

Table 20. Experimental Data on "Separation of coarse leaf in tea manufacture"

	Green leaf		Withered leaf		Dhool Wt (kg) / %							BB	
	Standard (%)		MC (%)	Wither (%)	Charge (kg)	1st	Through No.4	Over No.4	2nd	3rd	4th		2nd
	Count	Weight											
Control	78.9	76	75.88	45.2	208.7	69.3			58.35	21.90	18.20		34.05
						34.34			28.91	10.85	9.02		16.87
									Through No.4			Over No.4	
Treatment1	74.9	85.2	75.08	43.5	209	95.6	71.45	36.40	44.70	12.30	10.60	21.70	18.10
						47.09	35.12	17.89	22.02	6.06	5.02	10.69	8.92
Treatment2	71	80.3	75.41	39.2	225.8	80.35	99.50	46.30	62.95	18.65	16.75	17.60	29.90
						35.52	44.00	20.47	27.83	8.24	7.40	7.78	13.22

MC Moisture content
 Wither % Percentage made tea / withered leaf

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. The Table 21. shows the results of the chemical analysis.

Table 21. Results on chemical parameters of the test tea samples

Exp	trt	Blk	TF (%)	TR (%)	TR:TF	TC (%)	BR (%)
1	Cont	1	1.1702	19.1551	16.37	4.6411	22.9111
		2	1.1711	18.0112	15.38	4.5123	23.7741
		3	1.0203	17.7102	17.36	4.5422	20.1527
		4	1.1414	19.3832	16.98	4.8925	21.0104
	trt	1	0.9422	16.6011	17.62	4.2632	20.4015
		2	0.9812	16.6822	17.00	4.2914	21.1122
		3	0.9005	16.3225	18.13	4.7424	16.2142
		4	0.9203	19.0641	20.72	5.2817	15.1704
		5	0.9701	17.6214	18.16	4.5405	18.9819
2	Cont	1	0.9224	17.8612	19.36	3.8412	18.8009
		2	0.9804	18.7044	19.08	4.8111	15.7118
		3	0.9401	18.1611	19.32	4.7441	15.3511
		4	0.9241	18.2124	19.71	4.7821	15.1607
	trt	1	0.8822	17.4605	19.79	4.4504	17.7802
		2	0.9801	19.5531	19.95	4.6802	17.8222
		3	0.6921	18.3907	26.57	4.7770	13.7103
		4	0.8314	19.4403	23.38	5.0814	14.8111
		5	0.8132	20.8211	25.60	4.8722	6.4820
3	Cont	1	1.4307	26.8311	18.75	4.7222	17.5512
		2	1.9005	28.9822	15.25	4.7807	19.9331
		3	1.3210	27.6907	20.96	4.9022	14.2325
		4	1.5113	19.3008	12.77	5.3113	16.4422
	trt	1	1.3125	19.3332	14.73	5.1008	16.7423
		2	1.3522	18.8411	13.93	5.4915	15.4708
		3	1.2910	27.3220	21.16	5.1809	15.455
		4	1.1402	27.6806	24.28	6.3206	13.4112
		5	1.2140	29.0422	23.92	5.0723	14.0706
4	Cont	1	1.6511	27.4400	16.62	4.8814	18.4407
		2	1.8621	33.4301	17.95	4.9922	17.1714
		3	1.6604	30.3006	18.25	4.9817	17.4431
		4	1.4116	27.8411	19.72	4.5631	15.4205
	trt	1	1.6009	28.2608	17.65	4.4311	18.9006
		2	1.5512	29.5721	19.06	4.3250	17.6611
		3	1.5103	25.2111	16.69	5.1608	18.2824
		4	1.9515	33.2600	17.04	4.7616	17.6008
		5	1.6608	31.3630	18.88	4.8922	16.2318

Results from chemical analysis of samples indicated that there was no significant difference in quality parameters (Theaflavin, Thearubigin, colour & brightness of the liquor) between control and treated samples. Tasters' evaluation too did not report any quality differences in first and second dhools, from control as well as treatment samples. But, they preferred the

3rd and 4th dhools from the treatment samples to control. Therefore, it could be concluded that the quality of treatment samples had improved overall.

There was considerable improvement in the appearance of made tea samples as a result of the treatment. This was evident from presence of lesser amounts of fibre in 2nd, 3rd & 4th dhools of the treatment. Presence of lesser amounts of stalks and fibre minimizes sifting room operations. This in turn, will assist to preserve the quality in tea while directly reducing the cost of cleaning of made tea.

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 pectinase 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 59 advisory visits to factories with regard to various aspects of tea manufacture. The Table 22. shows the details of the advisory visits.

Table 22. Advisory Visit to Estates

Estate	Purpose of visit
Geekiyana kande	Advise on Tea Withering
Laksakande	Advise on Tea Withering
Vogan	Drier performance test
Southern tea factory	Drier performance test
Millakande tea factory	Advice on tea Manufacture
Talangaha	Drier performance test
Noori Estate	Drier performance test
Vogan	Drier performance test
Tea shakthi Mawarala	Advice on tea Manufacture
Geekiyana hena	Advise on Tea Withering
Sannasgama	Advise on Tea Withering
Sherwood	Advise on tea Grading
Nilvin View	Advise on tea Grading
Wootan	Drier performance test
Deenside	Advice on tea Manufacture
Dunkeld	Drier performance test
Kew Estate	Drier performance test
Deenside	Advice on tea Manufacture
Mousakelle	Advice on tea Manufacture
Ratnapura S.S	Advice on tea Manufacture

Troup	Drier performance test
Frotoft	Rolling programme
Wedamulla	Rolling programme
Brookside	Rolling programme
Liddesdale	Rolling programme
Kurugama	Rolling programme
Ancumbura	Rolling programme
Imboolpitiya	Rolling programme
Moray	Rolling programme
Brunswick	Rolling programme
Houteville	Rolling programme
Waverly	Rolling programme
Diagama East	Rolling programme
Laxapana	Rolling programme
Bambarakelle	Drier performance test
High Forest	Drier performance test
Poysland	Rolling programme
Alagalla	Rolling programme
Deenside	Rolling programme
Dambetanne	Rolling programme
Haputale	Rolling programme
Courtledge	Drier performance test
Mayfield	Drier performance test
Liddesdale	Drier performance test
Neluwa	Drier performance test
Waverly	Drier performance test
Greenwood	Advice on tea Manufacture
Concordia	Drier performance test
Mahanilu	Advice on tea Manufacture
Radella	Drier performance test
Frotoft	Advice on tea Manufacture
Weddamulla	Advice on tea Manufacture
Dusinane	Drier performance test
Greenview	Advice on tea Manufacture
Waverly	Drier performance test
Dotaloya	Advice on tea Manufacture
Craiglea	Drier performance test
Brunswick	Drier performance test
Mahanilu	Advice on 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)

Applied Research

1. Thrust A 31. Identification of appropriate labour-use patterns to improve profitability in tea plantations.

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 owing to lack of staff. A sample of sixteen estates was selected in the above three administrative districts, by the Advisory and Extension Division staff, Ratnapura.

The following data will be collected from the selected estates.

- (i) Change of total labour force, labour out-turn, total tea production and labour productivity.
- (ii) Views of managers and field staff on the estate workforce, out-turn, and alternative strategies undertaken to complete the workload.
- (iii) Views of the estate workers (both resident and non-resident) with regard to estate work, income, living standards, alternative job opportunities available in the location, etc.

The survey was completed in the Ratnapura and Kegalle 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.

Plans are in progress for undertaking a survey which has the objective of identifying the factors that discourage soil conservation investments in tea lands of the large plantations

as well as of the smallholdings, and assessing the amount of soil conservation investments undertaken by tea growers belonging to different management categories.

A questionnaire has been developed for this purpose.

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.

Basic Research

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.

Divisional Projects and Activities

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.

The Agronomy Division undertook irrigation and fertigation trials in the up-country and low country. Data obtained from these trials were used to analyse the cost benefit of this operation, and the results are given below.

Yield increments due to fertigation were in the range of 50 to 100%. The initial capital cost for the equipment sets required for fertigation of one hectare of tea was about Rs 550,000.

Table 1. Economics of fertigation of mature tea in the up-country

<u>With a 50% yield increment and an NSA of Rs 145</u>	<u>With a 100% yield increment and an NSA of Rs 145</u>
NPV of the investment for a 10-year period at a 10% discount rate - Rs (-31,369)	NPV of the investment for a 10-year period at a 10% discount rate - Rs (264,905)
Internal rate of return - 8%	Internal rate of return - 24%
Pay back period - 7 years and 2 months	Pay back period - 4 years and 8 months
<u>With a 50% yield increment and an NSA of Rs 150</u>	<u>With a 100% yield increment and an NSA of Rs 150</u>
NPV of the investment for a 10-year period at a 10% discount rate - Rs (60,798)	NPV of the investment for a 10-year period at a 10% discount rate - Rs (392,871)
Internal rate of return - 13%	Internal rate of return - 31%
Pay back period - 6 years and 3 months	Pay back period - 3 years

Table 2. Economics of fertigation of mature tea in the low country

<u>With a 50% yield increment and an NSA of Rs 145</u>	<u>With a 100% yield increment and an NSA of Rs 145</u>
NPV of the investment for a 10-year period at a 10% discount rate - Rs (-87,058)	NPV of the investment for a 10-year period at a 10% discount rate - Rs (218,443)
Internal rate of return - 5%	Internal rate of return - 22%
Pay back period - 7 years and 11 months	Pay back period - 4 years and 10 months
<u>With a 50% yield increment and an NSA of Rs 150</u>	<u>With a 100% yield increment and an NSA of Rs 150</u>
NPV of the investment for a 10-year period at a 10% discount rate - Rs. (5,109)	NPV of the investment for a 10-year period at a 10% discount rate - Rs. (341,355)
Internal rate of return - 10%	Internal rate of return - 28%
Pay back period - 6 years and 9 months	Pay back period - 4 years and 2 months

The above results indicate that in general fertigation is highly economical when the yield increment is about 100%, and the sales average of the made tea is about Rs 150 per kg, both in the low country and in the up-country. However, the cost of the fertigation operation and the yield increment would depend on the location. Therefore the economics of the operation varies with the location.

Project D 35.2.2. Cost-effectiveness of the nematode control methods recommended for tea nurseries.

Fumigation of tea-nursery soils with methyl bromide (MeBr) was widely used in the past as an efficient method for control of tea nematodes. Dazomate 98% G (Basamid) was also recommended as an alternative for MeBr. Since MeBr is now identified as an ozone-layer depleting agent, it has become necessary to do away with MeBr in the near future. As a result of the of the recent research findings of the Entomology Division, alternative chemical methods and non-chemical methods have been recommended for controlling nematode pests in tea nurseries. The technical efficiencies of these recommendations are found to be similar.

The cost effectiveness of these newly-recommended methods were analyzed. The results are given below in Table 3.

Table 3. Cost effectiveness of soil treatment methods

<u>Treatment for nematode control</u>	<u>Cost of soil treatment per nursery plant (Rs)</u>
1. Methyl bromide	1.50
2. Dazomate	1.31
3. Metam sodium	1.30
4. Soil solarization after mixing with urea	1.19
5. Paddy husk: soil (1:1)	0.99
6. Refuse tea: soil (1:1)	0.78

The results show that the use of the soil alternatives, refuse tea and paddy husk, are the most economical treatments. Soil solarization is also economical, in addition to being more environmentally friendly when compared to MeBr and Dazomate usage.

Project D 35.2.4. Cost-effectiveness of different weed-control methods.

A study was undertaken by the Agronomy Division at the Mid-Country Centre to study the effectiveness of eight methods of weed control in mature tea. The data from the trials were used to assess the cost effectiveness of these weed-control methods.

The results are given in Table 4.

Table 4. Cost benefits of manual and chemical weed-control methods

<u>Treatment</u>	<u>No. of workers/ha</u>	<u>Cost of weeding (Rs/ha)</u>	<u>Gross margin (Rs/ha)</u>
1. Manual weeding at monthly intervals	355	48,266	185,788
2. Manual weeding at two-month intervals	212	28,832	168,181
3. Manual weeding at three-month intervals	168	22,808	170,068
4. Chemical weeding with Paraquat (1.1 litres/ha)	112	34,465	153,959
5. Chemical weeding with Glyphosate (0.3%)	70	25,254	150,290
6. Chemical weeding with Sulphosate (0.3%)	69	28,149	139,659
7. Chemical weeding with Paraquat 1.1 litres/ha + 2,4 D (1.5 kg/ha)	68	35,483	162,770
8. Chemical weeding with Paraquat 1.1 litres/ha + 2,4 D (1.5 kg/ha) + Diuron	57	39,903	146,697
9. Slash weeding (control)	172	23,375	170,370

The above results indicate that manual weeding at monthly intervals is the most costly method of weed control. The cost of the other two manual-weeding methods is in the same range as the chemical-weeding methods using Glyphosate or Sulphosate.

The results of the gross margin calculations (the difference between the total revenue and the total cost of the field management/ha) show that manual weeding at monthly intervals gives the highest gross margin. The other two manual-weeding methods also give higher gross margins than the chemical-weeding methods.

These results indicate that manual weeding is more beneficial than chemical weeding in a situation where an adequate work force is available.

8 Project D 35.3. Project monitoring activities.

The INFORM database for the year 2003 was completed and submitted to the national INFORM Coordinator.

9. Staff

Miss R G N Rupasinghe joined the Division as a Contract Research Assistant with effect from the 4th August.

Dr Gaminda Ganewatta returned to the Division in October, after completing his Ph D at La Trobe University, Australia.

10. Publications

1. Jayakody JAAM, Shyamalie HW and Rajapaksa RMSS, 2003. Agricultural Economics in Tea Research. In: *Twentieth Century Tea Research in Sri Lanka* (ed. WWD Modder), p. 259-271. The Tea Research Institute of Sri Lanka.

2. 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.

3. 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.

11. The introduction of 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.

12. 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 31st 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.

ADVISORY AND EXTENSION SERVICES

Head – B. A. D. Samansiri

Staff as at 31st December 2003

Mr B A D Samansiri	I	Head
Mr S T Yatawatte	I	Senior Advisory Officer, Kandy
Mr J C K Rajasinghe	II	OIC/Advisory Officer, Passara
Mr J A S K V Jayasinghe	II	OIC/Advisory Officer, Deniyaya
Mr K D Dahanayake	II	OIC/Advisory Officer, Galle
Mr V S Sidhakaran	II	Advisory Officer, Talawakelle
Mr K M S L D Amaratunge	II	Advisory Officer, Ratnapura
Mr S Sanjayan		Research Assistant (Contract)
Mr H J M de Silva	III	Extension Officer, Kandy
Mr K G J P Mahindapala	IV	Extension Officer, Ratnapura
Mr R M A C Rajakaruna	IV	Extension Officer, Passara
Mr. Suranjan Fernando	IV	Extension Officer, Talawakelle
Mr T G N Mahinda	IV	Extension Officer, Ratnapura
Mr Saman Ratnayake	IV	Extension Officer, Galle
Mr K R W B Kahandawa	IV	Extension Officer, Kandy
Mr K K P Katulanda	IV	Extension Officer, Deniyaya
Mr L A M R C Liyanarachchi	IV	Extension Officer, Talawakelle
Mrs M A H Nishanthi	IV	Extension Officer, Talawakelle
Mr K G R Niroshan	V	Photographer
Mr N S Ekanayake	V	Audio Visual Assistant
Mr J T Thevadasan	V	Dark Room Attendant
Ms A S Jayasekara		Technical Assistant (Contract Basis)
Nalin Nishantha		Technical Assistant (Contract Basis)
Mr O W Jayawardana,	V	Station Assistant, Deniyaya
Mr E K Somapala	VI	Station Assistant, Galle
Station Assistant		Vacant (Passara)
Mrs Indrani Jayawickrema	VI	Clerk/Typist, Talawakelle
Mr M Sarath	V	Field Supervisor, Kottawa
Mr P S Kulasiri	VI	Field Supervisor, Kottawa
Mr Jagath Presanna	VI	Circuit Bungalow Keeper, Kottawa
Mr M I Mettananda		Driver, Galle
Mr A M Karunasundara		Driver, Passara
Mr K W K Chaminda		Driver, Deniyaya

Retirement, Appointments, Transfers and Leave

Mr S Wimaladharma, Head of the Advisory and Extension Services, retired from the services of the Institute with effect from 10 March 2003.

Mr B A D Samansiri, Senior Advisory Officer, was appointed Head of the Advisory and Extension Services with effect from 10 March 2003.

Mr J C K Rajasinghe was made permanent in the post of Officer-in-Charge of the Passara Station.

Mr J A S K V Jayasinghe was made permanent in the post of Officer-in-Charge of the Advisory and Extension Centre, Deniyaya with effect from 1st June 1996.

Mr S T Yatawatte was promoted to Grade 1 of the Institute's service, and designated as Senior Advisory Officer, with effect from 1st March 2003.

Mr S T Yatawatte, Advisory Officer, was appointed the Institute's Coordinator for the ADB Mother Bush Planting Programme, with effect from 1st February 2003.

Mr S Sanjayan, Research Assistant, was recruited on a contractual basis from 28th July 2003.

Mr Nalin Nishantha, Technical Assistant, was recruited on a contractual basis from 28th July 2003 to handle the networking and the maintenance work of computers in the Institute.

Ms A S Jayasekara was appointed Technical Assistant on a contractual basis, for three years, with effect from 4th August 2003.

Mr N Sinnathamby, Field Supervisor, retired from the Institute's service with effect from 17th April 2003.

Mr R Nandasena, Station Assistant, was transferred to Talawakelle with effect from 4th September 2003.

Mr R W Suwaris, Field Supervisor, was transferred to Talawakelle with effect from 1st December 2003.

Mr K K P Katulanda, Extension Officer, was transferred from the Advisory and Extension Centre, Deniyaya to Talawakele with effect from 01st October 2003.

Mr Suranjan Fernando, Extension Officer, was granted two years' no-pay leave, with effect from 15th December.

Summary of Advisory and Extension Activities

	Description	T'kelle	R'pura	Passara	Kottawa	Hantane	Deniyaya	Total
1	Advisory correspondence to estates/small holders	787	858	122	187	242	139	2335
2	Advisory visits (on-call and routine visits) to corporate sector and small holder sector.	216	193	92	47	176	74	798
3	Training programmes/ seminars/ NIPM programmes/group discussions/ field days/demonstrations/ educational programmes/ familiarization programmes	33	158	09	60	16	14	290
4	RSC programmes	01	02	02		02		07
5	Visitors to the Division: estates/students/ overseas/smallholders/ others	4480	841	393	859	486	389	7448
6	Issue of publications/ leaflets/extension pamphlets	2669	3045	85	-	185	972	6956
7	Other activities-NIPM /meetings	02	32	26		02	29	91
8	Exhibitions	03	02		02			
9	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	

Staff Training:

- Mr Shantha Jayasinghe, Advisory Officer/OIC Deniyaya Regional Station, participated in a training program on "Design & Development of Instructional Materials using Desktop, Web and Multimedia Tools" from 28 April to 28 May 2003, at the Asian Institute of Technology, Thailand.
- Mrs Hiromi Nishanthi, Extension Officer, attended a one-day Workshop on "Effective Proposal Writing, Conducting and Publishing Academic Research", organized by the National Science Foundation.
- Mr Rajika Nirosan, Photographer, successfully completed a training programme on "Graphic Designing and Desktop Publishing", at the Youth Council, Dehiwala.
- Mr M K S L D Amarathunga, Advisory Officer, and Mr K G J P Mahindapala, Extension Officer, attended a training programme on "Agricultural Extension: Methods and Approaches", under the ICAR-CARP Work Plan for 2003/04, at the Indian Agricultural Research Institute, New Delhi, during 6-18 December.
- Mr M K S L D Amarathunga attended the AIACC Project Workshop on developing integrated models for examining the effect of climate change and variability in the tea and coconut sectors in Sri Lanka, held at Hotel Galadari, Colombo during 16 -20 June.
- Mr J T Thevathasan underwent a computer training programme on photo-editing and desktop publishing at the Gamini Dissanayake Vocational Training Centre, Nuwara Eliya.

1. Routine Advisory Activities

Routine 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.

These visits were largely made as a special activity, undertaken by the Staff of the Advisory and Extension Services to cover all the 304 tea estates managed by the Regional Plantation Companies (RPCs), in April-September 2003.

The other visits were undertaken as and when requests were made 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.

1.3 Routine Estate Visits

This activity was undertaken by Mr R.K.Nathaniel, Consultant, and 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 proactive one with a high degree of client focus.

In addition to giving advice during these visits, a mass of valuable information was collected, initially in a pre-evaluation pro forma sent to the estates prior to the visit, and then by means of a thorough and detailed field-by-field evaluation during, and after, the visit.

2. Extension Programmes

2.1 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.

- Fourteen training programs were conducted on plucking, pruning, general cultivation practices, and use of fertilizer, for staff of the TSHDA and small holders in the Matara district.

J A S K V Jayasinghe and Kapila Katulanda

- Two training programmes on nursery management were conducted at the Station for small holders. These programmes were co-ordinated by the *Hadabima* Authority.

S T Yatawatte and B Kahandawa

- One training programme on nursery management was conducted for a group of smallholders at Menikdewela. This was organized by the *Samurdhi* Authority.

S T Yatawatte and B Kahandawa

- A one-day Workshop on New Agricultural Innovations in the tea industry was conducted for twenty-five Union Leaders in the Uva Region.

J C K Rajasinghe and V S Sithakaran

2.2 NIPM Training Programmes

Advisory staff participated as resource personnel for the following training programmes, conducted by the NIPM.

- Seven NIPM training programmes, on effective harvesting systems and minimizing the post harvesting losses in tea, was held for leaf suppliers and collectors of private tea factories in the Ratnapura Region, on November.

S L D Amarathunga

- A presentation was made on tea cultivation for NIPM students on 5th October.

T G N Mahinda

- Three Advisory Officers served as resource persons in the training programmes for planter trainees, organised by the NIPM in March.

B A D Samansiri, S T Yatawatta and J C K Rajasinghe

2.3 Awareness Programmes:

Sixteen awareness programmes were conducted for TSHDA staff and small holders in the flood-affected areas in the Ratnapura District, on the mitigation of flood damage in tea fields, during May - June 2003.

2.4 One-Day Training Programmes for University and Diploma Students

One student from the NAITA, Ratnapura, underwent training in stenography, typing and data entering, for a period of six months.

Two Diploma students from the School of Agriculture, Hardy, Naiwala, Kuliyaipitiya, underwent a four-month in-plant training programme on tea cultivation, at the Ratnapura Station.

One trainee, assigned through the *Thurunu Saviya* Programme, underwent training on data management and in computer activities in the Advisory and Extension Division, Talawakelle.

Three one-day education programmes on tea cultivation and extension activities in the Institute were held for Diploma students of the Agriculture Schools at Palwehera, in Aquinas and at Kuliyaipitiya.

Hiromi Nishanthi, Roshan Liyanarachchi and Suranjan Fernando

Two programmes were conducted, for the students of the University of Peradeniya and the University of Jaffna, on tea cultivation (general) and extension activities in the tea industry.

V S Sithakaran, B A D Samansiri, Suranjan Fernando, Hiromi Nishanthi and
Roshan Liyanarachchi

Four educational programmes on tea cultivation and processing, for the students of the Girls High School Kandy, Hemamali Balika Vidyalaya, Kandy and Seevali Maha Vidyalaya, Borella, were conducted at the Advisory and Extension Division of the Hantana Station.

S T Yatawatte and B Kahandawa

2.5 Familiarisation Programmes

Three familiarisation programmes for planter trainees were organised.

The Advisory Staff conducted a lecture for three Iranian trainees on tea cultivation (general), and also showed them around the Museum and the fields of St Coombs Estate.

Thirty-five field supervisors, who were attending training programme at NIPM, visited the Institute to acquire knowledge on its activities.

Two Workshops on the maintenance of mother bushes were held, in the auditorium of the Institute at Hantana, for Regional Managers, mother bush-site managers of the TSHDA, Superintendents, and OICs of the Institute's Stations. Both Workshops were chaired by the Institute's Director. The Project Coordinator for the Tea Development Project, and the other officers from the Project Office, also attended the meetings.

S T Yatawatta

2.6 Group Discussions

The following four group discussions were held in the Advisory Division, in collaboration with relevant scientific staff.

- On general agricultural practices, for Managers/Assistant Managers and field staff of the Maha-Oya Group, Bogawantalawa Plantation Ltd., on 19 March.

S L D Amarathunga, T G N Mahinda and K G J P Mahindapala, and the staff of the Agronomy and Plant Breeding Divisions

- An introductory discussion on the T Tape drip irrigation system for irrigating and fertigating tea lands, for the benefit of progressive Middle and Small Level tea growers, with staff of the Agronomy Division was held on 3 September.

S L D Amarathunga, T G N Mahinda and K G J P Mahindapala, and the staff of the Agronomy Division

- On problems associated with the quality of made tea in the Balangoda region, for the General Manager/Superintendents and Assistant Superintendents, Balangoda Plantation Ltd., on 18th September.

S L D Amarathunga, T G N Mahinda and K G J P Mahindapala, and the staff of the Agronomy and the Technology Divisions

- On general agricultural practices, with the Agronomy and the Plant Breeding Divisions, for the Managers/Assistant Managers, Kotagala Plantations, Kalutara Region, on 24th September.

S L D Amarathunga, T G N Mahinda and K G J P Mahindapala, and the staff of the Agronomy and the Plant breeding Divisions

- On all aspects of pruning was held for the General Manager (Plantations) and Managers of Kegalle Plantations Ltd.

V S Sithakaran, B A D Samansiri, and the staff of the Agronomy and of the Agricultural Economics Divisions

2.7 Seminars, Field Days and Demonstrations

- Sixteen demonstration programmes were conducted by the Advisory and Extension Division of the Low Country Station for the executive staff, field officers and workers of estates in the corporate sector, and for small holders, on cleft grafting, introduction of the TRI-Selective Tea Harvester and of the Plucking Basket, use of poly-tunnels, soil substitutes for the nursery, etc.

- A series of demonstrations was organised by the Advisory and Extension staff, in collaboration with the Head and the staff of the Entomology Division, on new techniques for soil substitutes in nursery bags, and new methods for soil fumigation. These demonstrations were for the benefit of the Management and field staff of nine clusters of RPC estates: Kataboola Estate (35 participants), Gampaha Estate (34 participants), Waverly Estate (25 participants), Batawatta Estate, Balangoda Estate Helbodde Estate, Mattakelle Estate and Telbedde Estate.

Suranjan Fernando, Kapila Katulanda, and staff of the Entomology Division

- A field day on all aspects of plucking was organised for the Managers and Assistant Managers of Udapussallawa, Maturata, Kegalle, Kelani Valley and Kahawatta Plantations.

Dr Anandacoomarswamy, Dr M A Wijeratha and Mr P B Ekanayake delivered the lectures.

B A D Samansiri and Suranjan Fernando

- A series of demonstrations was organised for the RM, ARM and TI/EO of the TSHDA. by the Advisory staff, in collaboration with the Head and the staff of the Entomology Division, in Kegalle (30 participants), Kalutara (35 participants), Galle (34 participants), Bandarawela (30 participants), Kandy (26 participants) and Matara (30 participants).

Suranjan Fernando and B A D Samansiri

- A field day was organized in collaboration with CIC fertilizers Ltd., on fertilizer management, tea pest management and weed management in tea fields, for the Managers and Assistant Managers of all the RPCs in up-country regions.

Mr Gamini Gunarathne, Mrs S I Vitharana and Mrs Laxmi de Silva delivered lectures on the relevant subjects.

- One-day educational programmes were conducted for the following groups of students and trainees on general tea cultivation practices, pruning, plucking, etc.. and the use of the TSTH for students of the Kuliyaipitita Technical College. Aquinas College, the staff of the Department of Technical Education and Training, and some Japanese students.

- Three demonstration programmes on the use of the TSTH were conducted for the field staff and workers of Strathdon Estate, Dickoya Estate and Abbosteleigh Estate, in participation with the staff of the Agronomy Division.

Suranjan Fernando

- A demonstration programme was conducted at Duckwari Estate, Rangala, for field staff of Udupussellawa Plantations, on methods of collecting soil and leaf samples.

S T Yatawatte

- Two demonstration programmes were conducted on shear harvesting for workers and field staff at Duckwari Estate, Rangala.

S T Yatawatte and B Kahandawa

- A Mobile Advisory Service was conducted by the Advisory Division for small holders at the AGA's Office, Godakawella. JPM, TGN

3. Regional Scientific Committee Activities

Seven Regional Scientific Committee (RSC) seminars were organized for the plantation managerial staff of RPCs in the Dickoya, Kandy, Uva and Ratnapura Regions.

RSC Seminars

The following topics were presented and discussed at RSC seminars.

RSC, Kandy Region

Improvement and management of fertility in mid-country tea soils.
Classification and characteristics of soils in tea-growing areas of the mid-country.

Biological control of tea pests
Pesticides residues of made tea
Fertiliser application in tea

(28th November)

RSC, Ratnapura and Kalutara Region

Contingency plans to overcome the current crisis situation in the Low Grown Tea Sector (13th March)

S L D Amaratunga

Back to Basics

Mr Daya Wickramatunga

Planning and implementation of field operations to produce quality tea

Processing of tea to meet buyers' expectations

An effective harvesting system for enhancing productivity and quality of tea (14th November)

S L D Amaratunga

Harvesting policies in tea
Ergonomics of harvesting in tea
Mechanical harvesting in tea
Post harvesting losses in tea

RSC, Passara Region

Effects of harvesting frequencies on yield and leaf standard
Energy saving on tea manufacturing
Nett out-turn of made tea to green tea.

J C K Rajasinghe

Rush crop management (April)

V S Sithakarana

Soil Management for higher productivity

Rush crop management, field aspects

Rush crop management, factory aspects

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, in the Institutes' Auditorium at Talawakelle.

The following topics were discussed.

11th Sinhala E & E Forum Meeting

Economic analysis of infilling and replanting of tea

Mrs A Jayakody

Intercropping in tea

Mr P B Ekanayake

Irrigating tea lands

Mr N P S N Bandara

12th Sinhala E & E Forum Meeting

New tea cultivars for future planting

Mr Mahinda Ratnayake

Integrated nutrient management in tea

Dr Kapila Soyza

Effect of rainfall pattern on tea yield

Mr M K S L D Amarathunga

5. Production of Advisory and Extension Material

5.1 Advisory Circulars

R K Nathaniel and V S Sithakaran

A total of 37 Circulars were updated and printed as a new series, on the following subjects.

i.	Land Use (LU)	02 Circulars
ii.	Planting Material and Nursery (PN)	01 Circulars
iii.	Soil Fertility Management and Plant Nutrition (SP)	06 Circulars
iv.	Planting and After Care (PA)	03 Circulars
v.	Shade, Green Manure and Intercrops (SI)	03 Circulars
vi.	Harvesting and Pruning (HP)	03 Circulars
vii.	Weed Management (WM)	03 Circulars
viii.	Pest Management (PM)	07 Circulars
ix.	Disease Management (DM)	06 Circulars
x.	Processing Technology (PT)	03 Circulars

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. Quotations have been called for, and printers have been selected to undertake this job.

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". (SLD Amarātunga)
- "Te Thathu" (Volume 2, Issue 2), a newsletter on the latest tea technologies, written in Sinhala. (Edited by S T Yatawatte and W B Kahandawa)
- A new Advisory Guideline on "Horse-Hair Blight", translated into Sinhala.
- A Sinhala version of "Tea Information" was updated. (JPM)
- A leaflet on "Pruning" in Sinhala. (TGN).
- A booklet on "Weed identification". (LDS, JCKR and JM)
- A pamphlet on "Nutritional Deficiency Symptoms", submitted to the PPP for necessary action. (TGN).
- "Te Thathu" (Volume 3, Issues 1 and 2) (Edited by B A D Samansiri and Hiromi Nishanthi).
- 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 Regional Plantation Companies (RPC) involved in tea. (R K Nathaniel and the Advisory and Extension Staff).
- A revision of the booklet, "Guide to the TRI", which includes the write-up/revision of the preface, introductory section, location of TRI Stations and Estates, a brief history of the Tea Industry of Sri Lanka, the functioning of the Advisory and Extension Service and the Research Divisions, etc. (R K Nathaniel, B A D Samansiri and Heads of Divisions)
- 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. (R K Nathaniel and the Advisory and Extension Staff)

Twenty-six posters and banners were prepared, and digitally printed, for display at exhibitions and in the Advisory Division's tea museum. (B A D Samansiri, Nalin Nishantha, Roshan Liyanarachchi, Kapila Katilanda, Hiromi Nishanthi, S Sanjayan and V S Sithakaran)

Digital Posters

1. Why Tea is good for you?(English) B A D Samansiri and Hiromi Nishanthi
2. Tea production, Tea areas, Tea exports, FOB, Exports earnings, Tea exports
B A D Samansiri and Hiromi Nishanthi
3. Why Tea is good for you? (Sinhala) K K P Katulanda and Nalin Nishantha
4. Mycorrhiza and tea -Dr Balasooriya, Predeepa Liyanage and Nalin Nishantha
5. Research Divisions of the TRI B A D Samansiri
6. Tea Plant to Tea leaf (Sinhala) Roshan Liyanaarachchi and V S Sidakaran
7. Tea Leaf to Tea Cup (Sinhala) Roshan Liyanaarachchi and V S Sidakaran
8. Our Objectives (Sinhala) K K P Katulanda and Nalin Nishantha
9. Our Objectives (Tamil) S Sanjayan and Nalin Nishantha
10. Why Tea is good for you? (Tamil) S Sanjayan and Nalin Nishantha
11. Tools of biological pest management in tea
Suranjan Fernando and Nalin Nishantha
12. Soil substitutes for nursery bag Suranjan Fernando and Nalin Nishantha
13. Tea crop improvement Roshan Liyanaarachchi
14. Soil solarization Suranjan Fernando and Nalin Nishantha
15. Innovations in tea processing Roshan Liyanaarachchi
16. James Taylor B A D Samansiri
17. Cleanest Tea in the World B A D Samansiri

Digital Banners

Hand pruner, Collapsible plucking basket, TSTH (English), TSTH (Sinhala)
B A D Samansiri

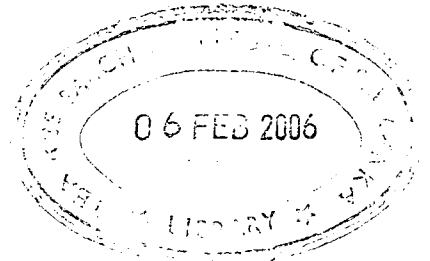
6. Mass-Media Activities

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 Paper articles were published on the following subjects.

- i. ගංවතුරට ගසු වූ තේ වගාවට දිලීර රෝගයක් (සිරිමිණ) - B.A.D.Samansiri
- ii. ගංවතුරට යටවූ ඕබේ තේ වගාවට ප්‍රකාර්ථයක් (දිනමිණ) - Lalith Amaratunga
- iii. රළ ගැල්මෙන් හානියට පත් තේ වගාවන් සඳහා කුමක් කරමුද (දිනමිණ) Lalith Amaratunga
- iv. ගංවතුර - නාය යාම් වලට ගොදුරු වූන තේ වගාවට කුමක් කරමුද (ලංකාදීප) Lalith Amaratunga
- v. ගංවතුරෙන් හානි වූ පහතරට තේ වගාව යලි නගා සිටුවන්නේ කෙසේද (ලංකාදීප) Lalith Amaratunga
- vi. New life for your tea plantation submerged by floods. (Daily News)
- vii. ඕබේ තේ ඉඩමෙන් වැඩි අස්වැන්නක් ඕනෑ නම් (ලංකාදීප) - J.C.K.Rajasinghe
- viii. තේ වගාවේ වල් පැල වනකමු (ලංකාදීප) - Laxmi de Silva
- ix. ඕබේ අඵත් තේ වගාව අසාර්ථකද (දිනමිණ) J.C.K.Rajasinghe
- x. Is your new tea plantation a failure (Daily News) - J.C.K.Rajasinghe
- xi. කුඩා තේ වතු හිමියන්ට නව තේ පර්යේෂණ දැනුම (දිවයින) - B.A.D.Samansiri
- xii. තේ වගා කරුවන්ගේ සම්මන්ත්‍රණය සාර්ථකයි (සිරිමිණ) - B.A.D.Samansiri
- xiii. කුඩා තේ වතු හිමියන්ට නව තේ ප්‍රභේද - ඩී.ඒ.ඩී. සමන්සිරි (දිනමිණ)
- xiv. The new environmental friendly technologies to control nematodes in tea lands (Daily News)
- xv. වට පණුවන් පාලනයට පාංශු ආදේශකයන් යොදා ගැනීම (දිනමිණ)
- xvi. තේ වගාව (දිනමිණ)
- xvii. Tea small holders benefit by intercropping (Daily News)
- xviii. වතුකරයේ හමා යන ඉම් හිතේ කුණාටුව (දිනමිණ) - Suranjan Fenando
- xix. Labour shortage . . a gale sweeping across plantations (Daily News) Suranjan Fenando
- xx. Dolomite Use in Tea Fields (Daily News) B.A.D.Samansiri
- xxi. තේ ඉඩම් වල ඩොලමයිට් භාවිතය - ඩී ඒ ඩී සමන්සිරි - දිනමිණ
- xxii. වසම් බිමේ වගා දෙකක් - ඩී ඒ ඩී සමන්සිරි - ලංකාදීප

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. (B A D Samansiri, Mahinda Ratnayake, Dr A. Balasooriya, Dr Keerthi Mohotti, Dr Kapila Soyza, Dr Ziard Mohamed, Dr Tissa Amarakoon and Suranjan Fernando)
- 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. (J A S K V Jayasinghe, B A D Samansiri, Dr M A Wijerathna, Dr Kapila Premathilake, J C K Rajasinghe, Dr A Balasooriya, and S L D Amaratunga)

7. 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 7448 visitors to the Advisory & Extension Division, Talawakelle and the Regional Extension Centers were handled. These included persons seeking tea information through informal discussions, as well as students on study tours for whom appropriate educational programs were arranged.

9. Extension Services

9.1 Issueing of Publications (leaflets/pamphlets etc.,)

A total of 6956 Advisory/Extension publications, pamphlets and leaflets were distributed.

9.2 Commercial Nursery Inspection

344 commercial tea nurseries were inspected in small holdings and private estates sector under the Tea Nursery Plant Certification Programme.

9.3 Soil Analysis

A total of 2245 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 the growers from Passara, Kottawa and Deniyaya Regional Centres.

9.5 Issuing of CDs

Sixteen CDs on “TRI Rolling Programs” were copied and sold on the request of 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 meetings 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 on the management of mother bushes.

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. (SLD/TGN).

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.

The following activities and awareness programmes were conducted for small holders in flood-affected areas.

1. Information collection on the level of damage caused by the floods in the area, and organisation of several meetings to discuss possible assistance to those affected by the floods.

2. Conducted 14 seminars for small holders in the affected areas on minimising the damage caused to tea lands by the floods, and care of the affected tea lands.
3. A video programme was prepared on the subject and arrangements were made to show the video to tea small holders in the affected areas.

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.

(B A D Samansiri)

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 Mr P.B. Ekanayake, in December in response to a request made by the TSHDA. (J C K Rajasinghe).
- 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. (J C K Rajasinghe).
- Widespread incidence of Shot-hole Borer infestation was reported from many plantations, especially in the Haputale-Koslanda area. (J C K Rajasinghe).

11.2 Kandy Region (S T Yatawatta and B Kahandawa)

- 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, that collected 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 (B A D Samansiri, V S Sithakaran, Suranjan Fernando, Roshan Liyanarachchi and Hiromi Nishanthi)

- A field survey, conducted with the Soils and Plant Nutrition Division, on the use of high-potash fertilizer mixtures was completed. Analysis of data has to be undertaken. (B A D Samansiri and Roshan Liyanarachchi).
- 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. (Roshan Liyanarachchi)
- Severe infestation of shot-hole borer were reported from the estates in the Maskeliya, Kotagala, Upcot Watawala and Nawalapitiya regions, especially in clones DT1 and TRI 2025. (B A D Samansiri, V S Sithakaran and Suranjan Fernando).
- 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 (S L D Amaratunga, T G N Mahinda and K G J P Mahindapala)

- 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. (TGN, PDU and JHNP).
- 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. (K J G P Mahindapala, P D Upali and J H Noel Piyasundara).

- 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. (S L D Amaratunga, T G N Mahinda and P D Upali)
- 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. (SW, MAW and PBE)
- 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. (S L D Amaratunga, K G J P Mahindapala, MAMMK and BSV)
- 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'. (SLDA and MAW)
- 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. (SLDA and MAW)
- A detailed investigation on nematode infestation in high-yielding tea fields, in the Hapugastenna Tea Estate, was initiated in collaboration with the Entomology Division. (SLDA, TGN, AP, SIV)
- 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. (SLDA, TGN, JPM and staff of the Agricultural Economics Unit)

11.5 Galle Region (K D Dahanayakea and Saman Ratnayake)

- The levels of Horse-Hair Blight damage were investigated by a team of advisory staff, in selected estates in the Galle region. (K D Dahanayake, Saman Ratnayake, S T Yatawatta and B A D Samansiri)

11.6 Deniyaya Region (J A S K V Jayasinghe and Kapila Katulanda)

- 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- and plant nutrient status and yield, is being carried out in Anninkanda Estate, Deniyaya.

12. Talks and Meetings

- Mr R K Nathaniel, Consultant, addressed the members of the Tea Research Board at their meeting on 2nd May, explaining the current strategy adopted to improve the Advisory and Extension services. Questions posed were answered.
- Mr Nathaniel attended the Consultative Committee on Advisory Services and Estates on 7th April, and presented the new approaches designed to build confidence between the Advisory Staff and the stakeholders (plantation managers). He also attended a TRI staff meeting where work progress was discussed.
- The Head, Advisory Division addressed a meeting with the Directors and the staff of three Crop Research Institutes, on the current position and future activities with regard to the issue of tea planting materials.
- The Head of the Advisory and Extension Service presented the forward-activity programme of the Advisory and Extension Service, at a meeting with the CEOs of RPCs, on 19th May.

13. 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.

The officers of the IT unit (Nalin Nishantha and B A D.Samansiri) attended to the following activities.

Configurations network cards, configuration of the TRI mail server, allocating new e-mail addresses, installing new OS and MS Office packages and virus packages, and other important software packages.

Made arrangements to shift the proxy and mail servers to a room next to the Publication Unit, which has initially been installed in the Library. A new computer was purchased for the IT unit.

Twenty new terminals were established, including the fibre-optics connection to the Technology Division.

14. Photography Services

The following services were rendered to the Research Divisions, the Advisory Division and the Institute's staff

Colour Photographs (3819)

- Advisory and Research Divisions - 2512
- Sports Clubs - 394
- *Seva Vanitha* Unit - 15
- Montessori - 399
- Buddhist Association - 16

Colour slides - 356

Colour enlargements - 22

B/W enlargements - 55

B/W passport photographs - 155

Preparing of former Directors' Photographs - 20

Preparing Board Members' photographs - 14

Preparing photographs for the "Twentieth Century Tea Research" volume - 215

15. Audio-Visual Services

(Nevil Ekanayake, B A D Samansiri and V S Sithakaran)

15.1 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).

15.2 Video-Filming of Special Official Functions

Opening Ceremony of the New Hostel Building, TRI Ratnapura; Horticulture Crop Development Project, Gannoruwa; Felicitation Ceremony, TRI, Talawakelle.

15.3 Issuing Video Programmes:

Kahawatta Plantations, Colombo	32 sets (160 video films)
University of Peradeniya	01 set (7 video films)
Agstar Fertilizer, Colombo	02 sets (16 video films)
HPL, Upcot	02 sets (5 video films)

University of Jaffna	01 set (8 video films)
Bambarakelle Estate	02 sets (10 video films)
Iranian tea experts	01 set (4 video films)
PPL, Colombo	02 sets (10 video films)
Balmoral Estate, Agrapatana	01 set (3 video films)
Ellied Commercial Fertilizer	02 sets (15 video films)
WPL, Colombo	02 sets (6 video films)
Agriculture School	01 set (4 video films)
ABC Plantations, Colombo	02 sets (16 video films)

15.3 Production of a Video Film

A video film entitled "Organic Tea Cultivation" was produced for the Tea Convention Exhibition.

(J C K Rajasinghe and Nevil Ekanayake)

16 Special Assignments, Advisory Staff

B A D Samansiri, Head of the Advisory and Extension Service served as the Convener/Secretary for Consultative Committee on Advisory Services and Estates; as TRI Media Coordinator for the Ministry of Plantation Industries; as TRI Coordinator for ADB extension activities; and TRI Coordinator for the Management of Information Systems for the Ministry of Science and Technology.

S T Yatawatta, Senior Advisory Officer served as the TRI Coordinator for the ADB Mother Bushes Programme, and as the Convener/Secretary for E & E (Sinhala) Forum meetings.

J C K Rajasinghe, OIC, Advisory and Extension Centre, Passara and Advisory Officer served as the TRI Coordinator of RSC III (Badulla Region); and the TRI Coordinator of the RSC for the smallholdings sector (the Uva Region)

V S Sidhakarana, Advisory Officer, was in charge of the Audio Visual and Photography Units; TRI Coordinator of RSC II (Maskeliya and Bogawantalawa Region); and the Coordinator for the revision of Advisory Circulars.

I A S K V Jayasinghe, OIC, Advisory and Extension Centre, Deniyaya and Advisory Officer, served as Joint-Coordinator, for the TRI, of RSC VII (Galle and Matara Region).

K D Dahanayake, OIC, Advisory and Extension Centre, Kottawa, and Advisory Officer, served as Joint-Coordinator, for the TRI, of RSC VII (Galle and Matara regions); and the Convener/Secretary for Advisory Officers' Forum.

S L D Amaratunga, Advisory Officer, served as the TRI Coordinator of RSCs V and VI (Ratnapura and Kegalle Regions); and the Convener/Secretary for the Research and Extension Linkages meetings.

**MID COUNTRY RESEARCH, ADVISORY & EXTENSION CENTRE, KANDY
2003**

Officer-in-Charge – P.B.Ekanayake

1.General

There are 17 technical and 10 administration staff at this Station. They conducted research in agronomy, entomology, plant breeding and soils & plant nutrition. Technical staff assisted the Advisory and Extension Division in transferring technology to the plantations and small holder sector. Other research activities in the mid country were served by the staff from the head office.

2.Appointments, transfers, retirements and resignations

Ms.P.Marapana Stenographer/typist was transferred to Talawakele in January and back to Hantane in April

Ms.D.Kalikotuwe & Ms.D.Ratnayake Stenographers were transferred to Hantane in January and back to Talawakele in April

Ms.W.RP.De Silva, typist clerk was transferred back to Talawakele in February

Mr.S.Abeysinghe, Experimental Officer, Entomology Division was transferred to Talawakele in August.

Ms.C.N.K.Edirisinghe was transferred to Talawakele in January and back to Hantane in November.

3.Hectarage as at 31st December 2003

<u>Type of land use</u>	<u>ha</u>
Seedling tea	2.00
VP tea (mature)	5.50
VP (young)	3.50
Mother bush	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 & roads	5.77
Total	23.25

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 kg
Income from sale of green leaf	Rs.346,645.95
Guest House occupation charges	Rs. 22,400.00
Soil testing (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 and Attending conferences

6 NDT trainees were trained during the year

1 Trainee of Tharuna Aruna was trained

7.Meteorological Station

Recording and monitoring of the meteorological data was 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 – 2 experiments
2. Effect of Intercropping tea and minor export crops in mid country - 2 experiments

3. Effect of alternate methods of soil reconditioning compared with traditional methods on the establishment and yield of tea – 1 experiment
4. Effect of vermi-compost on growth and yield of tea – 1 experiment
5. Effect of different formulations of glyphosate on weed control in mature tea.
6. Effect 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 on SALT hedgerows.

Entomology Division

1. Screening of insecticides to manage scavenging termites
2. Screening of insecticides for the control of SHB
3. New Shot-Hole Borer trial- Minimizing borer damage for short and long term benefits
4. Testing of suitable dosage of chemical “Regent” in controlling of SHB.
5. Effect of entomopathogenic fungi *Beauveria bassiana* on SHB.
6. Effect of entomopathogenic fungi *Beauveria bassiana* on SHB.
7. Effect of entomopathogenic fungi *Beauveria bassiana* on SHB.
8. Survey on SHB incidence in tea estates in Mid Country.
9. Assessment of SHB incidence in seed stocks
10. Screening of clones for Resistant/Tolerance & susceptibility to *R. similis* – 2 experiments
11. Chemigation Trial Glass House
12. Nursery soil substitute Experiment (continuous assessments at field level.)

Plant Breeding Division

1. Evaluation of bi-clonal and poly-clonal see stocks in mid country - 2000
2. Evaluation of cultivars for mid country
3. Development of seed cultivars for 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 – 2 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, Mg) for better growth of clonal tea under glasshouse conditions
4. Development of a fertilizer/dolomite applicator for improving broadcasting efficacy and to overcome labour shortage
5. Evaluating and improving the efficiency of fertilizer applicators
6. Development of regional analytical laboratories for soil, plant and fertilizer analysis.
7. Analytical laboratory service at Mid Country Station

9. New constructions:

Extension of the advisory building, construction of culture room of the entomology division and 2 store rooms for research divisions were completed.

Commenced laying tracts by paving rubble and applying a coat of premix for the road leading from the Office to laboratory Complex and Auditorium
Commenced fabricating doors to the garage

10.Maintenance of buildings, roads & water supply

Colour washing completed in 4 Nos: D type quarters, bath rooms and kitchens of 3 Nos B type quarters, 3 Nos C type quarters, Laboratory complex, Circuit bungalow, security guard rooms.

Re-tarring of part of the internal roads was completed.

Layed two tracts on the gravel road leading to 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

Vehicle fleet was increased by one due to allocation of the Panther for coordinating ADB funded mother bush project work.

Pajero 32 – 1809 was tinkered and painted, in addition a reconditioned engine was fitted.

All other vehicles had undergone various types of repairs during the year, so that as at end of the year the vehicles were in good condition.

12.Security service

Security service was strengthened by employing watchers for the guard room to operate the barrier during the night, weekends and public holidays.

13.Reading Room

At the request of the research staff arrangements was made to have the Board Room as the Reading Room. Several accessions and publications were received from the Library Head Office.

14.Special Scientific Visitors

- 1.Chaiwat Chumpun, Royal Project Foundation, Thailand in February
- 2.Tirasak Wannawichit “ “ “ “ “
- 3.Naoki Toshioka, Japan in March
- 4.ShShaijan Tea Research Institute, Iran in June
- 5.R.Koansal “ “ “
- 6.T.E.Nosratian “ “ “
- 7.Martn A Precious,Lipton Ltd. UK in August
- 8.A.Assiriyage, CIC in October
- 9.S.R.Sharma, India in November
- 10.Keron Budl “ “

**LOW COUNTRY RESEARCH, ADVISORY AND EXTENSION CENTRE,
RATNAPURA**

Officer-in-Charge – M. A. Wijeratne

Staffing

Senior Research Officers

- 1). M A Wijeratne - B.Sc (SL), Ph.D (London)
- 2). K G Premathilaka - B.Sc (SL), M.Phil (SL), Ph.D (Reading)

Research Assistants

- 1). N P S N Bandara - B.Sc. (SL)
- 2). S R W Pathiranage - B.Sc. (SL)
- 3). P H K Pathiraja - B.Sc. (SL)

Experimental Officers

- 1). H S N Peiris - B.Sc. (SL)
- 2). A J Gamage - B.Sc. (SL)
- 3). D W Vithana
- 4). E W T P Premathunga

New Appointments:

- 1). Dr M A Wijeratne was appointed Officer-in-Charge, TRI Low Country Station, Ratnapura, in addition to his substantive post of Senior Research Officer in Agronomy, with effect from January 1st 2003.
- 2). Two Research Assistants, Mr S R W Pathiranage and Mrs. P H K Pathiraja, were recruited on a casual basis and attached to the Agronomy Division to work on the weed management and land suitability classification project. Mrs. Pathiraja resigned from the Institute with effect from 3rd December 2003.

Miscellaneous Activities

- 1). Dr M A Wijeratne participated in a Regional Workshop on Impact of and Adaptation to Climate Change (AIACC), held in Bangkok, Thailand, during March 2003.
- 2). Dr M A Wijeratne was appointed a member of the Faculty Board, Faculty of Agriculture, University of Ruhuna, and also appointed a Visiting Lecturer in the same Faculty.
- 2). Dr M A Wijeratne addressed estate managers and small holders at RSC seminars and E & E forums.
- 3). Dr M A Wijeratne continued to train workers and field staff of tea estates on mechanical harvesting, with special emphasis on the use of the TRISTH.

- 4). Dr M A Wijeratne supervised the research projects of two undergraduates, Miss V R Premalatha and Mr I P S K Karunanayake, from the Faculty of Agriculture, University of Ruhuna.
- 5). Dr M A Wijeratne participated in a TV programme on post harvest losses in tea, and a radio programme on rush crop management, organized by the Tea Development Project.
- 6). Mr N P S N Bandara addressed tea growers and stakeholders, on tea irrigation and water management for higher productivity, at the Sinhala E & E Forum at Talawakelle, and at discussions held at the Low Country Station, Ratnapura.
- 7). Mr N P S N Bandara successfully completed two on-line training courses on Digital Literacy for Agriculture Professionals and Integrated Soil Fertility Management, conducted by the Asia Pacific Regional Technology Centre.
- 8). A group of NAITA trainees completed their training in the Agronomy Division.
- 9). Arrangements were made with Messrs Flowerland Lanka, Makola, for further development, and mass-scale production and sale, of the collapsible plucking basket and the hand pruner invented by Dr M A Wijeratne.

Research Activities (see Corporate Plan)

1. Thrust A 11. Development of an economically viable system to eliminate/reduce the soil rehabilitation period, prior to replanting in the low country.

Project A 11.1. Evaluating soil rehabilitation techniques

Balangoda Estate

This study was started in 1999. Planting of tea (TRI 2026) was done in September, 1999. Plants were brought into bearing in 2002.

Table 1. Yield of made tea kg/ha/yr, girth (cm) and spread (between rows) (cm)

Treatments	Yield	Girth (cm)	Plant spread (cm)
Planting after rehabilitation	1578	4.79	120
Direct planting (planting-hole)	1362	3.98	107
Planting with compost (planting-hole)	1472	3.77	104
Planting with compost (trenches)	1421	4.07	120
LSD (p=0.05)	NS	0.671	12.7
CV%		8.57	5.99

Rehabilitation and incorporation of compost into trenches have given rise to growth of tea bushes. Although there were marginal increases in yield due to rehabilitation and incorporation of compost, these higher yields were not significantly different from yields given by direct planting (p>0.05).

St.Joachim Estate

This experiment was begun in 2000 with the following treatments.

Rehabilitation with mana,
Compost in trenches
Compost in planting holes
Interplanting tea with Mana
Interplanting tea with 'Tur-dhal'
Interplanting tea with sweet corn

Tea plants were brought into bearing in October 2002, and the bushes were lightly harvested. Experimental plots went under flood water during the middle of the year, and hence they had to be rested for about three months.

The experiment is in progress.

M A Wijeratne, H S N Pieris

Project A 11.2. Minimum period required for soil rehabilitation.

St.Joachim Estate

Mana and citronella grasses were planted in two large blocks in Field No. 1, St Joachim Estate, in August 2001, for soil rehabilitation. Half of the blocks were uprooted and planted with tea, and the grasses in the balance area were maintained.

The tea plants were centered. The experiment is in progress.

N P S N Bandara

2. Thrust A 14. Development of intercropping systems (Rubber/coconut) for the low country

Project A 14.1. Evaluating the most compatible crop combinations.

Effect of intercropping tea and rubber on productivity, RRI, Kuruwita (1990)

This experiment is conducted in collaboration with the Rubber Research Institute of Sri Lanka. There are six treatments in four replicates (blocks). They are monocropping of tea, monocropping of rubber (18' x 12'), tea (rehabilitated) under rubber (27' x 8'), tea (rehabilitated) under rubber (40' x 8'), tea (unrehabilitated) under rubber (27' x 8'), and tea (unrehabilitated) under rubber (40' x 8'). Unrehabilitated tea and rubber were planted in 1990, while rehabilitated tea was planted in 1992.. Tea bushes planted without rehabilitation were pruned and tipped in 2003.

Table 2. Yield of rehabilitated tea under different spacings of rubber

	Green leaf yield kg/bush/yr
Rehabilitated tea	
Tea (monocropping)	1.037
Tea + rubber (8' x 40')	0.480
Tea + rubber (8' x 27')	0.392
LSD (p=0.05)	0.411
CV=19%	

The yield of rehabilitated tea under rubber was significantly lower than that of monocropped (rehabilitated) tea. There were no significant differences in tea yield under two spacings of rubber. The yield of tea, planted without rehabilitation (four months only), showed no significant differences between the two spacings of rubber. The recorded tea yield was 0.222 kg/bush and 0.225 kg/bush for rubber spacings of 8' x 40' and 8' x 27', respectively. The weight of tippings from tea bushes (unrehabilitated) was also not significantly different.

Effect of intercropping tea and rubber on productivity, St. Joachim Estate, TRI, Ratnapura (1990)

The feasibility of intercropping tea with rubber is being tested at St Joachim Estate. There are three treatments: tea (stand of tea 100%), tea under rubber (40' x 8') (stand of tea 75%), and rubber (20' x 12'), in three replicates. The rubber was planted in 1990, and the tea was introduced in 1993.

The yield of tea was significantly different ($p < 0.05$): 2.058 kg/bush/yr with tea as a monocrop, and 1.114 kg/bush/yr with the intercropping of tea under rubber.

The girth of the rubber trees at chest height was 79.8 (± 0.2) cm for rubber in tea, and 75.6 (± 2.1) for sole rubber treatments.

Effect of intercropping tea and rubber on productivity (demonstration plot), St Joachim Estate, Ratnapura (1989)

Field practices in the demonstration plot were continued during the year 2002.

Effect of intercropping tea and rubber on productivity (observation block), St. Joachim Estate, Ratnapura (1995)

There are four plots in this observation block: rubber (20' x 12'), tea, tea in rubber (40' x 8'), and tea in rubber (60' x 8' x 8'). Rubber rows were located in the east-west direction.

The harvesting of rubber and tea was continued. The tea bushes were pruned in June 2003, and harvesting commenced in November 2003, after tipping in September.

There was no significant difference in the girth of the rubber trees in different treatments. Tipping assessments of the tea bushes (number of shoots, number of leaves/shoot, and tipping weight) showed that the growth of tea bushes under rubber in both treatments were comparatively lower than with monocropped tea.

The recorded tipping weight was 580 g/bush for monocropped tea, 410 g/bush for tea under rubber (60' x 8' x 8'), and 245 g/bush for tea under rubber (40' x 8').

The rubber yield for the year was estimated to be 2389, 2228 and 1844 kg/ha/yr (dry rubber), at 40' x 8', 60' x 8' x 8' and 20' x 12' spacings, respectively.

M A Wijeratne, P B Ekanayake and P Premathunga

Effect of intercropping tea and rubber on productivity, RRI, Kuruwita (2003)

A new experiment was started in collaboration with the Rubber Research Institute and the Departments of Agriculture and Export Crops.

In this experiment, tea fruit crops (rambutan and durian) and cinnamon have been intercropped under four spacings of rubber (3 x 3 x 15 m, 3 x 3 x 18 m, 3.5 x 3.5 x 15 m and 3.5 x 3.5 x 18 m). There are nine rows of tea under rubber at a spacing of 15 m, and 12 rows under rubber at a spacing of 18 m. The tea areas are divided into two blocks, one for rehabilitation and the other for direct planting.

TRI 2027 was planted in 2001 (direct planting) and 2003 (after rehabilitation for two years). Tea planted without rehabilitation was brought into bearing in 2003, and the yield of the bushes was 0.360, 0.326, 0.343 and 0.323 g/bush/year, for 3 x 3 x 15 m, 3 x 3 x 18 m, 3.5 x 3.5 x 15 m and 3.5 x 3.5 x 18 m, respectively.

There was no significant difference in yield between the treatments. Yield, shoot density and % of dormant shoots were recorded from tea bushes in different rows (near the rubber row, and in the middle), and were found not to be affected by treatments.

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

Projects **20.2. Evaluating harvesting devices**
 20.3. Modifying harvesting intervals
 20.5. Modifying bush management

Raigama Estate (2000)

This experiment was begun at Raigama Estate to test a Kawasaki NV 60 H motorized harvesting machine, supplied free of charge by Messrs P P P Jinadasa Pvt. Ltd., on two clones planted as hedgerows, at two harvesting intervals, depending on the rate of shoot growth (14 and 21 days).

Treatments (methods of harvesting):

Manual harvesting

Mechanical harvesting (interval of 14 days)

Mechanical harvesting (interval of 21 days)

Clones: TRI 2027 and H1/58

Harvesting commenced after tipping, and the yield is given below.

	Made tea yield (kg/ha/yr)	
	H1/58	TRI 2027
Manual harvesting	3236	3496
Mechanical harvesting (14 days)	2587	2644
Mechanical harvesting (21 days)	2322	2658
LSD (p=0.05)	456	661
CV%	10.3	13.8

The results show that the use of motorised machines reduces tea yield in both clones irrespective of the changes in frequency of plucking.

M A Wijeratne, N P S N Bandara and D W Vithana

Balangoda Estate (1998)

This experiment was begun in 1998 under the Collaborative Research Programme with estates.

Four spacings of planting were tested using two clones, TRI 2026 and DG 39. The spacings are 0.6 x 1.2 m (100%), 0.6 x 0.9 x 1.5 m (100%), 0.6 x 0.6 x 1.5 m (114%) and 0.9 x 0.45 x 1.5 m (133%).

The tea plants were brought into bearing in the year 2000. The bushes were pruned in November 2003. Results of the statistical analysis of yield (January - August), and of weight of prunings, showed no significant difference between the spacings. However, TRI 2026 gave a yield about 20% higher than that given by DG 39.

The highest ground cover was given by the 0.6 x 1.2 m spacing (76%), followed by the 0.6 x 0.6 x 1.5 m (72%) and the 0.6 x 0.9 x 1.5 (65%) spacings. The 0.9 x 0.45 x 1.5 m spacing gave the poorest ground cover (50%).

M A Wijeratne, H S N Peiris and the Superintendent, Balangoda Estate

Project A 21.2. Assessing post-pruning vigour in mechanically-pruned bushes.

Field observations have shown that there are no variations in recovery between mechanically- and manually-pruned tea bushes, provided careful attention is paid to cut branches achieving a sharp cut end, and manual cleaning is adopted wherever necessary.

M A Wijeratne

Divisional Activities

5. Project D/AGRY

Impact of CO₂ fertilization on growth and yield of tea in the low country wet zone of Sri Lanka

A new research project was initiated in collaboration with SLAAS, CRI and the Meteorological Department. Collection of productivity and socio-economic data was completed and the results are being analysed. An experiment on impact of enhanced CO₂ on the yield of mature tea was begun in both St Joachim Estate and St Coombs Estate.

The ambient CO₂ level was enhanced by supplying CO₂ to open top chambers prepared by covering tea bushes with a thick polythene sheet. Analysis of weekly yield records showed that tea yield under enhanced CO₂ was 3257 kg/ha/yr compared to 2393 kg/ha/yr under ambient CO₂.

M A Wijeratne and P Premathunga

Variation of yield components under different CO₂ concentrations

This study was conducted in collaboration with the Faculty of Agriculture, University of Ruhuna and the AIACC project.

Yield components of tea were measured under high CO₂ (600-800 ppm) and ambient CO₂ (350-400 ppm) concentrations in the experimental blocks maintained at the Low Country Station (AIACC Project).

The results showed that shoot density, mean shoot weight and shoot extension rates were greater at high CO₂ levels. The percentage of dormant shoots were low in the plot with enhanced CO₂. The tea leaves in the CO₂ enhanced plots had higher chlorophyll content, and were smaller than the leaves in the ambient CO₂ plots. As a result, the tea yield in the CO₂ enhanced plots were higher than in the control plots.

Dry weather was found to have reduced shoot density, extension rate and mean shoot weight. Further increase in dormant shoots was also observed during dry months and this contributed to a lower yield.

M A Wijeratne and G V R Premalatha (Faculty of Agriculture, University of Ruhuna)

The factors associated with debilitation and death of tea bushes in the Deniyaya region

This study was done in collaboration with the Faculty of Agriculture, University of Ruhuna. Bush debilitation and death of bushes of many affected fields were reported to be due to nematode infestation. However, there were some areas without significant nematode infestation, but with symptoms of bush debilitation. Hence, this study was done in local patches of affected tea fields where nematode infestation was not found.

Analysis of soil samples, and observations of affected and healthy bushes in some estates in the Deniyaya region, showed that the physical and chemical parameters of soil (soil texture, pH and soil nutrients) had not contributed to bush debilitation. However, the soil organic carbon level of the affected areas was comparatively lower than that of healthy areas.

Affected bushes also had Mg deficiencies. No visible pest and disease attacks were identified on affected bushes. However, observations revealed that many good agricultural practices had not been attended to, right from land preparation to harvesting, in the affected fields. Hence, bush debilitation could have been largely due to poor cultural practices adopted in the past.

M A Wijeratne, Shantha Jayasinghe and I P K S K Karunanayake (Faculty of Agriculture, University of Ruhuna)

Growth of cuttings in the nursery under polythene tents of different colour and with enhanced ambient CO₂

Data collection on the growth of nursery plants was completed, and the results were summarized for analysis.

M A Wijeratne and P Premathunga

Land Suitability Mapping Project for tea-growing lands in the Ratnapura District

A new project for classifying tea lands in the Ratnapura district was begun in September 2003. Professor C R Panabokke and Mr L Amarasinghe were appointed as Senior Advisor and Consultant to the project, respectively. Mr S R W Pathiranage was appointed Research Assistant to work on this project. Staff of the Agronomy and Advisory Divisions of the Low Country Station assisted in data collection, analysis and mapping.

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

Data from existing tea lands were compiled, and information was also extracted from aerial photographs. These details were copied on to the 1:50,000 scale ABMP maps with the help of an 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, transferring the AER boundaries onto provincial maps, identification and location of all available rain-gauge stations, generalization of elevation boundaries of the up-, 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 percent of expectancy) was generated. It was observed that the value of this Productivity Index (PI) could range from 40-150 for most of the estates. The Productivity 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 classified according to these classes. Each group of estates, situated within a particular productivity class, falls within a recognized agro-ecological sub-region.

Publications

- 1). Wijeratne, M A, Premathunga, P and Karunaratne, W R M M 2002. Variation of root starch reserves of tea and its impact on recovery after pruning. *Journal of Plantation Crops* 30, 35-39.
- 2). Wijeratne, M A 2003. Harvesting policies of tea (*Camellia sinensis* L.) for higher productivity and quality. *Tropical Agric. Res. and Extension* 6, 91-97.
- 3). Wijeratne, M A, 2003. A new collapsible plucking basket. *TRI Update* 8, 2-4.
- 4). Wijeratne, M A, 2003. Newspaper articles: on post harvest losses (*Lankadeepa*); on minimizing drought damage in tea plantations (*Lankadeepa*); on a new collapsible plucking basket (*Lankadeepa*); and on improvement of productivity of tea lands (*Lankadeepa* and *SCCI News*).

UVA ADVISORY AND EXTENSION CENTRE, PASSARA

Officer-in-Charge - Mr J C K Rajasinghe

1. Staff

Mr J C K Rajasinghe	Officer in Charge
Mr R M A C Rajakaruna	Extension Officer
Ms A S Jayasekara	Technical Assistant (Contract Basis)
Vacant	Station Assistant
Vacant	Field Supervisor
Mr A M Karunasundara	Driver

2. Retirement, Appointments and Transfers

- Mr N Sinnathamby, Field Supervisor, retired from the service of the Institute with effect from 17th April.
- Ms A S Jayasekara was appointed as a Technical Assistant on contract basis with effect from 4th August.
- Mr R Nandasena, Station Assistant, was transferred to the Institute at Talawakelle with effect from 4th September.
- Mr R W Suwaris, Field Supervisor, was transferred to the Institute at Talawakelle with effect from 1st December.
- Mr J C K Rajasinghe was confirmed in the post of Officer-In-Charge, Passara Station.

3. Special Assignments

The Officer-in-Charge participated in the radio and video programmes initiated by the Tea Development Project.

The Officer-in-Charge participated in a fact-finding mission in the Walapane Tea Small Holder properties, along with Mr P B Ekanayake, in December, in response to a request made by the TSHDA .

4. Advisory and Extension Activities

➤ Advisory letters despatched	122
➤ Advisory visits made to estates and smallholdings in Uva (including routine visits)	158
➤ Seminars/field-days/training programmes held for estates/small holders/school children	09
➤ Regional seminars held in collaboration with the Uva RSC.	02
➤ Visitors to the Centre (including planters and small holders)	393
➤ Soil samples tested for pH	1084
➤ Soil samples tested for organic carbon content	712
➤ VP cuttings issued	45900
➤ Commercial nurseries Inspected	155

5. Hectarage as at 31st December

	<u>ha</u>
Mature tea in plucking	3.44
Mother bushes	1.15
Young tea (experimental block)	0.30
ADB clearing	2.06
Buildings, roads	0.50
Forest, scrub, grassland	6.85
<u>Total extent</u>	<u>14.30</u>

6. Crop

Green leaf harvested and sold.

	Sold (kg)	Price SL. Rs/kg.	Income Rs
January	1174	20.33	23867.42
February	2506	19.02	47664.12
March	2677	15.97	42751.69
April	4243	15.99	67845.57
May	3329	15.20	50600.80
June	2819	17.14	48317.66
July	3269	18.08	59103.52
August	3347	19.57	65500.79
September	3287	19.36	63636.32
October	3460	19.66	68023.60
November	3163	20.50	76886.50
December	3059	20.59	62984.81
<u>Total Revenue</u>	<u>36333</u>		<u>677182.80</u>

The total amount paid as transport charges was Rs 25,433.10.

The net income realized from the sale of green leaf was Rs. 651749.70.

7. Income

Income from the sale of VP cuttings	Rs 11,475.00
Income from green leaf	Rs 677,182.80
Soil analytical charges	Rs 110,840.00
Sale of publications	Rs 6,080.00
Guest house accommodation charges	Rs 5,150.00
Other income	Rs 24,000.00
<u>Total Income</u>	<u>Rs 834,727.80</u>

8. Infrastructure Development and Capital Items

Construction of (a) a twin toilet for workers, and (b) a main gate to the station, was completed.

9. Check-Roll Workers, as at 31st December

No. of check-roll workers	26
Out-turn (women)	36.1%
Out-turn (men)	47.3%

10. Field Trials

Activities in connection with the monitoring of the clonal observation trial, 2/VP37/UVA, are being continued.

The field trial on the evaluation of seed varieties was initiated and is being monitored by the Plant Propagation and Breeding Division.

The monitoring of the drip-irrigation trial at Dammeria Estate is being continued jointly with the Agronomy Division.

A field trial was initiated by SPND 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 Centre, under the Methyl Bromide Project, in order to evaluate TRI 300- and 400-series clones for tolerance to the nematodes, *P. loosi* and *R. similis*. This work is being continued.

Establishment of tea germplasm was started in collaboration with the Plant Breeding Division.

A trial was laid down at the Centre, by the Plant Breeding Division, in order to evaluate the performance of polyclonal and biclonal seed stocks in the Uva region.

Nursery experiments on finding alternatives to methyl bromide use was started at the Centre, 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 Entomology Division.

11. Special Uva Problems

Sulphur-deficiency symptoms were observed in few small holdings in Tea Inspector Ranges in Passara and Pelgahatenna during the year. The indications are that such symptoms would become commonplace among small holdings where zinc sulphate is not used for mature tea.

Widespread incidents of shot-hole borer infestation were reported from many plantations, especially in the Haputale-Koslanda area.

13. Summary of Activities

	Description	Number
01	Visitors to the Division (from estates/students/from overseas/small holders/others)	393
02	Advisory correspondence to estates and small holders	122
03	Advisory visits (on call and routine visits) to the corporate and small holder sectors, with regard to problem-solving, development programmes, pruning and manuring programmes, etc.	158
04	Training. Training programmes/ seminars, NIPM programmes, group discussions, field-days, demonstrations, educational programmes, familiarization, programmes	09
05	Issue of publications, leaflets, extension pamphlets	85
06	Soil samples tested for pH and C%	1084
07	Issue of VP cuttings	45,900
08	Commercial nursery Inspections	155
09	Green leaf harvested (kg.)	36333
10	RSC programmes for estates	02
11	Soil samples tested for carbon	712
12	Participation in exhibitions	02

Deniyaya Advisory and Extension Centre

Officer-in-Charge - J.A.S.K.V. Jayasinghe

1. Staff Position as at 31st December 2003

Mr J A S K V Jayasinghe	Advisory Officer
Mr O W Jayawardana	Station Assistant
Mr K W K Chaminda	Driver

2. Staff News

Mr K K P Katulanda, Extension Officer, was transferred from the Advisory and Extension Centre, Deniyaya to the Institute at Talawakele with effect from 1 October.

Mr J A S K V Jayasinghe was confirmed in the post of Officer-in-Charge of the Deniyaya Advisory and Extension Centre with effect from 1 June 1996.

Mr J A S K V Jayasinghe, Advisory Officer, attended a short training course in 'Design and Development of Instructional Materials using Desktop, Web and Multimedia Tools' conducted by the Asian Institute of Technology in Thailand.

3. Land Use

	<u>ha</u>
VP tea – mature	6.41
VP tea – young	0.38
VP tea - young (under ADB)	1.00
Mother bushes	0.5
Rehabilitation area (under ADB)	1.00
Nursery (tea)	0.1
Coconut area	0.1
Forestry	0.42
Marshy land	0.50
Building, gardens, roads	1.44
Pepper	0.05
Encroachment	0.36
Uncultivated area	0.96
<u>Total extent</u>	<u>13.22</u>

4. NBRO Declaration

In May, the Deniyaya area was badly affected by landslides and floods. The National Building Research Organisation (NBRO) declared that the area at Deniyaya occupied by the Tea Research Institute is to be considered a high risk area, and one that is vulnerable to landslides in the future.

5. Green Leaf Statement

	<u>Kg</u>	<u>Rate/kg</u>	<u>Amount</u> Rs. Cts	
January	3467	21.216	73,555.87	
February	2441	20.887	50,985.17	
March	3319	19.583	64,929.60	
April	3052	18.876	57,609.55	
May	Deniyaya TF	1327	23.266	30,873.98
May	Handford TF	640	23.340	14,937.60
June	Handford	615	24.290	14,938.35
June	MKTP Co-op	723	25.311	18,299.85
July		2628	25.574	67,208.47
August		2972	25.376	75,417.47
September		4114	24.935	102,582.59
October	Deniyaya TF	1943	24.262	47,141.08
October	MKTP CO-op	2214	24.707	54,701.29
November	Deniyaya TF	2199	23.814	52,366.99
November	MKTP Co-op	1950	25.326	49,385.70
December	Deniyaya TF	2168	23.194	50,284.59
December	MKTP Co-op	1695	25.458	43,151.31
<u>Total</u>	<u>37,467</u>			

6. Income

No. of cuttings sold	178,150
Sale of cuttings	Rs 44,537.50
No. of plants sold	Nil
Sale of plants	-
Crop harvested (kg)	37,467
Sale of crop	Rs.868,369.46
Average price (kg/green leaf)	Rs 23,177
Miscellaneous income	Rs. 14,555.95
<u>Total income</u>	<u>Rs.927,462.91</u>

7. Experiments

A. On-going Experiments (Corporate Plan, 1999-2003).

- LVP 74, Phase II. This trial, 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 commenced the evaluation of growth performance and resistance to specific regional diseases, according to the project guidelines in the Corporate Plan.

B. On-going Experiments on Estates (Corporate Plan, 1999-2003), conducted by research Divisions with the involvement of Deniyaya staff.

- Agronomy Division. Thrust 11. Development of an economically viable system to eliminate/reduce the soil rehabilitation period prior to replanting in the low country. The experiment continues on Handford Estate, Deniyaya.
- Soil and Plant Nutrition Division. Project A 15.2. Effect of different rates of N and K, and Mg, on soil- and plant-nutrient status and yield. The experiment is being carried out on Lumbini Estate.
- Effect of application of different levels of N, with different levels of compost manure, on growth, soil- and plant-nutrient status, and yield. The experiment is being carried out on Anninkanda Estate, Deniyaya.

8. Advisory and Extension Activities

8.1. Advisory Correspondence

- 139 advisory communications was sent out on regular advisory matters and problems.

8.2. Advisory and Extension Visits

- 59 advisory and routine visits were made by the Advisory staff to company estates, proprietary plantations and smallholdings.
- 15 extension visits were made to monitor experiment plots and adaptive research trials.
- 52 commercial nursery inspections were made.

8.3. Visitors to the Centre

Plantation staff: 24

Smallholders: 182

Students/school children: 183

8.4. Advisory and Extension Programmes

Regional Scientific Committee activities. One seminar attended by the Advisory Officer.

Awareness programme. 14 programmes for were conducted for small holders.

Exhibition. The Advisory Officer attended an exhibition organised by the Seva Lanka Foundation, namely the Yuga Dekma Exhibition in Colombo.

Radio Programmes. 11 programmes were conducted by the Advisory Officer (Rhunu Sevaya).

Informal Discussions.

With small holders: 42

With planters: 2

With students: 3

8.5. Meeting attended by the Advisory staff:

- Advisory Officers' meetings: 2
- E & E meetings: 3
- Other meetings (Advisory Circulars, Research–Advisory Linkage, TSHDA –TRI): 18

8.6. Soil samples for pH analysis: 119

8.7. Advisory publications distributed: 972

8.8. Sale of planting materials: 178,150

8.9. Meteorological Observations, 2003

Advisory and Extension Centre, Kottawa, Talgampola

Officer-in-charge: K D Dahanayake

1. Special Assignments

In addition to his normal duties, Mr K D Dahanayake shared the responsibilities of inspection of the Institute's tea fields at Walahanduwa.

2. Labour force

No. on check-roll	56
Out-turn (on average)	38

3. Land Use Information

	<u>ha</u>
VP tea (mature)	10.0
VP tea (young) for ADB	5.0
Nursery tea	1.0
Seed garden tea	1.0
Coconut, fruit trees and germplasm	1.5
Forestry	7.3
Buildings, gardens and roads	9.8
<u>Total extent</u>	<u>35.6</u>

4. Mother Bush Project

Planting four hectares has been completed.

5. Clonal Mother Bushes

The establishment of clonal mother bushes were completed.

6. Sale of Planting Material

A total of 62850 clonal cuttings, of the TRI 2022, 2025, 2027, 3025, 3055 and 4049 series, were distributed.

7. Crop

Green leaf harvested (kg)

	Harvested	Sold	Rate paid/kg Rs cts	Total Income Rs cts
January	5886	5886	25.94	152682.84
February	4597	4597	23.35.9	107381.32
March	5985	5985	21.80.5	130502.93
April	6457	6457	23.02	148640.14
May	4581	4581	24.55.5	112486.46
June	4843	4843	26.07.9	126300.60
July	5169	5169	27.32	141217.08
August	4341	4341	26.57	115340.37
September	4195	4195	25.31.4	106192.23
October	4429	4429	26.08	115508.32
November	4338	4338	26.01.6	112857.41
December	5519	5519	approx 26.00.	approx.143494.00.00
<u>Total</u>	60340	60340		approx.1512603.70

Total rainfall 3194.5 mm
No. of wet days 188

8. Income

Sale of VP shoots	Rs 12570.00
Sale of green leaf	Rs 1512603.70
Miscellaneous	Rs 47307.00
<u>Total</u>	<u>approx. Rs.1572480.70</u>

9. Maintenance

Repairs to staff quarters C2 and leaf shed, and tarring of existing internal roads commenced.

10. Advisory and Extension Services

10.1. Advisory Correspondence

Number of advisory communications made by Advisory and Extension staff: 177.

10.2. Advisory Visits

A total number of 47 advisory visits was made by the Advisory and Extension staff. These included routine visits to estates and smallholdings.

10.3. Commercial Nursery Inspections

Mr K D Dahanayake made 13 commercial nursery inspections.

10.4. Testing of Samples

pH determinations were made on 196 soil samples.

10.5. Training Programmes

10.5.1 Seminars

Mr K D Dahanayake and Mr S P Ratnayake conducted 23 seminars at the Kottawa Centre and outside, in collaboration with the Central Bank of Sri Lanka, the Forest Department, the Ministry of Indigenous Medicine and the Tea Commissioner's Division. The target groups were tea smallholders, green-leaf suppliers and factory owners.

10.5.2 Video Programmes

Eight video shows were presented on plucking, land preparation and soil conservation for tea, at the Kottawa Centre and outside.

10.5.3 Demonstrations and Field Days

Nineteen (19) field days were held with Superintendents, Assistant Superintendents and smallholders in order to demonstrate methods relating to nursery work, weed management, plucking, pruning and pest/disease control.

10.5.4 Educational Programmes

Ten educational programmes, relating to identification of new clones, the new fertilizer policy recommended for the low country, shear harvesting and the new plucking basket, were conducted by the Advisory and Extension staff.

10.5.5 Awareness Programmes

Eight awareness programmes for plantation staff and workers, and smallholders, were organized and conducted by the Advisory and Extension staff.

10.5.6 Informal Discussions

Seven informal discussions were held on finding solutions to various problems encountered in the tea industry, such as labour shortage, and pest and disease control.

10.5.7 Advisory Publications

A total of 621 Advisory and Extension publications were distributed.

10.5.8 Upgrading Tea Museum and AV Saloons

Upgrading the tea museum and AV saloons is on progress.

11. Visitors

Visitors to the Centre were individuals seeking advice or those wishing to obtain VP shoots.

Their numbers were as follows:

Estate management and smallholders	859
University students/Diploma students and others	19

12. Students

- a) One student from the University of Sri Jayawardenapura successfully completed her research project on improving the productivity of tea smallholders in the Galle district, under the supervision of Mr S P Ratnayake. This was a case study in the Akmeemana and Kottawa tea inspector ranges.
- b) Three students from the University of Moratuwa were instructed by demonstrations, and furnished with a set of data, by Mr S P Ratnayake. This was towards inventing a motorized plucking machine specific to the low country, as partial fulfilment of their final-year research project.
- c) The projects of two agriculture diploma students from the School of Agriculture, Naiwala, relating to tea nursery management and low-country specific pests and diseases, were supervised by Mr S P Ratnayake at Kottawa.
- d) The project of an agriculture diploma student from the School of Agriculture, Kundasale, relating to tea nursery management, was supervised by Mr S P Ratnayake at Kottawa.
- e) Three advanced-level students gained information and completed their project reports under the supervision of Mr S P Ratnayake.

13. Meetings Attended

Mr K D Dahanayake and Mr S P Ratnayake attended 15 meetings including HOD, Advisory Officers' Forums, Grade I-V, E & E Meetings, Advisory Circular Revision meetings, DDC meetings and Research Linkage meetings.

14. Experiments and Observations

- 01 Shear plucking observation block
- 02 Hedge planting observation block
- 03 TRI 4000 series observation block
- 04 *Calliandra* plants block
- 05 Intercropping. 200 cinnamon plants in boundaries.
- 06 Growth performance of *Gravellia*. Reported by Talawakelle and Ratnapura Centres.
- 07 Growth performance of young tea. Reported by the Ratnapura Centre.
- 08 Lopping high shade (*Albizzia*)
- 09 Clonal Mother Bush Project. TRI 3000- and 4000-series clones.
- 10 Seed garden trial in Field No. 07.
- 11 Fertilizer demonstration trial in Field No. 04 (VP/LC 880 and U 709).

15. Special Tea Problems of the Southern Province

The spreading of Horse Hair Blight disease was noticed, and a group comprising Mr Samansiri and Mr Yatawatte visited the main areas affected by the disease.

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.

Fifty-eight books and 139 journals were sent to the library of the Low Country Centre, Ratnapura. Sixty publications were sent to the library of the Mid-Country Centre, Hantana.

The Librarian visited the Low Country Centre 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 U Hulangamuwa

1. Personnel

Mr S G Ekanayake resigned from the post of Superintendent on 31st March.

Mr C Karunaratne, Superintendent, Waltrim Estate overlooked the estate from 1st April to 15th June.

Mr J U Hulangamuwa assumed duties as Superintendent with effect from 16th June.

Mr Mahen Madugalla was appointed Visiting Agent and visited the estate on 12th December.

Mr S Fernando, Estate Medical Assistant, was re-instated with effect from 1st December with 50% back wages.

Mr S Rajapakse, Junior Assistant Field Officer, Passara Centre, was transferred to the estate on a temporary basis, with effect from 1st December.

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

	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
<u>Total in tea</u>	<u>105.42</u>	<u>50.21</u>	<u>155.63</u>
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
<u>Total</u>	<u>171.79</u>	<u>65.91</u>	<u>237.70</u>

4.2 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
<u>Total</u>	<u>288,597</u>	<u>2,147</u>	<u>295,200</u>	-
Bought leaf	1,235	-	-	-
<u>Grand Total</u>	<u>289,832</u>	<u>2,147</u>	<u>295,200</u>	<u>2,155</u>

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

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	528	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, CY9	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, Gravelia & Calliandra
9	4.8	3	TRI 3000 & 2043	2001	1986	2433	2219	Dadaps, Gravelia & Calliandra
10	-	2	SALT Area	June 1999	1993	1550	2064	Dadaps, Gravelia & Calliandra
11A	-	2.0	TRI 2025, 629	June 2003	1988	1979	645	Gravelia & Calliandra
11B	1	-	-	June 2003	1935	1784	684	Dadaps, Gravelia & Calliandra
12A	-	1.2	TRI 2025 KO 145	June 1999	1985	2515	1923	Dadaps, Gravelia
12B	-	1.5	-	-	1935	190	810	Gravelia
13	8.0	-	-	July 2001	1935	1777	2205	Dadaps, Gravelia & Calliandra
13A	-	1.4	TRI 2025 2043, DT 1	July 2001	1986	1314	1675	Gravelia & Calliandra
13NC	-	2	TRI 3000 Series 2025, DT1	Aug. 2001	1996	940	1607	Gravelia & Calliandra
14	-	5.1	TRI 777, 2023 2024, 3000 Series N2	Oct. 1999	1961	2012	1981	Dadaps, Gravelia & 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	161	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 - Lamiliere 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	TRI2025	Jul 01	1984	2550	2847	Dadaps & Gravelia
4B	-	1.9	TRI2025	Jul 03	1986	3001	963	Dadaps & Gravelia
5	0.5	-	-	Oct 03	1999	2784	2142	Dadaps & Gravelia
5NC	-	1.0	TRI3041	-	-	4262	1965	Dadaps & Gravelia
6A	1.5	-	Mixed Clones	Aug 03	-	1667	848	Dadaps & Gravelia
6B	-	2.0	DT1, WT26 TRI2025	Oct 02	1990-1991	1694	1357	Dadaps & Gravelia
7	-	4.5	TRI2025	Jun 03	1983	2472	1277	Dadaps & Gravelia
8A	-	5	TRI2025 & CY9	Jun 00	1979	2753	2933	Dadaps & Gravelia
8B	-	4	TRI2025 DN, N2, WT26 CY9	Jun 01	1989-1990	2875	2687	Dadaps & Gravelia
9A	-	4	TRI2025	May 02	1979	1117	2624	Dadaps & Gravelia
9B	-	4	TRI2025, DN CY9	Jul 02	1980	1255	2631	Dadaps & Gravelia
10	-	6.6	DN, TRI2025	Jun 99	1967-1969	2703	1911	Dadaps
11	-	6.4	DN, TRI2025	May 00	1970-1971	2768	2355	Dadaps

ST JOACHIM ESTATE

Superintendent – M S E Perera

1. 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.

2. Hectarage as at 31st December

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
<u>Total</u>	<u>118.54</u>

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:

<u>Year</u>	<u>Estate Crop</u>	<u>Bought Crop</u>
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 or 1.51 %, 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 TRI 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.

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. Their services were discontinued as from September.

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).

Nursery

The supply of planting materials to small holders in the District continued during the year.

The sale of planting materials compared to the previous year was as follows. (Values are in Rupees.)

	Shoots Sold	Proceeds	Profit on sale of shoots Rs.	Plants sold	Proceeds	Profit on sale of plants 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

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 damage 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/= *

* Bought crop made tea
Estate crop made tea

* To end November 03

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
February	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 (m.m)	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												Total
				Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	
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	134	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 (°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° 56'N, Longitude 81° 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 mm	Difference from 30 years	Wet Days	Difference from 30 years	Pan Evaporation (mm/day)
	Mini: dry	Max: dry	9.00 hrs	16.00 hrs	H' 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°54'768'n,Long.80°42'39'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			