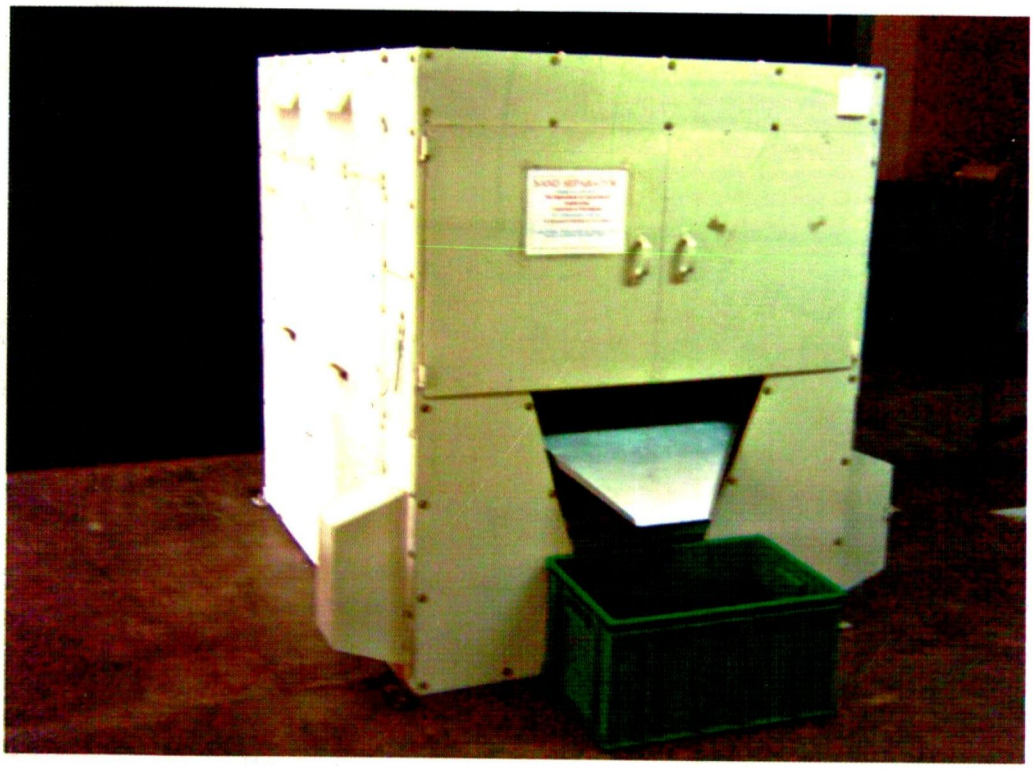

The Tea Research Institute of Sri Lanka

Annual Report 2004

TEA RESEARCH INSTITUTE OF SRI LANKA

ANNUAL REPORT FOR THE YEAR 2004

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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 rationalize and optimize the fertilizer inputs

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

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

REPORT OF THE CHAIRMAN
TEA RESEARCH BOARD

During the year, several important decisions were implemented at the Institute. The decision to privatise and restructure the Institute was suspended by a major shift in policy of the new Government, elected in April, as the new objective is to strengthen Institutes of government to benefit Sri Lankans. Adhering to that main objective and new policy, the new Board of Management of the Institute undertook several important policy strategies to enhance the Institute's contribution to benefit the tea industry, in relation to Research and Innovations, Technology Transfer and Stake Holder Participation, Human Resource Development, and Administrative and Financial Management, with relevant re-engineering processes for cost effectiveness and efficiency.

Since details of the main activities undertaken by the Institute are presented in the reports by the Directorate and Research Divisions, only the important strategies and policy directives taken by the Board, with resulting achievements, are summarised below under four main categories, for easy reference and in order to avoid duplication.

1. Research and Innovations

The new Board emphasized that the final objective of all research programmes of the Institute should be to increase the productivity and the profitability of the tea industry in a sustainable way, for enhancing the living standards of all stakeholders and Sri Lankans in general, while developing appropriate short-, medium- and long-term strategies to overcome existing and anticipated field problems and issues in all aspects of the industry. Further, the Board reiterated that the effective and efficient transfer of appropriate technologies developed by the Institute is essential, with the Institute taking steps to monitor adoption rates by the stakeholders and related benefits. Hence, the Corporate Plan (2002-2006) was re-valuated and relevant new projects inserted under research thrusts.

Some important issues and priority research projects with subsequent actions, taken during the year, are given below.

1 a. Productivity/Profit Levels and High Cost of Fertilizer

To increase productivity of tea, fertilizer recommendations were provided to tea growers based on soil-nutrient levels, resulting in significant monetary savings to many estates, owing to the reduced recommended rate of KCl. Research is directed at providing Site-Specific Fertility Management Packages for individual

lands and estates, based on soil- and leaf-nutritional levels and on present, potential and achievable yield levels, considering chemical, physical, and biological factors and adhering to cost-benefit ratios.

1 b. Fertigation

Preliminary research on drip irrigation of tea showed a 20-25% yield increase indicating an agronomic benefit. Economic evaluations are in progress.

The cost of drip-irrigation systems are expensive owing to the need for imported drippers and complex filtration systems. Preliminary studies were therefore undertaken to compare the benefits of local drippers, such as the Soaker Tube developed by the Rubber Research Institute, and the novel Screw Dripper, with the Gravity Flow Drip Irrigation Package, developed by the Coconut Research Institute. Demonstration field trials are being arranged to establish them in smallholder tea lands, and in the Institute's estates, to evaluate their benefits under growers' conditions.

1 c. Soil Erosion, Contour Live Hedges and SALT

To arrest soil erosion and degradation, and improve fertility, steps were taken to popularise the implementation of the Sloping Agricultural Land Technology (SALT) package in contours, and the planting of nitrogen-fixing shade trees. The leguminous creeper, *Arachis pintoi*, is found to be an effective nitrogen fixer in most tea lands. It was decided that the all the Institute's tea lands, specially St Coombs and St Joachim Estates, should be managed as 'model' tea estates, and immediate steps were taken to implement all agronomic recommendations such as SALT, shade trees, and the use of *Arachis pintoi*.

1 d. Quality of Made Tea

Studies have shown that damage to harvested leaves during transportation could be minimised by an easily removable racking system, placed in trailers or in lorries, with significant benefits related to quality and out-turn. Research is in progress in this direction with the participation of private-sector estates and factories for fine refinements.

Similarly, steps were taken to improve the level of the tea factories at St Coombs and St Joachim. The St Coombs Tea Factory was awarded the ISO 9001 accreditation with the implementation of programmes such as 5 S, TQM and JIT. The factories are also in the process of adhering to HACCP and other product and process certification programmes.

1 e. Cost of Fuel and Dendro Power

Several options were evaluated, and the most practical and easily implemented technology was found to be Dendro Thermal Power Generation, using fuel woods harvested by coppicing Nitrogen Fixing Trees (NFT), grown in tea lands along contours, or as SALT or shade trees, or in lands with degraded soil and uneconomical tea lands. Studies are in progress to evaluate fuel-wood efficiency of *Calandra* species that are grown in the up country, since *Glyricidia* was found to be the species best suited for mid- and low-country lands. Evaluations are also in progress to establish the most appropriate system as a pilot-scale project to demonstrate benefits. Studies are also in progress to evaluate the appropriate use of Dendro Thermal Power Generation technology to benefit the tea industry.

1 f. Free Fertilizer and Free Energy

It is emphasized that our agriculture, including tea cultivation, should change from the use of 'cheap' sources to high use of 'free' sources, in relation to fertilizer and energy. 'Free' fertilizer sources would be those available locally and *in situ*, namely bio- or organic manures from NFT plants and animal husbandry, as compared to 'cheap' or 'expensive' chemical fertilizers. 'Free' energy could be obtained locally and *in situ* by growing appropriate NFT plants, using the coppicing technique for the sustainable supply of fuel wood, as well as for 'free' bio- or organic manures, compared to energy from expensive hydrocarbon fuels. This change of practice would reduce costs and give several other sustainable social and ecological benefits.

1 g. Innovations

The research staff were briefed about the importance of innovative and out-of-box creative thinking for developing beneficial technologies for the tea industry. The implementation of a merit reward scheme is under discussion to recognize significant contributions and to motivate staff, as indicated by the awarding, during the year, of two patent rights related to the anti-fungal activity of black tea components, and to the Deep-Placement Fertilizer Applicator.

1 h. Publications

The Institute played the main rôle in organizing the First Symposium on Plantation Crop Research, with the theme 'Current Trends and Future Challenges', together with the Rubber Research and Coconut Research Institutes, during 8-9 July. The Proceedings were published by the Institute.

The Director and staff took a keen interest in publishing all journals, bulletins, annual reports, etc., within the time schedules.

Several CDs with multimedia presentations were produced to disseminate the Institute's recommendations, and the high level of sales indicates their acceptance and benefit to the industry.

1 i. Replanting Rate

The book, entitled 'Agricultural Profile of the Corporate Tea Sector', based on a survey of the status of tea cultivation, revealed that the replanting rate during the 1993-2002 period was only about 0.7% of the total extent tea, indicating a high level of aging, as the required replanting rate is 2%. This revelation resulted in a special focus to increase the level of replanting in the estate sector, using the anticipated increase in cess collection.

2. Technology Transfer and Stakeholder Participation

The Board reiterated the importance of effective and efficient technology-transfer programmes, as it is useless to conduct research if the adoption rate is poor. It was also noted that most stakeholders are aware of the benefits of the Institute's recommendations and technologies, but the problem is that they are not highly 'convinced' to make a change for implementation.

2 a. Tea Crop Clinics and "The Dallaka Vidu nana"

To increase interaction with stakeholders and enhance technology transfer, for the first time in the history of the Institute, the Directorate and scientists took the novel and innovative approach of conducting Tea Crop Clinics in the tea-growing regions, during the year. The first Crop Clinic was held on the 1st October at Passara. The Ratnapura Crop Clinic was held on the16th November.

The Tea Crop Clinics are similar to that conducted by medical professionals. Growers and stakeholders could obtain advice, recommendations, information, and demonstrations on any aspect of tea cultivation and the tea industry, to increase their yields and profit. Scientific staff, representing all research disciplines, participated with the relevant analytical instruments for appropriate measurements and checks, such as pH, conductivity, pest and disease attacks, nutritional deficiencies and nematodes.

Stakeholders have commended the novel approach of the Tea Crop Clinics, as is evident by the participation of large numbers of senior staff of RPCs, Superintendents, SDs, field and factory staff, and growers and public with special interests in the tea industry.

Since the technology and knowledge requirements for personnel in large estates and small holdings are different, a 'Tea *Vidu Sayanaya* ' was organised specially for tea small holders at the village level, in collaboration with the Tea Smallholdings Development Authority, for the first time, at Danture, Kandy on the 26th of November.

2 b. Scientific Interactions

Since whole land development with an integrated approach is beneficial, specially for tea small holders, the Institute participated in growers' field days organised by the Coconut Research Institute and the Coconut Cultivation Board. The Ministry of Plantation Industries has encouraged the four research institutes, related to tea, rubber, coconut and sugarcane, to work with much closer collaboration in a holistic approach to benefit growers.

2 c. Mother Bush Programme

To enhance the extent of planting of the 3000 and 4000 series tea cultivars developed by the Institute, large numbers of cuttings for about 2800 ha of replanting extent were issued during the year, to raise quality seedlings for subsequent planting, under the Mother Bush Programme funded by the ADB through the Tea Development Project. The programme is being monitored in detail to quantify the benefits related to tea cultivation, productivity, etc.

2 d. Participatory Management with Stakeholders

The Board strengthened the participation of all categories of stakeholders in committees concerned with Research, Advisory and Extension, etc., in addition to the appointment of Members of the Tea Research Board as representatives from the Planters Association, Tea Small Holdings Development Societies, Private Tea Factory Owners Association, etc.

With the active participation of tea growers, a research survey was initiated in August, to study the widespread occurrence of tea-bush dilapidation reported in the Deniyaya area. Adaptive trials are in progress in growers' fields, and progress is being monitored quarterly, together with representatives of growers at field-level discussions.

2 e. Tea Policy

Institute staff are actively involved in the preparation of the Tea Policy document, now in its final stages. Staff also provided valuable inputs at the National Council for Economic Development (NCED) of government, in relation to the development of the tea industry.

2 f. Products and Enterprise Development

It is essential that products developed by the Institute should be commercialised by entrepreneurs to attain the expected return on investment. To commercialise the tea wine developed by the Biochemistry Division, funding was sought from the National Science Foundation for enterprise development work with a local wine manufacturer, and pilot-scale production trials are in progress.

The Institute is also looking for a suitable entrepreneur to commercialise the ready-to-drink 'Fizzy Tea' it developed a few years ago.

2 g. Extension through the Media

Steps were taken to use the print and electronic media to disseminate the Institute's technologies and recommendations to stakeholders, by placing extension notes in national papers on Wednesdays, and by radio and TV programmes, with the assistance of the Media Unit of the Ministry of Plantation Industries. Several display boards were also erected, along estate and public roads, depicting beneficial technologies developed by the Institute.

3. Human Resource Development

The Board considered the educated, experienced and skilled staff of the Institute as its most important asset.

3 a. Scientific Discussions

To provide a conducive research environment for scientists and supportive staff, several interactive discussions and presentations were held, such as brief research presentations at Board meetings and at Heads of Division meetings, and regular discussions with staff associations, in addition to normal management meetings.

3 b. Merit Awards

The Board also approved in policy the implementation of a Merit Award Scheme for outstanding contributions by staff. As motivation for increased efficiency, estate and factory staff were given the relevant portion of bonuses, since they contributed to an increase in production and profit levels after several years of low production with losses.

3 c. Training

Since the Institute should have the best-trained scientific staff to develop creative and beneficial technologies to allow the tea industry to compete internationally, the new Board decided to extend postgraduate training to developed countries also. Instead of suspending overseas training opportunities, the Board decided to initiate legal proceedings to recover the monetary bonds, and to take appropriate legal action against past defaulters (14 officers). Subsequently, some defaulting officers have requested to have their names cleared. by repaying bonds as per the agreements related to their training.

3 d. Vacancies

Based on the policy decision of the new Government to strengthen the research institutes by filling all vacancies, the Institute also took steps to fill all vacancies, specially the categories of Deputy Director and scientific staff.

4. Management (Administrative and Financial)

4 a. Administrative Procedures

The Board emphasized the importance of efficient and transparent administrative and financial management at the Institute to achieve the expected results. Specially the educated and skilled human assets should be looked after with care, without favouritism or revenge. Hence all administrative and disciplinary matters were attended to by adhering to the accepted rules and regulations of the Establishment Codes of government and the Institute. The Manual of Procedure is also being revised to suit the recent changes in open and democratic but firm style of management.

Disciplinary, legal, and administrative matters, related to staff and other assets, are monitored at Board level with a separate Board Paper giving details of progress until completion.

4 b. Staff Remuneration and Facilities

The Board rectified several salary and promotional anomalies that had existed for several years, and decided to revise the whole incentives and benefit schemes of the Institute, in accordance with increased inflation, and in order to retain staff at distant places such as Talawakelle and Passara.

Staff travelling from Colombo and Kandy, at the weekends, were benefited by the allocation of two separate buses to both destinations every weekend, as against the allocation on alternative weekends. This was approved during the familiarisation visit of the Hon. Minister in August.

4 c. Staff Cadre

Under the Tea Development Project, all tea-related institutes were to be re-structured with reduced staff and certain legislative changes. However, the government decided to implement the Voluntary Early Separation Package (VESP) at the Institute for non-executive staff only. Ten officers opted for the VESP.

4 d. Assets' Management

Steps were taken to implement the suggestions made by the Internal Audit Unit of the Institute, and the Auditor General, relating to the effective management of assets. Tender procedures were streamlined to adhere to standard procedures, and any deviation for urgent research requirements were granted only after separate justification and special approval from higher authorities. The Board decided to adhere to government financial rules and regulations, as cess funds are also treated as public funds by the Treasury.

4 e. Financial Management

The Audit and Management Committee, comprising representatives from the Ministry and the Treasury, assisted the Board in monitoring and evaluating the financial aspects. Cash flow and balances were monitored with regular evaluation of debtor and creditor levels.

Dr K Sunil Jayasekara
Chairman,
Tea Research Board

REVIEW OF THE DIRECTOR TEA RESEARCH INSTITUTE

1. Cess Allocation and Corporate Plan

The cess allocation was reduced to 26% (Rs 195.9 million) for the year under review, as in the previous year, in spite of a recommendation by the Asian Development Bank (ADB) for an allocation of 34% to the Institute. Research projects for the year 2004, in the revised Corporate Plan of the Institute, were initially formulated on the basis of a budget of Rs 225 million (30% of the cess), but were later amended to suit the revised budget.

As in the past, the research programmes continued in a multi-disciplinary mode. Despite the restricted flow of cess funds, the Institute has done remarkably well, during the period under review, to fulfill its objectives. There was a delay in the flow of cess funds as more funds were diverted to meet the payment of subsidies for re-planting in the smallholding sector.

2. Achievements

The achievements during the period under review could be summarized under the following headings:

1. Research highlights
2. Patents, awards and recognition
3. Publications
4. Advisory and Extension Services
5. New initiatives.

2.1 Research Highlights

The major research highlights during the period under review could be summarized as follows.

Germplasm

A database was constructed, incorporating all available information on traits evaluated, to facilitate rational selections of parents for hybridization programmes. A draft document, "Spatial distribution of tea cultivars originated from estate selections", was prepared.

Green leaf transportation

A system for the transportation of green leaf in lorries, equipped with racks, was studied. According to an analysis of the new system, the cost of transportation increased marginally, but the quality of the final product was significantly better than with the traditional transport system.

De-gritting machine

A commercial-scale de-gritting machine was fabricated in collaboration with the Agricultural Engineering Department of the University of Peradeniya. This machine will be useful in cleaning tea contaminated with grit or sand particles.

Design and development of a tea-bulking machine

A unit for bulking leafy-grade teas was fabricated and tested with low-grown teas at the St Joachim Factory, Ratnapura. Action has been taken to improve the performance of the unit. A paper describing the performance of the machine was presented at the annual SLAAS sessions held in December.

Control of Passali Kodi and Getakola

The control of the weeds, Passali Kodi (*Anredera cordifolia)* and Getakola *(Hedyotis* spp.), were investigated in field trials. For their control, a cocktail mixture of glyphosate (5.5 litres ha^{-1}) and MCPA (3l litres ha^{-1}), with isoprophyl alcohol (5%), proved satisfactory. Repeated applications may be necessary.

A computer model to predict yield due to climate change

A simple computer model was developed, with the assistance of the Indian Institute of Agricultural Research, to predict the yield of tea in different agro-ecological regions as a result of climate change. The linked climate scenario model 'Sri Lanka Clim' and the impact model 'Tea' predicted that tea yields will not be affected under a high emission scenario (A1F1) at low elevations and high elevations, but will be affected under a low emission scenario (B2) at low elevations, in the years 2025 and 2050.

A boundary-line technique to define nutrient ranges for VP tea

A boundary-line technique was used to precisely define the optimum nutrient ranges for VP tea. This method could be used to work out the critical values of nutrients needed, and is expected, therefore, to result in savings in fertilizers used.

Classification of leafy grades by sieve analysis

A mathematical model established for broken- and small-leaf grades was successfully adopted for classifying large leafy grades. Adopting this classification will help to improve the quality, and hence the prices, of low-country tea.

The horse-hair blight problem in the low-country

Propiconazole and F-500 (Pyraclostrobin, a new fungicide) at 0.05% effected prolonged control of horse-hair blight under *in vitro* conditions.

Effect of irrigation on *Macrophoma* canker

Irrigation reduced the incidence of *Macrophoma* canker at low elevations.

Comparison of quality parameters of organic and conventional tea

Conventional tea was found to have a higher theaflavin and thearubigin content, while organic tea had a higher crude-fibre content. However, there were no differences between organic and conventional tea in total polyphenol, catechins, caffeine and soluble solids.

DNA markers for molecular characterization of tea

Under this project, 46 TRI cultivars were characterized using the Random Amplified Polymorphic DNA (RAPD) technique.

Growth accounting analysis

Economic growth accounting analysis indicated that the output growth rate had increased in Corporate Sector estates after privatization, although the input growth rate had decreased.

Control of shot-hole borer

Seventeen cultural collections of local isolates of insect pathogens, for shot-hole borer control, were collected from natural forests.

Control of black root diseases

The systemic fungicides, Propiconzole and F-500, were found to be effective in controlling the black root pathogen, *Ustulina deusta, in vitro*.

Health benefits of tea

The antioxidant activity of Sri Lankan black tea, measured *in vitro and in vivo*, has shown that it is dose-dependent *in vitro*, and dose- and time-dependent in *in vivo*.

Flavonoid synthesis

Enzyme activities, directly involved in flavonoid synthesis in tea, were demonstrated for the first time.

Microbial populations in biodynamic farming

Microbial populations were higher in biodynamic farming than in conventional farming.

A land suitability classification map for the Ratnapura District

A map (1:10000) was prepared showing the exact extent of tea cultivation in the Ratnapura District, and the land suitability classes in each location. The extent of tea cultivation is 28,000 ha, which is about 2,000 ha higher than the figure reported earlier.

Site-specific fertilizer recommendations

The Institute is recommending site-specific fertilizer recommendations to improve fertilizer-use efficiency. This would give a higher return on inputs.

Project proposal on green leaf price formula

A project proposal has been formulated to study and revise the green leaf price formula. This study would take into account the cost of tea cultivation, the cost of tea processing, the nett outturn, etc.

Strengthening biological control research

Dr Dave Moore, an insect pathologist from CABI, and other entomologists and nematologists from local institutes, visited the Institute on 25 October, to discuss strategies to improve the biological control research. A new laboratory for biological control research was opened on 25 October.

2.2. Patents, Awards and Recognition

The Institute obtained patents for the following, during the period under review.

i. The discovery of anti-fungal activity of the black tea components, catechins and theaflavins, against *Candida albicans, Candida parapsilosis, Candida tropicalis, Candida krusei* and *Candida glabrata*. This will help to enhance the promotion of tea as a health drink.

ii. A deep-placement fertilizer applicator.

A film, entitled *The Story of the Tea Estate*, produced by the Open University in collaboration with the Institute, received the award as the Best Asian (Foreign) Educational Video Programme for the year 2003, at the UGC-CEC Educational Video Competition held in India.

Dr M T Ziyad Mohamed, Director, was invited to serve as a member of the Expert Group by the ISO Technical Committee on Tea (ISO/ TC 34/ SC 8).

Dr M T Ziyad Mohamed, Director, made a presentation under the title *Tea Industry in Sri Lanka*, highlighting the issues faced by the industry and on current trends and future challenges in tea research in Sri Lanka, at the 150th Anniversary celebrations of the Planters Association of Ceylon, held on 17 February.

Dr M T Ziyad Mohamed, Director, led a Sri Lankan Delegation to Iran, which included Dr K Mohotti as a member, from 15 to 22 November, pursuant to an agreement signed between the Governments of the Islamic Republic of Iran and of Sri Lanka, on various trade issues in respect to the export and import of tea and other commodities.

2.3. Publications

The Institute published the following, during the period under review.

i. *Agricultural Profile of the Corporate Tea Sector*

A corporate sector document entitled, *Agricultural Profile of the Corporate Tea Sector*, was published, and launched on 16 April with Mr J R Cooney, Country Director, Asian Development Bank (ADB) as the Chief Guest. The Chief Executive Officers of Regional Plantation Companies (RPCs) were presented with individual CDs containing field-wise information on estates coming under their purview.

ii. *Twentieth Century Tea Research in Sri Lanka*

A comprehensive review of the past 75 years of tea research in Sri Lanka was published under the title *Twentieth Century Tea Research in Sri Lanka.*

The book was launched on 14 June, with the Honourable Mahinda Rajapakse, the Prime Minister of Sri Lanka, gracing the occasion as Chief Guest. This book should have been published in the year 2000, but could not be finalized earlier, owing to various reasons.

iii. *Proceedings of the First Symposium on Plantation Crop Research*

A Symposium on Plantation Crop Research was jointly organized by the three crop research institutes (the Tea Research Institute, the Rubber Research Institute and the Coconut Research Institute). It was held at the BMICH in Colombo on 8 – 9 July. Since this was the first of its kind in Sri Lanka, this Institute was entrusted with the task of organizing the event. The Director, Tea Research Institute, presented the first copy of the Proceedings of the Symposium, entitled *Proceedings of the First Symposium on Plantation Crop Research*, to the Minster of Plantation Industries, the Honourable Anura Priyadhrashana Yapa, who graced the occasion as the Chief Guest, on the first day.

The Institute received several letters of commendation from stakeholders and participants for its rôle in organizing this unique event in the history of the plantation sector, and also for the quality of the presentations made by the Institute's scientists.

iv. *Weeds of Tea Lands in Sri Lanka*
v. *A Guide to the Tea Research Institute of Sri Lanka*
vi. *Tea for Health*
vii. *Tea Information* (in Sinhala)
viii. Annual Report, 2003 (in English, Sinhala and Tamil)
ix. A leaflet on *The Leaf to the Cup* (in Sinhala and Tamil)
x. TRI Update, Volume 9 (1) & (2)
xi. Sri Lanka Journal of Tea Science, (Volume 68, Part II)
xii. Sri Lanka Journal of Tea Science, (Volume 69, Part 1 & II)
xiii. Tea Bulletin, Volume 18 (1 & II)
xiv. CD on Tea Text
xv. The Thathu Vol. 3 (II)

In addition, the Institute's scientists published the following papers in outside journals.

P A N Punyasiri, I S B Abeysinghe, V Kumar, D Treutter, D Duy, C Gosch, S Martens, G Forkmann and T C Fischer (2004). Flavonoid biosynthesis in the tea plant *Camellia sinensis*:: properties of enzymes of the prominent epicatechin and catechin pathways. *Archives of Biochemistry and Biophysics, 431, 22-30.*

P A N Punyasiri, G Tanner, I S B Abeysinghe, V Kumar, P Campbell and N H L Pradeepa (2004). *Exobasidium vexans* infection of *Camellia sinensis* increased 2,3-cis isomers and gallate esterificatin of proanthcyanidins. *Phytochemistry.*

S Koneswaramoorthy, M T Ziyad Mohamed and G Galahitiyawa (2004). Developing and evaluating solar energy techniques for tea drying. J Natn. Sci. Foundation Sri Lanka, 32 (1 & 2), 49 – 60.

2.4. Advisory and Extension Services

i. Interaction between Institute staff and stakeholders

Staff of the Advisory Division visited all 304 estates managed by the Regional Plantation Companies (RPCs), and collected information on the productivity of their lands. Based on the information collected, twenty documents, highlighting the agricultural profile of every tea estate managed by the 20 RPCs, were prepared. One of the objectives of carrying out this exercise was to strengthen the interaction between the staff of the Institute and its stakeholders, and this was achieved to a large extent.

Arising from discussions with the Chief Executive Officers of the RPCs, several workshops on selected topics, such as the revised fertilizer recommendations made by the Institute, pest management, etc., were organized separately for the executives. This further strengthened the interaction between the Institute's staff and the stakeholders.

ii. "Crop clinics"

"Crop clinics" are an initiative through which the Institute's scientists visit different regions, with their instruments and equipment, to provide mobile advisory and extension services to stakeholders. Personnel from the tea industry could walk into these "clinics" and clarify any doubts and problems then and there, through one-to-one interactions with the Institute's staff. This particular approach was found to be much more effective than the typical stereotype seminars and conferences the Institute has been conducting for a long time. The "clinics" also provide a forum for the scientists to get to know the problems on the ground,

so that they may focus on areas which need attention. The Institute received overwhelming responses and many commendation letters from stakeholders on this initiative.

The first "crop clinic" was held in the Uva on 1 October, followed by four further clinics for the benefit of the planting community in the Uva, Ratnapura, Dimbula and Nuwara Eliya districts. Arrangements have also been made to conduct another two in Kandy on 11 and 12 February. The one planned for the 11 February is for the smallholders, and it is the first of its kind. The Institute also received a request from the Private Tea Factory Owners' Association for a separate "crop clinic" for the benefit of their membership.

iii. Workshops for corporate sector

Arising from discussions the Director had with Chief Executive Officers of RPCs, two workshops were held for the benefit of corporate sector stakeholders. The details are as follows:

Workshop for the executives of two companies on 24 November. Along with the CEOs, 92 participants attended this workshop.

Workshop on Tea Pest Management by Entomology Division staff, on the same day, in response to a request made by Mr J P Y Ratnayake, the CEO of Elpitiya Plantations Limited, to the Consultant. Along with Mr Ratnayake,. 26 executives attended.

Iv. Experiments and Extension Forums

As in the past, two Experiment and Extension Forums were held for the benefit of stakeholders from the corporate sector.

Two Experiment and Extension Forums for smallholders were held at the Institute in Talawakelle. The Chairman, Tea Small Holdings Development Authority, attended the forum held in October.

2.5. New Initiatives

New initiatives taken by the Institute could be summarized as follows.

i. In addition to conducting Experiments and Extension Forums, seminars at regional levels on selected topics were organized for the benefit of small holders in all the tea growing districts.

ii. Translations of all Advisory Circulars into Sinhala and Tamil have been completed and are being edited.

iii. The Institute's TRI web page, www.tri.ac.lk, was launched. This was long overdue but was finalized during the year under review.

iv. Action was initiated to revise the *Handbook on Tea*. Once this is accomplished, the revisions of other publications of the Institute, such as the Monographs, will follow.

3. Human Resource Development:

i. Mrs B A P Cooray, Research Assistant, Plant Pathology Division, proceeded to the UK in January, to pursue her Ph D in Molecular Plant Pathology at the University of Reading.

ii. Mr J W K K Jayasundera, Experimental Officer, Plant Pathology Division, proceeded to India in January, to pursue his M Sc in Microbiology at the Punjab Agriculture University, Ludhiana.

iii. Mr M A B Ranatunga, Research Assistant, Plant Breeding Division, proceeded to India in August, to pursue his M Sc in Biotechnology and Molecular Biology at the Tamil Nadu Agricultural University.

iv. Mr S P Rathnayake, Extension Officer, Kottawa Station, proceeded to China to pursue postgraduate training leading to the M Phil at the Wuhan University of Technology.

4. General

4.1 ADB-Funded Mother Bush Project

In spite of several setbacks at the early stages, the mother bushes of new TRI 3000 and 4000 series cultivars were established, covering a total extent of about 87 ha. Out of the total extent identified, the 54 ha maintained by the Institute has progressed well at most of the sites, except at Deniyaya, which was affected by floods in May 2003. The Asian Development Bank funds this project and it is managed by the Institute. The physical progress has been estimated at around 96% of the total area identified, including TSHDA and smallholder lands. As a result of establishing mother bushes in this project, there will be no shortage of cuttings of the new TRI 3000 and 4000 series cultivars, even if 2% of the existing tea land is to be replanted every year.

4.2 The Low Country Station, Ratnapura, Building Expansion Project

The ADB allocated a sum of Rs 42 million, under the Second Tea Small Holder Development Project, for the construction of six staff quarters (two 'B' type, two 'C' type and two 'D' type), a glass-house, and an auditorium-cum-seminar/ lecture hall. The State Engineering Cooperation was selected as the contractor for the construction. The project commenced during the second week of February, and was to be completed before the end of the year. The physical progress was satisfactory, and the project would be completed by the end of January 2005.

4.3. Restructuring of the Institute

Messrs P E International Consultants Ltd. was assigned the task of making proposals towards restructuring the Institute, along with other tea-related institutions coming under the purview of the Ministry of Plantation Industries. The Cabinet of Ministers approved certain recommendations contained in the final report submitted by the Consultants. Action was taken to implement these recommendations. As per the scheme proposed by the consultants, ten members of staff, in the categories of Allied Clerical Staff, and Middle and Minor Grade Staff, were offered a voluntary early-separation package (VESP). This has led to difficulties in carrying out day-to-day activities at the Head Office and in the sub-stations.

4.4 Performance of the Institute's Estates

The two estates, St Coombs and St Joachim managed by the Institute, have made losses during the previous few years. However, in the year under review, the St Coombs and the St Joachim Estates made profits of about Rs 1.8 million and Rs 2.8 million, respectively. This was possible due to a closer supervision and better management, and this trend is expected to continue in the future. Furthermore, the officers and workers attached to the St Coombs Estate were paid an incentive of Rs 1000/= per head as green leaf bonus. St Coombs also recorded a record yield of 2316 kg/ha, which is the highest-ever yield recorded in its history. Action was taken to implement, on these two estates, all the practices recommended by the Institute, and also to manage them as model estates which other estates could follow. Both estates and their factories have been registered under the Tea Association of Sri Lanka (TASL) in order to obtain TASL certification, recently introduced, for the tea produced.

4.5 Overseas Visits

During the period under review, the following scientists traveled abroad as members of the trade delegation, and to attend various seminars and workshops.

Dr M T Ziyad Mohamed, Director
Dr A Anadacoomarasamy, Acting Deputy Director Research (Production)
Dr K M Mohotti, Acting Head, Entomology
Dr Kumudhini Gunasekare, Head, Plant Breeding Division
Ms J A A M Jayakody, Head, Agricultural Economics Division
Dr M A Wijeratne, SRO, Agronomy Division
Dr A M T Amarakoon, SRO, Biochemistry Division
Dr G Ganewatte, SRO, Agricultural Economics Division
Mr P A N Punyasisri, SRO, Biochemistry Division
Mr T G N Mahinda, Extension Officer.

5. Other Issues

i. The following areas of research were identified as priority areas.

Mechanization of field practices
Biological control of pests, diseases and weeds
Product development and diversification
Computer-aided manufacture.

To strengthen these areas of research, expertise has to be hired, or collaborative research projects with outside organizations have to be formulated, since the Institute does not itself have adequate resources.

ii. Yield decline and bush debilitation were noticed in tea plantations in the Deniyaya area. Scientists from the Institute visited the sites, and planned strategies to identify the root causes of the problems. Multi-factor reasons are thought to have contributed to the problems, and to create awareness among the stakeholders articles have been written in our newsletters.

iii. Several important positions, both in the technical and administration cadre, remained vacant. Owing to restrictions imposed by the Treasury/Department of Management Services, and also owing to the restructuring of the tea-related institutions proposed by the Asian Development Bank, these vacancies could not be filled. Action has already been taken to fill these vacancies in the year 2005.

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 the above 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 direction, 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 at Talawakelle is responsible for the maintenance, administration, overall planning and execution of research, and extension and advisory programmes, from the main Centre at Talawakelle and from five other Centres located in the different tea-growing districts.

4. Members of the Tea Research Board

a) Upto April 2004

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. Ronie 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. A C Liyanage	–	Convenor/Secretary .

b) From August 2004 to December, 2004

1.	Dr. Sunil Jayasakara	–	Chairman, TRB
2.	Dr. M T Ziyad Mohamed	–	Director, TRI
3.	Mr. Y G Wijeratne	–	Member
4.	Dr. D S A Samaraweera	–	Member
5.	Mr. Malin Goonatillake	–	Member
6.	Mr. Tikiri Kobbekaduwa	–	Member
7.	Mr. N M D Navaratne	–	Member
8.	Mr. Ranjan Dharmawardena	–	Member
9.	Mr. J M B Bandara	–	Member
	Dr. A Anandacoomaraswamy	–	Convenor/Secretary

5. Members of the Consultative Committee on Research

a) Upto April 2004

1.	Dr. S D I E Gunawardena	–	Chairman
2.	Dr. M T Ziyad Mohamed		
3.	Prof. Y D A Senanayake		
4.	Mr. Camilus 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. A Anandacoomaraswamy – Convenor/Secretary

b) From August 2004 to December, 2004

1.	Dr. Sunil Jayasakara	–	Chairman/TRB
2.	Dr. MT Ziyad Mohamed	–	Director/TRI
3.	Dr. DT Wettasinghe	–	Member
4.	Dr. DBT Wijeratne	–	Member
5.	Dr. DSA Samaraweera	–	Member
6.	Mr. Anil Cooke	–	Member
7.	Mr. KGB Obeysekera	–	Member
8.	Mr. Malin Goonatillake	–	Member
9.	Mr. DV Seevaratnam	–	Member

Dr A Anandacoomaraswamy – Convenor/Secretary

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

a) Upto April 2004

1. Mr. D V Seevaratnam – Chairman
2. Dr. S D I E Gunawardena
3. Dr. M T Ziyad Mohamed
4. Mr. Asoka Somaratne
5. Mr. Nihal Bopearachchi

6.	Mr. Kamal Obeysekera		
7.	Mr. W M P B Wijekoon	–	Observer
8.	Mr. D A Jayatunga	–	Observer
	Mr. B A D Samansiri	–	Convenor/Secretary

b) From August 2004 to December 2004

1.	Mr. DV Seevaratnam	–	Chairman
2.	Dr. MT Ziyad Mohamed	–	Member
3.	Dr. A Anandacoomaraswamy	–	Member
4.	Mr. WMP Wijekoon	–	Member
5.	Mr. DA Jayatunge	–	Member
6.	Mr. N Bopearachchi	–	Member
7.	Dr. S Jayasekera	–	Member
8.	Mr. A Somaratne	–	Member
9.	Mr. M Gunatillake	–	Member
10.	Dr. Jayantha Gunatillake	–	Member
11.	Mr. SD Nandasena	–	Member
	Mr BAD Samansiri	–	Convenor/Secretary

7. Members of the Audit & Management Committee

a) Upto April 2004

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

b) From August 2004 to December 2004

1.	Mr. N M D Navaratne	–	Chairman
2.	Mr. Y G Wijeratne	–	Member
3.	Mr. W M P Wijekoon	–	Member
4.	Dr. Nihal Samarapuli	–	Member
5.	Dr. D S A Samaraweera	–	Member
	Mr. D A Jayatunge	–	Convenor/Secretary

8. Senior Management Staff as at 31st December, 2004

Dr. M T Ziyad Mohamed	–	Director
Dr. A Anandacoomaraswamy	–	Actg. Deputy Director Research (Production)
Vacant	–	Deputy Director Research (Technology)
Mr. W M P Wijekoon	–	Deputy Director (Administration)

9. Executive Staff, Grades I and II, as at 31st December, 2004

Administration Division

Mrs.S Anusha	–	Administrative Officer
Mr. K G Piyasena	–	Public Relations/Welfare Officer

Engineering Division

Mrs. D W Manawadu	–	Resident Engineer

Finance Division

Mr. D A Jayatunga	–	Senior Accountant
Ms. R. Dissanayake	–	Actg. Accountant I
Vacant	–	Accountant II
Mr. K D H Pathirana	–	Stores Executive

Internal Audit Unit

Mr. R Kariyawasam	–	Internal Auditor

Agronomy Division

Mrs. M S D L de Silva	–	Senior Research Officer

Agricultural Economics Division

Mrs. J A A M Jayakody	–	Head/Senior Research Officer

Biochemistry Division

Dr. I S B Abeysinghe	–	Head/Senior Research Officer
Dr. A M T Amarakoon	–	Senior Research Officer
Mr. PAN Punyasiri	–	Senior Research Officer
Mrs. J Jayasundara	–	Research Officer

Entomology and Nematology Division

Dr. M M Keerthi	–	Actg. Head/Senior Research Officer
Mr. R S Walgama*	–	Research Assistant

Library

Mrs. R W M W K Illangantilake	–	Librarian

Publications Unit

Vacant	–	Publications/Publicity Officer

Plant Pathology Division

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

Plant Physiology and Plant Propagation Division

Mr. V Shanmugarajah	–	Head/Senior Research Officer
Dr. (Mrs) AJ Mohotti	–	Senior Research Officer

Plant Breeding Division

Dr. (Mrs) 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
Dr. A K N Zoysa	–	Senior Research Officer
Mrs. S Anandacoomaraswamy	–	Senior Research Officer
Mr. G P Gunaratne	–	Senior Research Officer

Statistics and Biometrics Unit

Ms. T U S Peiris	–	Research Assistant

Technology Division

Mr. K Raveendran	–	Actg. OIC/Chemical Engineer
Mr. W S Botheju	–	Senior Research Officer
Mr. S Koneswaramoorthi	–	Mechanical Engineer

Advisory and Extension Division, Talawakelle

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

Low Country Station,Ratnapura

Dr. M A Wijeratne	–	OIC/Senior Research Officer
Dr. K G Prematillake	–	Senior Research Officer
Mr. N P S N Bandara	–	Research Assistant
Mr. G L C Galahitiyawa	–	Research Officer
Ms. S M Samarasinghe	–	Research Officer
Mr. M K S L D Amarathunga	–	Advisory Officer

Mid Country Station, Kandy

Mr. P B Ekanayake	–	OIC/Senior Research Officer
Mr. S T Yatawatte	–	Senior Advisory Officer
Ms. R M D T Pallemulla	–	Research Officer

Advisory and Extension Centre, Talgampola

Mr. K D Dahanayake	–	OIC/Senior Advisory Officer

Advisory and Extension Uva Centre, Passara

Mr. J C K Rajasinghe	–	OIC/Senior Advisory Officer

* On overseas leave

10. Other Administrative, Scientific, Research and Advisory Staff, Grades III-V, as at 31st December 2004

Office of the Director

Mrs. S Jeyasingham	–	Secretary to the Director
Mr. RJ Rayappan	–	Office Attendant

Office of the Deputy Director Research (Production)

Mrs. Devika Ratnayake	–	Stenographer /Typist (English)

Administration Division

Mr. R Nandasena	–	Administrative Assistant
Mrs. S Shanmuganathan	–	Stenographer/Typist (English)
Mrs. I Jayawickrama	–	Clerk/Typist
Mr. K R M Priyantha	–	Clerk/Typist
Mrs. W M G R Jayasinghe	–	Clerk/Typist
Mrs. W M S R Wanasinghe	–	Clerk/Typist
Mr. I W Nihal Kumara	–	Office Attendant
Mr. S Dharmalingam	–	Office Attendant

Electrical Division

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

Engineering Division

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

Finance Division

Mr. C B Koswatte	–	Senior Accounting Assistant
Mr. S G Punchibanda	–	Accounting Assistant
Ms. V Pahalage	–	Accounts Clerk
Mrs. G A S Gunasekaa	–	Accounts Clerk
Mr. Saman Hewasiliyan	–	Accounts Clerk
Ms. A A A P Amaratunga	–	Accounts Clerk
Ms. P V D Chandrakanthi	–	Accounts Clerk
Mr. H B Talgahagoda	–	Accounts Clerk/Cashier
Mrs. R Godage	–	Clerk/Typist
Mr. M G Weeratillake	–	Cashier
Mr. W A Nishantha	–	Data Entry Operator/Accounts Clerk
Mr. K T U Kulatunga	–	Assistant Store Keeper
Mr. H P W Gunasekera	–	Stores Assistant
Mr. HN Dharmapala	–	Office Attendant

Internal Audit Unit

Mr. P S Wickramasinghe	–	Internal Audit Officer
Ms. N C Jayaweera	–	Internal Audit Clerk
Mr. W N K I Ariyaratne	–	Internal Audit Clerk

Mechanical Workshop

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

Motor Garage

Mr. G G E H Gamage	–	Chief Motor Mechanic
Mr. R Gabriel	–	General Mechanic
Mr. WG Wijeratne	–	General Mechanic

Purchasing Unit

Mr. B Tilakaratne	–	Purchasing Officer
Mr. P D S de Silva	–	Clerk/Typist

Telephone Exchange

Mr. K M Seneviratne Banda	–	Telephone Operator
Mrs. P K N Damayanthi	–	Telephone Operator/Receptionist
Mr. S Karuppiah	–	Telephone Linesman

Transport Division

Mr. M L H Perera	–	Transport Officer
Mr. S H Chandrasena	–	Clerk/Typist
Mrs. C Jayaram	–	Clerk/Typist

Agronomy Division

Mr. A R Amarasekara	–	Experimental Officer
Mr. U P Abeysekera	–	Experimental Officer

Agricultural Economics Unit

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

Biochemistry Division

Mr. M D L P Gunatillaka	–	Experimental Officer
Mr. K M Mewan	–	Experimental Officer
Mr. G A A R Perera	–	Experimental Officer
Mrs. J M D Abeysinghe	–	Technical Assistant
Ms. A D M Damayanthi	–	Technical Assistant
Mrs. R W T Dharshanie	–	Technical Assistant
Mr. P K P Muthukumarana	–	Technical Assistant
Mr. P G C Priyantha	–	Technical Assistant
Mr. M W Silva	–	Skilled Mechanic

Entomology and Nematology Division

Mr. D D Liyanage	–	Experimental Officer
Mr. N Navaratne	–	Experimental Officer
Mrs. R D P Dharmalatha	–	Experimental Officer
Ms. S S C J de Seram	–	Technical Assistant

Library

Mrs. R W M S K Amunugama	–	Library Assistant

Plant Pathology

Mr. J W K Jayasundara*	–	Experimental Officer
Mr. R M A Ratnayake	–	Experimental Officer
Mrs. K M N K Ratnamalala	–	Experimental Officer

Plant Physiology and Plant Propagation Division

Mrs. D M S Nawaratna	–	Experimental Officer
Mrs. V Sidhakaran	–	Experimental Officer
Mr. H P Baddage	–	Technical Assistant

Plant Breeding Division

Mr. R Paskaradevan	–	Experimental Officer
Mr. B A Ratnagoda	–	Experimental Officer
Mrs. U Sritharan	–	Experimental Officer
Mr. J D Kottawa Arachchige	–	Technical Assistant

Publication Unit

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

Soils and Plant Nutrition Division

Mr. R G A Wijayawardena	–	Experimental Officer
Mr. T C N Peiris	–	Technical Assistant
Mr. D H B N Dissanayake	–	Technical Assistant
Mr. O G K A Gunaratne	–	Technical Assistant

Technology Division

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

Advisory and Extension Division, Talawakelle

Mrs. M A H Nishanthi	–	Extension Officer
Mr. M A J S Suranjan Fernando**	–	Extension Officer
Mr. H Jayaweera	–	Experimental Officer
Ms. C S K Kiribathgoda	–	Stenographer/Typist (English)
Mr. K G R Niroshan	–	Photographer
Mr. N S Ekanayake	–	Audio Visual Attendant
Mr. J T Thevadasan	–	Photography/Dark Room Attendant

Low Country Station, Ratnapura

Mr. H J M de Silva	–	Extension Officer
Mr. T G N Mahinda	–	Extension Officer
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. A G Gamage	–	Experimental Officer
Mrs. B S N Vithanage	–	Experimental Officer
Mr. J H N Piyasundara	–	Experimental Officer
Mrs. E W TP Prematunga	–	Experimental Officer
Mr. D W Vithana	–	Experimental Officer

Mrs. K Sarathchandra	–	Experimental Officer
Mrs. M M Jayatilake	–	Technical Assistant
Mr. M A Chamindra	–	Technical Assistant.
Mr. A K Mudalige	–	Technical Assistant
Mr. K A D Mervin	–	Accounting Assistant
Mrs. P V G Karunanayake	–	Stenographer (English)
Mr. K A S Kumarapperuma	–	Clerk/Typist
Mrs. H K Seetha	–	Accounts Clerk
Mr. K Gunawardana	–	Works Supervisor
Mr. J S K de Silva	–	Electrician
Mr. M A B de Silva	–	General Mechanic
Mr. M M Bowie	–	General Mechanic
Mr. U W K Munasinghe	–	Asst. Plumber Mechanic

Mid Country Station, Kandy

Mr. T M Sarathchandra	–	Experimental Officer
Mr. A P D A Jayasekera	–	Experimental Officer
Mr. U B Herath	–	Experimental Officer
Mrs. B Sureshkumar	–	Experimental Officer
Mr. S Wijethunga	–	Experimental Officer
Mrs. S N Wijesekera	–	Experimental Officer
Mr. C S K A Ratnayake	–	Experimental Officer
Mrs. P L K Tennakoon	–	Experimental Officer
Mrs. P V A R Abeysekera	–	Experimental Officer
Mr. G P Udumulla	–	Experimental Officer
Mrs. C N K Edirisinghe	–	Station Assistant
Mrs. B K S Herath	–	Accounts Clerk
Mrs. Ramani de Silva	–	Clerk/Typist
Mrs. RMDK Ratnayake	–	Clerk/Typist
Mr. K Pahalathanthrige	–	Works Supervisor

Advisory and Extension Centre, Deniyaya

Mr. K G J P Mahindapala	–	Extension Officer/Actg. OIC
Mr. O W Jayawardena	–	Station Assistant

Advisory and Extension Centre, Talgampola

Mr. P K Jayawickrama	–	Experimental Officer
Mr. S P Ratnayake*	–	Extension Officer
Mr. M Sarath	–	Field Supervisor
Mr. P S Kulasiri	–	Field Supervisor

Advisory and Extension Uva Centre, Passara

Mr. R W Suwaris	–	Field Supervisor

Soils and Plant Nutrition Laboratory Complex, Walahanduwa

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

Superintendents

Mr. J U Hulangamuwa	–	St Coombs Estate
Mr. M Perera	–	St Joachim Estate

* On overseas leave
** On overseas no-pay leave

11. Promotions during the year

a) Mrs. R W M W K Illangantillake/Librarian promoted Grade I w.e.f. 01.01.2004.

b) Mr. J C K Rajasinghe/Advisory Officer promoted Grade I w.e.f. 01.01.2004.

c) Mr. K D Dahanayake/Advisory Officer promoted Grade I w.e.f. 01.01.2004.

d) Mr. J A S K V Jayasinghe/Advisory Officer promoted Grade I w.e.f. 01.01.2004.

e) Mr. U W K Munasinghe/Asst.Plumber Mechanic promoted Grade V on 01.01.2004

f) Mr. R W Suwaris/Field Supervisor promoted Grade V on 01.01.2004

g) Mr. H P W Gunasekera/Stores Assistant promoted Grade IV on 07.05.2004.

h) Mr. H Jayaweera/Experimental Officer promoted Grade III on 01.06.2004.

i) Mrs. G A S Gunasekera/Accounts Clerk promoted Grade III on 01.08.2004

12. Transfers during the year

a) Mr. K M T Senaviratne/Driver was transferred to TRI Mid-country station w.e.f. 01.02.2004.

b) Ms. P V A R Abeysekera/Experimental Officer was transferred to TRI Mid-country station w.e.f. 01.03.2004.

c) Mrs. R M D K Ratnayake/Clerk Typist was transferred to TRI Mid-country station w.e.f. 01.03.2004.

d) Mrs. W R P de Silva/Clerk Typist was transferred to TRI Mid-country station w.e.f. 01.03.2004.

e) Mr. G P Udamulla/Experimental Officer was transferred to TRI Mid-country station w.e.f. 06.05.2004.

f) Mr. K G J P Mahindapala/Extension Officer was transferred to TRI, Adv & Extension Centre, Deniyaya.

g) Mr. H M J de Silva/Extension Officer was transferred to TRI Low-country station w.e.f. 29.09.2004.

h) Mrs. K Sarathchandra/Experimental Officer, TRI Mid-country station was transferred to TRI Low-country station w.e.f. 15.10.2004.

i) Mrs. U Sridaran/Experimental Officer, TRI Mid-country station was transferred to TRI Head Office w.e.f. 15.10.2004.

j) Mrs. K M N K Ratnamalala/Experimental Officer, TRI Mid-country station was transferred to TRI Head Office w.e.f. 15.10.2004.

k) Mr. H Jayaweera/Experimental Officer TRI Mid-country station was transferred to TRI Head office w.e.f. 15.10.2004.

13. Retirements during the year

Name of Officer	Designation	Date of retirement	No. of years of service
Mrs. S I Vitarana	Head/Entomology	13/05/2004	33
Mr. S P Jinasena	Driver	13/06/2004	18
Mr. B G D Premadasa	Clerk/Typist	17/07/2004	37
Mr. J M Sirisena	Driver	28/11/2004	24

14. Resignations during the year

Name of Officer	Designation	Date of resignation
Mr. J A S K V Jayasinghe	Senior Advisory Officer	01.04.2004
Mr. R M A Rajakaruna	Extension Officer	15.04.2004
Mr. S N W M Premaratne	Tinker/Welder	15.06.2004
Dr. (Ms) A C Liyanage	Senior Research Officer	30.06.2004
Mr. L A M R C Liyanaarachchi	Extension Officer	01.07.2004
Mr. P S Munasinghe	Research Assistant	07.07.2004
Mr. K K P Katulanda	Extension Officer	18.07.2004
Ms. W G N Udayanganie	Technical Assistant	23.07.2004
Mr. A H M L L S Abeysinghe	Experimental Officer	16.09.2004
Mr. SMUK Samarapperuma	Clerk of Works	30.11.2004
Mr. L. Kodikara	Guest House Keeper	10.12.2004

15. Officers sent on Vacation of Post

Name of Officer	Designation	Date of vacation from post
Dr. G Ganewatte	Senior Research Officer	31.05.2004
Mr. N P Felsingher	General Mechanic	31.10.2004

16. Voluntary Early Separation Package

(Circular No. G 10/2004, dated 08/10/2004)

The Management of the Tea Research Institute decided to release the following officers on VESP, with effect from 31st October 2004.

Name	Grade	Designation
Mr. D S E Weerasooriya	II	Administrative Officer
Ms. W G Piyaseeli	III	Accounts Clerk
Mr. E K Somapala	III	Station Assistant
Mrs. P V D L A N Saparamadu	III	Stenographer/Typist (E)
Mrs. M B M R P Marapana	IV	Stenographer/Typist (E)
Mrs. D H Kalikotuwa	IV	Stenographer/Typist
Mr. R Nadarajah	IV	Clerk/Typist
Ms. J A P I Jayawardena	IV	T.P.Operator/Receptionist
Mrs. L N K Udamulla	V	Internal Audit Clerk
Mr. A P Thomas	V	Telephone Operator

17. Maintenance Divisions

Engineering Division

Total work undertaken by staff of the Engineering Division:

Roads/building repairs/maintenance	355 Nos.
Water supply and maintenance	250 Nos.

Facilities added to the Engineering Division

A Jar Tester and accessories have been purchased for the Filtration Plant.

A Pressure Testing Meter has been purchased for the Water Supply section.

Building and Roads Maintenance

Colour-washing under annual programme:

05 Nos. 'A' Type Bungalows, A 03, A 09, A 12
01 No. 'B' Type Bungalow, B 14

12 Nos. 'C' Type Bungalow, C 04, C 05, C 07, C 13, C 29, C 30, C 42, C 44, C 46, C 51, C 55, C57
01 No. 'D' Type Bungalow, D 42
06 Nos. 'E' Type Bungalows, E 03, E 04, E 80, E 10, E 12, E 13

Painting work undertaken in addition to annual programme:

Internal/external colour-washing of new building, Entomology, Plant Physiology, Administration and Finance Divisions, A I Hostel (room 1), Mechanical Workshop and Filtration Plant.

Special work undertaken under building maintenance programme, in connection with the visit of Hon. Minister and Hon. Deputy Minister of Plantation Industries:

Refurbishing of surroundings and layout of the Institute.
Repairs to road from the Mattakelle junction to the Institute

Water Supply and Maintenance

Total work attended to under the vote, C/ENGW 05.3 {b}: 250 Nos.
Construction of water supply system at the extension area of the Nematology Division.
Installation of water heaters in 'D' Type Quarters has been completed.
Cleaning of water and sedimentation tanks at the filtration plant have been carried out twice during the year.

Construction Work at the Institute in Talawakelle

(a) Construction of rubble-retaining wall: work pending.
(b) Construction of inoculation pit in the Pathology Division: work completed.
(c) Renovation of Nematology laboratory: work completed.
(d) Construction of hot-house and nursery for Plant Physiology Division: work completed.
(e) Repairs to Duke's Bungalow road: work completed.
(f) Construction of main water-line from Filtration Plant: work pending.
(g) Construction of a burial house in the Institute cemetery has been completed.

Work by Outside Contractors

Sheds for the mother bush areas at the Institute's Centres and estates has been completed.

The construction of a shed for the mother bush area at the Kottawa Centre is in progress.

Demolition and Removal of the Deniyaya Guest House

This work has been completed.

Relief Work in connection with the Tsunami Destruction

The Divisional staff with other officers of the Institute participated in relief work in Galle, Ampara, etc.

Electrical Division

Total work undertaken by the staff of the Electrical Division during the year, 319 jobs, as follows:

Maintenance work in Institute bungalows	181
Maintenance work in laboratories, office buildings, etc.	75
Maintenance work in Institute sub-stations	13
Maintenance work on street lights, security lights, etc	50

Major work undertaken and completed by the staff of the Electrical Division at the Institute in Talawakelle, included purchase of a 3-phase panel board and cables for the installation of hot-water geysers for 'D' Type Quarters; and the completion of re-wiring and repairs, etc., in the Nemotology Division's new building.

The re-wiring, repairs, etc., in the Advisory and Extension Centre, Hantana, were completed.

Telephone Exchange and Test Room

The Telephone Exchange and Test Room personnel attended to the following work during the year:

(a) New telephone connections to five Divisions and five Bungalows were made.
(b) Repairs to the intercom-telephone underground cable and overhead lines were carried out at the Advisory and Extension Centre, Hantana.
(c) 16 Nos. of maintenance jobs in the Divisions, and 24 Nos of maintenance jobs in bungalows were carried out.
(d) Repairs to telephone lines and instruments were carried out at the Passara Centre.
(e) The workmen attend continuously to the general maintenance of telephone lines, underground and overhead cable lines.

Motor Garage

The Motor Garage personnel attended to 560 jobs during the year, as follows:

Repairs/servicing of Institute vehicles	515 Nos.
Repairs/servicing of St Coombs Estate vehicles	28 Nos.
Repairs/servicing of sub-station vehicles	06 Nos.
Repairs/ servicing of personal vehicles	11 Nos.

With effect from October 2004, the Motor Garage was transferred to the supervision of the Transport Officer.

REPORT OF THE FINANCIAL DIVISION

TEA RESEARCH BOARD

BALANCE SHEET AS AT 31ST DECEMBER - 2004

2003 Rs.			Tea Research Institute 2004 Rs. Cts.	St. Coombs Estate 2004 Rs. Cts.	St. Joachim Estate 2004 Rs. Cts.	Total 2004 Rs. Cts.
	FIXED ASSETS					
596,135,980	Property, Plant, Equipment etc.	(Anx. I)	621,441,745.26	–	–	621,441,745.26
(332,449,145)	Less: Accumulated Depreciation	(Anx. I)	(376,575,529.51)	–	–	(376,575,529.51)
263,686,835			244,866,215.75			244,866,215.75
38,510,813	Capital Work in Progress	(Anx. II)	71,704,252.92	1,593,401.46	92,577.58	73,390,231.96
302,197,649			316,570,468.67	1,593,401.46	92,577.58	318,256,447.71
22,550	Other Assets-Patents		22,550.00	–	–	22,550.00
302,220,199			316,593,018.67	1,593,401.46	92,577.58	318,278,997.71
	CURRENT ASSETS					
13,493,806	Stocks	(Anx. III)	10,396,371.47	893,265.50	2,163,555.25	13,453,192.22
146,853,081	* Debtors and Other Debit Balances	(Anx. IV)	122,820,020.80	6,366,600.42	3,034,476.16	132,221,097.38
24,397,387	Deposits, Pre-Payments & Purchase Advances	(Anx. V)	15,415,957.12	560,586.48	423,003.73	16,399,547.33
29,592,638	Loans and Advances to Staff & Employees	(Anx. VI)	28,963,474.05	4,447,670.03	1,076,775.14	34,487,919.22
4,000,000	Short Term Investments - 7 day Call Deposits	(Anx. VII)	16,887,281.73			16,887,281.73
50,000,000	Short Term Investments-Gratuity Reserves		50,000,000.00	–	–	50,000,000.00
7,908,500	Cash and Bank Balances	(Anx. VIII)	8,998,827.98	36,050.15	27,837.67	9,062,715.80
276,245,412			253,481,933.15	12,304,172.58	6,725,647.95	272,511,753.68
500,558	Identified Losses	(Anx. IX)	500,557.87	–	–	500,557.87
439,295	Excess & Shortages	(Anx. X)	192,552.77	–	–	192,552.77
277,185,265			254,175,043.79	12,304,172.58	6,725,647.95	273,204,864.32
	CURRENT LIABILITIES					
(33,876,248)	Creditors and Provisions	(Anx. XI)	(15,304,511.91)	(10,010,713.71)	(11,772,846.29)	(37,088,071.91)
243,309,017	Net Current Assets		238,870,531.88	2,293,458.87	(5,047,198.34)	236,116,792.41
545,529,216	**TOTAL ASSETS LESS CURRENT LIABILITIES**		555,463,550.55	3,886,860.33	(4,954,620.76)	554,395,790.12
	REPRESENTED BY					
123,828,689	Grants and Reserves	(Anx.XII)	158,088,328.40	–	–	158,088,328.40
381,213,621	Tea Research Fund		349,723,657.00	–	–	349,723,657.00
–	A/C Current St. Coombs Estate		8,757,251.32	(8,757,251.32)	–	–
–	A/C Current St. Joachim Estate		10,216,709.58	–	(10,216,709.58)	–
40,473,256	Long Term Liabilities - Provision for Gratuity	(Anx. XIII)	28,664,154.25	12,644,111.65	5,262,088.82	46,570,354.72
13,650	Petrol Deposit Refundable	(Anx. XIV)	13,450.00	–	–	13,450.00
545,529,216			555,463,550.55	3,886,860.33	(4,954,620.76)	554,395,790.12

Senior Accountant - T.R.I. Director - T.R.I. Chairman - T.R.B.

* See Annexure A

TEA RESEARCH BOARD
OPERATING ACCOUNT FOR THE PERIOD 1ST JANUARY TO 31ST DECEMBER - 2004

2003 Rs.				2004 Rs. Cts.
		INCOME		
192,309,726	1	Cess	(Note 1)	197,527,449.54
5,112,445	2	Income from Other Commercial Activities	(Annx. XV)	5,878,231.20
5,497,481	3	Interest on Investments		4,024,506.20
10,315,597	4	Miscellaneous	(Annx. XV)	4,925,095.39
213,235,249				212,355,282.33
(2,544,954)	5	Estate Profits/(Loss) - St.Coombs Estate	(Annx. XVII)	1,992,572.47
(1,258,852)		- St. Joachim Estate	(Annx. XVIII)	2,358,368.91
209,431,443		**Total Income**		**216,706,223.71**

Total		EXPENDITURE		Administration Finance and Common Service Rs. Cts.	Advisory, Extensions & Publicity Rs. Cts.	Research Rs. Cts.	Total Rs. Cts.
71,648,879	01	Personnel Emoluments		27,363,337.52	15,371,571.99	34,299,518.90	77,034,428.41
5,604,316	02	Travelling		1,795,686.63	1,255,344.06	2,019,867.62	5,070,898.31
31,485,115	03	Supplies and Requisites		4,978,082.70	7,223,100.92	24,655,517.07	36,856,700.69
23,632,804	04	Repairs and Maintenance of Capital Assets		12,906,537.24	5,956,077.75	1,698,174.45	20,560,789.44
46,719,812	04	Depreciation of Fixed Assets		6,611,573.34	5,656,864.94	28,024,765.33	40,293,203.61
	05	Transportation, Communication, Utility					
36,475,255		and Other Service		22,305,105.18	13,225,800.59	752,289.28	36,283,195.05
2,378,439	07	Contributions, Grants and Subsidies		2,281,687.08	181,651.96	272,923.57	2,736,262.61
6,288,836	08	Pensions and Retirement Benefits		1,815,769.09	1,018,823.92	3,204,453.36	6,039,046.37
6,745,896	08	Gratuity Provision		8,227,076.50			8,227,076.50
1,362,082	10	Media, Advertising, Publicity and Gifts		237,881.36	958,701.05	15,541.00	1,212,123.41
8,673,139	11	Cultivation and Field Trials		–	5,334,160.90	2,693,016.92	8,027,177.82
1,712,924	12	Miscellaneous - Others	(Annx. XVI)	953,253.29	20,325.00	1,121,915.50	2,095,493.79
859,119	12.04	- Training - Local		101,639.50	45,242.50	337,351.00	484,233.00
2,552,384	12.05	- Training-Overseas				2,380,873.50	2,380,873.50
246,138,999		**Total Expenditure**		89,475,989.93	56,202,423.08	101,476,207.50	247,301,502.51
(36,707,556)		**Operating Surplus for the year 2004**					**(30,595,278.80)**
(1,171,352)		Less: Tax Payments					(894,685.15)
(37,878,908)		**Operating Surplus/(Deficit) after the Tax Payments transferred to Tea Research Fund**					**(31,489,963.95)**

Note : 1. Tea Cess receivable as at 31st December 2004 - Rs. 74,906,058.35

TEA RESEARCH BOARD
CASH FLOW STATEMENT 2004

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

	Year ended 31st December			
	2004		2003	
Cash flows from Operating Activities	Rs.	Rs.	Rs.	Rs.
Surplus/(Deficit) for the year excluding interest on investments		**(35,514,470)**		**(43,376,389)**
Adjustment for items not involving movement of cash:				
Depreciation	44,126,384		50,825,582	
Provision for Gratuity	6,097,099		5,398,352	
	50,223,483		56,223,934	
Less: Income from sale of fixed assets	–	50,223,483	(4,957,939)	51,265,995
		14,709,013		7,889,606
Adjustment for items not involving movement of cash:				
Less: Prior period items-Cess Adjustment	–	–	–	–
Operating surplus before changes in items of working capital		**14,709,013**		**7,889,606**
Changes in items of working capital				
Stocks - (Increase)/Decrease	40,614		(1,717,640)	
Debtors and other balances - (increase)/Decrease	14,631,984		(63,463,094)	
Deposits, Prepayments and purchase advances - (Increase)/Decrease	7,997,840		8,430,890	
Loans and advances to Staff & Employees - (Increase)/Decrease	(4,895,281)		(2,454,152)	
Other Current Assets - (Increase) / Decrease	–		(7,000)	
Excesses and shortages - (Increase)/Decrease	246,742		(138,784)	
Creditors and provisions - (Decrease)/Increase	3,211,624	21,233,523	(12,919,797)	(72,269,577)
Cash generated from operating activities		**35,942,536**		**(64,379,971)**

Cash generated from operating activities C/F		**35,942,536**		**(64,379,971)**
Cash Flows from Investing Activities				
Interest on investments	4,024,506		5,303,591	
Purchase of fixed assets	(25,305,765)		(91,244,087)	
Proceeds from sale of fixed assets	–		4,957,944	
(Increase)/Decrease in capital work-in-progress	(34,879,419)		16,764,937	
Cash used in investing activities		**(56,160,678)**		**(64,217,615)**
Cash Flows from Financing Activities				
Grants received from :				
NRC	–		6,000	
ADB	34,259,640		33,520,098	
UNDP	–		318,000	
Cash generated from financing activites		**34,259,640**		**33,844,098**
Net Increase/(Decrease) in cash and cash equivalents		**14,041,498**		**(94,753,488)**
Cash and cash equivalents at beginning of the year		61,908,500		156,661,988
Cash and cash equivalents at end of the year (Note)		**75,949,998**		**61,908,500**
Note: Head Office				
Short Term Investments - 7 Day Call Deposits		16,887,282		4,000,000
Short Term Investments - Gratuity Reserves		50,000,000		50,000,000
Bank of Ceylon Corporate Branch		958,523		2,690,581
Bank of Ceylon - Talawakelle		6,152,407		2,117,648
Bank of Ceylon - Talawakelle ADB		1,250		1,879,835
Bank of Ceylon - Deniyaya		5,092		5,392
Petty Cash Imprest		1,850,372		1,049,318
Stamp Imprest		31,184		40,279
St. Joachim Estate				
Cash In Hand		1,509		1,738
Cah at Bank		26,300		58,740
Stamps		29		51
St. Coombs Estate				
Cash in Hand		27,849		20,140
Cash at Bank		8,192		44,774
Stamps		9		4
		75,949,998		**61,908,500**

TEA RESEARCH BOARD

Annex - XVII

ST. COOMBS & LAMILIERE ESTATES WORKING ACCOUNT FOR THE PERIOD 1ST JANUARY TO 31ST DECEMBER 2004

2003		INCOME	2004		
Rs. Cts.	Kg.	Tea Sales Gross Proceeds	Kg.	Rs. Cts.	
38,828,691.43	254,711	Tea Sales Ex Brokers (Gross)	283,775.25	52,117,170.21	(Note 1)
3,283,299.76	32,776	Tea Sales Local & Graties	31,046.75	4,080,933.27	
42,111,991.19	287,487		314,822.00	56,198,103.48	56,198,103.48
		Add:			
		Tea Lost (2880 Kg) M. Y. Hemachandra		534,040.00	
174,284.45		Miscellaneous Income		213,550.44	747,590.44
42,286,275.64		Total Income		–	56,945,693.92
		EXPENDITURE			
		Less: Estate Expenditure			
8,893,623.89		General Charges		14,689,713.96	
4,911,980.07		Field work & Cultivation		5,633,163.26	
25,426,304.98		Production		29,453,418.49	
179,729.80		Bought Leaf (including transport charges)		655,486.16	
39,411,638.74					50,431,781.87
		Administration & Finance			
2,446,723.45		Bonus and Holiday pay		1,700,327.08	
1,995,341.57		Depreciation		1,781,196.01	3,481,523.09
4,442,065.02					
		Sales Tax & Distribution Expenses			
914,438.65		Brokerage, Handling chgs., & Sales Expenses		1,115,351.88	1,115,351.88
44,768,142.41		Total Expenditure			55,028,656.84
(2,481,866.77)		Profit/(Loss) for the year 2004			1,917,037.08
63,086.91		Add: Under valued Tea last year			75,535.39
(2,544,953.68)		**Profit/(Loss) transferred to TRI Operating A/c**			**1,992,572.47**

Notes:- (1) 3525.25 Kgs. unsold Teas valued NSA@179.73

Prepared by: S. G. Punchibanda

TEA RESEARCH BOARD

Annex - XIII

ST. JOACHIM ESTATE WORKING ACCOUNT FOR THE PERIOD 1ST JANUARY TO 31ST DECEMBER 2004

2003		INCOME	2004		
Rs. Cts.	Kg.	Tea Sales Gross Proceeds	Kg.	Rs. Cts.	
103,674,115.48	689,344	Tea Sales Ex Brokers (Gross)	628,535.00	114,320,952.88	(Note 1)
569,013.43	6,890	Tea Sales Local & Graties	6,504.50	563,577.88	
104,243,128.91	696,234		635,039.50	114,884,530.76	114,884,530.76
280,177.86		Add:			
		Nursery Working A/c(Net) & Sale of Cuttings		526,570.85	
66,985.51		Miscellaneous Income		38,533.78	
765,287.00		Income from Rubber		838,869.06	1,403,973.69
105,355,579.28		Total Income		–	116,288,504.45
		EXPENDITURE			
		Less: Estate Expenditure			
19,703,797.66		General Charges		2,643,792.92	
1,632,917.78		Field work & Cultivation		1,705,707.46	
3,171,386.74		Production		3,224,102.38	
1,102,137.98		Expenditure on Rubber		929,911.53	
73,704,510.75		Bought Leaf (including transport charges)		99,579,549.83	
99,314,750.91				108,083,064.12	
		Administration & Finance			
1,009,014.21		Bonus and Holiday pay		752,507.90	
2,110,427.99		Depreciation		2,051,984.87	
		Sales Tax & Distribution Expenses			
2,466,386.85		Brokerage, Handling chgs., & Sales Expenses		2,375,263.33	
104,900,579.96		**Total Expenditure**		5,179,756.10	113,262,820.22
454,999.32		**Profit for the year 2004**			3,025,684.23
(1,713,851.52)		**Less: Over Provision 2003**			(667,315.32)
(1,258,852.20)		**Profit/(Loss) transferred to TRI Operating A/c**			2,358,368.91

Notes:- (1) 6505.5 Kgs. unsold Teas valued NSA@172.56

Prepared by: S. G. Punchibanda

BOND DEFAULTERS

1. Dr Athula Ekanayake
2. Dr U K Wickremasinghe
3. Mr Sri Ramarathnam
4. Ms A K Basnayake
5. Mr T Thevathasan

The following outstanding Bonds have not been taken into the account.

1. Dr T S Gunasekera
2. Dr W A D P Wanigasundera
3. Ms S M Nagahaulla
4. Ms S K J Liyanage
5. Ms R M S S Rajapakse
6. Dr G Ganewatte

AGRONOMY DIVISION

Head - A. Anandacoomaraswamy

Research Activities (see Corporate Plan)

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

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

The systems tested were:
(1) soil organic carbon enrichment by incorporating coir dust, refuse tea and compost;
(2) *in situ soil rehabilitation;*
(3) growing economic crops such as cowpea, 'tur-dhal', green gram, citronella and sweet corn in-between the replanted tea;
(4) rehabilitating with nitrogen fixing trees such as *Flemingia congesta*.; and
(5) rejuvenation pruning of existing seedling bushes with subsequent infilling after *in situ* soil reconditioning with a grass.

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

There are seven experiments located at high-, mid- and low elevations. Some of the experiments were in the second cycle. In all the trials, none of the alternative systems matched traditional soil rehabilitation in terms of establishment, growth and yield of tea. In some trials, benefits of soil reconditioning with grass for two years was seen in the second cycle as well.

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 between the seedling tea.

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

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

develop intercropping systems at low elevations with plantation crops such as rubber and coconut.

The spacings for rubber were varied, ranging from 20' x 12', 40' x 8', and 60' x 8' x 8' (triangular). Rubber rows were located in the east-west direction to allow more sunlight for the tea plants. In addition to the above intercrops, fruit crops such as rambutttan and durian, and spice crops, such as cinnamon and vanilla, were also tested in collaboration with Department of Agriculture and Department of Minor Export Crops. The trials on plantation crops were conducted with the collaboration of the Rubber Research and Coconut Research Institutes.

In most trials, the yield of tea under rubber in the rehabilitated soil was about 50% lower than that of mono-cropped, rehabilitated tea. Analysis of the results on the yield of tea, planted without rehabilitation, showed no significant difference between the different spacings of rubber. The rubber yield was higher under the wider spacings of rubber.

3. Thrust A19. Development of water management techniques for young and mature tea in drought-prone areas to minimise casualties and enhance yields.

The objectives of this thrusts are (1) to determine the quantity of water and the frequency of its application for drought-resistant cultivars, and (2) to evaluate existing technologies for water application in tea.

Five studies are being conducted in the low country, the up-country and the Uva.

In the low country, yield of mature tea was monitored, with and without fertigation, under two systems of planting, namely on raised beds and flat beds (as control), with two cultivars, TRI 2023 and TRI 3025. Both yield and pruning weights of TRI 2023 were higher with raised beds and fertigation, than with the control. There were two studies on fertigation with TRI 2025, at three frequencies of water application, in the low country and the Uva. The yield response was very marginal.

In the up-country, fertigation was tested with two nitrogen levels, 120 kg N ha^{-1} and 180 N ha^{-1}. The control plots received 360 kg N ha^{-1}. There was no significant difference in yield between the nitrogen levels under fertigation. However, fertigation improved the yield by 40% when compared to the control.

In another trial in the up-country, three cultivars, TRI 3072, DT1 and DN, were tested under fertigation. Detailed physiological measurements were taken during the dry weather. It was found that the mean stomatal conductance of fertigated tea was 47% greater than in the control. According to the fitted light-response

curves, the mean Pmax and initial quantum efficiency of fertigated and control treatments were 7.69 μmol m^{-2} s^{-1} and 6.74 μmol m^{-2} s^{-1}, and 0.038 mol mol^{-1} and 0.047 mol mol^{-1}, respectively. Leaf transpiration was greater, and average leaf temperature lower, in the fertigated treatment, compared to the control. The leaf area index (LAI) was higher in the fertigated plants than in the control. The mean yield response to fertigation was 21%. Among the clones, tested TRI 3072 showed the highest response (47%), followed by DT (18%) and DN (1%).

4. Thrust A20. Development of harvesting devices to overcome labor shortage.

The objectives of this thrust are to (1) evaluate harvesting devices, (2) modify harvesting intervals, (3) modify bush management practices for mechanical harvesting, and (4) modify the supply of plant nutrients, such as potassium and zinc, to suit mechanical harvesting.

In one study at low elevation, a Kawasaki NV 80H motorized machine was used for mechanical harvesting of two cultivars, TRI 2027 and Hulandawa, at intervals of 14 and 21 days. Manual harvesting at an interval of seven days was used as the control.

The results indicated that manual harvesting, at the interval of seven days, give the highest yield. Mechanical harvesting at the 21 days' interval depressed the yield and increased the crude fibre content in the made tea. Similar observations were made in another study in the up-country with TRI 2025.

In a further study, yield records showed that the harvesting machine had reduced tea yield by about 13-16%, during the first year after tipping. Machine harvesting also results in about 20-30% more coarse leaves than manual harvesting does. There were no significant differences in yield, or formation of *banjis*, with double the recommended rate of application of zinc.

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

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

Improvements were made to the already-fabricated hand-pruner with the assistance of Messrs Flowerland Lanka. Arrangements were made for mass-scale production.

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

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

A new herbicide, Trigger (20.5 me), was screened. In a pot trial, Trigger alone, or with Ammonium Sulphate @ 2g/l, effectively killed Passali and *Syngonium* seedlings. The sprouting of the remaining buds was very poor.

Studies on problem weeds, such as Passali Kodi and Wel Kohila, were continued.

In one study undertaken in the up-country for the control of Passali Kodi (*Anredera cordifolia)* and Getakola (*Hedyotis)*, a cocktail mixture of glyphosate (5.5 litres ha^{-1}) and MCPA (3 litres ha^{-1}), with isoprophyl alcohol (5%), gave satisfactory control. Repeated applications were made, if necessary

In another investigation, the infestation rate of Wel Kohila was undertaken. The highest degrees of infestation occurred in pruned and unweeded situations.

The rate of infestation in newly-pruned tea fields was significantly greater when the weed was manually removed at 10 and 14 weeks after pruning (WAP), compared to removal at 2 and 6 WAP.

The management of couch grass with *Brachairia brizantha* and *Arachis pintoii*, and various combinations of slash weeding, was undertaken in an organic tea field at Venture Estate.

Divisional Activities (Project D/AGRY)

1. Impact of CO_2 fertilization on growth and yield of tea in the low-country wet zone of Sri Lanka.

An experiment on the impact of enhanced CO_2 on yield of mature tea was commenced at both St Joachim Estate and St Coombs Estate. The ambient CO_2 level was enhanced by supplying CO_2 (600-800 ppm) to open-top chambers prepared by covering tea bushes with a thick polythene sheet.

Analysis of weekly yield records showed that the tea yield under enhanced CO_2 was 3257 kg/ha/yr compared to 2393 kg/ha/yr under ambient CO_2. The results showed that shoot density, mean shoot weight, and shoot extension rates, were greater under higher CO_2 levels. The percentage of dormant shoots was lower in the enhanced

CO_2 plot. The tea leaves in the CO_2 enhanced plots had a higher chlorophyll content, and were smaller, than in the ambient CO_2 plots. As a result, the tea yield in the CO_2 enhanced plots were higher than that in the controls.

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

The tea bushes were pruned in April and the experiment terminated. Measurements were made on yield, assimilation, transpiration, starch reserves and growth.

2. Effect of climate change on productivity of tea lands in the low-country wet zone of Sri Lanka.

This 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.

In order to study the effect of varying climatic factors on yield of tea, a simple empirical model was developed with the assistance of the Indian Agricultural Research Institute, India. The rainfall and yield data collected from estates were analysed, and used in this crop model to predict tea yield under varying climatic conditions.

In the empirical model, the total biomass production was estimated, based on the work of Monteith (1977) for humid areas, by taking into account the Leaf Area Index (LAI), solar radiation and radiation use efficiency of the tea canopy. The yield of tea was estimated using the Harvest Index (HI). As total biomass production was influenced by the temperature (relationship between temperature and yield), and rainfall (relationship between rainfall during dry months and yield), these coefficients were included in order to adjust results obtained for biomass production. However, it was assumed that the nutrients are not limiting in tea fields, since the growers adopt TRI recommendations for fertilizer application. Further, yield reduction by pests and diseases was not taken into account in this model. In addition to these environmental factors, soil factors, namely soil organic carbon, and plant factors, namely plant population, were incorporated into the model.

3. An alternative method for raising cuttings in tea nurseries.

An observation trial was conducted at the Tea Research Institute's Low Country Station at Ratnapura, in order to examine an alternative method for raising tea plants from cuttings in the nursery, using the TRI 4006 clone. The growth

performance of shoots and roots, and the survival rate and rooting ability of mother leaf, half mother leaf and fish leaf (taken from harvested tea bushes, and grown in 2.5 and 5 inches-deep seeding trays under polythene covers) were compared with single-node cuttings in poly bags.

4. 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 fields, not showing significant nematode infestation, were investigated. Assessments were made of all factors (physical and chemical properties), toxic compounds and growth retardation. The history of the tea fields were also recorded for further analysis.

5. Land Suitability Classification & Mapping of Tea Lands: A Case study in the Ratnapura District

This project for classifying tea lands in Ratnapura district was commenced September 2003. The objectives of the project were to produce maps showing present tea lands in the Ratnapura District and classify tea lands into Land Suitability Classes.

Aerial photographs and maps were collected from the Surveys Department. Flight indexes and revised agro-ecological boundaries were demarcated on the 1:50,000 ABMP maps and 1:63,000 scale topo-maps. Present tea lands were demarcated on aerial photos and classified into three categories i.e. corporate estates, smallholding/propriety estates and home garden with tea. The tea lands, roads, streams and other important places which were helpful for identifying the location were then compiled and copied into 1:50,000 ABMP maps using Optical Pantograph. According to the findings the present tea extent of Ratnapura district was 28,157 ha in the year 2002 whereas the reported figure was 26,120 ha.

In this study, yield and rainfall data were collected from estates for further analysis. Based on the productivity of tea lands, it was able to group tea lands in the Ratnapura district into four productivity regions with tea yields of more than 2000, 2000 to 1500, 1500 to 1000 and less than 1000 kg/ha/yr. These regions belong to WM1(b), WM1(a), WL1(a) and WL2(a) respectively. Further to this broad (macro level) classification, a micro level classification was also done for the benefit of tea growers. In this classification, three main criteria were used i.e. land form or slop (undulating to rolling =0%-16%, hilly terrain = 16%-30%, steep terrain = 30%-60% and very steep terrain = more than 60%), soil depth (deep more than 90 cm, moderately deep = 60 to 90 cm and shallow =

less than 60 cm) and rockiness (X = 5% to 15%, XX = 15% to 30%, XXX = 30% to 50% and XXXX = more than 50%). Using these criteria, lands were classified into four categories as Class A = vry suitable, Class B + suitable, Class C = marginal and Class D = unsuitable. The Class A land does not have any limitations for tea cultivation. Class B can have minor one or two limitations. Class C lands were the lands that are having two or more moderate limitations. Having only one severe limitation or interacting two or more moderate limitations will categorize tea lands into Class D or unsuitable.

The classification and mapping of tea lands helps tea growers identify new lands for tea cultivation, good tea lands to be given high priority, crops more suitable than tea for the land, limitations for agriculture and proper conservation methods to make the land more productive.

6. Designing a Deep Fertilizer Applicator

A deep fertilizer applicator was designed using a manual fork. Each spine of the fork was modified by fixing a piece of a metal box (Applicator, 2 x 2 x 5 cm) on the top of the spine for receiving fertilizers, and guiding it into the deep hole prepared behind the spine, by pulling down the fork and pushing the fork forward a few inches away from the plant. These applicators receive fertilizers from a fertilizer box fixed on the top of the handle of the fork, through PVC tubes or distributors (diameter: 1.5 cm).

The fertilizer box can hold about 4 kg of fertilizer. Each dose of fertilizer is measured by a measuring tube with a series of small buckets (semi-cylindrical in shape) that equals the number of spines, and that are supplied to each distributor. The size of the measuring buckets is prepared according to the fertilizer-dose to be applied to each plant. The buckets receive fertilizer and get filled by it, when the they are kept with their top-sides open and the fork shaken (to make deep holes in soil). The fertilizer is then pushed down to the distributors underneath, when the buckets are turned through an angle of 180° clockwise, so that the openings of the buckets overlap with the openings of the distributors, and pull the series of buckets outwards to empty the entire bucket.

Once the fertilizer is applied into the holes, the holes should be closed by pushing or scraping the soil, by foot or by the fork itself.

The use of this fertilizer applicator allows for the deep application of fertilizer to the root zone of young plants. As a result, loss of fertilizers by volatilization, and through wash-off by rain, is minimized. This will also prevent the establishment of a shallow root-system owing to surface application of fertilizers. Further, use of this applicator will reduce plant to plant variation in fertilizer application, resulting

from approximate measurements of fertilizer by hand. The use of this fertilizer applicator will also minimize the drudgery of application by hand, skin irritation or burning, and frequent body movements. All this will improve worker productivity.

The ability to change the fertilizer doses to be applied, for any of the upland crops, can be considered as another important advantage of this fertilizer applicator.

Preliminary observations in flat land have shown that the labour requirement for applying fertilizer to young tea, with this applicator, was about 10 man days/ha, whereas that of manual application was 15 man days/ha.

The design has been patented, and further testing and modifications are in progress.

BIOCHEMISTRY DIVISION

Head – I.S.B. Abeysinghe

Research Activities (see Corporate Plan)

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

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

The progress of the project up to 2003 could be summarised as follows. (-)-Epicatechin could be used as a biochemical marker to identify blister blight-resistant tea cultivars. The enzymology of the flavonoid biosynthetic pathway in the tea plant was studied extensively. Anthocyanidin reductase, one of the key enzymes in the biosynthesis of proanthocyanidins, was reported in tea for the first time. Proanthocyanidins (condensed tannins) in tea were identified as defence-response chemicals, using techniques such as TLC, histochemical staining, radial diffusion array, and Matrix-Assisted Laser Desorption Ionization-Time-of-Flight-Mass Spectrometry (MALDI-TOF-MS).

Proanthocyanidins are known to be potent inhibitors of cell-wall degrading enzymes. In 2004, attempts were made to isolate and characterize proanthocyanidins present in the tea flush, using High Speed Counter Current Chromatography (HSCCC) for studying the effect of these proanthocyanidins on the germination of *E. vexans* spores and cell-wall degrading enzymes. A proanthocyanidin with a high degree of purity was obtained, and characterization of this compound is in progress.

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, and infestation with SHB is a serious problem affecting 30% of land under tea cultivation in Sri Lanka. The continued depredation and 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 formulated, with minimal environmental impact, and also with a limit on 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 management of pests has the potential of providing control methods more in line with current demands than conventional pesticides.

In 2004, the focus was on identification of semiochemicals in a SHB-resistant cultivar (TRI 2023), and SHB-susceptible cultivars (TRI 2025 and DT1), at New Peacock Estate, Pussellawa. Volatile compounds present in SHB-infested and non-infested stems of these cultivars were extracted using steam distillation, and identified by Gas Chromatography-Mass Spectroscopy.

A study on the effect of soil organic amendments on the volatile composition of tea-bark.

A field trial (TRI-ORCON), established by the Nematology Division, was used in this study. Tea waste (TW), neem oil cake (NOC) and compost (COM) were incorporated into the soil as organic amendments. The volatile composition of tea stems from these plots were compared with that following conventional treatment. The volatile extractions were handed over to the Nematology Division for olfactometric assays.

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

The study on RAPDs, Random Amplified Polymorphic DNA, generated useful information on genetic diversity of tea cultivars. Phase II of the RAPD of tea cultivars, in order to look for diverse cultivars, was initiated in the Molecular Biology Laboratory which was recently set up in the Institute. RAPD-PCR was performed on all 46 tea cultivars selected for Phase II, using five primers, OPA9, OPA11, OPB4, OPE11 and OPE9. The primers, OPA 16, OPB13, OPB17 and OPC14, were tested on 24 cultivars.

The development of more specific and highly reproducible markers, such as SSRPs (Simple Sequence Repeat Polymorphisms) and AFLPs (Amplified Fragment Length Polymorphisms), are very important for further studies. Therefore a more informative and accurate AFLP technique was initiated, in addition to SSRPs, to characterise tea cultivars. In this study, AFLP conditions were optimized for tea. DNA from 39 selected tea cultivars were extracted, using a mini prep method. Initially AFLP reactions were carried out for 15 selected tea cultivars, using two ^{32}P-labeled AFLP selective primers, EcoRI and MseI. An AFLP study for all 39 selected cultivars, using more primers, is in progress.

A tea genomic library has been constructed to screen for SSRPs markers which are used for molecular characterisation. A few cultivars, thought to be positive, have been identified. Sequencing reactions are now in progress to obtain

sequences of the inserts of genomic clones, identified as positive for simple sequences.

4. Project B 19. Establishment of biological affects of black tea.

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

In Sri Lanka, different regions have different climates and, in the different regions, different types of manufacturing procedures are adopted which produce different types of tea. The present study was carried out to find the chemical composition of teas produced in six tea-growing regions of Sri Lanka, namely Dimbulla, Nuwara Eliya, Uda Pussellawa, the Uva, Kandy and Ruhuna. Notable findings, from the samples analysed so far, are that the fluoride content in the Uva and the Udapussellewa teas is higher than in teas from the other regions. The highest antioxidant activity was found in Nuwara Eliya teas. The caffeine content was lowest in Nuwara Eliya teas, and the highest in low-country teas.

The collection of teas and their chemical analysis will be continued.

(b) *In vitro* and *in vivo* antioxidant activity of Sri Lankan black tea.

The antioxidant potential of high-grown Sri Lankan black tea (BOPF grade, obtained from St Coombs Estate, Talawakelle) was measured in this study. Antioxidant activity was measured both in vitro (using the DPPH and the TBARS assays) and in vivo (using the DPPH assay on rat serum, following oral administration for three months). Total polyphenols, caffeine, theaflavin, thearubigin, the total catechin levels, and individual levels of five major catechins (EGCG, EGC, ECG, EC and C), were also estimated in the study.

The results show that Sri Lankan black tea possesses mild but dose-dependant antioxidant activity in vitro. The in vivo antioxidant activity was both dose- and time-dependant. The antioxidant activity of rat serum was elevated during the period of tea consumption, and decreased towards the baseline value when tea consumption was stopped.

The study was carried out in collaboration with the Department of Zoology, University of Colombo.

(c) Effect of fresh high-grown BOPF grade Sri Lankan black tea (*Camellia sinensis* L.) on the serum lipid profile of rats.

This study was carried out in order to investigate the effect of fresh high-grown BOPF grade Sri Lankan black tea on the serum lipid profile. Wistar rats were used as a model for the study. The duration of the experiment was three months.

Three doses of tea were given to the rats: low dose, mid dose and high dose were equivalent to the human consumption of one cup, three cups and 12 cups per day, respectively. It was found that the tea dose dependently decreased total cholesterol (TC), LDL cholesterol and HDL cholesterol in the serum. It was also found that the HDL/LDL ratio significantly increased after three months. The study was carried out in collaboration with Department of Zoology, University of Colombo.

5. Project D 30. Quantitative and qualitative assessment of pesticides residues in large-scale vegetable plots surrounding tea plantations.

The availability of lands for vegetable cultivation is a major problem as most of the lands are under tea cultivation. As a result, marginal tea lands and some good tea lands have been converted for vegetable cultivation. The indiscriminate use of pesticides in vegetable cultivation could contaminate tea, as the tea fields are in close proximity to the vegetable lands. Therefore in this study an attempt was made to understand the effects, on nearby tea fields, on made tea and on the environment in and around the vegetable fields, of indiscriminately using pesticides in fields used for large-scale vegetable cultivation.

Three large-scale vegetable sites in the Nuwara Eliya area were selected for the study. Tea flush, made tea, vegetables, water and soil were analyzed for the selected pesticides, namely, chlorpyrifos-ethyl, diazinon, fipronil and chlorfluazuron.

The residue levels of chlorpyrifos-ethyl and diazinon found in made tea were below the Maximum Residue Levels (MRLs) specified by the European Union (EU), indicating that the use of chlorpyrifos-ethyl and diazinon in vegetable fields is not a threat to the tea industry. However, chlorpyrifos-ethyl and diazinon residue levels found in cabbage were above the MRLs specified by the Sri Lanka Standards Institute (SLSI), showing that it is important to apply the correct pesticide dosages, and also to keep to proper pre-harvest intervals.

The chlorfluazuron levels found in made tea were from 0.002 ppm to 0.045 ppm. The chlorpyrifos-ethyl and diazinon residue levels found in water were above the EU specified limits, indicating a potential threat to the environment in using chlorpyrifos-ethyl and diazinon in vegetable cultivation.

6. 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.

A total of 16 estates (six organic and ten conventional estates) were selected and categorized into six groups. For each organic estate, two conventional estates producing a common grade of tea, from the same locality, was taken. Samples were evaluated by professional tea tasters, and were analysed for chemical parameters: TF, TR, total polyphenols, caffeine, catechins, soluble solids and crude fibre. This exercise was carried out for a period of six months at two-week intervals. The data were analysed statistically.

The comparative results indicate that conventional teas have significantly higher TF and TR content, while some organic teas have significantly higher crude-fibre content. There was no significant difference in total polyphenols, caffeine and soluble solids between the two types of tea. The results of tasters' evaluations for both types of teas did not give any conclusive results.

7. Project A 1.5. Screening lines for quality.

In addition to high yields and other desirable characteristics, the quality potential of a cultivar is also considered when developing new tea cultivars. Therefore, evaluating the quality potential of cultivars at an early stage of the tea-breeding programme is important.

In 2004, a preliminary screening of selections from the Phase II stage of the breeding programme from the up country (21 selections), and the Uva regions (five selections), was carried out. Green leaf samples were supplied by the Plant Breeding Division, and the manufacture of the samples was carried out using an environmentally-controlled miniature manufacturing facility. Made tea samples were tasted by three professional tea tasters, and ranked on the basis of quality, using the hedonic scale procedure. The results of the study are being analysed.

8. Project A 29.2.

(a) Improvement of technology for producing a liquid tea concentrate.

Trials to replace clarifying agents (aluminium sulphate and bentonite) with microfiltration was continued. The samples are being observed visually for clarity at three-month intervals. Samples filtered through 0.30 μm and 0.22 μm filters are found to have the same degree of clarity as that of the control, up to a period of nine months, indicating that there is a possible use of these filters to replace the aluminium sulphate and bentonite clarification step.

(b) Extraction of proteins from black tea.

In black tea manufacture, 3% of the harvested tea leaf is discarded as refuse tea. Refuse tea contains 20-30% of crude protein. If this valuable protein can be utilized in feeding animals, or for direct human consumption, it would certainly reduce the widespread protein energy malnutrition in less developed countries, like Sri Lanka, to a certain extent. It will also generate an additional income for the tea industry.

This project was carried out with the objective of establishing procedures for extracting protein from refuse tea, and for recovering and purifying the protein so extracted.

The maximum yield of crude protein (13.22 g per 100 g of medium-sized particles of refuse tea) was obtained at a pH of 12.93 with 0.55 N NaOH. A solid to solvent ratio of 1:12 yielded the highest amount of crude protein (14.69 g per 100 g of medium-sized particles of refuse tea). The highest amount of crude protein (68.88%) was precipitated at a pH of 4.4, whereas the highest recovery of extracted protein (67.37%) was obtained under centrifugal conditions of 12000 rpm for 15 minutes. It was possible to obtain higher extraction and recovery of protein by the hot-extraction procedure than by the cold-extraction procedure. A crude extract, which contains 43.48% of crude protein, was obtained by washing the sediment twice with boiled distilled water and with 96% ethanol.

9. Project 4: Interaction of tea with milk.

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

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

It was found that epicatechin and epicatechin gallate levels in the fresh leaf of DT1 were higher than in that of K 145.

The study will be continued to find the milk-interaction ability of all the tea cultivars recommended for the up country.

10. Green tea specifications. A work item under the ISO/TC34/SC8 work programme.

At the 20th meeting of ISO/TC34/SC8, it was decided to collect data on total polyphenol and catechin levels in green tea, in order to set the ISO specifications for green tea. For this purpose, 206 Sri Lankan green tea samples were analysed for their catechin, total polyphenol and caffeine levels. The results were submitted for ISO/TC34/SC8 for consideration.

External Collaborators

Prof. V Kumar and Prof. (Mrs) S Kumar, Department of Chemistry, Faculty of Science, University of Peradeniya on Biological Pest Control Project.

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.

Donors

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2. Sida/SAREC, a grant for Capacity Building in Biotechnology.

3. The 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

Acting Head - Keerthi Mohotti

This report summarizes the studies carried out by the Entomology and Nematology research staff in the Division on screening for resistance and tolerance of cultivars to, and for the efficacy of pesticides against, various tea pests; miscellaneous entomological and nematological problems; biological control; and 'organic' and 'biodynamic' tea cultivation. The studies were carried out in the up-country, the mid-country, the Uva, and the low country, and in the Kottawa and Deniyaya regions. The Plant Breeding, Plant Physiology, Biochemistry, and Technology Divisions collaborated in some of the studies.

Research Activities (see Corporate Plan)

1. Cultivar screening

Trials and field operations for the screening of new cultivars, and lines resistant to various tea pests, were carried out in collaboration with the Plant Breeding Division, in different locations (Table 1).

Table 1. Screening new cultivars and lines for resistance to various tea pests in different locations.

Pest	*Project*	*Experiment No.*	*Location*
Shot-hole borer	A 2.2		Plant Breeding: Seed stocks Trial, Hantane
	A 4.2	LE 91/ LVP 75	St Joachim Estate
		LE 92 / LVP 74	TRI Station, Deniyaya
Livewood termite	A 1.2		TRI Station, Kottawa
		LE 50	Lower Amunutenna Division, Hapugastenna Estate
		LE 78	Hadaraganga Division, Hapugastenna Estate
		LE 81	Upper Wewelketiya Division, Hapugastenna Estate
		LE 83	LPG Division, Balangoda Estate
		LVP 76, 77, 78 and 79	St Joachim Estate
Pratylenchus loosi	A 1.6	N 1A	Nematology experimental area, Talawakele
		N 1A	TRI Station, Passara
Radopholus similis	A 2.5	N 1B	Hantane Estate, Hantane
		N 1B	TRI Station, Passara

As the data generated from the experiments during the year were not sufficient to make firm recommendations, further evaluations and fine-tuning of assessment methods and parameters are in progress, in addition to short-cut methods for existing screening techniques.

2. Screening of synthetic pesticides

Field evaluations were carried out during the screening of new pesticides against various tea pests, in different locations (Table 2).

Table 2. Screening of new synthetic pesticides against various tea pests in different locations.

Pest	Project	Experiment No.	Location
Shot-hole Borer	A 22.1	LE 87	Dehenakanda Division, Hapugastenna Estate
	A 4.2	ME 26	Levellon Estate, Pupuressa
		E 320	Brunswick Estate, Maskeliya
Up-country Livewood Termite	D 18	E 319	Gouravila Estate
Pratylenchus loosi	D 17	LE 97	Gallella Division, Hapugastenna Estate
Mites	D20	E 323	Somerset Estate

Periodic assessments made in different locations revealed that the application of Fipronil (Regent 50 SC) seems to be superior to the recommended chemical, in terms of reduction in the number of galleries of shot-hole borer. However, further analyses are needed to confirm its efficacy, effects on non-target organisms, cost effectiveness, and worker friendliness, prior to making recommendations.

The results indicate that, although the tested chemicals did not show significant control of the pest, 100% mortality of the up-country livewood termite did occur when Fipronil (Regent 50 SC) was allowed to reach colonies inside the affected wood. Therefore, follow up experiments are envisaged on effective placement of the chemical through stem injections.

3. Pesticide use in tea

Restrictions on the use of insecticides, nematicides, fungicides, acaricides and herbicides for tea, were considered by the Institute in keeping with sensitivity to pesticide residues on the part of major tea markets, namely the European Union and Japan. In order to meet the requirements of these markets, the research programmes of the Divisions were concerned with exploitation of efficient

biological control methods, natural pesticides, and monitoring and adhering to cultural pest-management methods. In this respect, the following activities and units were strengthened in the interests of efficient and effective monitoring.

3.1 A central biological laboratory

A well equipped, central facility for mass-culturing and formulation of insect and nematode biocontrol agents was established at the Institute. It is expected to utilize this facility to meet the demands of the biomanagement component of insect, mite and nematode pests in tea.

3.2 Development of a database on indigenous and natural pest control methods and techniques

Local and foreign experiences in non-chemical pest management methods, materials and techniques were studied and compiled onto a database. This will be up-dated periodically. Scientific validation of some of the best practices in managing tea pests are in progress. This include a few studies on isolation of chemicals from various pesticidal and medicinal plant species.

3.3 Nature-farming research and demonstration areas

Ecological and traditional agricultural practices, aimed at sustainable crop production, were established at the nematology experimental area for research and demonstration purposes. Scientific validations to organic and biodynamic agricultural practices are also under study.

4. Biological control

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

During the period under review, a remarkable amount of information was generated, from both laboratory and field, to support the attempts made since the 1990s to develop biological control methods which would reduce the damage caused by shot-hole borer to tea. These efforts were supported by advice received from scientists at CABI, UK.

Table 3 highlights the field experimentation involving application of the entomopathogenic fungus, *Beauveria bassiana*, against shot-hole borer in different locations.

Table 3. Field experimentation with applications of the entomopathogenic fungus, *Beauveria bassiana*, against shot-hole borer in different locations.

Region	*Location*	*Experiment No.*
Up-country	Brunswick Mayfield	E 321
Uva	Haputale Estate, Dambetenna	E 313
Low Country	Cecilton Estate, Balangoda	LE 94
	Galaboda Estate, Galaboda	LE 95
	Kithulgala Estate, Kithulgala	LE 96
Mid- country	New Peacock Estate	ME 27

The mortality rates and infections of shot-hole borer with the fungus, in the different experimental sites, were monitored periodically. The data revealed that the field efficacy of the fungus was not comparable with the success rates obtained in the laboratory.

The field application of the fungus was therefore suspended until effective application techniques can be developed. Also, further studies are planned to explore the efficacy of various isolates or strains of B. bassiana on shot-hole borer, their effects on non-target organisms, and user-friendly bioformulation methods, prior to making recommendations.

An experiment was performed to test the synergistic effect of insecticides on *B. bassiana*

In another study conducted at the Hantane station (ME 28), the spraying efficacy of the fungus was tested using a mist-blower and knapsack sprayer.

The application of *B. bassiana* for controlling the up-country livewood termite was also tested at Gouravila Estate (E 319).

4.2 Mass rearing of *Beauveria bassiana*

At Talawakele (E 334) and Hantane (ME18), *in vitro* mass-rearing of four strains of the fungus, *B. bassiana*, obtained from CABI, UK, on a rice medium, were continued for use in experiments.

4.3 E 333. Isolation of local strains of biocontrol agents to control shot-hole borer.

Based on the field survey of SHB-damage levels, and management strategies in the different agro-ecological regions, localities with potential to allow better bio-management of the pest were identified. During the period under review, 32 sites from SHB low-infestation areas, organic and biodynamic tea estates, and tea lands adjacent to forests, in the up-country, mid-country, the Uva, low country, and the Deniyaya region, were explored.

About 2-3 potential fungal types, with similar morphological features to *B. bassiana*, could be recovered from cultures, and they are now being in bioassays for confirmation of efficacy.

4.6 N 369. Mass propagation of nematode biocontrol agents.

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

Preliminary studies resulted in both adhesive net-type traps, and constricting ring-type traps, by nematode-trapping fungi against *Pratylenchus loosi*.

Various locally-available and cost-effective substrates were evaluated for efficacy in monitoring fungal densities for field dissemination. Tea waste favoured *Arthrobotrys oligospora* (an Australian isolate). Tea waste also enriched nematode-trapping fungi with adhesive nets.

In order check the natural growth of local nematode-trapping fungi, tea waste collected from different locations was checked under laboratory conditions, using the sprinkle method. They were observed to be undergoing degeneration.

Further experiments are in progress to quantify nematode-trapping fungal densities and their correlation with the nematode population in the soil.

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

Periodic monitoring of data on densities of nematode biocontrol agents, and soil populations of *P. loosi* and *Radopholus similis* in Needwood Estate, Haldummulla and at the Kottawa station, respectively, was carried out.

5. Miscellaneous studies

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

Different fertilizer levels did not result in significant changes in borer damage to tea. In depth studies on cell structure and thickness are planned, for better understanding of the effect.

5.2 Project A 22.7. Computerized database and modeling of yield relationship for shot-hole borer.

The data generated from the survey, on the distribution pattern of shot-hole borer in the different tea-growing areas, were utilized in a postgraduate study programme for developing a model of outbreaks of the pest.

5.3 E 315 (a). Temperature-dependent development and reproductive parameters of shot-hole borer.

Egg hatching, pupal emergence and mortality of shot-hole borer under constant temperatures, were studied in order to generate information on the development parameters to be utilized in the life-cycle module of DYMEX.

5.4 E 315 (b). Survey of the distribution of shot-hole borer in tea-growing areas in Sri Lanka.

During the period under review, 55 estates in the up-country were surveyed for shot-hole borer infestation, and the data were used to develop the DYMEX pest model.

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

Nematodes

Young plants of a few cultivars known to be susceptible and tolerant to *P. loosi* were subjected to biochemical and morphological studies, in order to establish relationships in cultivar screening. Data are to be studied in view of their potential use as screening parameters.

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

Biochemical investigations on the amino acid and polyphenol content in the roots of the tested tea cultivars were made.

5.7 N 386 (b). Root morphology of different 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 feeder roots of the tea cultivars, were studied.

5.8 Project B 30. Biochemical resistance of tea cultivars towards major pests, such as nematodes and low country livewood termite.

Low country livewood termite

The postgraduate study programme on biochemical resistance to low country livewood termite was continued at the Chemistry Department, University of Peradeniya.

The compounds, S/16/H/1, S/16/H/2, S/16/C/5, S/16/C/9, S/16/H/7/1 and A, were isolated from rotted and dead pruned cuts of affected cultivars, TRI 2023 and TRI 2016, by the cold extraction method. The NMR spectra of the compounds were obtained, although not mass spectra as yet.

Tea-seed fractions showed toxic effects against the termite.

5.9 D 17. Management of nematode pests in tea lands.

MeBr 9 Development of a steam chamber for soil sterilization for nurseries.

A steam chamber and boiler for use as a soil sterilizing unit were constructed for testing.

MeBr 49 Evaluation of the combined effect of soil solarization and soil substitutes on tea nematodes.

Tea raised in nurseries under soil solarization and soil substitute treatments were planted in Nayabedda Estate, Bandarawela. A fertigation/drip-irrigation system was also installed in the field for further monitoring of yield and the health of the tea.

LE 97

In order to arrive at a cost-effective nematicidal treatment to recover nematode-infested tea, several combinations of synthetic chemicals and organic amendments were tested at Hapugastenna Estate.

5.10 N 375 (b). Nursery performance of tea on different sources of soil.

The potential of soils in *Eucalyptus* and *Pinus* plantations as alternative nursery media for tea propagation was compared with the conventional soil, namely Mana soils, which posses considerable limitations at present.

The results of the long-term experiments, conducted with the tea cultivar DN established in the tea nursery at Great Western Estate, Talawakelle, revealed that *Eucalyptus* soils continued to give better growth of nursery plants. The mean shoot height, root depth, and root biomass were significantly superior ($P<0.05$) to plants grown in *Pinus* and Mana soils. Young tea plants raised on *Eucalyptus* and *Pinus* soils also proved better for establishment in the field. Owing to their being free from parasitic nematode populations, these soils could well serve as a source of nursery media that could be used without fumigating, where fumigants become restricted in terms of cost and practice.

Further work is underway to make final evaluations.

5.11. Project A 32.3. Pest and disease management under organic tea cultivation.

Post-prune assessments on growth, and pest and disease incidence, in the experimental plots of the 'TRIORCON' trial at St Coombs were completed. Yield and quality of tea will be monitored in collaboration with Plant Physiology and Technology Divisions.

Post-prune growth parameters

Mean collar-girth, number of prune cuts, prune-cut diameter, and prune weight, in organically-managed tea (with tea waste and compost) were greater compared to that of conventionally-grown tea (except when neem-oil cake was used in the organic tea). Shoot growth, however, was superior in conventionally grown tea.

The results of studies on root establishment and physiological parameters are presented in the report of the Plant Physiology Division.

Nematode incidence

Data revealed that although parasitic nematode populations are abundant in organically-managed soils, the damage is below threshold levels. The trap formation of nematode-trapping fungi was studied *in vitro* using the sprinkle method. Organic treatments in general were enriched with *Arthrobotrys* sp. and *Monacrosporiun* sp. In the adhesive-net formation group.

Shot-hole borer incidence

A comparative study was carried out to evaluate SHB incidence, and phloem-sap content and volatile compounds responsible for attraction and repellence. A few olfactometry studies were also performed.

In the second pruning cycle, tea bushes grown organically showed significantly lower SHB infestation ($p=0.05$) compared to those having the conventional treatment. Neem-oil cake and tea waste showed pesticidal effects, but compost treatment failed to reduce SHB infestation at any time. Neem-oil cake did not encourage colony formation of the ambrosia fungus.

Overall, organically-grown tea exhibited a lower incidence of shot-hole borer, while sustaining comparable crop yields. Studies on the effects of the sugar contained in the phloem sap on ambrosia fungal growth, healing capacity, and various volatile chemicals in shot-hole borer-affected branches, as well as on biological phenomena are in progress, in order to validate the behaviour of the shot-hole borer beetle in organically- and conventionally-grown tea systems.

Data on the various volatile chemicals, extracted from the different treatments, are presented in the report of the Biochemistry Division Division.

5.12 N 423 (a). Nematicidal properties of the *Toona* plant.

The nematicidal properties of *Toona* leaves, seeds and flowers were evaluated in a pot experiment at the Nematology experimental area. The results indicate, although not with statistical significance, that *Toona* treatments result in nematode control comparable to that with neem-based treatments (leaves and poonac). The experiment is repeated to get additional information.

The chemical extracts of leaves, flowers and seeds of the *Toona* plant, carried out at the ITI laboratories in Colombo, are to be tested in laboratory and field bioassays with tea nematodes.

5.13 N 422. Nematicidal properties of 'vermi-wash'.

The potential of vermi-wash applications in reducing the root population of root-lesion (*Pratylenchus loosi)* and root-knot nematodes (*Meloidogyne incognita)* in young tea (cultivars: TRI 2043 and TC 9), and tomato seedlings (variety: Thilina), respectively, was studied in comparison to conventional methods under glasshouse conditions.

The results revealed that vermi-wash had developed resistance in the roots against both nematode species, resulting in significantly lower *P. loosi* populations in tea roots, and a lower root-knot nematode index in tomato, than in the conventional and untreated controls ($p=0.05$). Also, there was a significant elevation in microbial activity in the soil ($p=0.05$), owing to an improved antagonistic potential to nematodes in the soil from the vermi-wash applications.

5.14 N 425. Development of soil biofumigation methods.

Laboratory studies were initiated to develop biofumigation methods using materials of animal and plant origin.

Cabbage and radish, belonging to the genus *Brassica* (known to produce compounds such as methyl isothiocyanate, which is similar to the commercial fumigant, metham sodium), and fish waste (used in traditional agriculture) were tested. *In vitro* studies, performed under controlled temperature condiitons, revealed that gas production was higher at 35°C than at 20°C.

Identification and quantification of the various gases produced are to be carried out, along with bioassays using nematodes, and with possible application methods.

Biodynamic tea cultivation

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

Biodynamic applications and practices adopted for seedling tea plants, as per the Sri Lankan biodynamic planting calendar in the 'BIDORCON' field trial, were periodically monitored for scientific validation. During the period under review, growth measurements, and pest and disease incidence in tea, from skiffing were monitored. Green-leaf yields and plant nutrition, in biodynamically- and organically-grown tea, were compared to that in conventionally-grown tea. Organic and biodynamic treatments resulted in greater numbers of healthy shoots, free of pests and diseases, although the differences were not statistically significant. During the study period, the plants had less damage to their shoots

from foliar pests and diseases, such as blister blight, tea tortrix, thrips and leaf miners, as well as from plant parasitic nematode populations in the soil. Moreover, soil microbial activity was also greater under the biodynamic and organic systems. Further experimentation is warranted to establish pest and disease incidence levels and justifications under biodynamic farming.

Similar studies are performed with short-term plants, such as anthurium and African Violet, to monitor the above parameters including quality aspects.

5.16 Project A 23.6. Effect of agro-chemicals on non-target organisms in tea plantations.

N 400 (b). Perfluorinated organic compounds, in human serum and seminal plasma, from two rural tea-workers and from an urban population in Sri Lanka.

The accumulation of 13 perfluorinated organic chemicals (FOCs) found in the sera and seminal plasma of subjects from two rural populations (a population of organic-tea workers in Haldummulla, and of conventional-tea workers in Talawakele) was compared with that in an urban population (from Colombo).

Six of the FOCs such as PFOS, PFHS, PFUnA, PFDA, PFNA and PFOA, were detected in all of the sera. The accumulation of FOCs was not significantly different in the sera from the Colombo (urban) population and the Talawakele (rural) population (conventional-tea workers). However, the Haldummulla (rural) population (organic-tea workers) had a relatively lower exposure to FOCs compared to the other two groups, urban and rural conventional-tea workers.

5.17 C 2. Nematode analysis

The nematology staff continued to assist the tea plantations in analyzing soil- and root-samples from nurseries and fields for possible contamination with plant parasitic nematode populations.

5.18 D 19. Insect identification

The entomology staff served many tea-packaging companies by identifying insects found contaminating made tea and the ingredients used in value addition, and in warehouses. In order to recommend measures to overcome this contamination, possible causes are to be explored.

PLANT BREEDING DIVISION

Head - M.T.K. Gunasekare

Towards meeting the objectives of the Institute's Corporate Plan, 1999–2004, the following activities were undertaken by the Division in the year 2004.

1. Research Activities (see Corporate Plan)

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

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

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

Evaluation of accessions: Phase I

Two hundred and ninety-eight accessions are currently under Phase I evaluation in five different trials in the up-country region. The first-cycle yield recording of evaluation trial, VP 82, was completed. Weekly yield recordings of the other four trials have been continued.

Evaluation of accessions: Phase II

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

VP 80: Fifteen promising accessions based on yield, quality, blister-blight tolerance, and bush recovery after pruning, were propagated to establish Phase III trials. Nearly 400 cuttings per accession were propagated together with two standard cultivars, TRI 2025 and DT 1. Nursery plants were evaluated based on plant attributes.

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

Shoots of the cultivars issued last year are being screened by the Pathology Division for Poria.

1.3. Project A 1.5. Screening accessions for quality.

VP 81: In collaboration with the Biochemistry Division, sampling of 21 accessions, together with standards DT 1 and TRI 2025, for quality testing has been completed.

1.4. Project A 1.6. Screening accessions for plant parasitic nematodes.

Cuttings of the 32 accessions from VP 80, as well as from TRI 3016, 3047, 3072, 3073, 4014, 4046 and 4049, which were issued last year, are being screened for nematodes by the Entomology Division.

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.

Nursery plants, raised from selected accessions from VP 80 and LVP 75, have been propagated in the Institute's mid-country nursery.

Visual growth assessments of the nursery plants were monitored at the 6th month, and growth attributes (plant height, number of branches, number of leaves, length and width of 3rd leaf, root length, and root, stem and leaf, fresh and dry, weights) from 10 randomly-selected plants were recorded at the 8th month.

Land, earmarked for establishing plants, were rehabilitated in 2003/2004.

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

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

Evaluation of accessions: Phase I

UVP 10: Bushes were pruned in October on completion of the first-cycle yield recording. Pruning weights were recorded.

Evaluation of accessions: Phase II

UVP 9: Bushes were pruned in October on completion of the first-cycle yield recording. Pruning weights were recorded.

1.7. Project A 3.2. Screening accessions for shot-hole borer, blister blighta and stem canker (*Macrophoma*).

The Plant Pathology Division screened the accessions from UVP 9 and UVP 10 for blister-blight resistance and susceptibility.

1.8. Project A 3.5. Screening accessions for made tea quality.

Five accessions from the UVP 9 (Phase II) trial were sampled six times, for testing made tea quality in collaboration with the Biochemistry Division.

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

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

Evaluation of accessions: Phase III

Evaluation of 377 accessions in Phases I and II in the low country has been continued. The first-cycle yield recording with LVP 76 has been completed.

Evaluation of accessions: Phase III

Observational trial, Kottawa

Follow-up visits were made to observe plant establishment. First and second centering were carried out in June and November, respectively. Infilling was done in June.

Commercial evaluations

(i) Cecilton Estate, Balangoda

Ten promising accessions selected from LVP 75, together with control cultivars of TRI 2026, TRI 4042 and DG 39, were established in a commercial evaluation trial at Cecilton Estate, Balangoda, in October, to assess TRI 5000-series cultivars on a large scale.

(ii) Deniyaya Estate, Deniyaya

Ten promising accessions selected from LVP 75, together with control cultivars of TRI 2027 and TRI 4049, were established in a commercial evaluation trial at Deniyaya Estate, Deniyaya, in November, to assess TRI 5000-series cultivars on a large scale.

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

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

The Entomology Division undertook to screen accessions in LVP 74 and LVP 75 for LCLWT and SHB.

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

A study, initiated to evaluate the suitability of new accessions for mechanical harvesting, in collaboration with the Agronomy Division, Ratnapura, was continued.

Thrusts A 5 – A 8. Development of biclonal and polyclonal seed cultivars for the up-, mid-, Uva and low-country regions.

1.12. 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 progenies suitable for commercial planting.

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. The yield-component assessment of different seed stocks were commenced in August.

Seed Tea Reserves

Of the eight "tea reserves" established in the year 2003, the first batch of seeds was collected from the Gouravilla Tea Reserve in August. A seed nursery was established in the Plant Breeding Division nursery to monitor germination percentage and to raise seedlings. These plants will be used to infill tea reserves at Gouravilla next year.

Mid-Country

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

The yield recording of nine seed stocks was re-commenced in June following the drought. The yield-component study was commenced to analyze the variability within progenies.

Commercial evaluation of seed progenies, Hasel Lanka Ltd., Galaha.

The preliminary activities necessary to establish a commercial evaluation trial for selecting seed progenies were completed. Eighteen different seed progenies from six seed gardens were raised in the nursery, and growth performances were monitored at different time intervals.

The Uva

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

The yield recording of seed stocks under evaluation in the Uva was continued.

Evaluation of seed progenies. Uva Centre, Passara (2004).

Seedlings raised in the nursery from seed sources at Rambukkanda, Salawa, Reucastle, Halpe and Kiriporuwa were established, in October, as a non-replicated trial at the Uva Centre, Passara, to assess seven different seed progenies from five seed gardens. Seedlings originating from different parents from each seed garden were planted separately. TRI 2025 and TRI 4042 were used as standard cultivars.

Low Country

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

The yield recording of different seed stocks continued for the 3rd year of the first cycle. In addition, yield-component assessments were repeated once to confirm the previously generated data.

Seed gardens in the low country.

Follow-up visits were made to Salawa, Maliboda, Anhettigama, Reucastle, Rambukkande, Halpe, Rygama, Sorana, Karadupona, Sapumalkanda, Urumiwella and Kiriporuwa Estates to monitor the seed-setting and flowering pattern of parental cultivars. Various cultural practices, such as removal of unproductive branches and fertilizer application, undertaken with the assistance of the respective estates, were continued.

2. Activities for Generating Information for Plant Breeding Research Programmes.

2.1. Controlled Hybridization Programmes

Up Country

A total of 1522 single crosses, involving 25 different parental combinations, were carried out in the 2003/2004 programme. Six hundred and forty-seven crosses, in a diallele consisting of six parental combinations, were also carried out. Harvesting of hybrid seeds generated from the controlled hybridization programme of 2003/04 commenced in July. Three hundred and eleven hybrid seeds/progenies generated through various cross combinations were collected, and germinated in the nursery. The percentage of seed set per cross, and the % germination has been monitored.

Low Country

A total of 4190 single crosses, involving 31 selected parental combinations, were carried out in the 2003/2004 programme. A sufficient number of crosses was possible with parental combinations of TRI 4004 x 3052; TRI 4061 x KEN 16/3 ; TRI 2016 x 4053 and TRI 2016 x KEN 16/3. Of the 175 hybrid seeds generated from some of the crosses, 88 seeds germinated. From last year's programme, 35 hybrid plants have already been planted in Field No. 2, St Joachim Estate.

2.2. Germplasm

A database was constructed, incorporating all available information on traits evaluated, to facilitate rational selections of parents for a hybridization programme.

A document on "Spatial distribution of tea cultivars originated from estate selections" was prepared and published.

Measures were taken to expand the existing germplasm on St Coombs Estate aimed at preserving useful genetic resources.

Studies initiated on flowering behavior of germplasm accessions at St Coombs and St Joachim, Ratnapura have been completed, after making observations all year round.

One hundred and sixty-seven accessions, conserved in the tea gene bank at Talawakelle, were characterized using morphological descriptors related to leaf

characters. Fifty accessions were characterized using reproductive traits (floral-, fruit- and seed-related).

A study to develop a model for categorization of germplasm accessions, conserved in the *ex situ* gene bank, in the low country at Ratnapura, was concluded successfully, and a research article was prepared based on the analysis.

2.3. Polyploid breeding

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

2.4. Mutation breeding

Over 2000 cuttings of DG 7 were exposed to gamma irradiation to induce mutation.

Plants raised from VP cuttings of TRI 2025, exposed to gamma rays and planted in the field, have been assessed for morphological characters, 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 each month. Centering was carried out, and weights of centered branches were recorded for each plant.

2.5. Estate Cultivar Selection Programme

Seedling selections from:

(1) Labukelle Estate (in Field No 13, St Coombs Estate)

As there were many casualties in some accessions, the plants remaining were uprooted in September, and replaced with Liddesdale selections.

(2) Fairlawn Estate

Eighty-four promising seedling selections made last year from the old seedling block on Fairlawn Estate, Maskeliya, were raised in the nursery, and the performance of each selection was assessed at the 6th and the 8th month after propagation. A piece of land on Fairlawn Estate was earmarked for establishing promising selections next year.

3. Issuance of Planting Material

The issuing of planting material of the TRI 3000- and 4000-series cultivars has been handed over to the Institute's two estates and to the Institute's regional Centres, since large-scale mother bush blocks have been established in those locations under an ADB-funded project. Mother bush blocks, owned by the Plant Breeding Division, were handed over to the Institute's two estates in August.

PLANT PATHOLOGY DIVISION

Head – A. Balasuriya

Research Activities (see Corporate Plan)

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

Screening for resistance to *Poria*

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

The plants were maintained in two pits. The construction of a third pit was completed. The inoculum was added to the inoculation pits at two-monthly intervals. A few plants from the cultivar 3015 died less than a year after planting. The pathogen was re-isolated from the dead plants. Only a portion of the new pits were filled with soil.

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).

Screened progeny from TRI 2043 and TRI 2023 females were planted in Field No. 13 by the Plant Breeding Division. Some casualties occurred. Infilling was carried out using some of the assessed plants, with additional tags.

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

The field performance of eight selected cultivars were monitored nine months after planting. The field was visited twice during the quarter. There were some vacancies among the selections.

2. Project A 3.2. Screening and selection for resistance, Uva.

Screening in Phase II trials. The assessment of 128 lots for resistance to blister blight, in two Phase II trials, UVP 9 (46) and UVP 10 (82), in the Plant Breeding trials maintained at the Passara Station, was completed.

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

Screening for resistance to *Macrophoma* canker disease

Screening in Phase II trials. The assessment of 142 lots for resistance to *Macrophoma* canker disease, in four Phase II trials, LVP 76 (25 x 2), LVP 77 (6 x 2), LVP 78 (21 x 2) and LVP (9 x 2), in the Plant Breeding trials maintained at St Joachim Estate, Ratnapura., was completed.

Selection for resistance to *Macrophoma* canker disease and wood rot

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

Five selections were planted in the field and are being maintained by the estate. A visit could not be made during the year.

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

Biological control of root and stem diseases of tea

More attempts were made to isolate beneficial and antagonistic organisms from tea soils in both the up-country and the low country. Their viability in storage was checked periodically. *Trichoderma harzianum* showed greater antagonistic effects against *Poria hypolateritia* than did *T. pseudoconingii, in vitro.* The *Rosellinia arcuata* isolate from St Coombs was successfully controlled by the antagonist, *T. harzianum*, using the dual-culture technique.

Attention was aid to bulking and preserving the antagonistic *T. harzianum* fungus spores, collected by means of the suspension and centrifugation technique, using talc powder. This process is proving to be more efficient, and refinements are being effected.

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

PP/VAM1/04. Nursery inoculation experiment (St Coombs Estate).

This nursery experiment was started with five tea cultivars, TRI 3016, 3972, 4052, 4067 and 4071. The nursery was raised using 180 cuttings of each cultivar in a separate block, obtained from the Plant Breeding Division's general nursery area.

The initial percentile levels of C, N, K and P in the nursery soil were recorded. The treatments included different levels of P fertilizer, with and without VAM. The inoculum added contained approximately 2342 spores per gram of soil mixed with a host species for their multiplication. The mixtures used were: 2152 spores and *Alternanthera dentata* (80%); 2328 spores and *Browalia americana* (78%); and 2673 spores and *Centella asiatica* (53%).

Nursery fertilizer (T 65) was first applied when the cuttings were three months old. The fertilizer treatments (T 65, T 65 with P, and T 65 without P) were repeated at fortnightly intervals.

Growth measurements (plant height, number of leaves, etc.) were started at five months. Destructive sampling was started with three plants from each treatment, at six months, in order to measure per cent root colonization, spore counts and percentage levels of N, P, K and C. Sampling is continuing. The infections recorded remained at very low levels.

6. Project D 21 (D/LEAFDC). Leaf disease control

PP/BB/03/03. Use of fungicides in the control of blister blight (Field No. 13, St Coombs Estate).

A blister-blight control trial using new and existing fungicides was started in July in Field No 13 of St Coombs Estate, using the tea cultivar TRI 2025. The trial design is RCBD with four replicates. Disease severity was assessed at weekly intervals.

Treatments

1. Cu fungicide (Champ) at 0.1%
2. Bitertanol (Baycor) at 0.05%
3. F-500 (Pyraclostrobin, a new fungicide) at 0.05%
4. Unsprayed Control

Twenty-nine spraying rounds and 22 assessment rounds (including three pre-assessments) have been completed.

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, Field No 8).

A latex-bitumen mixture developed by the Rubber Research Institute (RRI) was amended with different concentrations of the fungicide, hexaconazole (Contaf), for application to pruning cuts as a protective paint.

The initial results showed that latex-bitumen mixture amended with 0.1% of hexaconazole was able to yield more buds at close proximity to the cut end, thus reducing the volume of snags that die off eventually.

Improvements to the latex-bitumen compound were suggested to the RRI for attaining better applicability and spreadability. This resulted in the development of four new combinations of the product by the RRI.

An expanded trial, using these products, was initiated in Field No. 8. Two of them (A and B) were used with hexaconazole at 0.1%, and the other two without any fungicide, along with a control. The trial design is RCBD with five treatments and four replicates. One month after the application of paint, the physical parameters of the protective paints were assessed.

SPND trial (Lumbini Estate, Deniyaya)

In a separate exercise, the Division assisted the SPND in assessing wood rot in their trial at Lumbini Estate, Deniyaya, in which different fertilizer rates had been used. The assessment was completed, and the data has to be analysed.

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

This trial was visited once during the year, and the necessary treatments effected. There is no sign of any *Hypoxylon* stem blight (HSB) infections as yet.

8. PROJECT D 23 (D/ROOTDC). Root disease control.

PP/RDC1/04. Field testing of systemic fungicides and *Trichoderma* sp. in the control of *Poria* root disease (Field No. 3, Rajamalai Division, Moray Estate, Maskeliya).

The blocks were selected for an incomplete block design for the treatments (Bitertanol at 2%, hexaconazole at 1%, *Trichoderma harzianum* at 5g/l of 10^5 spores, and control). The treatments were effected in May. Soils were sampled one month after the treatments to assay the levels of *T. harzianu.m.*.

The treatments were repeated two months later, in July. The repeat treatments scheduled could not be carried out owing to the unavailability of staff time.

In vitro screening of fungicides

Systemic fungicides available (Bitertanol, Tridemorph, hexaconazole, Propiconazole, Tebuconazole and F-500) were screened against a new isolate of the black root pathogen, *Rosellinia arcuata*, from St Coombs Estate, using the poisoned-food technique at a 0.05% concentration on PDA.

Propiconazole and F-500 proved to be very effective in controlling the fungus *in vitro*.

9. Project D 25 (D/MISCEL). Miscellaneous Activities.

Microbial analysis of made tea

Altogether 141 samples were analysed for levels of contamination by microorganisms. Out of the 141, 84 samples suspected to be of poor quality had been forwarded by the Sri Lanka Tea Board (Tea Commissioner). The analysis reports were sent to the Tea Commissioner, with indications that 29 of them were in excess of the limits considered favourable for human consumption.

A total of 55 (20 + 35) made tea samples were analysed for the Technology Division in Ratnapura.

Protocols for detecting *Salmonella* and *E. coli* bacteria were established.

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

Several morphological studies and fungicide-efficacy tests were undertaken in the laboratory. Propiconazole and F-500 at 0.05% were able to effect prolonged control under *in vitro* conditions.

PP/HHB/01/04. Study of the impact of horse-hair blight on the yield and management of tea (Field No. 8, St Joachim Estate, Ratnapura).

This study was carried out in collaboration with the Advisory Staff.

A trial using six treatments (control; cleaning + hydrated lime at 10% on the frame only; cleaning + *T. harzianum*; cleaning + $Cu(OH)_2$; cleaning + propiconazole; cleaning + hydrated lime onto frame and litter) was initiated in collaboration with the Advisory & Extension staff at Ratnapura. The trial design is RCBD with four replicates. All the prunings were removed from the trial area.

The initial infestation levels and bush vigour were recorded. The viability and vigour of the fungus were assessed under *in vitro* conditions, by culturing the harvested HHB strands on Rose Bengal-streptomycin agar in two rounds.

The die-back problem in the ADB mother bush area (cultivar TRI 4053)

Histopathological studies of the diseased samples revealed that the infested patches contained damaged vascular tissues, including ray parenchyma.

The suspected organisms which were isolated from the infected tissues included *Fusarium* sp., *Macrophoma theicola*, and an unidentified fungus quite similar to *Fusarium* sp. The systemic fungicides available (Tridemorph, Bitertanol, hexaconazole, Propiconazole, Tebuconazole and F-500) were tested against the suspected organisms using the poisoned-food technique at 0.05% concentration. The *Fusarium* sp. was controlled by Tebuconazole at 0.1%, *M. theicola* by Tridemorph, Propiconazole and F-500, and the unidentified fungus by all the fungicides tested, except Bitertanol.

An inoculation trial with the suspected organisms revealed that the combination of organisms, *Fusarium* sp. and *Macrophoma*, and the unidentified fungus and *Macrophoma*, together, were able to reproduce symptoms, giving indications of a stress-related, complex pathological problem. The pathological aspect of the problem could probably be addressed using fungicides like Tridemorph, Propiconazole or Pyraclostrobin (F-500), at a 0.1% concentration of the product.

Two organisms isolated from the diseased patches were sent to the IMI for confirmation of identification.

The TRI 2025 die-back syndrome (the 'High Forest problem').

One final round of measurements to assess the spread of the disease patch (in Field No. 1 of the Upper Division in the Nuwara Eliya Estate) was taken before terminating the trial.

The final decision is to discourage planting of TRI 2025 at elevations exceeding 1500 m, in order to avoid senility and associated pathological invasions at the early age of 25 – 30 years.

Divisional Activities (D/PLPA)

Identification of organisms

Altogether, seven samples (five fungal and two bacterial samples) were sent to the CABI Bioscience Centre in the UK, for identification. The identifications are awaited.

PLANT PHYSIOLOGY AND PROPAGATION DIVISION

Head - V. Shanmugarajah

Research Projects on Plant Physiology

1. Basic Research Projects (see Corporate Plan)

1.1 Project B 11. Studies on Photosynthesis and Dry Matter Partitioning.

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

Variation of yield, and number and weight of shoots, 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 and available soluble root starch determined. Leaf fall was also monitored.

Comparatively, TRI 2025 gave a higher yield than DT 1. The lowest yield, and the lowest number of active and banji shoots, obtained during the fourth year in both cultivars are significantly different from that in the other years. In both cultivars, more active shoots were produced during the first year, and the highest LAI obtained during the third year. Though not significantly different from that of the other years, the rate of photosynthesis was high during the first and fourth years. The root starch content was high during the first and fourth years.

2. Experiments on shade effects and shade trees.

2.1. Effect of shade on yield of mature tea.

There was no significant difference in yield and pruning weight between the treatments.

2.2. Photoinhibition of photosynthesis in tea.

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

2.3. Possible alternative shade tree species

Identification of the best species from the comprehensive database of possible shade tree species is in progress. The database is also being developed for user-friendly use.

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

This study was terminated.

3. Tea Root Physiology

Under this project, the following experiments were carried out in order to gain a comprehensive understanding of tea root physiology.

Root studies in field-grown tea

3.1. Study of the root system in cultivars vs seedling tea, mature tea.

The general understanding is that seedlings survive better than cultivars in drought-prone areas. In recommending cultivars or seedlings to such areas, a comprehensive knowledge about the behaviour of the tea root system in the field, in different regions, is essential. Hence a study was initiated to study the behaviour of the tea root system in seven estates in different agroclimatic regions.

3.2. Study of the tea root system in cultivars vs seedling tea, young tea.

In order to understand the root system of young, field-grown tea, the same measurements, as in the experiment described in section 3.1, are being taken in respect of five-year old tea plants in the Seedling Trial, at the Institute's Uva Centre, Field No 4, initiated by the Plant Breeding Division. The cultivars planted are TRI 2023 and DN, and the seed stocks are from Karandupona, Densworth, Salawa, Reucastle, St Coombs, Poonagala, Halpe, Auhetigama, Aislaby and Sapumal.

A glasshouse study was also initiated, in parallel with the field study, in order to observe the root system of glasshouse plants, soon after the planting of the seed and cuttings. These were planted in the rhizotrons and the growth monitored.

The experiment is in progress

3.3. Study of the tea root system in organic vs inorganic tea, in relation to shoot growth.

Root windows were installed in the 'TRI-ORCON' organic vs inorganic field experiment with the objective of obtaining a better understanding of the tea root system and rhizosphere interactions. Periodic monitoring of root growth was started in relation to shoot growth.

3.4. Anatomical studies of tea roots.

Root samples were taken periodically from the 'TRI-ORCON' organic vs inorganic field experiment, in order to study possible anatomical changes in the roots of field-grown tea under organic and inorganic treatments.

4. Tea Leaf Anatomy

Changes in the stomata of the tea flush of the cultivars, DT1 and TRI 3035, after plucking were studied. The stomatal densities, length: breadth ratios of stomata, and the percentiles of opened stomata for these cultivars were 159.4 and 79 per mm^2, 4.88 and 4.61, and 82.2 and 74.8%, respectively.

5. Studies on Organic Tea

5.1. Yield of organic tea vs conventional tea.

There was no significant difference in yield between the treatments. The bushes were rested from the end of May, and pruned in July. The sub-plots were pruned in September after completion of the study, which was in collaboration with the Biochemistry Division.

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

This study was carried out to investigate the shoot- and root-growth, and yield, under different organic and conventional management systems of mature tea, prior to the second prune of the 'TRI-ORCON' trial.

The soil- and leaf-nutrient content in the organic treatments were at the required optimum level, and similar to that of plants in the inorganically-fertilized system. The yield was high in plants grown with tea waste. The conventionally-grown plants had higher total root fresh and dry mass, and total root length, in the 0-15 cm layer than in the deeper layers. In the organically-managed systems, the plants had higher total root fresh and dry mass, and total root length, in the deeper layers.

5.3. Studies on 'The Conversion Period and Organic Tea'.

An experiment was initiated at Giragama Estate, Pilimatalawa with seedling and old VP tea with the following objectives: converting marginal lands into a

more productive form using cultural practices, and reducing the In-conversion period in the conversion plan to achieve improved plant vigor and health.

The following treatments were given: conventional management with normal prune, organic management with normal prune, organic management with collar prune, and organic inputs plus conventional management with normal prune.

The bushes were pruned in June according to the treatments. The normal pruned bushes were tipped in September. The pruning and tipping weights, recovery two months after pruning, and yields up to December, did not show any significant differences.

The experiment is in progress.

In this experiment, initial pre-assessments were made for major pests and diseases in collaboration with the Entomology and Pathology Divisions. Overall bush vigour was estimated considering the span of the bush, number of primaries and visual score of decay.

6. Studies on Drought Mitigation

Development of selection criteria for drought tolerance in tea.

The experiment could not progress owing to a delay in obtaining the growth chamber.

Research Projects on Plant Propagation

7. Thrust A 38. Development and management of nurseries.

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

As there were many casualties owing to heavy rains experienced after the cuttings were planted, the trial initiated earlier was abandoned. A fresh trial was initiated once more in the nursery at Kottawa Centre, 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 4054 are used. They are raised under a polythene roof to avoid casualties from heavy rains.

7.2. Project A 38.6. Developing techniques for the production of quality plants.

A trial was initiated to study the possibility of producing plants with sufficient leaves, and with 2–3 side branches, within a reasonable time. The trial is of a RCBD with five replicates and four treatments.

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

Identification of graft combinations for high quality and high yield.

The plants of the fifteen combinations produced earlier are maintained in the nursery for planting in the field during the next season, for further observation.

8. Other Studies on Propagation

8.1. Effect of some growth substances on rooting of cuttings.

Using cuttings of a moderately rooting cultivar, TRI 4079, the trial carried out, to study the effect of four growth substances (Secto, an UPASI formulation, Clonex powder and Clonex gel) on rooting, was concluded.

The treatments were T 1 – Control (no hormone), T 2 – Secto, T 3 – UPASI formulation, T 4 – CLONEX (powder) and T 5 – CLONEX (gel). The growth of the plants was assessed three times at four, eight and ten months. The differences seen initially in height of the plants, and length of the longest roots, could not been seen thereafter.

Effect of some growth substances on rooting of cuttings in the low country.

A trial was initiated in the nursery at St Joachim Estate to study the effect of four growth substances on cuttings of the cultivar TRI 2027 (which is a poor, or slow, rooter), TRI 3025, 3047 and 4006.

8.2. Effect of age of bushes on growth of cuttings.

The growth of cuttings obtained from bushes which are one, two and three years old, and from mother bushes, was compared in two trials, one in the up country (Mattakelle Estate) and the other in the low country (St Joachim Estate). Observations on the growth of the plants in these trials were concluded.

Effect of age of bushes on growth of cuttings; up country trial (Mattakelle Estate).

There was no significant difference between treatments with respect to most of the parameters. However, the dry weights of the plants obtained using cuttings from the one year-old bushes were the lowest of all.

Field performance of plants raised from cuttings obtained from bushes of different ages; up country trial (Mattakelle Estate).

Plants of TRI 4052 from the Mattakelle trial were planted in Field No. 6 of Mattakelle Estate for further observation in the field. The trial is of a RCBD with four replicates, and the number of plants per treatment per replicate is 40.

Effect of age of bushes on growth of cuttings; low country trial (St Joachim Estate).

The growth of the plants of the cultivar TRI 4042, used in the low-country trial, was assessed twice, at four and eight months. At both assessments, no significant difference between the treatments was seen in any of the parameters studied.

Field performance of plants raised from cuttings obtained from bushes of different ages; low country trial (St Joachim Estate).

Plants from the St Joachim trial were planted in Field No. 6 of St Joachim Estate for further observation in the field. The trial is of a RCBD with four replicates, and the number of plants per treatment per replicate is 24.

8.3 Effect of black polythene on the growth of cuttings.

The trial in the nursery at St. Joachim Estate, Ratnapura to study the effect of black polythene on the growth of the cuttings was concluded. No significant differences were seen in any of the parameters at any stage, when the plants were assessed at three, six and nine months.

8.4 Observation trial

Propagation of flush shoots

An observation trial was initiated to examine the possibility of using flush shoots for propagation. The trial is in progress.

SOILS AND PLANT NUTRITION DIVISION

Head - L.S.K. Hettiarachchi

Applied Research

1. Thrust A 15. Development of regional and site-specific fertilizer recommendations for improvement of productivity and 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 work carried out, along with the objectives, tangible outcomes, publications, etc. appeared in the Institute's Annual Reports of 1996 to 2003.

The soil series from both the wet and Intermediate zones have been recognized, and the characteristics of soil series are available for use as tangible outcomes, such as books and digital maps. This information was used for diagnosing some problems associated with tea research and developmental activities, such as genotype X environment interactions, and growing regions together with laying-out trials. The information was also helpful in formulating the protocol for site-specific schedules.

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

Fertilization experiments

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

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

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

There was no significant increase in yield from increasing rates of N, as observed in all the 12 months during last cycle, except in the 2nd year. As in the past, no significant effect was seen from increasing rates of K and Mg; also there was no interaction between any of the fertilizer treatments.

Soil pH levels at 0-15 and 15-30 cm depths decreased significantly with increasing rates of N as in most years. So far, no variation has been seen with increasing rates of either K or Mg. As in previous years, soil ex. K level in the 1st year also increased with increasing rates of K at both depths. However, soil K level was not significantly influenced by increasing rates of N and Mg.

Soil Mg levels at both depths did not vary significantly, either with increasing rates of N and K, or with Mg fertilizer rates, except at the 15-30 cm depth where an increasing trend was present. With increasing rate of N fertilizer, leaf N, K, Mg and Ca concentrations, estimated in the 1st year after pruning, did not vary significantly, although a higher value for leaf N was present at the highest rate of N. With increasing rates of K, leaf K concentration increased, while, with increasing rates of Mg, leaf Mg concentration also increased, although at the same time other leaf nutrient concentrations remained unaffected.

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

This trial was concluded with a three-cycle progression, but the overall data analyses continue.

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

There was no significant increase in yield from increasing rates of N, as observed in all the 12 months during the last cycle, except the 2nd year. Again, as in the past, there was no significant increase in yield from increasing rates of K and Mg. There was no interaction between any of the fertilizer treatments.

Soil pH levels, at 0-15 and 15-30 cm depths, decreased significantly with increasing rates of N, as in most years. Also, no variation was seen with increasing rates of either K or Mg, as is to be expected. This year also the soil ex. K level increased with increasing rates of K fertilizer at both depths. At the same time, it decreased with increasing rates of N fertilizer, but did not vary with Mg fertiliser.

This year's estimation showed that soil Mg levels at both depths increased significantly with increasing rates of Mg fertilizer, and reduced with N fertilizer.

In the last year of this pruning cycle, increasing rates of N fertilizer caused leaf N to increase curvilinearly, while leaf K and Mg decreased, and leaf Ca did not vary. With increasing rates of K, leaf K concentration increased, while leaf Mg decreased, and leaf N and Ca did not vary significantly. No significant variations in leaf N, K, Mg and Ca concentrations were found with increasing rate of Mg fertilizer at this site.

No significant variations were found with fresh pruning weight, base stem circumference, and average circumference of secondary branches 2.5 cm below the pruned cuts, including fresh tipping weight.

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

This trial was concluded with a two-cycle progression. Again in this experiment, no significant variations were found in fresh pruning weight, base stem circumference, and average circumference of secondary branches, including fresh tipping weight, with increasing rates of any of the treatments.

Overall data analysis continues.

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

This trial was concluded with a two-cycle progression. In this experiment also, no significant variations were found in fresh pruning weight, base stem circumference, average circumference of secondary branches and tipping weight, though the data was not presented with increasing rates of any of the treatments.

In addition, the volume of rotten, decayed wood was measured in collaboration with the Plant Pathology Division. No significant effect was observed.

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

So far no significant effect on yield was found with increasing rates of any of the treatments.

Soil pH levels, at 0-15 and 15-30 cm depths, decreased significantly with increasing rates of N as in the previous year. As expected, no variation was seen with increasing rates of either K or Mg. As in the previous year, the exchangeable K level in the soil increased significantly with increasing rates of K at both depths, while it decreased with increasing rates of N, but was not significantly affected by Mg fertilizer rates. So far exchangeable Mg and Ca levels in the soil did not significantly vary with increasing rates of any of the treatments.

Unlike in the previous year, leaf N, K, Mg and Ca concentrations estimated this year showed significant variations with increasing rates of fertilizers. With an increasing rate of N fertilizer, leaf Mg concentration significantly reduced, while leaf N, K and Ca concentrations did not vary significantly. However, an increasing trend for N, particularly with the second rate, was found.

With increasing rates of K fertilizer, leaf Mg and Ca concentrations decreased, while leaf N and K did not vary. With increasing rates of Mg fertilizer, leaf Mg increased significantly while the others did not vary.

The trial continues.

(7) Cultivar TRI 2025, Field No. NC, New Division, Rangala Estate, Karaliyadda (2002)

As in the previous year, yields increased significantly with increasing rates of N fertilizer, but not with increasing rates of K and Mg fertilizers. Unlike in the previous year, soil pH levels decreased with increasing rates of N fertilizer. This year's estimation, surprisingly, did not show any significant variations. As expected, no variation was seen with increasing rates of either K or Mg.

As in the previous year, the exchangeable K level in the soil increased significantly with increasing rates of K at both depths, but did not vary with increasing rates of N and Mg. The exchangeable Mg levels in the soil increased significantly with increasing rates of Mg, particularly beyond the middle rate. Soil Ca level was not affected by any of the treatments.

So far with increasing rates of fertilizer, leaf N, K, Mg and Ca concentrations did not change significantly, except that there was a decreasing pattern of leaf K concentration with an increasing rate of N fertilizer.

The trial continues.

(8) Cultivar TRI 2025, Field No. NC 5, Midlands Estate, Ratthota (2000)

At this site also, as was observed the previous year, yield increased significantly with increasing rates of N fertilizer, but not with increasing rates of K and Mg fertilizers. Soil pH levels, at 0-15 and 15-30 cm depths, decreased significantly with increasing rates of N, as in the previous year, but increasing rates of K or Mg showed no effect on soil pH as is to be expected.

So far, ex. K, Mg and Ca levels in the soil have not changed significantly. However, a tendency for soil K to increase with increasing rates of K fertilizer was seen.

This year's estimation on leaf N, K, Mg and Ca did not show any great variations. However, a particular tendency for leaf N to increase with increasing rates of N was observed.

The trial continues.

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

(1) Cultivar TRI 2025, St James Estate, Hali Ela (1990)

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

The yield in the fourth year increased significantly with increasing rates of N fertilizer, but did not vary with increasing rates of K fertilizer.

As before, soil pH levels at both depths reduced significantly with increasing rates of N.

Soil K levels increased with increasing rates of K fertilizer, while they decreased with increasing rates of N.

This trial will continue until next year, and conclude with an assessment of SHB incidence as well.

(2) Cultivar TC 9, Brunswick Estate, Maskeliya (1998)

Rates: N 240, 420 and 600 kg ha^{-1} yr^{-1}
K_2O 120, 300 and 480 kg ha^{-1} yr^{-1}

Frequencies: 6, 8 and 12 weeks

Although the second year yield did not change significantly with increasing rates of N and K fertilizers, a tendency for an increase in yield with increasing rates of N was seen.

Soil pH levels, at 0-15 and 15-30 cm depths, decreased significantly with increasing rates of N as in previous years. Also, as previously, exchangeable K levels in the soil increased significantly with increasing rates of K at both depths, and at the same time decreased with increasing rates of N. Soil Mg and Ca did not change significantly with increasing rates of the treatments.

With increasing rates of N fertilizer, leaf N concentration increased significantly as before, without any significant changes in K and Mg. With increasing rates of K fertilizer, leaf K concentration increased significantly while leaf Ca decreased. Mg and N did not vary significantly.

The trial continues.

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

(1) Cultivar DT1, St Coombs Estate, Talawakelle (1992)

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

There was no significant variation in fresh pruning weights with increasing rates of N fertilizer, but the pruning weights, averaged over compost application at 5 mt ha^{-1} yr^{-1}, were significantly higher than in the nil treatment.

The yield in the 1st year after pruning, in October 2003, together with soil and leaf nutrient data, will not be presented, as the quantities of nutrients given were less than scheduled.

The trial continues.

(2) Cultivar TRI 2025, Baddegama Estate, Baddegama (2000)

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

This experiment was terminated in March, owing to heavy infestation with horse-hair blight and bush debilitation.

(3) Cultivar TRI 2026, Anninkande Estate, Deniyaya (2001)

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

The yield information collected following the application of the treatments, during the 3rd year (February 2003 to January 2004), showed no significant variation with increasing rates of N fertilizer, although yields did show a tendency to increase.

However, the yields during the year varied significantly with the application of compost; this was pronounced particularly when the rate of compost changed from 10 to 20 t ha^{-1} yr^{-1}.

The fresh pruning weights increased significantly with the increasing rates of compost, although they did not vary significantly with increasing rates of N.

Unfortunately the experiment had to be terminated in September, owing to a sudden unavailability of compost *in situ*..

Overall data analysis continues.

(4) Cultivar TRI 2026, Kallebokke Estate (2002)

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

Yields increased significantly with increasing rates of N fertilizer, and the pattern of increase appeared to be linear in this year alone. Compost application had not shown any significant influence on yield so far.

The trial continues.

(d) Effect of application of different rates and proportions of urea, and sulphate of ammonia, on growth, soil- and plant-nutrient status and yield of tea.

The seven trials, detailed below, are being carried out as part of a post-graduate study on S nutrition, with specific objectives. Detailed investigations with each trial are underway.

(1) Cultivar TRI 2025, St Coombs Estate, Talawakelle (May 1979)

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

As in earlier findings, a significantly higher yield was obtained when N was applied at 360 kg ha^{-1} yr^{-1} rather than at 240 kg ha^{-1} yr^{-1}, but no variations occurred with the different proportions of SA and urea. The fresh pruning weights were also significantly higher at the higher rate of N. As before, both the rate of N fertilizer, and the proportions of sulphate of ammonia, in the N combination significantly altered the soil pH and sulphate sulphur, at both depths. Lower pH levels were found at the higher rate of N. At the same time, when the proportion of sulphate of ammonia increased in the combination, sulphate sulphur in soil too increased. However, the leaf S concentration was not affected either by the urea + S/A combinations, or by the N rates.

The experiment continues as a long-term trial.

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

So far neither the yield nor the pruning weight significantly varies with the increasing rates of N, and the application of N in different proportions of urea and sulphate of ammonia, unlike in other trials. The proportion of sulphate of ammonia in the N combination significantly altered the soil pH and sulphate sulphur, at both depths. However at this site, the rate of N did not significantly alter either the soil pH or the soil sulphur.

Leaf S concentrations also did not show significant variations.

The trial continues.

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

As previously observed, yields increased significantly with increasing rates of N fertilizer, but there was no variation with the different proportions of urea and SA. As expected, and observed in the first trial above, both the rate of N fertilizer, and the proportions of sulphate of ammonia in the N combination, significantly altered the soil pH and the sulphate sulphur, at both depths.

The pH levels decreased with increasing rates of N. At the same time, when the proportion of sulphate of ammonia increased in the combination, the sulphate sulphur in the soil too increased.

However, at this experimental site too, leaf S concentration was not affected either by the urea + S/A combinations, or by the N rates.

(4) Cultivar TRI 2023, Field No. 3, Upper Division, Mahaousa Estate, Madulkelle (2001)

The yields in the first year did not vary significantly, either with the increasing rates of N, or with application of N in the different proportions of urea and sulphate of ammonia. Both the rates of N fertilizer, and the proportions of sulphate of ammonia in the N combination, significantly altered the soil pH and the sulphate sulphur, at both depths.

The pH levels decreased with increasing rates of N. At this site, soil sulphur, at both depths, appeared to be increasing with increasing proportions of sulphate of ammonia in the N combination, but it was not statistically significant, unlike in the first and third trials above. At this site, the sulphate sulphur in the soil increased significantly with increasing rates of N.

Leaf S concentration was not affected, either by the urea + S/A combinations, or by the N rates. However, it is noteworthy to place on record that the leaf S concentration in the TRI 2023 cultivar is relatively higher than in the others.

The experiment continues.

(5) Cultivar TRI 2026, Field No. 7, St. Francis Division, Milakande Estate, Horana (2001)

The first-year yields, obtained during June 2003 - May 2004 of the cycle, did not significantly vary, either with the increasing rates of N, or with the application of N in different proportions of urea and sulphate of ammonia. The soil pH levels estimated in this year did not show significant variations, perhaps owing to dolomite application carried out in July 2003. At this trial site, no significant variation in the soil sulphur was found unlike in the other trials. Leaf S also did not show significant variations.

The trial continues.

(6) Cultivar TRI 2026, Field No.13, B Division, Kiriwangange Estate, Deniyaya (2001)

The yields, obtained during the third year (March 2003 to February 2004) of the cycle, did not significantly vary, either with the increasing rates of N, or with the application of N in different proportions of urea and sulphate of ammonia. The application of urea and S/A, and its effects on soil pH and the sulphate sulphur levels (at 0-15 and 15-30 cm), and the leaf S concentrations, are given in Tables 86, 87, 88, 89 and 90, respectively. Both the rates of N fertilizer, and the proportions of sulphate of ammonia in the N combination, significantly altered the soil pH and the sulphate sulphur, at both depths.

The pH levels decreased with increasing rates of N. At the same time, when the proportion of sulphate of ammonia increased in the combination, the sulphate sulphur in the soil too increased. At this experimental site, the leaf S concentration was significantly affected, owing to the urea + S/A combinations, and the N rates. It increases when the proportion of sulphate of ammonia increases in the N combination rates.

The experiment continues.

(7) Cultivar TRI 2025, Field No. 3 A, Lower Abbotsford Division, Dessford Estate, Nanu-oya (2001)

Young tea plants in the experimental plots were pruned in September 2003. Operations on the mature plants continue.

It is noteworthy to place on record that the coefficients of variation (CV%) in the sulphate sulphur measurements in the soil were exceptionally high, being in the range of 35 – 79, and 26 – 64 %, for the 0-15 and 15-30 cm depths, respectively. This is despite significant increases shown in the soil sulphate sulphur levels, with increasing proportions of sulphate of ammonia in the urea and sulphate of ammonia combinations. It indicates the inherent variability of the present method of extraction, and its interaction with the soil types.

An evaluation of widely-accepted test methods was completed for assessing plant-available soil sulphate sulphur, using a tea cultivar, TRI 4052, grown under glasshouse conditions with major soil series.

(e) Effect of application of "Humic" substances on soil properties, plant-nutrient status, and the growth and yield of tea.

Effect of foliar application of "Humate" on the growth and yield of tea.

Rates: A detailed description of the treatments was reported in Annual Report 2003.

Cultivar TRI 2027, Field No. 1999/3Ha Raigam Estate, Ingiriya

Increased rates of spraying Super Humate, from 3 to 7 l, on tea foliage have significantly increased tea yields by 444 kg in the absence of normal Humate application in the ground. The incorporation of urea at 3 kg per 400 l of Super Humate, at all levels of Super Humate spraying, improved the yields.

Effect of application of "Humate"-treated waste tea compost on soil chemical and physical properties, and the growth and yield of tea.

Rates: Chemically treated waste tea compost 5 and 10 Mt ha^{-1} yr^{-1}
Control

Cultivar TRI 2027, Field No. 1999/3Ha Raigam Estate, Ingiriya

The experiment continues.

Project A15.3. Estimating crop response to micro-nutrients (Zn, B, Mn, etc.) at regional level.

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

(1) Cultivar TRI 2025, Field No. 3 B, St Coombs Estate, Talawakelle (1999)
(2) Cultivar TRI 2025, Field No. 9, Madulkelle Estate, Madulkelle (2000)
(3) Cultivar TRI 2025, Field No. 3 B, Greenwood Estate, Nawalapitiya (2000)
(4) Cultivar TRI 2025, Field No. 3, Upper Division, Indola Estate, Deniyaya (2000)
(5) Cultivar TRI 2027, Field No 3 D, Second Division, Dammeria Estate, Passara (2004)

At site (1), the average yield in the cycle varied significantly between treatments. Futher, the average yield in the cycle of Multiplex-treated plots gave significantly higher yields when compared to other treatments. The application of other foliar treatments, such as zinc sulphate and commercial Epsom salt, zinc sulphate alone, and Kiecite, also gave relatively higher yields.

The trial continues.

At site (2), the average yield over two years, following pruning, varied significantly with treatments. At this site, the average yield of Multiplex-treated plots gave significantly higher yields when compared to the control, but not when compared to the other treatments. The application of other foliar treatments, such as zinc sulphate and commercial Epsom salt, zinc sulphate alone, and Kiecite, also gave relatively higher yields.

The trial continues.

At site (3), all the treatments gave higher yields than in the control, although the differences were not statistically significant, except with Kiecite.

The trial continues.

At site (4), the average yield in the cycle varied significantly between treatments. At this site, the average yield of Multiplex-, Zinc sulphate-, and zinc sulphate plus CES-treated, plots gave significantly higher yields when compared to the control.

The trial was concluded.

At site (5), a mature-tea field, planted in 1997 and last pruned in January 2003, was chosen from Field No. 3 D, and 20 plots, each consisting of 40 ± 2 plants, were demarcated on a RCB design in July 2004. Pre-treatment plucking commenced in September.

The trial continues.

Project A 15.4. Evaluating the effects of macro and micro nutrients on colour and strength of tea liquor

Cultivars DT 1 and CY 9, St Coombs Estate, Talawakelle (1992)

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

The optimum quantities of nutrients were given to the soil as mineral fertilizers. However, following the inclusion of the TRI 2025 cultivar, no attempt was made, during the preceding year as well, to assess made-tea quality. Yield records were maintained, and soil- and plant-nutrient status assessed, with a view to undertaking quality assessments when possible.

The experiment continues.

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

The survey was completed, and soil and leaf samples collected were analyzed for nutrient status. A part of the dataset was critically analysed, and ranges of leaf-nutrient concentrations have been determined for N, K, Mg, S and P. The ranges, designated as 'low' (<60%), 'deficient' (60-90%), 'optimum' (90-100%) and 'in excess' (above 100%), can be used for the diagnosis of VP tea nutrition, using a relatively new and quick technique known as "Boundary Line".

Other data are being analyzed statistically.

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

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

Cultivar TC 9, Field No. 4, St Coombs Estate, Talawakelle (1989)
Rates of dolomitic limestone: Increasing levels
Frequencies: Cycle, Mid-cycle and Yearly

As observed before, this year too the yield varied significantly with increasing rates of dolomitic limestone, the pattern of change being a linear increase initially, followed by yields dropping sharply beyond an application rate of 2500 kg ha^{-1}. However, the yield was not significantly affected by the frequency, or strategy, of dolomitic limestone application.

Activities continue as a long-term trial.

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

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

There were no noteworthy outcomes owing to constraints, both in terms of fine-tuning mechanisms and devices to prevent clogging and free flow in the loading container (or hopper) of the applicator, and in terms of expertise.

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

Field trials at Gami Seva Sevana: Farmer-centered organic tea research.

Soil and leaf samples were collected periodically, and soil-fertilization treatments were carried out. The activities continue.

Basic Research

1. Effect of waste-tea composting material on plant growth.

Glasshouse studies were undertaken to evaluate the effect of mixing chemically-treated waste-tea composting material, and untreated waste tea, with soil, at ratios of 0, 10, 25 and 50%, on the growth of bean (*Phaselous vulgaris*) plants.

An increase in the amount of both forms of waste tea increased soil pH, EC, available N, organic C, P, Ex. Mg, Na and K, and trace elements (Mn, Cu, Zn and Pb) in the soil. Application of 10% chemically-treated waste-composting material to the soil gave the best results, in terms of plant height, dry-matter production, and plant-nutrient uptake, compared to the other treatments.

A field trial was conducted in a new clearing, using nine months-old tea seedlings of TRI 3013, at St Coombs Field No 14 over three months, by mixing chemically-treated waste-tea composting material with soil at rates of 0, 0.5, 1, 2 and 3 kg per planting hole. The treatments were replicated four times.

The mixing of treated waste-tea compost with soil, and insertion into the planting hole at the rate of 0.5 kg, gave an increase in plant height. Further increase in the addition of waste-tea composting material did not show any additional benefit.

2. An evaluation of chemically-treated waste-tea composting on tea plants.

A field study was conducted, at St Coombs Estate Field No. 3 A, on soil properties and tea yield. This was done by surface application of increasing levels of chemically-treated and untreated waste black tea in the field.

The treatments were 2500, 5000 and 7500 kg of chemically-treated and untreated waste black tea, with a control. The treatments were replicated four times. Representative samples from pre- and post-treated soil and leaf were randomly collected from the experimental plots, and analyzed for the presence of macro and micro nutrients and other chemical properties. Plot yields were recorded for five months, but no clear relationship to the treatments was seen, probably because the duration of the study was short.

The concentration of soil NH_4^+ and NO_3^- increased with increasing rates of waste-tea treatments. However, increasing levels of chemically-treated waste tea did not increase Ex. Na in the soil so as to cause any adverse effects on the tea plants.

3. Thrust B 35. Establishment of critical nutrient levels for better growth of cultivar tea.

Research and development activities concluded in March, and chemical analyses of plant materials was also completed. Overall data analyses continue with a view to drawing conclusions.

4. Thrust B 15. Environmental studies.

Project B 15.1. Impact of variation of weather conditions on crop environment and productivity of tea: assessment of the effects of wet- and dry-depositions from the atmosphere.

The monitoring of rainwater quality continued in collaboration with the meteorological centres of the Institute's Centres at Talawakelle, Ratnapura,

Hantane, Passara, Kottawa and Deniyaya. Parameters such as rainfall, *in situ* pH, NO_3^--N, SO_4^{2-}-S, Mg^{2+} and Ca^{2+} are being monitored on a continuing basis.

The data collected during March 1999-April 2002 have been analysed for variances. The analysis reveals that the highest NO_3^--N, SO_4^{2-}-S and Ca^{2+} loads are reported from the Ratnapura Centre. The mean of the monthly pH at all the Centres was in the range 5.67 - 6.35. The mean values of monthly NO_3^--N deposition was in the range of 0.47 - 1.55 kg ha^{-1}, while the corresponding SO_4^{2-}-S, Mg^{2+} and Ca^{2+} ranges were 0.85 - 2.06, 0.15 - 0.46 and 0.64 - 1.54 kg ha^{-1}, respectively.

When compared with other regional studies, the results indicate that the tea-growing regions in Sri Lanka are unlikely to have experienced acid rains.

5. Thrust B 'New'. Evaluation of the effect of fertilizer application in up-country tea estates on down-stream pollution of water bodies.

A study was conducted to assess the effects of applying mineral fertilizer nutrients in up-country tea lands on pollution of downstream water bodies. This study was conducted during two monsoon periods (March 2003 to February 2004).

The study area was the Agra-Kotmala Oya region, the streams under investigation originating from the Horton plains and flowing through several tea estates. Water samples were collected at regular intervals from 24 sites, and analyses were conducted for chemical parameters (pH, NO_3^-, Cl^-, SO_4^{2-}, PO_4^{3-}, Na^+, Mg^{2+}, Ca^{2+}, COD, alkalinity, total hardness and total dissolved solids).

The values of these chemical parameters were relatively lower than that of the standards set by the World Health Organization for drinking-water. This indicates that nutrient losses from tea lands have not posed any significant threat to downstream water quality. However, it was found that the concentration of elements and other parameters increased with the distance downstream, compared to these parameters at the beginning of the streams in the forest areas.

Supportive Projects

1. Adaptive fertilizer trials

(a) Collaboration with Balangoda and Madulsima Plantations, 2002.

The effect of applying fertilizer mixtures with a N to K_2O ratio of 1:1 (U 877) ,and 2:1 (U 709), on soil- and plant-nutrient status, growth and yield in seedling

and VP tea was studied at Kew, Kirkoswald, Mahadowa, Wewessa Telbedde, El Teb, Balangoda, and Cecilton Estates.

Trials laid out at Cecilton and Balangoda Estates were to be abandoned owing to treatment non-compliance. The quantity of N applied over these 12 monthly periods varied from 100 to 270 kg per ha.

The yield data collected over the second 12 month period for Mahadowa, and the third 12 month period for all the other estates, showed no significant differences between the two ratios of N to K_2O.

The activities continue.

(b) Collaboration with the Advisory and Extension Division

Six trials were laid out at the Institute's Advisory and Extension Centres, in order to compare the present and the former fertilizer recommendations, with a view to raising grower confidence.

The yield obtained from the Ratnapura Centre during October 2003 to September 2004 showed no significant difference between the two recommendations.

The activities continue.

(c) Collaboration with Nayabedde Estate: comparison of the present fertilizer recommendation, estate fertilizer practices, and site-specific fertilization.

Three mature-tea fields (two VP fields and one seedling field) were chosen. Each field consisted of nine plots, with 30 plants in each plot, were demarcated in Fields No. 2 B and No. 3 (TRI 2025), Meiyan and Nayabedde Divisions respectively and Field No 1 (seedling), Nayabedde Division.

Three mature-tea fields (two VP fields and one seedling field) were chosen. These were Fields No. 2 B and No. 3 (with TRI 2025) at Meiyan Division, and Nayabedde Division, respectively, and Field No. 1 (with seedling) at Nayabedde Division. .Each field consisted of nine plots, each plot having 30 plants.

Pre-treatment plucking has commenced, and activities continue.

(d) Collaboration with Uvakellie Estate: an observation trial on recovery from S-deficiency following application of different S sources

A mature-tea field, that presented with S-deficiency symptoms, was chosen for investigating recovery following sulphur inputs. Twenty-one plots each consisting of 20 plants (TRI 2025) were demarcated in September. The treatments were micronized sulphur, Kieserite, and Sulphate of Ammonia, at 20 and 40 kg S ha^{-1} yr^{-1}, with a control. These treatments were replicated thrice.

The trial continues.

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

(a) Analytical laboratory service.

Some routine tests, together with the mean, minimum and maximum values obtained, carried out in the Talawakelle and the Walahanduwa laboratories, are indicated in Tables 1 and 2, respectively.

(b) Analytical laboratory accreditation.

The Division's Analytical Laboratory at St Coombs, Talawakelle participated with international laboratory evaluation programmes, 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 for the year. They were subjected to test methods, such as for pH (water, $CaCl_2$ solution), % C (Walkley and Black), E.C., Na, K, Mg and Ca in soil samples, and for Cu, Fe, Mn, Zn, Ca, K, Mg, Na, P, and Cd in plant samples. The results were submitted to the Wageningen University for evaluation.

Evaluation reports, issued by the Wageningen Evaluation Programme for Analytical Laboratories, during 2004, showed that, most of the time, the soil analytical results from the Division's Laboratory at St Coombs, such as for pH (water), pH ($CaCl_2$), pH (KCl), soil organic carbon, and soil nitrogen, were within the satisfactory range of the Z score, that is, + 2 e" Z e" - 2. In addition, the total plant analytical results, such as for Ca, Mg, Cu, K, Mn, Zn, and N, were also within the satisfactory range of the Z score. As before, this evaluation exercise was helpful in improving the Laboratory's performance.

Table 1. **SOIL ANALYSIS**

AER	pH				C %				P ppm				K ppm				Mg ppm			
	Count	Max	Min	Mean	Count	Max	Min	Mean	Count	Max	Min	Mean	Count	Max	Min	Mean	Count	Max	Min	Mean
WU1	537	7.23	3.71	5.12	207	3.82	0.48	2.11	417	607	0.7	34	417	675	8	163	494	444	3	97
WU2	1857	7.84	3.70	4.88	1604	9.07	0.80	2.63	1090	281	0.3	33	1253	800	22	193	1171	551	4	104
WU3	47	5.96	3.38	4.87	47	6.80	0.70	2.98	-	-	-	36	-	-	-	-	-	-	-	-
IU2	426	7.97	3.80	4.79	417	9.51	0.09	2.94	122	193	3.1	47	160	380	27	155	93	525	16	119
IU3	182	6.90	3.97	4.84	125	6.96	1.30	2.31	91	193	3.1	36	141	387	75	175	91	304	16	92
WM1	7	4.83	4.19	4.51	7	2.3	0.89	1.54	7	29	1.0	10	9	117	16	52	9	35	7	14
WM2	4	5.00	4.80	4.88	4	3.83	1.40	2.59	-	-	-	-	-	-	-	-	4	79	56	66
WM3	61	6.09	3.88	4.60	43	2.47	0.33	1.50	-	-	-	-	-	-	-	102	28	192	10	30
IM2	40	5.72	4.16	4.84	50	4.50	0.90	2.65	28	193	1.0	58	22	200	27	90	28	328	14	88
IM3	79	6.66	3.71	4.81	42	3.21	0.73	1.96	-	-	-	-	37	365	51	162	37	265	17	59
WL1	99	5.54	3.60	4.89	92	3.1	0.50	1.40	3	44	18	33	52	242	35	86	51	140	13	53
WL2	162	6.70	3.60	4.90	25	4.4	0.80	1.56	7	52	7	32	7	70	18	100	7	76	22	138
WL4	13	6.02	5.88	4.67	-	-	-	-	12	68	12	30	12	150	64	107	12	175	55	113

WU1 Up country wet zone 1
WU2 Up country wet zone 2
WU3 Up country wet zone 3
IU2 Up country intermediate zone
IU3 Up country intermediate zone 1
WM1 Mid country wet zone 1
WM2 Mid country wet zone 2
WM3 Mid country wet zone 3
IM2 Mid country intermediate zone 2
IM3 Mid country intermediate zone 3
WL1 Low country wet zone 1
WL2 Low country wet zone 2
WL4 Low country wet zone 4

Table 2. **LEAF ANALYSIS**

AER	N%				P%				K%				Mg%			
	Count	Max	Min	Mean	Count	Max	Min	Mean	Count	Max	Min	Mean	Count	Max	Min	Mean
WU1	07	3.20	3.00	1.40	07	0.20	0.10	0.14	07	1.60	1.20	1.40	7	0.28	0.23	0.26
WU2	126	4.16	2.45	3.02	149	0.32	0.12	0.21	152	1.93	0.73	1.26	152	0.36	0.16	0.26
IU2	-	-	-	-	-	-	-	-	36	1.97	1.17	1.46	36	0.29	0.14	0.20
WM1	32	3.6	1.0	2.78	31	2.37	2.37	0.13	31	1.28	0.85	1.07	32	0.27	0.22	0.20
IM2	02	3.40	3.0	3.20	02	3.40	3.00	0.15	02	1.20	1.20	1.20	2	0.25	0.24	0.24

TECHNOLOGY DIVISION

Officer-in-Charge – K. Raveendran

Research Activities (see Corporate Plan)

1. Project A 25.1. Evaluating the use of speed controllers in the trough withering system.

The tea industry adopted the use of the withering fan motor system, coupled with a variable speed drive, recommended by the Institute. The harmonic filters called 'line chokes' available in the market were not up to the standard necessary to completely filter the harmonics ejected by the system. As such, it was decided to develop suitable harmonic filters with the help of the University of Peradeniya. However, the Electrical Engineer who initiated this project had left the Institute and the project could not be continued.

2. Project A 26.1. Developing and evaluating solar energy techniques for tea drying.

The booster fan, which is used to supply heated air from the solar collectors to the air heater–drier system, was under repair. As such, monitoring the performance of the system could not be continued. The official of Messrs. CCC, Ratnapura was contacted to accelerate the repairs.

3. Project A 27. Development of alternative packing materials for bulk tea.

This project was designed to test and recommend newly-produced low-cost packing materials for teas, in order to reduce the cost of tea manufacture. During the period under review, four trials were conducted on paper sacks obtained for testing from Messrs. Ceylon Paper Sacks Limited, Quick Pack (Pvt) Ltd. and UNI PACK Enterprises. The paper sack supplied by Messrs. Ceylon Paper Sacks Limited is of one ply. The moisture-barrier property and the strength of the paper sack were found to be satisfactory. Further, Messrs. Ceylon Paper Sacks Limited and Quick Pack (Pvt) Ltd. were able to produce container-type packing materials during the year. These packing materials are being tested.

4. Project A 28.2. Determining the optimum conditions for producing best grade mix in the Uva during the off-season.

This project was designed to find the suitability of following the orthodox-CTC type of manufacture in the Uva region, and to optimize the grade mix in order to obtain better prices for the teas. The El Teb Estate tea factory was selected as

the location of the experiment, and twenty-one (21) trials were conducted using miniature tea machinery. The made tea produced in these trials were tested and analysed for quality parameters. The experiment continues.

5. Project B 47. Developing tea bulking machines.

A unit was designed to bulk low-country teas in collaboration with the Department of Agricultural Engineering, Faculty of Agriculture, University of Peradeniya. The prototype unit designed was fabricated at the Institute's mechanical workshop at Ratnapura.

The bulker was tested with four different leafy-grade teas, and the results were analysed. The bulking of these teas in the bulker was found to be satisfactory. The unit will be further developed for use in tea factories.

6. Project B 49. Classification of leafy grades of tea by particle-size analysis (ISO 11286).

The results of the test were presented at the Symposium on 'Plantation Crop Research', held on the 8th and 9th of July 2004 at the Bandaranaike Memorial International Conference Hall, Colombo. The details of the experiment was published in the Proceedings of the Symposium. Based on the recommendation adopted last year, more true-to-type samples from St Joachim Estate were analysed, in consultation with Mr W C A De Silva, Chief Executive, Messrs. De Silva, Abeywardena and Peries.

Other Divisional Research

1. ISO 9001: 2000 certification for tea processing at the St Coombs factory.

The quality system being implemented at the factory was ISO 9002. This system has been revised as ISO 9001: 2000. As such, the consultant working on this was requested to submit new manuals to enable the factory staff to follow and implement the ISO 9001: 2000 system at the St Coombs tea factory. The consultant was given the necessary details for this.

2. Development of a sand separator for low-country tea factories.

The performance of the sand separator developed at the Department of Agricultural Engineering, Faculty of Agriculture, University of Peradeniya was found to be satisfactory. However, the unit needed further development for matching the requirements of tea factories. Action was therefore taken to

fabricate a commercial-scale sand separator for the tea industry at the University. Fabrication of the machine is almost completed. This machine will be tested and recommended for use in tea factories.

3. A computer-aided withering system.

A simple system to control the withering process was fabricated and tested at the St Coombs tea factory. The hygrometer of the system was calibrated, and the performance of the system was monitored. The project could not be continued as the engineer involved left the Institute. Later, Mr Hemantha Kumara was assigned to continue with the project. He started the project in November.

Also, an effort was made to develop "Withering Programme" software with the help of an undergraduate from the Faculty of Engineering, University of Peradeniya. As the student was busy with her undergraduate studies, the software could not be developed further.

4. Monitoring the standard of leaf and tea manufacture at the St Coombs factory.

The staff continued to monitor the standard of green tea leaf received at the St Coombs and St Joachim tea factories. Also, the staff supported the St Coombs tea factory to improve tea manufacture and the arrangement of the factory machinery.

5. Miniature tea manufacture

Green tea-leaf samples from Albion Estate, from the Agronomy Division and from the Entomology and Nematology Division (164 samples in total) were manufactured in the Division, and the made teas were chemically analysed and sent to professional tea tasters for evaluation. The results of the evaluations were sent to the respective estate and Divisions.

6. Development of a temperature indicator and alarm unit for the FBD-4.

The unit was designed in the Technology Division, to monitor the weir-end temperature in the Fluidized Bed Drier, in order to control the feeding rate of dhool. Several units were fabricated and installed at a few factories, including the St Coombs tea factory, and the performance of the units were monitored continuously.

The unit was showed to the visitors from the tea industry who attended the Crop Clinics held at Passara, Ratnapura and Talawakelle. Orders for units

were received from 34 visitors. The number of units fabricated and installed at the tea factories of these visitors was nine. Action was taken to fabricate 25 more units to meet the demand.

7. A new and efficient approach for removing surface moisture from tea leaves.

A prototype unit was designed and fabricated in the mechanical workshop, to remove surface moisture from green tea leaves which are brought to the factory on rainy days. The performance of the unit was found to be satisfactory. However, as the speed of the unit was high, the unit failed. Therefore, it was decided to check the performance of the unit at various speeds, with the use of a variable speed drive system, in order to find the optimum speed for the unit.

8. Factors affecting blackness and curliness of low-country teas.

Teas produced in the low country fetch good prices, mainly because of blackness and the twisted appearance of the teas. An experiment was designed by the Biochemistry Division, and conducted in collaboration with the Technology Division. Green-leaf samples were manufactured using pilot-scale tea machinery, and samples of made tea were sent to the Biochemistry Division for further analysis.

9. Blackness improvement in off-grade teas in the low country.

In practice, most factory owners artificially enhance the colour of off-grade teas, such as BM, by adding the extract of refuse tea/drier blow-out. The improvement of blackness in BM grade teas when mixed with the extract of drier blow-out, distilled water and normal tap water, and re-fired, was tested. The samples were analysed for leaf appearance, theaflavin (TF), thearubigin (TR), water extractability, moisture content, total aerobes and total moulds.

The blackness improved in all the treated teas, and it was found to be significant in the case of mixing teas with extract of drier blow-out. There were no significant differences observed in the amount of TF, TR, water extractability, moisture content, total aerobes and total moulds.

10. Effect of the post-harvest damage of green leaves on the quality of made tea

An experiment was conducted to study post-harvest damage to green tea leaves, and its effect on the quality of made tea, at St Coombs Estate. The damage done to green leaves was studied on plucked leaf collected from pluckers' baskets,

plucked leaf from the weighing shed after weighing, transported leaf at the factory receiving-point, and withered leaf from the withering trough.

The study shows that about 73% of the green tea leaves are damaged at the time of discharge of the withered leaves from the troughs, and most of the damage to green leaf takes place during plucking and weighing of plucked leaves in the weighing sheds. A significant drop in the theaflavin content of the made tea was observed owing to the damage mentioned above.

Several measures were taken to minimise the damage to leaves, such as use of new plucking baskets, use of plastic crates for transporting the green leaf from the field to the factory, and careful handling of green leaves at the factory. After practising preventive measures, post-harvest damage to green leaves was reduced to about 15%. A significant improvement in the theaflavin content off the made tea was observed.

11. Automated tea rollers.

The automated system to orthodox rollers which was designed, fabricated and installed by Messrs. Jinasena Engineering Technologies (Pvt) Ltd., and Messrs. Nikini Automation Systems (Pvt), Ltd., at St Joachim Estate, was monitored, and failures observed in operating the system were pointed out to the companies to enable them to improve the system.

12. Performance test on a stainless-steel rotorvane.

The rotorvane, made of stainless steel material, was tested at the St Coombs tea factory. A preliminary trial was conducted to observe the temperature build-up in leaves while they were being rolled in the rotorvane. The temperature build-up was found to be low. The stainless-steel rotorvane will be tested after incorporating two reverse-pitched vanes in order to compare its performance with the conventional rotorvane.

13. Fabrication of suitable trolleys to be used in tea factories to prevent damage to plastic boxes.

Several complaints have been received from overseas customers that teas from Sri Lanka were contaminated with green or blue plastic impurities. The mixing of damaged particles of plastic boxes with teas during tea manufacture at the factories was found to be one of the reasons for this. A trolley was designed and fabricated to minimise damage to plastic boxes.

14. Reduction of the cost of electrical energy in withering, using an improved low-horsepower, motor-driven withering fan.

An improved fan driven by a low-horsepower motor, supplied by RTS Engineers (Pvt) Ltd., was tested for withering green tea leaf in a trough at St Joachim Estate. The performance of the system was found to be satisfactory for green leaf, at a loading rate of up to 2.5 kg/sq. ft. The energy saving was found to be 26.8% in this case. More experiments will be conducted when loading the green leaf at the rate of 3.0 kg/sq. ft.

15. Advisory and other Services

- The staff made 87 advisory visits to factories on various aspects of tea manufacture. The visits to ten Tea Shakthi factories, six JEDB factories, the Kalubowitiyana tea factory and the Deraniyagala tea factory were made on special requests.

- The number of samples received from estate for moisture determination was 784. These were reported with advice for correction of defects wherever necessary.

- The number of made tea samples received for crude fibre-content tests was six.

- The number of moisture meters calibrated was 11.

BIOMETRY UNIT

Research Assistant– T. U. S. Peiris

Research Activities (see Corporate Plan)

1. Project B 12. Optimum Field Plot Techniques.

The slopey nature of tea lands brings problems of greater intricacy to biometrical studies than the demands for accuracy and precision in field experiments. Therefore, an adequate characterization of positional variation in an experimental site is a good guide, and at times even a prerequisite, in choosing a good experimental design with an adequate plot size for maximizing the information obtained for the money spent.

The present study concludes that, irrespective of the slope level, the change of coefficient of variation is not significant above the total of 16 bushes per plot. Therefore, the optimum size of an experimental tea plot can be reasonably recommended as 16-20 bushes per plot, based principally on coefficient of variability, but also on economic considerations. Though the gradients may subsist in both directions, the square-plot shape is not advisable. The shape of the plot should be narrow and long, and the length of the plot should be along the gradient.

2. Project D. Biometry.

(a) The efficiency of pre-information in the calibration of tea experiments.

The study was initiated to determine a suitable covariate, as well as an effective period during which pre-data should be collected.

A pre-measurement period of two months was found to be best for pre-yield, if pre-yield alone is used as covariate. The results showed that the efficiency of dry weight, shoot length and active banji ratio, as calibration measurements to the yield was not significant. Pre-experimental data, of the same yield component, are a successful means of calibration.

The optimum period for pre-data to be used was different for each variable. For the variables, active banji ratio, dry weight and shoot length, the optimum periods are nine, seven and six weeks, respectively.

(b) Re-investigation of the analysis of long-term field experimental data for tea.

Long-term field experiments are preceded by the expenditure of large amounts of resources and manpower by the Institute. The experimenters could be concerned that the fertilizer treatments are not significant, because repeating such experiments is difficult. Therefore, the objective of the present study was to re-investigate a set of such long-term data, and to find out if, and where, things have gone wrong, from the statistical point of view.

The results suggest that blocking by itself was not sufficient to account for variability patterns, or to substantially reduce experimental error, in long-term fertilizer experiments. Both nearest-neighbour and pre-yield like spatial variability analysis methods resulted in a reasonable reduction of CV, around 17.48 % and 18.57 %, compared to the randomized complete block design, owing to the heterogeneity within the blocks in experimental sites.

For all sites, both pre yield and NNT were significant as covariates. Thus, it is reasonable to include both adjustments together in the analysis. With both covariates, CV was reduced by 28.15% on average.

(c) Efficiency of spatial analysis in improving Phase I and Phase II varietal trials, and long-term fertilizer experiments, in tea.

Varietal trials evaluate performance of different genotypes in crop-improvement programmes, and test a large number of selections for possible release as new varieties.

Accurate estimates of varietal means, or varietal differences, require a control of error variation that is left unaccounted for by varietal effects, either by use of appropriate experimental designs or by statistical analysis.

The objective of the present study is to evaluate the efficiency of model-based techniques, like Nearest-Neighbour Adjustments, Least-Square Smoothing and the First-Order Autoregressive Model, that exploit the information on plot positions with design-based control of error variation in removing the field trends.

3. Project B 31. Rainfall variability and its impact on tea in the Uva region of Sri Lanka.

(a) Assessment of variability in amount and distribution of rainfall in the Uva region.

Thirty-eight estates were selected, out of 64, to provide a representation of nearly all the tea-growing agroecological regions in the Badulla district.

The total annual rainfall has not changed from 1983-1992 to 1993-2002. However, the total number of rainy days per year has declined in the majority of the estates in 1993-2002, In comparison to the number of rainy days in 1983-1992. There is evidence for a change in the distribution of rainfall, but not in the amount of rain over the past 20 years.

This study clearly indicates that more than 50% of the annual rainfall is concentrated into a few months of the year, October- January. Only less than 25% of the rainfall is in the five consecutive months from May to September. With respect to the optimum growth of tea, it is clear that there is a large imbalance in distribution of rainfall in the Uva region.

Although the monthly rainfall distribution in all the estates follows the expected pattern according to AER, the 75% expectancy values of monthly rainfall significantly deviates from that of the AER values. Therefore, site-specific analysis of long-term rainfall variability provides valuable guidelines for planning and implementation of management practices for tea lands, in the Uva region.

(b) Assessment of predictability of seasonal rainfall in the Uva region using the El-Nino/Southern Oscillation (ENSO) phenomenon.

A knowledge of the impact of global climatic change on the weather patterns of Sri Lanka is essential, because knowing aspects of global climatic change will facilitate the prediction of unexpected extremes of rain, and of changes in weather patterns. The El Nino/Southern Oscillation (ENSO) is a global climatic change phenomenon that influences the climate of half of the planet. Correlating SOI with rainfall gives potential for long-term predictions of rainfall fluctuations in a region.

Monthly rainfall data for 73 successive years (1930-2002), from Welimada Estate, were used for this study.

It was not possible, using the lag correlation analysis for lag periods of 0-10 (monthly SOI and rainfall), to detect a pattern of correlation. Therefore this cannot be used for prediction purposes.

The influence of ENSO episodes on seasonal rainfall was also tested. The number of years was significant only for the SIM and the NEM seasons. It seems that El Nino does not have any effect on the FIM and the SWM seasons.

The significance of the relationship, between the occurrence of El Nino events and SIM rainfall, suggests that the increased rainfall during the SIM in the El Nino years, at Welimada, is not due to chance but due probably to changes in

general circulation. It is unlikely that El Nino would cause drought conditions during the SIM season at Welimada, because in none of the El Nino years has rainfall below 1 (standardized value) been received.

It is important to note that rainfall, during the NEM, also showed a significant link with the occurrence of El Nino events at Welimada Estate.

This study was completed for the one estate, and is continuing for other selected estates in the Uva region.

(c) Development of a Drought Index for obviating the problems involved in prediction of crop using rainfall.

Any pragmatic crop planning needs a thorough understanding of the climatic parameters, particularly the variability in the amount and distribution of rainfall. Such studies are helpful in identifying risk levels, for various planning activities, in the management of a tree crop.

The results of part (a) of the present project confirm that the total amount of rainfall has not been affected over the last 20 years, although the distribution of rainfall has been severely affected. As a result, the prospects for forecasting crop using only the amount of rainfall are not good.

Therefore, this project is focusing on a new approach which promises to obviate the problems outlined above. Instead of the amount of rainfall, a Drought Index, based on the distribution of rainfall, is in the process of being developed.

This study continues.

(d) Modeling daily sunshine hours and temperature: a multivariate stochastic approach.

The objective of this study is to assess the predictability of variation in daily sunshine hours, and the minimum, maximum and diurnal variation, using a multivariate stochastic approach.

This study continues.

4. Project. A risk assessment model for major diseases in tea.

Tea Blister Blight.

Epidemics of Tea Blister Blight (TBB) result in severe losses through direct attack on harvestable shoots. TBB causes a reduction in important precursors

that determine the final quality of black tea. Though chemicals are normally applied on a regular schedule throughout the blister season, rising costs of control using chemicals, and increased stringency in food regulations, are forcing growers to consider more rational approaches using advanced technology in disease management, with the final objective of reduced dependency on chemical control.

Therefore, this study aims at identifying the best combinations of weather variables associated with the development of epidemics, using hourly records of temperature, relative humidity, the amount, intensity and duration of precipitation, the direction and velocity of wind, and solar radiation, in order to develop an advanced model to directly assess the risk of TBB. Further, the study aims at providing information important to disease management, and at developing computer software of the model for easy access and decision making by end-users.

This project is a collaborative project with the Plant Pathology Division and the Faculty of Agriculture, University of Peradeniya.

Designing Field Experiments, and Data Analysis and Interpretation.

Based on requests from other Divisions, advice was given on efficient protocols for experiments and surveys, and on sound statistical methods for data analysis and for drawing statistical inferences.

AGRICULTURAL ECONOMICS DIVISION

Head – J. A. A. M. Jayakody

Research Activities (see Corporate Plan)

1. Thrust A 31. Identification of appropriate labour-use patterns to improve profitability in tea plantations

Project A 31.3. Identifying the factors that influence the out-migration of workers in the low country (Ratnapura, Kalutara and Kegalle Districts).

This study was completed.

Findings

A shortage of workers in tea plantations occur owing to two main reasons.

(a) A declining trend in young people joining the estate workforce arising from:
changing social attitudes;
availability of other job opportunities; and
better education facilities available in the plantation sector.

(b) Higher absenteeism among estate workers arising from:
the workers' interest in having daily cash wages;
their trying to earn a higher daily income; and
flexible working hours outside the estates.

Suggestions to overcome this problem were given in three categories, namely short-term, medium-term and long-term strategies.

2. Project A 31. Identifying appropriate labour-use patterns to improve profitalbility in tea plantations – up-country.

Objectives

To identify actual labour requirements and labour availability, in order to identify labour excess and deficit time periods for better planning, and to minimize the adverse effect of labour shortage on estate profitability.

Labour profiles on a monthly basis have been developed, with regard to elevation, tea type, yield category and cropping calendar for the up-country. Similar estimations for other elevational categories are in progress.

3. Thrust A 35. Development of an appropriate financial support system for soil conservation in tea lands.

Data collection was completed in the smallholder sector, in the private-management estates, and in a part of the sample of the JEDB/SLSPC estates in the mid-country. Data analysis was undertaken to develop an Index for identifying the soil conservation efforts of tea growers.

Preliminary results show that the actual effort of soil conservation, compared to the expected levels, is below 50% in all management categories: the smallholder sector 43.3%; PMC-managed plantations 38%; and the JEDB/SLSPC-managed plantations 28.8%.

Further analysis will be undertaken to conform these results.

4. Thrust A 36. Assessment of the impact of an adaptation to climate change in the plantation sector in Sri Lanka.

The Growth Accounting approach was used to assess the socio-economic impact of climate change in the tea sector. Productivity Growth of the tea sector during the base period (1960 – 1990) was compared with the period after 1990. The results show that the management changes that took place in the tea sector have contributed more to the growth of productivity in the sector.

The first draft of a paper on "Vulnerability of tea sector to future climate change" was completed.

5. D 35. Tea sector studies

A cost-benefit evaluation of the following research recommendations were completed.

(a) Harvesting methods
(b) Irrigation
(c) Mechanical Pruning

6. D 35.2. Economic impact of green-leaf transportation on leaf quality.

Damage caused to green leaves during transportation has been identified as one of the major factors leading to poor quality of made tea. An assessment was done on an improved system of green-leaf transportation, being used in one of the estates in the medium western region. An article is ready for publication based on the results of the analysis.

7. Assessment of financial viability of estates and tea fields.

Total variable and fixed costs are compared with revenue in order to determine the level of production at which the business makes neither a profit nor a loss (the "break-even point"). Break-even yields for the estate and divisions were calculated. Based on the break-even yield, financial viability of the fields could be identified.

8. Tea information

National and international tea-data collection and compilation is continuing.

9. D 35.3. Project monitoring activities

The INFORM database for the year 2004 was completed and submitted to the national INFORM coordinator, Council for Agricultural Research Policy.

Questionnaires were distributed for the collecting of information required by the Division for the year 2005 INFORM database.

10. Restructuring of the Tea Research Institute

The Agricultural Economics Division coordinated the initial discussions with the staff and the ADB consultants, and also prepared reports of comments and suggestions from the staff to the consultants.

ADVISORY AND EXTENSION SERVICES DIVISION

Head - B.A.D. Samansiri

1. Routine Advisory and Extension Activities

Table 1. Summary of the Routine Advisory and Extension Activities.

2. Special Advisory and Extension Activities

The following special activities were undertaken during the year.

2.1. 'Crop Clinics'

'Crop Clinics' were organized with the participation of the Institute's senior scientists and advisory officers. The intention is to achieve several objectives within a relatively short period; to provide remedies to problems in tea cultivation and processing; and to assist estate staff in enhancing their knowledge on various aspects of cultivation and processing, so that they may become familiar with the problems on the ground, and be able to focus on areas which need more attention.

The dates of the clinics were: 01 October (the Uva region), 16 November (low-country regions), and 08th and 09th December (up-country regions).

2.2. E & E Forum (in Sinhala) for the Small Holdings sector

The Extension and Experiment forum for the small holdings sector is for the purpose of having direct dialogues between scientists and the representatives of the tea small holdings sector. Two sessions were organized during 2004.

2.3 Regional Technical and Extension Forum meetings (06)

The Regional Technical and Extension Forum, which has a wide representation from the small holdings sector, and the regional-level extension workers of the Tea Small Holding Development Authority (TSHDA), was initiated to achieve the following three objectives.

- to identify the research needs of small holders in the region;
- to disseminate the latest research findings; and
- to update the tea knowledge of Extension Officers of the TSHDA.

The committees include TSHDA staff, TRI staff and officials of Tea Smallholder Societies. The Regional Manager of TSHDA chairs the committee.

The inaugural Regional Technical and Extension Forum for the small holder sector in Ratnapura region was held on 29.04.04, and the second forum for the same sector in Kalutara and Kegalle regions on 13.05.04.

Meetings in Talawakelle (the Nuwara Eliya region), Deniyaya (the Matara region), Kandy (the Kandy region), and Kottawa (the Galle region), were held with the participation of TRI scientists, extension staff, TSHDA staff, and representatives of the Tea Smallholder Society in the region.

2.4 The ADB Mother Bush Project

Mr S.T. Yatawatta, Senior Advisory Officer, continued to serve as the coordinator of the Mother Bush Project activities.

The Mother Bush Project, which was designed to multiply new tea cultivars at various locations, comes under the purview of the TRI and the TSHDA in the tea-growing areas. The TRI is responsible for the performance of each site. Performance is monitored by the Mother Bush Project Coordinator (from the TRI), with the assistance of other field staff.

The extent of the mother bushes under the different organizations are: TRI 55.56 ha; TSHDA 18.98 ha; private tea estates 4.00 ha; and smallholder lands 4.50 ha (Total 83.04 ha).

Mother bush sites at the TRI and their extents

St. Coombs Estate	-	13.00 ha.
St Joachim Estate	-	30.40 ha.
TRI Hantane	-	04.00 ha.
TRI Kottawa	-	05.00 ha.
TRI Deniyaya	-	01.00 ha.
TRI Passara	-	02.00 ha.

3. Extension Research and Survey Activities

3.1 Agricultural Profile of the Corporate Tea Sector and Individual RPCs

Agricultural Profile of the Corporate Tea Sector is a compilation of a mass of valuable data, collected by the staff of the Advisory and Extension Service, on the agricultural status of 304 tea plantations, managed by 20 Regional Plantation Companies (RPC). Twenty individual RPC reports and CDs were also produced along with this document, on the same subject.

3.2 Adoption of the TRI Fertilizer Recommendations in Corporate Sector Tea Plantations

This study aims to find out the current practices in the corporate sector with regard to fertilizer application, and in particular to find out the factors, affecting the adoption of TRI fertilizer recommendations, in the corporate sector.

Findings and Recommendations

Fertilizer usage in the corporate sector:

- The majority (95%) of plantations were applying inorganic fertilizer, whereas regular organic fertilizer application is comparatively low (7.9%).

- T 65 was the main nursery mixture (87.3%).

- There were 19 different mixtures for mature tea. Most of the plantations were using the former TRI mixture, especially the U 709 mixture (68%). The other major TRI mixtures, recommended formerly, were U 877, U 270 and U 300. These mixtures were used for both VP fields and seedling fields. Only 7.94% were following the new TRI mature-tea mixtures. A considerable number (23.8%) was using their own company mixtures.

- More than half of the estates (57.2%) had high adoption of the young-tea fertilizer recommendation. About 36.5 per cent had medium adoption of the young-tea mixtures. There was a negligible number of low adopters.

- About 50 percent were medium adopters of the new mature-tea fertilizers. There were 41.3 per cent of low adopters. Only 7.9 percent had a high level of adoption of the new recommendations.

Reasons for poor adoption of the new fertilizer recommendations:

- Company policy, regarding the fertilizer application, was the major reason for 87.3% of the estates to deviate from application of the new mature-tea mixtures.

- The second factor influencing deviation from the new mixtures was low practical feasibility, followed by low economic feasibility and low technical feasibility.

Attitude of planters towards the new fertilizer mixtures:

- Many of the respondents (92%) had a negative attitude towards the practicality of the new fertilizer mixtures.

- On the other hand, there were positive attitudes towards the economic and technical aspects of the new fertilizer mixtures.

3.3 Factors affecting the Spread of Horse-Hair Blight (*Marasmius equicrinis)* Disease in Tea Small Holdings in the Low Country.

A study was carried out by a student of the Agricultural Extension Division, University of Peradeniya, in collaboration with the advisory staff of the Institute's Low Country Station at Ratnapura, for identifying the factors influencing the spreading of Horse-Hair Blight (HHB) disease, caused by *Marasmius equicrinis*, in small holders' tea lands in the Low Country. The field survey, and the field assessment, were conducted among 104 small holders in the Nivitigale and the Elapathe tea inspector ranges. Field assessments were conducted to determine the severity of the HHB problem in each field.

3.4 Survey on Fertilizer Usage Pattern.

A survey on the fertilizer usage pattern of smallholdings in the Nivithigala region was conducted with the assistance of a diploma student from Aquinas College, Colombo.

The results of the survey revealed that the tea small holders have deviated from TRI recommendations owing to lack of proper knowledge, unavailability of different fertilizer mixtures at the proper time, or in remote areas, financial difficulties, etc.

3.5 COP Survey in Smallholder Sector

The survey to assess the cost of production of green leaf in the small holdings, in the Ratnapura, Kegalle and Kalutara districts, was begun in mid-December. Pre-testing of questionnaires was done with selected small holders outside the study area. The survey is in progress.

4. Collaborative Research Activities

4.1. In the Ratnapura Region

The following studies are being undertaken.

- **A comparative study on the effectiveness of different control measures for Horse-Hair Blight (HHB).**

- **Mapping and Assessment of Land-Use Patterns in the Ratnapura District.**

The advisory officers coordinated data collection regarding yield, rainfall, soil, and other general information from tea estates, and the selection of tea estates for this project.

- **Cultivars' Popularization Programme.**

The establishment of Phase III trials for the evaluation of growth performance of 5000 series cultivars in the Balangoda region was completed.

The monitoring of the cultivars popularizing block, consisting of 18 cultivars (3000 and 4000 series) in two replicates, established in the Millakanda Estate, Bulathsinhala, was continued.

The Advisory staff in Ratnapura station involved in the following research / survey projects, with the collaboration of Physiology, Entomolgy and Agricultural Economics Division. The information collected for these studies are being analysed.

- **Impact of Global Climate Change on the Productivity of Tea Plantations**

Advisory staff assisted the Crop-Modelling Programme of the 'Assessment of Impact and Adaptation to Climate Change' project being conducted by the Agronomy and the Economics Divisions.

- **A study on the root-distribution pattern of mature VP and seedling teas, under different field conditions, conducted at Hapugastenna Estate.**

- **Assessment and Monitoring of Nematode Infestation in the Babarabotuwa Region.**

- **The identification of factors that contribute to labour migration from the plantation sector in the Ratnapura, Kalutara and Kegalle districts.**

4.2. In the Deniyaya Region

The following studies are being undertaken.

4.2.1. LVP 74 Phase II.

This trial, which commenced in August 1997, has completed nearly two cycles. Various assessments are being continued by the Plant Breeding, Entomology, and Advisory staff.

Based on performances, 13 cultivars have been selected and planted in the Deniyaya estate (WM1a), in a Phase III trial, in order to evaluate their regional suitability. Preliminary arrangements have been completed to commence the same trails at Indola Estate (WL2a) and Kiruwanaganga Estate (WL2a).

The Advisory staff in Deniyaya station was involved in the following projects, with the relevant research divisions.

4.2.2. Development of an Economically-Viable System to eliminate or reduce the Soil Rehabilitation Period in the Low Country.

4.2.3. The Effect of Different Rates of N and K, and Mg, on Soil- and Plant-Nutrient Status, and Yield.

4.2.4. The Effect of Application of Different Levels of N with Different Levels of Compost Manure, on Growth, Soil- and Plant-Nutrient Status and Yield.

4.2.5. The Evaluation of Crop Response for Different Proportions of SA and Urea.

4.2.6. The Estimation of Crop Response to Micro Nutrients at Different Levels.

4.3. In the Passara Region

The Advisory staff in Passara station was involved with the following relevant research divisions.

- **Evaluation of the Performance, under Uva Conditions, of Polyclonal and Biclonal Seedlings from Salawa, Kiriporuwa, Halpe, Reucastle and Rambukkanda Estates, planted at the Passara Station.**
- **Monitoring of the Clonal Observation Trials UVP 9 and 10 (2/VP37/ Uva), and Seed Stock Evaluation.**
- **Monitoring of a Drip Irrigation Trial.**
- **Evaluation of 30 and 40 Series Cultivars on Tolerance to Nematodes.**
- **Field Trial on Application of High Potash.**
- **The Establishment of Germplasm.**
- **A Study of Root Depth in Seedling Tea.**
- **A UVP 9 Clonal Trial (Phase III).**

4.4. In the Kandy Region.

The Advisory staff in Hantana station was involved with the following relevant research divisions.

- **A Survey on the Present Status of Soil-Conservation Practices in Mid-Country Tea Lands.**
- **The Establishment of Clonal Mother Bushes of 3000 and 4000 Series Cultivars in the Mid-Country.**
- **Tea Nursery Demonstration.**

4.5. In the Galle Region.

- **Collaborative Trials in Observation Blocks at the Kottawa Centre.**

The following trials are being conducted in observation blocks maintained at the Kottawa Centre.

- Shear plucking.
- Intercropping. 4000 series cultivars in observation block with 200 plants of cinnamon in the boundaries.
- Growth performance of *Gravellia.*
- Growth performance of young tea.
- Lopping high shade, *Albizzia.*
- Seed garden trial in Field No. 07.
- Fertilizer demonstration trial in Field No. 04, VP/LC 880 and U 709.

5. Exhibitions

The advisory staff participated in three exhibitions, and at one publication stall, at the request of the Ministry of Plantation Industries.

The exhibitions were "Wevili Udanaya" at Bopitiya, "Nilwala Harasara" at Morawaka Maha Vidyalaya, and the one-day Industrial Exhibition at the Galle Town Hall.

The publication stall was set up at the Gannoruwa In-Service Centre, to sell TRI publications at a meeting held for tea smallholders.

6. Special Problems.

6.1. Sulphur-Deficiency Symptoms.

Sulphur-deficiency symptoms were observed in a few company estates in the Madulsima area. After investigation, it was found that the soil- and the leaf-sulphur levels were very low in these locations. Since similar symptoms were found in other locations in the Uva, more attention is warranted to get to the root of the problem.

6.2. The Deniyaya Ant.

A small holding in Kahataruppa was found to be affected by the Deniyaya ant (*Acropyga acutiventris*).

6.3. Drought in the Uva.

The tea plantations in the Uva experienced the worse drought, next to that of 1992, in May-September of this year, and as a result there was a drastic decline in crop during the period.

6.4. The SHB Problem in Mayfield Estate.

Reports of the incidence of shot-hole borer, in the up-country regions, have been increasing over the last five to eight years. Most of the estates in the Kotagala, Pundaluoya, Lower Dickoya, and Maskeliya regions have reported shot-hole borer in their new clearings, specially in cultivars such as DT1 and TRI 2025. This condition was reported to the subject-matter specialists for the drawing up of an effective strategy to arrest further damage.

6.5. The Deniyaya Problem

There has been a yield decline, and in some instances casualties have been observed in the Deniyaya region, since the mid-1990s. The affected bushes are mostly high-yielding VP cultivars such as TRI 2026 and TRI 2025. The investigation of this problem is in progress.

6.6. Death of some Tea Cultivars in the Up-Country Regions.

Several complaints have been received from estates in the up-country regions, that high-yielding tea cultivars such as TRI 2026, HS 10A, WY, and K145, are dying in the absence of any known pest or pathology. This matter was referred to the relevant scientists for further investigation.

6.7. Die Back of Tea Shoots in Mother Bushes of the Cultivar TRI 4053.

Die back of shoots of the cultivar TRI 4053, in the mother bush areas, was observed in March 2004. A team of senior scientists and advisory staff made a field investigation to identify the causes for this phenomenon.

7. Extension Activities

7.1. Tea Science and Exhibition Park

The establishment of a Tea Science and Exhibition Park was initiated by the Advisory Division at the Institute's Main Centre at Talawakelle. The construction work for a pavilion for visitors was started.

7.2. Tea Museum

The Institute's section at the Ceylon Tea Museum was constructed, and the interior arrangements and the setting-up of exhibits are in progress.

7.3 Seminars, Training Programmes, Field Days, and Educational Programmes

Details are given in Table 1.

7.4. Activities of Regional Scientific Committee VI

The Institute's representative on RSC VI continued to coordinate all the scientific and estate-sector affairs in the Ratnapura, Kalutara and Kegalle Regions.

An RSC seminar was conducted at Koggala for planters from Galle and Matara.

7.5. Mass Media Activities

A video film, 'Tea Production and Processing in Sri Lanka', was produced, with funding from the SAARC Agricultural Information Centre, Bangladesh.

A video programme on Tea Manufacture was initiated, and the filming completed.

Three CD programmes on 'Rainfall and Cropping Patterns' in the Tea Inspector ranges in the Ratnapura, Kalutara and Kegalle districts were produced.

Twelve display or sign boards, with technical messages highlighting key cultural operations required for the improvement of productivity of tea lands in the low country, were produced.

7.7. Adaptive Trials

The following adaptive trails are in progress.

The new TRI fertilizer mixtures (VP/UM 910, VP/Uva 945 & VP/Low 880) were compared with the U 709 mixtures, in St Coombs and at the Ratnapura, Passara, Hantana and Kottawa. Centres. The Soil and Plant Nutrition, and Advisory, Divisions are involved in the trial.

Preliminary site selections were completed for establishing an irrigation demonstration trial in the tea-growing areas of the Hambantota district.

Demonstration plots on shear- and hand-plucking, together with the use of different fertilizer mixtures (U 709, Uva 945 and T 1130), were started in Field No. 01 of the Passara Centre.

Commercial Nursery Inseption

District	No. of Nurseries Inspected	Total Plants available at the CN-6 inspection	Total good plants recommended for selling	% of Good plants 2004
Ratnapura	5	93,704	72,275	77%
	6	143,170	20,944	15%
Kalutara	18	550,403	198,223	36%
Kegalle	5	28,789	16,865	59%
Badulla	166	2,426,840	2,032,305	84%
Monaragala	5	44,600	24,990	56%
Kandy	52			
Galle	50	240,530	108,130	45%
Matara	30	135,725	32,575	24%

8. Audio-Visual and Photography Unit

Officer-in-charge: Mr. V. S. Sithakaran

The photographs and prints produced in the year were:

	Number
Colour prints (official)	3772
Digital photographs	1565
Colour and B/W photographs (for staff)	124
Colour prints (for staff)	203

The following video programmes were issued to tea growers:

	VHS	VCDs	Films
Tea Small Holders	02	11	51
Trainees	04	11	41
Tea Plantations	01	11	25
Universities/Institutes	03	08	25
Exhibition (Deniyaya)	-	13	26
Crop Clinics (three)	-	134	282
TRI Divisions	02	04	26
TRI Centres	03	28	81
Others	05	50	143

9. IT Unit

Officer–in-charge: Mr B.A.D. Samansiri

The activities of the unit were managed by Mr Nalin Nishantha.

The major problems encountered during the year included the frequent incidences of computer virus, breakdown of the network owing to sudden power fluctuations, lightning, etc. All the problems were handled with the assistance of E-Wis Limited.

The Institute's web page was hosted on the TRI server. The web address is www.tri.ac.lk.

10. Other Involvements of the Division Staff

In addition to his duties as Head of the Division, Mr B.A.D. Samansiri, served as the Convener/Secretary of the Consultative Committee on Advisory Services and Estates of the Tea Research Board; as Coordinator of TRI media activities for the Ministry of Plantation Industries; and as a Member of the Editorial Board of the *Wevili Udana* Newsletter of the Ministry of Plantation Industries.

Mr S.T. Yatawatta, Senior Advisory Officer, served as the Coordinator of the ADB Mother Bush Project, and as the Convenor/Secretary both of the Advisory Officers Forum, and of the E & E Forum for the small holder sector.

Table I : *Summary of Advisory and Extension Activities - 2004*

No.	Activity	T'kelle	R'pura	Hantane	Passara	Kottawa	Deniyaya	Total
1.	**Visits**	–	–	–	–	–	–	–
1.1	On-Call Advisory Visits- Estate	111	37	52	34	4	9	247
1.2	On-Call Advisory Visits- TSHDA	22	40	50	6	16	8	142
1.3	Routine Advisory Visits	20	1	–	–	3	17	41
1.4	Extensions Visits	25	66	16	6	4	33	150
	Total Advisory & Extension Visits	**178**	**144**	**118**	**46**	**27**	**67**	**580**
1.5	Collaborative research visits	14	23	5	13	3	10	68
1.6	Familiarization Visits	2	–	–	1	2	21	26
1.7	Social Visits	–	–	–	9	38	1	48
	Total Other Visits	**16**	**23**	**5**	**23**	**43**	**32**	**142**
	Total Visits Made	***194***	***167***	***123***	***69***	***70***	***99***	***722***
2	**Individual Contacts**							
2.1	Office Calls	157	210	138	382	222	–	1109
2.2	Inquiries through Telephone	649	415	239	186	204	131	1824
2.3	Informal contacts		113	111	107	81	–	412
	Total	**806**	**738**	**488**	**675**	**507**	**131**	**3345**
3.	**Advisory & Extension correspondence**							
3.1	Advisory Documents	773	276	134	114	47	59	1403
3.2	Extension /Services report	189	136	52	–	124	333	834
3.3	HRD Documents	–	38	–	–	–	–	38
3.4	Publications	–	64	–	–	–	–	64
3.5	Administrative matters	941	51	–	538	76	351	1957
	Total	***1903***	***565***	***186***	***652***	***247***	***743***	***4296***
4	**Training Programme**							
4.1	Familiarization Programme	–	9	–	3	–	–	12
4.2	Familiarization Programmes - Estate	3	4	5	–	–	4	16
4.3	Familiriazation programmes - TSHDA	4	5	4	–	–	12	25
4.4	Skill Training Programme	11	–	–	1	10	2	24
4.5	Educational Programme	6	10	2	1	7	2	28
4.6	Client Originated Training Programme	5	3	–	2	8	6	24
	Total	***29***	***31***	***11***	***7***	***25***	***26***	***129***
5	**Meetings**							
5.1	Internal Meeting	50	19	–	11	18	22	120
5.2	Outside Meeting	12	19	–	24	18	6	79
	Total	***62***	***38***	–	***35***	***36***	***28***	***199***
6	**Commercial Nursery Inspections**	**0**	**34**	**52**	**171**	**86**	**30**	**373**
7	**Exhibitions**	**2**	–	**2**	–	**1**	**1**	**6**

Table I : *Summary of Advisory and Extension Activities - 2004 (contd.)*

No.	Activity	T'kelle	R'pura	Hantane	Passara	Kottawa	Deniyaya	Total
8	**Visitors**							
8.1	Tea Growers	235	308	–	134	670	504	1851
8.2	Higher Educational students	402	101	–	1	32	–	536
8.3	School Students	4092	39	–	5	87	151	4374
8.4	Foreign Personnel	237	10	–	31	4	–	282
8.5	General visitors	1223	171		85	182	50	1711
	Total	***6189***	***629***	***410***	***256***	***975***	***705***	***8754***
9	**Group Extension Techniques**							
9.1	Method Demonstration	–	8	–	–	–	4	12
9.2	Result Demonstration	–	3	–	–	13	–	16
9.3	Contents	–	–	–	–	–	–	–
9.4	Field Trips	–	–	–	–	–	–	–
9.5	Field Days	10	2	–	1	7	–	20
9.6	Crop Clinic attended	3			2	2	1	8
9.7	Lecture/Panel/Symposium/ Seminar	13	10	–	4	18	6	51
9.8	Workshop	–	10	–	2	–	1	13
9.9	Informal Discussions	–	–		–	19	80	99
	Total	***26***	***33***	***0***	***9***	***59***	***92***	***219***
10	**Mass Media Extension Techniques**							
10.1	News paper articles	4	7	–	0	–	1	12
10.2	Wall Newspapers	–	–	–	0	–	–	–
10.3	News Letters	1	–	–	0	–	–	1
10.4	Folders/Leaflets/Pamphlets	1	2	–	0	2	4	9
10.5	Radio Programme	–	–	–	0	–	–	–
10.6	TV Programme	–	–	–	0	6	–	6
10.7	Video Programme	–	5	–	0	17	–	22
10.8	Posters/Wall Charts	36	1	–	0	–	–	37
	Total	***42***	***15***	***0***	***0***	***25***	***5***	***87***
11	**Soil Testing**							
11.1	pH	–	633	506	886	–	–	2025
11.2	Organic Carbon Content	–	–		669	–	–	669
11.3	Nematode	–	–		25	–	–	25
	Total	**–**	**633**	**506**	**1580**	**–**	**–**	**2719**
12	**Publication distributed**							
12.1	Free Issuing	3601	1335	116	407	372	751	6582
12.2	Priced Publication	–	2100		85	716	777	3678
	Total	**3601**	**3435**	**116**	**492**	**1088**	**1528**	**10260**

MID-COUNTRY RESEARCH, ADVISORY AND EXTENSION CENTRE, KANDY

Officer-in-Charge – P. B. Ekanayake

1. General

There are 14 technical and 13 administration staff at the Centre. They conducted research in agronomy, entomology, plant-breeding, and soils- and plant-nutrition. The technical staff assist the Advisory and Extension Division in transferring technology to the plantation and small holder sectors. Other research activities in the mid-country are carried out by staff from the main station at Talawakelle.

2. Hectarage as at 31st December 2003

Type of land use	ha
Seedling tea	2.00
VP tea (mature)	5.50
VP tea (young)	3.50
Mother bushes	2.75
Nursery tea	0.20
Under mana grass	0.50
Fruit trees	0.40
Coconut	0.81
Forestry	1.20
Marshy land	0.62
Buildings, gardens, paths and roads	5.77
Total	23.00

3. Crop

Green leaf harvested (kg)

Month	Crop harvested	Crop sold	Rate paid/kg Rs.cts	Total Rs.cts
January	1537	1537	15.51	23838.87
February	443	443	15.51	6870.93
March	916	916	16.88	15462.08
April	3978	3978	16.88	67148.64
May	1479	1479	18.23	26962.17
June	1935	1935	20.58	39822.30
July	2383	2383	19.00	45277.00
August	1966	1966	19.00	37354.00
September	2102	2102	19.00	39938.00
October	2549	2549	20.00	50980.00
November	2533	2533	20.00	46660.00
December	2248	2248	0.00	44960.00
Total		**24069**	**200.68**	**445,273.99**

4. Income

No. of cuttings sold		11,021,000
Income from sale of cuttings	Rs.	293,975.00
No. of VP plants sold		4,500
Income from sale of plants	Rs.	33,750.00
Total crop harvested (kg)		24,069
Income from sale of green leaf	Rs.	445,273.99
Guest-house occupation charges	Rs.	30,750.00
Soil testing (for pH) charges	Rs.	14,410.00
Sale of TRI publications	Rs.	17,220.00
Miscellaneous	Rs.	250.00
Total income:	**Rs**	**835,828.99**

5. Special Scientific Visitors

1. Mr David Scott, Syngenta, CIC, UK, in January
2. Mr David Berry, Syngenta, CIC, UK, in January
3. Mr V.S. Pandit, CIC Colombo, in January
4. Ms Ann E. Kingsolver, University of Peradeniya, in March
5. Ms Nshadi Somaratne in May
6. Dr W.M.A.D.B. Wickremasinghe, Research Station, Department of Agriculture, Batalagoda, in June
7. Mr K.M.A Kendrargama, NRMC, Peradeniya, in June
8. Mr Nalaka Kottahachchi, Baur & Co., in June
9. Mr Ananada Gunapal, in July
10. Mr Josdis Abatenner Raiser, Germany, in September
11. Mr Anil Boange, JEDB, in October
12. Mr K.M Opananda in November
13. Mr Padeep Kumar Yadav, Nepal Agricultural Research Council, in December

6. Experiments conducted by the Research Divisions

The results, and other details of the experiments, will be reported under the relevant Divisions.

Agronomy Division

1. Effect of intercropping tea and coconut on productivity and land utilization – Citrus Estate, Poddala and Mawarala Estates.

2. Effect of intercropping tea and minor export crops (pepper and coffee) in the mid-country – Sunwin Hill Estate and New Peacock Estate.

3. Effect of Intercropping tea and minor export crops (vanilla) in the mid-country – Surya Agro Estate, Galaha.

3. Effect of alternative methods of soil-reconditioning in comparison to traditional methods) on the establishment and yield of tea – Ratwatte Estate, Ukuwela.

4. Effect of vermi-compost on growth and yield of tea – Stelenberg Estate, Pupuressa.

5 Effect of surface application and incorporation of mulch materials on soil properties and growth of tea.

6. Comparison of manual and shear-harvesting of tea – demonstration block.

7. Demonstration of SALT hedgerows.

Entomology Division

1 Screening of insecticides to manage scavenging termites.

2. Screening of insecticides for the control of Shot-Hole Borer, Levallon Estate, Pupuressa.

3. Screening of biological control agents for reducing Shot-Hole Borer damage in tea.

4. Testing of suitable dosages of the chemical, "Regent" in controlling Shot-Hole Borer.

5. Effect of the entomopathogenic fungus, *Beauveria bassiana* on Shot-Hole Borer.

6. Survey of Shot-Hole Borer incidence in tea estates in the mid-country.

7. Assessment of Shot-Hole Borer incidence in seed stocks.

Plant Breeding Division

1. Evaluation of cultivars for the mid-country.

2. Development of seed varieties for the mid-country.

3. Controlled hybridization programme.

4. Use of nuclear and related techniques to improve tea cultivars.

Soils and Plant Nutrition Division

1. Estimating crop response to micro nutrients (Zn, B, Mn, etc.) at regional level – two experiments, at Green Wood and Madulkele Estates.

2. Estimating crop response to macro nutrients (N, K, Mg, etc.) at regional level – two experiments at Rangala and Midland Estates.

3. Farm-centered research on organic tea: soil fertility studies (collaborative research project with Gami Seva Sevana, Galaha).

4. Development of a fertilizer/dolomite applicator for improving broadcasting efficacy and overcoming the labour shortage.

5. Evaluating and improving the efficiency of fertilizer applicators.

6. Developing regional analytical laboratories for soil, plant and fertilizer analysis.

7. Providing analytical laboratory services at the Mid-Country Station.

7. New Constructions

Completed laying tracts with rubble-paving and premix for the road leading from the Office to the Laboratory Complex and Auditorium.

Completed fixing doors to the garage.

Completed construction of Nursery Shed funded by the ADB Clonal Mother Bush Project.

Completed partitioning a room in the Tea Museum for TRI exhibits.

8. Maintenance of Buildings, Roads and Water Supply

Completed painting roofs in A 1 Quarters, Circuit Bungalow, Stores, Office and Advisory Building, and Security guardroom.

Fixing of name-boards for the fields planted under the ADB Clonal Mother Project was completed.

Completed painting of D3 quarters.

9. Transport

All vehicles had undergone various types of minor repairs during the year.

LOW COUNTRY RESEARCH, ADVISORY AND EXTENSION CENTRE, RATNAPURA

Officer-in-Charge – Dr M.A. Wijeratne

1. General

There are 24 technical and 16 administration staff assigned to the Low Country Centre, Ratnapura. The technical staff of the different Research Divisions conducted experiments in Agronomy, Entomology, Plant Breeding and Technology, while the staff in the Advisory and Extension Division carried out advisory and extension activities for the plantation sector and for tea small holders in the low country, with the assistance of technical staff. In addition, the Low Country Centre staff engaged in training activities for the Institute, and acted as resource personnel for workshops, seminars and training programmes organized by various institutes and organizations.

2. Research, Advisory and Extension Programmes

Research work in the Agronomy, Plant Breeding, Entomology and Technology Divisions are in progress. There are more than 62 long-term experiments managed by the Low Country Centre. In addition, the Plant Breeding Division maintained 13 seed gardens in the low-country tea-growing districts. A "Crop Clinic" was held for the benefit of tea growers and factory staff of the Ratnapura, Kegalle and Kalutara regions. There were more than 250 participants, and the Clinic was able to provide solutions and remedies to tea-related problems which would enhance the productivity and profitability of tea plantations. In addition to the Crop Clinic, a large number of advisory and extension programmes were conducted by the advisory and extension staff in collaboration with the research staff. The land suitability classification project for the Ratnapura District, which commenced at the end of last year, is also nearing completion. Field investigations for suitability classification, map compilation and printing are in progress. The other details of research, and advisory and extension, activities of each Division are given in the Reports of the relevant Heads of Divisions.

The Low Country Centre received more than 950 visitors, and conducted more than 450 advisory and extension activities during the year. The Advisory and Extension Division has also tested more than 630 soil samples for pH.

3. The Low Country Centre Expansion Project (Phase II)

The construction of a seminar hall, staff-quarters and the glasshouse is in progress. Most of the building construction, and the procurement of furniture and equipment, have been completed. The construction work was behind schedule,

and hence the State Engineering Corporation was given an extension of contract until January 31, 2005. The progress meetings regarding the project work were held with the participation of the Director/TRI, TDP Officials, SEC Officials and the Consultants.

4. Building and Layout Maintenance

1. Fixing of wooden pelmets and railings for a B 4 bungalow was completed.

2. A 2" water pump for the Agronomy Division experimental area was installed.

3. The laying of a pipe line from the tube well to the main tank was completed.

4. Repairs, roof-painting and colour-washing of quarters B2, B5, C2, C4, C6, C7, C10, C14, C16, D5, D6, D7 and D8 were completed.

5. Conversion of an open space in the rear section of eight D-type quarters into a protected area, and the vehicle garage into stores for the Technology Division was completed.

6. Most of the construction work on garages for hand tractors and the bus was completed.

7. The maintenance work and correction of defects in the newly-built hostel were completed.

8. Internal colour-washing of the Entomology laboratory following termite treatment, and of the Office and Advisory Division, was completed.

9. Repairs to the beds in the Drivers' Rest Room in the Circuit Bungalow were completed

10. The sewer pipelines of quarters C1, C2 and C3 and of the Circuit Bungalow, and the septic tanks of bungalow C8, were replaced.

11. The roof of the electrical workshop/security mess was repaired.

12. Other day-to-day maintenance of buildings and layout was satisfactorily done.

5. Electrical Maintenance

1. Rewiring of quarters C2, C6, D5, D6, D7 and D8 was completed.

2. The laying of a new overhead line for the new Auditorium was carried out.

3. Lightning arrestors were installed in the Sports Club.

4. The laying of a new overhead line for the quarters near the St Joachim Factory was carried out.

5. Other day-to-day electrical maintenance of the buildings and scientific Divisions was satisfactorily done.

6. Transport

General maintenance, repairs and servicing of the vehicles in the Centre's fleet were carried out satisfactorily, and the vehicles maintained in good condition. The vehicles have done about 243,542 km in total, at an average running-cost (fuel, repairs, servicing and other maintenance) of about Rs 9.00 per km.

7. Security Service

As a result of continuous complaints and requests from the company providing security, the performance of the security guards was improved. However, the number of guards on duty was less than the required number, and hence appropriate deductions were recommended to the Institute's Administration.

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 60. The library subscribed to 55 journals, and about 26 journals were received on a gift or exchange basis. The number of Annual Reports received was 15.

The library continued its normal routine work such as classification, cataloguing, indexing, and lending of materials. It also maintained a collection of news clippings. Five hundred and thirty-two copies of news clippings were distributed to the relevant Divisions and Centres of the Institute.

In addition to quick reference queries made by the staff, 11 literature searches were made on the internet. Ten CD-ROM searches were made from the Council for Agricultural Research Policy. and two searches were made from the SAIC (the SAARC Agricultural Information Centre)

Inter–library loan activities continued satisfactorily. On request, 23 articles were sent to various agricultural libraries, while 47 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 21 journal content pages were received according to Institute-user requirements, and 18 content pages were forwarded to AGRINET member libraries on the SDCP services. A further 12 articles were received from other libraries, and 8 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.

Twenty-one publications were sent to Low Country Station Library at Ratnapura. The Librarian visited the Low Country Station Library, and 92 books were entered in the Accession Register. Fifteen publications were sent to the library of the Mid-Country Station, Hantana.

Collection of library books borrowed by the Institute's staff in December were initiated.

Thirty students from Universities and Technical Colleges used the Library for reference during the year.

The Librarian attended the AGRINET and the SLSTINET meetings.

RESEARCH PUBLICATIONS

Journal Articles and Proceedings

A) TRI Publications

Sri Lanka Journal of Tea Science Vol. 68 (2) 2003

Ekanayake P B, Jayasekara A P D A and Rajapakse R M S S. Effect of different mulching materials on some soil properties, earthworm populations and growth of mid-grown young tea. 5-13

Gunasekara M T K and Ranatunga M A B. Polyploidy in tea (*Camellia sinensis L.*) and its application in tea breeding: A review. 14-26

Liyanage A C, Punyasiri P A N, Bandara U B S, Pradeepa N H L and Ziyad Mohamed M T. Two-stage drying of black tea using microwave energy. 27-33

Liyanage A C, Punyasiri P A N, Bandara U B S and Ziyad Mohamed M T. Microwave drying of black tea. 34-43

Ziyad Mohamed M T, Raveendran K, Botheju W S, Priyanthi S H and Jayasinghe L. Rapid method to determine moisture content in green leaf, withered leaf and made tea, using microwave oven. 44-46

Sri Lanka Journal of Tea Science 69 (1&2) 2004
(Reproduced from the Proceedings of the First Symposium on Plantation Crop Research)

Gunaratne G P, Hettiarachchi L S K and Jayakody A N. Boundary-line approach in specifying nutrient diagnosis ranges for vegetatively propagated tea in Sri Lanka. 5-19

Gunasekara M T K, Piyasundara J H N and Upali P D. Improved seed cultivars of tea (*Camellia sinensis* L): a source of planting material. 20-26

Mohotti A J. Shade in tea, is it beneficial? 27-39

Wijeratne M A . Effect of soil moisture deficit and temperature on dry matter accumulation in tea shoots. 40-50

Ziyad Mohamed M T, Galahitiyawa G L C, Chamindra M A and De Silva W C A. Classification of tea grades including long leaf types by sieve analysis. 51-70

Tea Bulletin Volume 18 (1& 2) 2003

Ziyad Mohamed M T, Botheju W S and Koneswaramoorthy S. Guidelines for performing an Endless Chain Pressure (ECP) drier test. 1-4

Wijeratne M A. Twin problems of the tea industry: Causes and a way-out. 5-9

Ekanayake P B. Management of the rush crop. 10-14

Piyasundara J H N, Upali P D and Gunasekara M T K.Preliminary yield evaluation of improved seed tea cultivars. 15-19

Premathilake K G. Management of Pasali Kodi, *Anredera cordifolia* Ten. (Steenis), a noxious weed in tea plantations. 20-23

Ziyad Mohamed M T,Raveendran K, Alagiyawadu U D and Abeykoon A M M V. Separation of coarse leaf in tea manufacture. 24-28

TRI Update Volume 9(1) 2004

Zoysa A K N. Fertilizer application in tea fields following a prolonged drought

Premathilake K G. Commelina weed in Nuwara Eliya

Gunasekare M T K. Systematic establishment of mother bushes of tea cultivars

Premathilake K G. Problem weeds in Low-grown tea

Ganewatta Gaminda. Valud addition for the development of tea industry

TRI Update Volume 9(2) 2004

Zoysa A K N and Gunaratne G P. Site-specific fertilizing: a novel approach.

Abeywickrama K R W, Amarakoon A M T and Ratnasooriya W D. Health Benefits: Sri Lankan Up-country black tea on serum lipid profile.

Shanmugarajah V and Ziyad Mohamed M T. Cuttings of TRI 3000 and 4000 series cultivars – shortage eases?

Sanjayan S. Crop Clinic: A novel way of technology dissemination.

Keerthi Mohotti. Bush debilitation and yield decline of tea in Deniyaya region.

Proceedings of the First Symposium on Plantation Crop Research (held on July 8th & 9th 2004)

Ziyad Mohamed, M T. Current trends and future challenges in tea research in Sri Lanka 1-7

Mohotti A J. Shade in tea, is it beneficial? 21-31

Wijeratne M A. Effect of soil moisture deficit and temperature on dry matter accumulation in tea shoots. 53-61

Gunaratne G P, Hettiarachchi L S K and Jayakody A N. Boundary-line approach in specifying nutrient diagnosis ranges for vegetatively propagated tea in Sri Lanka. 75-86

Gunasekara M T K, Piyasundara J H N and Upali P D. Improved seed cultivars of tea (*Camellia sinensis* L): a source of planting material., 103-108

Punyasiri N, Tanner G J, Kumar V, Campbell P M, Pradeepa N H L and Abeysinghe I S B. Preformed and induced chemical resistance in the tea plant against *Exobasidium vaxans* infection. 147-164

Ziyad Mohamed M T, Galahitiyawa G L C , Munasinghe A Chamindra and De Silva W C A. Classification of tea grades including long leaf types by sieve analysis. 180 - 197

B) International Publications and Communications

Ekanayake P B 2003 Crop diversification and intercropping in tea lands, Tropical Agricultural Research and Extension. 6, 67-70

Guruge K S, Taniyasu S, Yamashita N, Miyazak S, Yamanaka N, Wijeratne S, Mohotti K M and Seniviratne H R 2004. Pertluorinated compounds in human serum and seminal plasma from an urban and rural population in Sri Lanka. *In* Proceedings 24th International Symposium on Halogenated

Environmental Organic Pollutants and POPs, September 6-10, 2004 Berlin, Germany.

Mannakkara A and Mohotti K M 2004 Incidence of Shot Hole Borer *(Xyleborus fornicatus* Eichhoff) damage in tea as influenced by organic and conventional crop management systems. *In* Proceedings of the Sixth IFOAM Asia conference on 'Benign Environment and Safe Food' pp. 523-529, 7-11 September 2004, Yangpyang, Republic of Korea.

Prematilake K G, Robert J Froud-Williams, and Ekanayake, Punchi B 2004 Weed infestation and tea growth under various weed management methods in a young tea *(Camellia sinensis* L.). plantation. Weed Biology & Management. 4 (4), 239-248.

Punyasiri P A N, Abeysinghe I Sarath B, Kumar Vijay, Campbell Peter and Tannner Gregory J Pradeepa N H L 2004 *Exobasidium vexans* infection of leaves of tea *(Camellia sinensis)* increase 2,3-cis-isomers and gallate esterification of proanthocyanidins. Phytochemistry. 65, 2987-2994

Punyasiri P A N, Abeysinghe I S B, Kumar V, Treutter D, Duy D, Gosch C, Forkmann G and Fischer T C 2004 Flavonoid biosynthesis in the tea plant *Camellia sinensis:* Properties of enzymes of the prominent epicatechin and catechin pathways. Archives of Biochcmistry and Biophysics. 431, 22-30

Punyasiri P A N, Abeysinghe I S B, Kumar V and Pradeepa N H L 2004 Host responses to infection by *Exobasidium vexans* in tea leaves *(Camellia sinensis). In* Proceedings of IUP AC International Conference on Biodiversity and Natural Products Chemistry and Medical Applications, p. 246 New Delhi.

Punyasiri P A N, Abeysinghe I S B, Kumar V, Treutter D, Duy D, Gosch C, Maretns S, Forkmann G and Fischer T C 2004 Flavonoid biosynthesis in the tea plant *Camellia sinensis:*. Polyphenol Communications. *In* 22nd International Conference on Polyphenols, pp 511-512 Helsinki, Finland.

Punyasiri P A N, Abeysinghe I S B and Kumar V 2004 Preformed and induct:d chemical resistance of tea plant against *Exobasidium vexans* infection. (Accepted to the Journal of Chemical Ecology).

Wijeratne M A 2004 Tea Industry in Sri Lanka. *In* Abstracts of the Proceedings of ICOS-2004 Conference, pp 46, November 4-6, Shizuoka, Japan.

Wijeratne M A 2004 Development of a selective tea harvester for enhancing worker productivity and quality of made tea. *In* Abstracts of the Proceedings of ICOS-2004 Conference, pp. 77. November 4-6, Shizuoka, Japan.

C) National Publications and Communications

Abeysinghe I S B 2004 Semiochemicals in the control of shot-hole borer and role of catechins in resistance to blister blight leaf disease. *In* Proceedings of Africa, Asia and South America Regional Symposium on Natural Products. pp 37, University of Perdaeniya,Peradeniya.

Abeywickrama K R W, Amarakoon A M T and Ratnasooriya W D 2004 Effect of fresh high grown BOPF grade Sri Lankan black tea *(Camellia sinensis* L) on serum lipid profile of rats. *In* Proceedings of the Institute of Biology. pp 16, Colombo, Sri Lanka.

Abeywickrama K R W, Amarakoon A M T and Ratnasooriya W D 2004 An assessment of *in vitro* and *in vivo* antioxidant activity of fresh high grown Ceylon black tea *(Camellia sinensis* L) *In* Proceedings of the 60th Annual Sessions, Sri Lanka Association for the Advancement of Science. pp 229, Colombo.

Balasuriya A 2004 Presidential address, Section B (Agriculture and Forestry) of the Sri Lanka Association for the Advancement of Science (SLAAS): Lessons learnt, contributions made to plant pathology, managing blister blight disease of tea (*Camellia sinensis)* in Sri Lanka. *In* Proceedings, Part II of the 60th Annual Sessions of the SLAAS, December 18th – 22n , Colombo.

Bandara N J G T, Kandawinna K M W G and Mohotti K. M 2004 Comparison of compost derived from different sources for agricultural purposes. *In* Proceedings of the Sixtieth Annual Session of Sri Lanka Association for the Advancement of Science pp 115. Colombo, Sri Lanka.

Ekanayake P B, Prematilaka K G & Gamage A 2003 Management of getakola (*Spermacoce hispida* L) in tea plantations in Sri Lanka, Journal of National Institute of Plantation Management. 19(01) 19-29

Ekanayake P B 2003 Effect of intercropping tea and rubber on increasing productivity in the low country wet zone in Contract Research Abstracts 1990-2000, Council for Agricultural Research Policy. 30-32

Ekanayake P B 2003 Management of Tea Lands through "Sloping Agricultural Land Technology" (SALT). Journal of the Soil Science Society of Sri Lanka. 15, 11-19

Koneswaramoorthy S, Ziyad Mohamed M T and Galahitiyawa G 2004 Developing and evaluating solar energy techniques for tea drying. Journal of National Science Foundation, Sri Lanka, 32 (1 & 2), 49 – 60.

Kulasekera K H L, Gunasekare M T K and De Costa W A J M 2004 Factors affecting *in vitro* seed germination of tea *(Camellia sinensis* L). *In* Proceedings 60th Annual Sessions, Sri Lanka Association for the Advancement of Science, pp 50, Colombo.

Kulasekera K M L, Gunasekare M T K and De Costa W A J M 2004 Effects of plant factors on *in vitro* seed germination of tea *(Camellia sinensis* L *) In.* Proceedings University Research Sessions 9, pp. 12, Peradeniya

Mohotti K M, Rohan K G G R, Karunanayake U A and Athukorale K 2004 Potential exploitation of *Eucalyptus a*nd *Pinus s*oils as alternate sources of nursery media in tea - An example of sustainable natural resource management. Abstracts of paper presented at the Nineth Annual Forestry and Environment Symposium, pp 16, 27- 28 February 2004 Colombo, Sri Lanka.

Mohotti K M, Herath C N, Weerasinghe K W L K and Navaratne N 2004 Nematicidal properties of 'Vermiwash': A case study with root lesion and root knot nematodes. *In*_Abstracts of the AFASSA Regional Symposium on Natural Products, pp 28, 16-18 June 2004 Kandy, Sri Lanka.

Prematilake K G and Ekanayake P B 2004 Be cautious in the use of Glyphosate on tea plantation. Journal of National Intstitute of Plantation Management. (20 (2), 01-07.

Punyasiri P A N, Abeysinghe I S B, Kumar V, Treutter D, Duy D, Gosch C, Forkmann G and Fischer T C 2004 Flavanoid Biosynthesis in tea. Properties of enzymes involved in epicatechin and catechin pathways. *In* Proceedings of Africa, Asia and South America Regional Symposium on Natural Products, pp 40, Peradeniya, Sri Lanka

Punyasiri P A N, Tanner G, Campbell P M, Pradeepa N H L, Abeysinghe I S B and Kumar V 2004 Preformed and induced chemical resistance of the tea plant against *Exobasidium vexans* infection. *In* Proceedings of the Peradeniya University Research Sessions, 9, Peradeniya, Sri Lanka.

Ranatunga M A B, Piyasundera J H N, Paskarathevan R and Gunasekare M T K 2004 An alternative criterion for selecting high yielding cultivars of tea *(Camellia sinensis* L). *In* Proceeding 60th Annual Sessions, Sri Lanka Association for the Advancement of Science. pp 49,Colombo.

Wijeratne M A 2004 Contamination of tea (Sinhala) SCCI News, Sabaragamuwa Chamber of Commerce and Industries. 8, 6-7

Books

* Twentieth Century Tea Research in Sri Lanka. Ed. Dr W W D Modder- A comprehensive review of 75 years of tea research in Sri Lanka from 1925 - 2000

* De Silva M S D Luxmei, Rajasinghe J C K. and Mahindapala K G J P Weeds of Tea Lands in Sri Lanka.

* Amarakoon, Tissa. Tea for Health.

- Nathaniel R K and Advisory Division staff. Agricultural Profile of the Corporate Tea Sector.

* A Guide to the Tea Research Institute of Sri Lanka.

Reports

Twenty Reports on the Agricultural Profile of Tea Estates managed by the Twenty Plantation Management Companies, by R.K. Nathaniel and Advisory Division staff.

Software

Tea Fert - Zoysa A K N , Alagiyawadu U D, Ziyad Mohamed M T and Gunaratne G P

Twenty interactive CDs containing the Agricultural Profile of Tea Estates managed by the twenty Plantation Management Companies, and Agricultural Profile of the Corporate Tea Sector. Available in both PDF format and HTML formats, by B.A.D. Samansiri and S. Sanjayan

Serial Publications

1. Sri Lanka Journal of Tea Science 2003 Vol. 68 Part 2
2. Sri Lanka Journal of Tea Science 2004 Vol. 69 Parts 1 & 2
3. Thei Thathu Newsletter, 2004.
4. Tea Bulletin 2003, Vol. 18, No. 1 & 2
5. TRI Update Vol. 9, Part 1 & 2

Other Publications

1. Plucking (a leaflet in Sinhala) by Hiromi Nishanthi.
2. Tea Information leaflet (Sinhala)
3. The Tea Leaf to the Cup leaflet (Sinhala)
4. Wall Chart on Major Pests of Tea in Sri Lanka by V.S. Sithakaran.
5. Advisory Circular Serial No 1 / 04 (PT6) –Moisture levels of black tea

ST. COOMBS / LAMILIERE ESTATE

Superintendent - J. V. Hulangamuwa

The Visiting Agent visited the Estate on 1st November 2004.

Messrs Asia Siyaka Commodities recommenced auctioning all the St Coombs teas with effect from 15th January 2004.

Mrs K.G.S. Sriyani resigned from the post of midwife on 1st August 2004.

2. Weather and Rainfall

A rainfall of 2,068.5 mm was recorded on 223 wet days, against 1,629.2 mm on 180 days in 2003.

3. Field Works & Cultivation

3.1. Hectare Statement as at 31st December 2004

	St.Coombs	*Lamiliere*	*Total*
Old seedling tea in bearing	9.60	2.00	11.60
V.P. tea in bearing	79.32	44.50	123.82
V.P. tea immature	-	-	-
ADB Project	11.39	2.62	14.01
Nurseries	1.20	0.10	1.30
Experimental Area	3.90	1.00	4.90
Total in tea	**105.41**	**50.22**	**155.63**
Labour housing	1.09	-	1.09
Ravines and grassland	31.00	1.00	32.00
Buildings, roads, workers' gardens, etc.	34.28	14.70	48.98
Total	**171.78**	**65.92**	**237.70**

3.2. Crop and Yield

	2004		2003	
	Crop (kg)	Yield (kg/ha)	Crop (kg)	Yield (kg/ha)
St.Coombs	200,872	2,259	185,367	2,108
Lamiliere	112,316	2,415	103,230	2,220
Total	313,188	2,313	288,597	2,147
Bought Leaf	4,514	-	1,235	-
Grand Total	317,702	2,313	289,832	2,147

The highest yield recorded in St.Coombs / Lamiliere Estate was 2,313 kg/ha in 2004.

3.3. Cultural Operations

All agricultural operations were undertaken as programmed.

In addition, 5.9 ha. (St.Coombs Lower Division, Field Nos. 7 and 12 A) were pruned.

3.4. ADB Mother Bush Project

79,266 shoots of TRI 3000 and 4000 series were issued from the ADB Mother Bush Project.

4. Factory and Manufacture

4.1. Top Prices

Silver Tips teas were sold at Rs 7,000.00.

5. Wages

Wages for workers were increased as shown below.

Daily wage, basic salary	Rs.	135.00
15% of EPF and ETF	Rs.	20.25
Price Share Supplementary	Rs.	20.00
Attendance incentive	Rs.	25.00
Checkroll Average	Rs.	200.25
Price Share Gain (Depending on the National Average)	Rs.	15.00
Total wages	Rs.	215.25

6. Working Results

The Estate should make a profit of approximately Rs.2,000,000.00

ST. JOACHIM ESTATE

Superintendent - M. S. E. Perera

1. Visiting Agent

he Visiting Agent, Mr Lalin I de Silva, Aislaby Estate, Bandarawela, made two visits to the estate on 08 May and 27 November 2004, respectively.

2. Hectarage as at 31st December 2002

Mature tea	48.32
Nursery	1.58
Land under coconut	3.89
ADB Project	30.00
Land under paddy	8.74
Tea/Rubber	3.68
Rubber	7.12
Mana grass	13.02
Total	**116.35**
Acquisition by Government	
Buildings, roads, ravines and jungle	25.63
Grand Total	**141.98**

3. Crop (made tea kg)

The production in 2004, compared to the previous year was:

Year	Estate Crop (Kg)	Bought Crop (Kg)
2003	62,484	648,692
2004	56,100 approx.	585,940 approx.

The production on the estate registered a decrease of 6,384 kg or 10.22 %, in comparison to that in the previous year. Severe drought conditions were experienced during the 1st quarter of the year.

3.1 Bought Leaf

The bought leaf manufactured at the St. Joachim factory decreased by 62,752 kg or 9.67 %, in comparison to that in the previous year.

4. 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.

The Nett Sale Average for the year was Rs.171/85. The working of the St. Joachim estate resulted in a profit of Rs.3,440.22/- (as at 30th November 2004).

5. ADB Mother Bush Project

An extent of 2.50 ha was planted during the 2004 season, under the ADB Project, with 3000- and 4000-series clones. The 30.0 ha estimated under the Project has been completed.

6. Cultural Operations

Pruning, mossing and ferning, draining, and fertilizing and weeding operations as per the estimates were carried out. No major pest and disease problems were encountered. Vacant areas which had not been planted in tea were planted with rubber at a spacing of 60' x 9 '. Interplanting of tea to be carried out in the future.

7. Nursery

The supply of planting materials to small holders in the District continued this year too.

Sale of planting materials compared to the previous year was as follows.

Year	Cuttings		Plants	
	sold	Proceeds Rs.	sold	Proceeds Rs.
2003	769775	192443/=	44012	352096/=
2004	1582945	474883/=	34510	261085/=

8. General

The upgrading of the crèche, re-roofing two sets of workers' quarters, and construction of 30 units latrines for workers, were carried out with funds received from the Plantation Human Development Trust. Twenty-five per cent of the expenditure had to be borne by the estate.

Approval for the construction of a D-type staff quarters was received, and the contract was awarded by the Administration of the Institute to Mr Chaminda Sampath, Hidellana.

The construction of a Nursery Shed under the ADB Mother Bush Project was completed at a cost of Rs 117,137.50.

The construction of a manure shed was awarded to Mr M.W. Dannie, and the work is in progress.

The tenders for purchase of a new Colour Separator, and the automation of Roller No. 09, was awarded to Messrs Senvec Ltd. and Messrs Nikini Automation Ltd., respectively.

A 12.5% salary increase to staff was approved as per the Collective Agreement, with effect from October 2003, and the arrears were paid along with the May 2004 salaries.

Labour wages were increased by Rs 59/60 (from Rs 165/15 to Rs 204/50 + EPF) with effect from July 2004.

The following work was carried out in the factory during the year.

- Painting of the factory roof, firing/rolling.
- Repairs to troughs and the hot-air ducting system.

The colour-washing and painting of the roof of five staff quarters and the estate office were carried out.

Table 1

Working Accounts, 2004 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, COMBINED RS.
1998	890,131 73,473	1359	133/64	94/25	87/43	16,605,650/=
1999	746,768 78,197	1446	120/22	100/30	117/33	8,262,014/=
2000	711,325 75,336	1393	138/70	82/98	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	143/37	130/09	93/46	155,325/=
2004 #	585,940 56,100	1161	171/85	^144/36	^165/41	^3,440,216

^ To end November 04

* Bought crop made tea
# Estate crop made tea
} Approximately

Table 02

St. Joachim Estate (from 1999 - 2004)
Monthly yield (kg/ha) rainfall and average N applied

	1999	2000	2001	2002	2003	2004
January	122	117	123	102	106	79
Februay	94	105	115	81	88	71
March	132	139	122	109	105	89
April	133	141	113	109	131	117
May	108	143	118	127	116	90
June	113	118	87	130	112	111
July	102	95	86	116	124	103
August	101	100	88	130	95	103
September	135	101	56	104	100	92
October	121	100	88	113	112	106
November	138	110	78	105	107	104
December	147	124	90	85	97	
Total	**1446**	**1393**	**1140**	**1358**	**1293**	**1065***
Total rainfall (mm)	4526.4	3740.6	3593.5	3194.8	3984.6	3914.3
No of wet days	224	211	189	206	227	216
Average "N" (kg/ha/yr)	164	162	163	162	124	127

*to Nov-04

METEOROLOGICAL OBSERVATION - 2004
TRI, DENIYAYA
(Lat 6^0 43'N;Long 80^{0}E 33.3'E 250m amsl)

Month	Mean Temperature (°C) Ambient Air		Relative Humidity (%)		Wind travelled (km)	Sunshine Hrs (hours/day)	Evaporation (mm)	Rainfall (mm)
	min.	max	9.00 am	16.00 pm				
January	21.5	31.6	28.22	28.56	688.0	6.39	78.43	240.8
February	21.3	31.2	28.58	28.77	614.0	6.53	79.46	189.1
March	20.0	32.9	28.80	29.15	1010.0	6.5	97.96	263.5
April	23.0	32.2	29.58	29.83	865.0	6.66	84.96	366.6
May	23.9	30.1	28.41	28.61	2190.0	4.94	85.25	469.2
June	23.5	29.6	27.74	27.91	2681.0	4.73	96.30	241.2
July	23.2	29.1	27.28	27.57	2769.0	6.21	81.22	335.8
August	23.8	29.9	27.87	28.18	3525.0	7.53	119.04	72.6
September	22.6	29.7	28.16	28.29	1477.0	4.52	59.10	316.4
October	23.0	30.5	28.20	28.49	1207.0	5.11	62.62	345.8
November	21.8	30.8	27.96	28.33	706.0	4.65	84.00	194.6
December	21.2	30.2	27.83	27.84	685.0	5.42	83.70	317.0
Total							1012.04	3352.6
Average	22.4	30.6				5.8		

METEOROLOGICAL OBSERVATION - 2004
TRI, HANTANE, KANDY

(Lat 7°.26'N;Long.80°.38'E;762m amsl)

Month	Mean Temperature (°C) Ambient Air		Relative Humidity (%)		Sunshine Hrs (hours/day)	Evaporation (mm)	Rainfall (mm)
	min.	max	9.00 am	16.00 pm			
January	19.2	28.0	99.4	98.7	7.2	106.09	24.8
February	20.5	28.9	99.1	98.4	7.2	113.18	19.2
March	19.0	31.1	99.3	98.4	4.9	112.92	193.0
April	20.8	30.4	98.7	98.8	6.9	90.52	142.1
May	20.6	27.6	99.0	99.1	5.5	62.90	191.0
June	20.7	26.8	99.2	99.2	4.2	68.85	244.0
July	20.8	26.0	99.5	99.2	4.5	58.11	220.0
August	20.2	27.4	99.1	99.1	6.9	97.50	92.4
September	19.8	27.3	99.3	99.3	4.4	59.40	114.8
October	19.8	27.0	99.4	99.4	5.1	52.80	188.8
November	19.6	26.5	99.4	99.3	4.0	56.70	141.9
December	18.8	26.0	97.1	99.2	5.4	64.49	322.3
Total						943.46	1894.3
Average	20.0	27.8					

METEOROLOGICAL OBSERVATION - 2004
TRI, PASSARA

(Lat 6.56'N;Long.81.07E;1120m amsl)

Month	Mean Temperature (°C) Ambient Air		Relative Humidity (%)		Wind travelled (km)	Sunshine Hrs (hours/day)	Evaporation (mm)	Rainfall (mm)
	min.	max	9.00 am	16.00 pm				
January	16.7	24.2	85.0	86.0	1532.6	4.5	63.89	166.8
February	16.9	25.0	78.0	78.0	2060.2	5.9	85.57	45.8
March	17.9	27.2	72.0	68.0	1138.3	6.7	109.45	33.3
April	19.4	27.4	77.0	77.0	590.4	5.0	80.99	234.3
May	18.8	27.6	77.0	78.0	1599.6	5.1	88.65	73.7
June	18.4	27.9	76.0	74.0	3988.8	5.8	89.91	0.0
July	14.0	27.5	83.0	82.0	1815.4	4.8	82.67	98.9
August	18.4	27.5	83.0	79.0	1421.0	4.9	113.47	31.0
September	16.5	25.8	85.0	89.0	748.8	3.6	37.65	246.0
October	16.2	25.8	91.0	88.0	1034.2	3.2	44.29	470.0
November	13.1	23.3	93.3	93.6	2160.0	2.7	59.04	247.0
December	4.2	23.9	91.0	92.0	2693.3	3.6	98.86	483.9
Total							954.44	2130.7
Average	16.7	26.1				4.7		

METEOROLOGICAL OBSERVATION - 2004
TRI, RATNAPURA

(Lat 6^0.41'N;Long.80^{0}E;40^{0}E 29m amsl)

Month	Mean Temperature (^{0}C) Ambient Air		Relative Humidity (%)		Sunshine Hrs (hours/day)	Evaporation (mm)	Rainfall (mm)
	min.	max.	9.00 am	16.00 pm			
January	22.9	34.6	87.0		6.3	100.13	90.3
February	22.3	34.5	59.0	59.0	6.3	100.34	44.0
March	22.9	35.3	87.0	52.0	5.9	98.27	255.4
April	23.7	34.2	88.0	78.0	5.1	80.70	359.2
May	24.0	32.5	86.0	78.0	3.9	79.36	498.0
June	23.8	30.4	84.0	80.0	4.7	95.70	332.8
July	23.0	30.5	87.0	68.0	3.6	68.82	437.8
August	23.7	31.9	87.0	70.0	5.1	87.11	143.9
September	23.0	31.7	86.0	66.0	3.2	81.00	540.2
October	23.0	32.2	86.0	63.0	3.6	79.98	638.6
November	22.8	32.6	86.0	75.0	4.0	71.70	279.8
December	22.3	32.5	90.0	69.0	4.6	77.81	293.9
Total				63.0		954.44	3913.9
Average	23.11	32.74					

METEOROLOGICAL OBSERVATIONS - 2004

TRI - ST.COOMBS, TALAWAKELLE

(Lat.6. 54 'N;Long.80.42E; 1382m amsl)

Month	Mean Temperature (°C)				Relative Humidity		Wind Travelled (miles)	Sunshine Hrs (hours/day)	Evaporation (mm)	Rainfall (mm)	Wet days
	Ambient Air		Soil temp. at 20 cm								
	min.	max.	9.00 am	16.00 pm	9.00 am	16.00 pm					
January	12.7	26.7	20.8	23.0	93.8	95.2	1584.5	6.3	100.39	42.0	4
February	11.5	26.3	21.6	22.3	91.8	93.9	1287.0	7.4	78.89	16.5	6
March	10.9	28.0	22.0	24.3	90.4	89.7	1417.4	7.6	93.63	113.6	8
April	14.2	26.7	22.3	23.9	95.4	95.4	984.2	5.5	75.89	350.5	23
May	15.3	23.3	22.2	23.0	96.2	96.1	1818.6	3.3	44.31	267.9	25
June	15.4	22.6	20.8	21.5	97.3	95.7	2658.1	3.8	73.60	255.3	21
July	15.5	22.1	20.6	21.5	98.0	96.7	1753.7	2.9	55.67	143.8	22
August	14.8	23.3	21.3	22.3	96.3	94.7	1794.4	4.5	55.04	125.3	13
September	14.8	24.0	21.0	22.4	96.0	95.6	979.2	3.1	52.36	131.0	19
October	17.6	24.5	21.6	21.7	95.2	95.8	4534.2	3.8	80.46	198.6	20
November	15.2	24.7	21.3	22.6	95.5	95.9	1755.8	4.2	60.39	139.1	15
December	13.3	25.1	21.0	22.2	93.7	92.1	1606.8	4.6	93.58	134.5	10
Total									864.21	1918.10	186
Average	14.3	24.8	21.4	22.6				4.8			

METEOROLOGICAL OBSERVATION - 2004
TRI, KOTTAWA
(Lat 6.5'N;Long.80E.20'E;29m amsl)

Month	Sunshine Hrs (hours/day)	Rainfall (mm)	Wet days
January	6.5	73.5	7
February	7.2	34.1	5
March	7.0	134.6	9
April	5.3	137.3	13
May	3.8	306.2	20
June	5.2	221.9	18
July	4.3	210.4	18
August	6.0	135.2	11
September	3.2	462.8	22
October	3.8	292.6	24
November	4.4	203.3	15
December	4.8	219.7	13
Total		2431.6	175
Average			