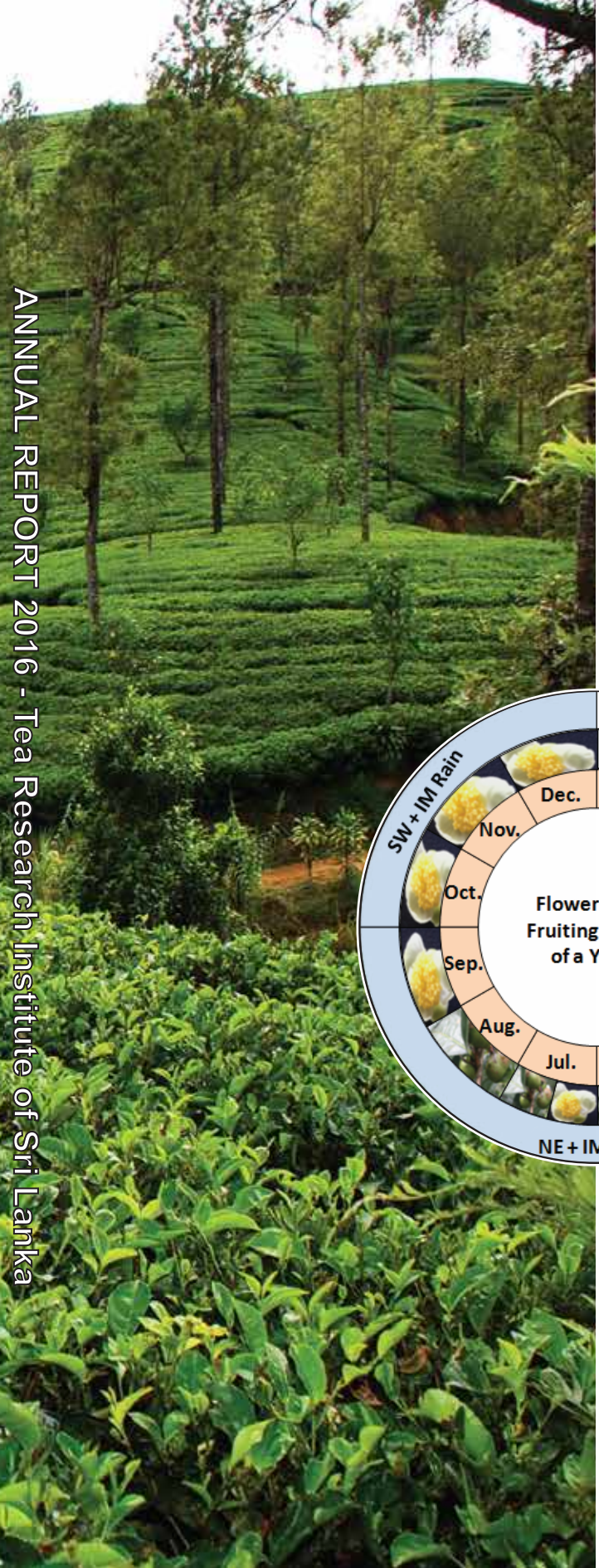
Annual Report 2016



ANNUAL REPORT 2016 - Tea Research Institute of Sri Lanka

Tea Research Institute of Sri Lanka
Talawakelle

Annual Report

2016

Tea Research Institute of Sri Lanka
Talawakelle
Sri Lanka

Annual Report 2016

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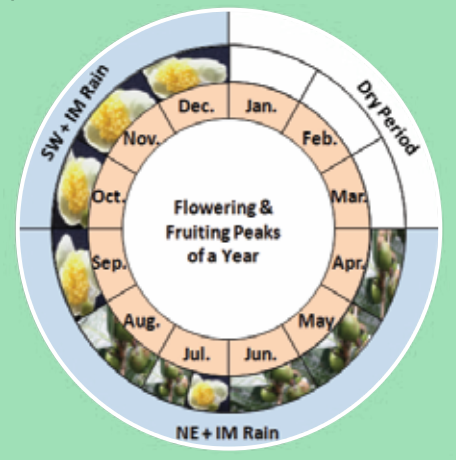

Phenological Calendar of flowering and fruiting peaks in Low country Tea Seed Gardens

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TEA RESEARCH INSTITUTE OF SRI LANKA

The Tea Research Institute of Sri Lanka (TRISL) was founded in 1925 in accordance with the provisions of an Ordinance passed in the Legislative Council of Ceylon to enrich the tea industry through professional tea research. The TRI established as an arm of the Planters' Association of Ceylon, is presently governed by the Tea Research Board of Sri Lanka subsequent to gradual transformation.

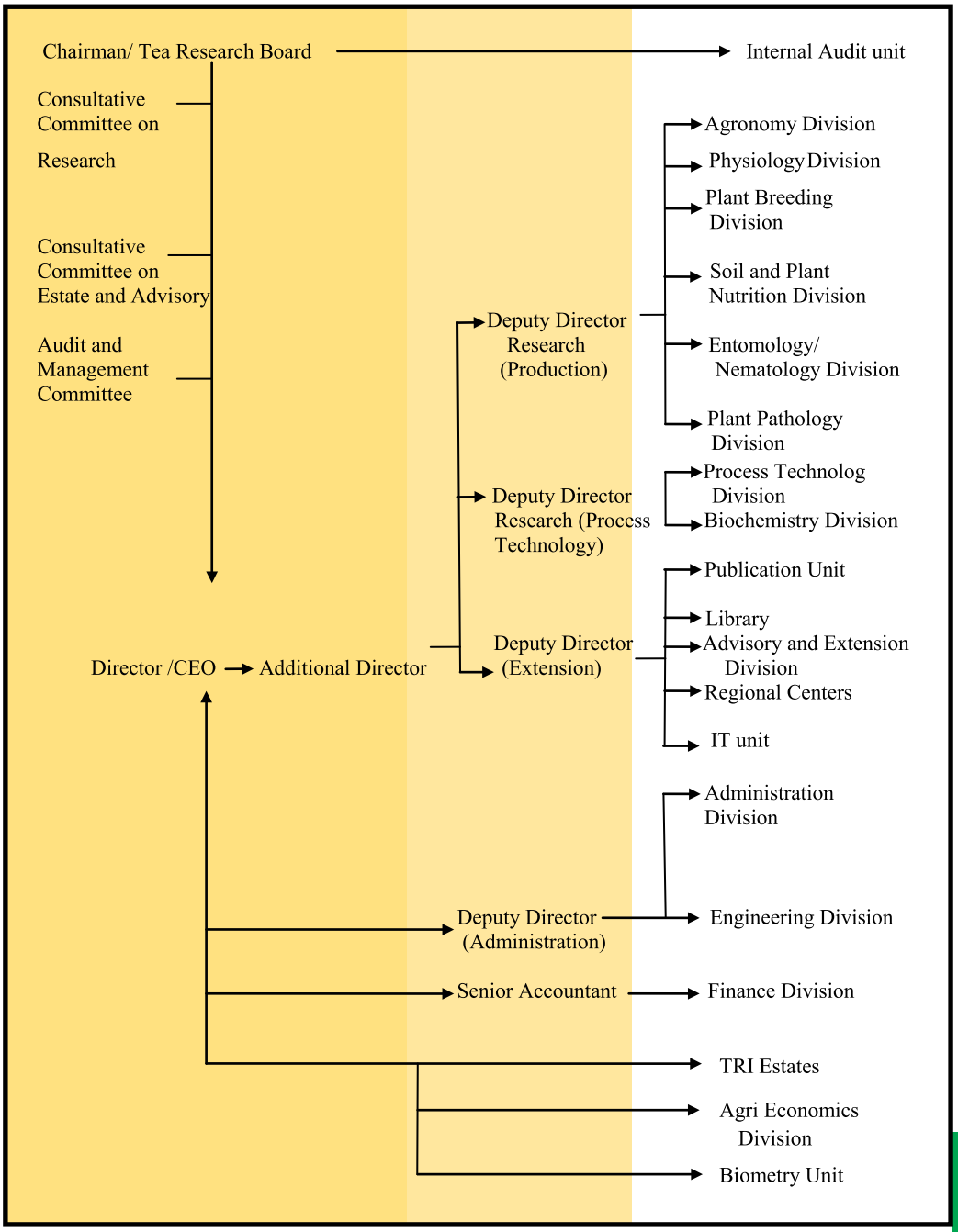
Vision

To achieve excellence in tea research and to provide technological guidance to the tea industry, in order to make Sri Lankan tea the most preferred tea in the world, at a competitive price.

Mission

To generate and transfer scientific knowledge and technologies appropriate for the stakeholders to improve productivity and quality of Sri Lankan tea in a most profitable manner.

Organizational Structure of the TRISL



BOARD OF MANAGEMENT

Tea Research Board of Sri Lanka

The TRISL is governed by the Tea Research Board of Sri Lanka that was established on 12th November 1993 under the provisions of the Tea Research Board Act No. 52 of 1993. In 2007, the Tea Research Board Act was amended and a Supplementary Act No. 43 of 2006 was approved by the Cabinet.

The functions of the Tea Research Board shall be to engage in and to encourage, foster and facilitate, research leading to cultivation and processing of tea.

Specific functions of the Tea Research Board

- To conduct, assist and encourage scientific and technological research and investigations into all problems and matters affecting the production and processing of tea including the prevention and control of pests and diseases, improvement of quality of processed tea, as well as diversification of products of tea and to disseminate and publish results of such research
- To conduct, assist and encourage research into the economic viability of the tea industry in Sri Lanka, including future economic trends of the industry
- To establish and maintain relations with research institutions in Sri Lanka and abroad
- To conduct joint study programmes, seminars or symposia, with foreign and local research institutions

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Mr R S Jayarathne
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Mr Padmakeerthi Hemachandra
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- Ms K P K A Sewwandi (Observer Member)
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REVIEW OF THE CHAIRMAN, TRB

Dr M M J P Gawarammana
Chairman,
Tea Research Board,
Talawakelle

It is with great pleasure I present the Annual Report of the Tea Research Institute (TRI) of Sri Lanka for the year 2016.

The Sri Lanka Tea industry had to face numerous challenges during the year 2016 among which adverse weather pattern prevailed in most of the tea growing regions and worker shortage continued to be the major constraints in plantations. Weed management cost continued to escalate which became one of the major concerns of the tea growers. The Institute suffered due to the tragic accident of the TRI staff bus occurred in December 2015 causing serious damage to the staff.

With the guidance of the Tea Research Board (TRB), the Institute took initiatives to discuss the issue of high cost of weed management at various formal meetings where the relevant subject ministers and higher officials participated. This issue was further discussed at Parliament appointed Committee level. The TRI submitted detailed report on the impact of this issue on the tea industry and appropriate recommendations. Further, the collaborative work on alternative new weedicides with other parties continued to progress.

Various research and development projects on crop and land productivity improvement, crop protection, climate change impact, mechanization of field practices, tea processing technology, product development, socio-economic and resource planning were in progress. The Institute progressively continued its advisory and extension services and analytical services to the industry. Further, progress in the trials of TRI 5000 series cultivars, improved seed materials as alternative planting materials, alternative mulching material and rehabilitation grass and impacts on mechanical tea harvesting, carbon sequestration of VP and seedling tea and carbon budgeting in different tea growing regions were made. Screening of alternative pesticide against Tea Tortrix, Nematodes, Blister Blight and Weeds continued to progress. Early diagnosis method of Canker disease and Blister Blight disease assessment keys were validated.

Studies were carried out on the potential use of tea factory firewood ash as a plant nutrient source, soil acidity buffering capacity, volatilization and leaching losses of applied fertilizers and growth promoting rhizobacteria. Research on development of techniques to extract protein from spent tea and detection of Anthraquinone contamination in tea, sugar adulteration in made tea and green tea quality were conducted.

Trials were conducted on moisture absorption by made tea at different stages, optimization of electrical energy efficiency, effective monitoring of FBD Drying, development of self-cleaning shifter and copper alloy cast components of machinery and alternative energy sources for tea processing.

Socio economic studies such as return on investment on soil fertility management, investment on mechanization, labour turn over and absenteesm were also undertaken. Para Extension Approach for the RPCsector, educational exhibitions and investigation on dieback problem in Deniyaya region were undertaken.

The year 2016 was an eventful year in terms of infrastructure and HR Development. Having realized the long felt need and the importance of infrastructure and human resource development of the Institute, the Board took various initiatives in this regard.

Among the infrastructure developments accomplished during the year, renovation of the internal road system (3 Km), renovation of the water treatment plant and colour washing of 21 staff bungalows and 5 hostel rooms at the TRI Head Office, Talawakelle and renovation of the office complex (stage II) of the TRI Regional Centre, Galle were the major achievements. The road connecting the TRI campus and Nuwara Eliya-Hatton main road was in a badly damaged status causing severe inconvenience to the TRI staff and general public over the last many years and the Board initiated negotiations with the local authorities to renovate and lay carpet on this road.

In addition, renovation and upgradation of the St. Coombs Dispensary, the Maternity Ward, Midwife Quarters, two Crèches and construction of 60 toilets for the workers of St. Coombs estate were commenced with the financial assistance of "Save the Children"-INGO which was another major achievement.

The Board was highly concerned of the dearth of staff including some key positions that were vacant for the last many years and emphasized the importance of filling those positions to facilitate smooth functioning of the Institute and ensured filling of 26 vacant positions through new recruitments.

Various capacity building events such as trainings, seminars and conferences (local and overseas) for scientific staff continued to progress. A medical fund was developed and assisted the staff victims of the unfortunate TRI bus accident took place in the previous year.

The St. Coombs Estate performed appreciably well during the year 2016 in terms of yield, tea sale prices and profit made. Gross sale average for the year was significantly high securing first in the rank of western high growers' category. St. Joachim Estate also showed improved performance in prices as against the previous year. Important decision was taken by the Board to improve the productivity of the estate and factory.

The recommendations made by the Consultative Committee on Research (CCR), Consultative Committee on Estates & Advisory Services (CCE & A) continued to guide the Board in decision making process on matters related to research and development, technology transfer and management of the St. Coombs and St. Joachim Estates. Guidance of the Audit and Management Committee helped the Board in monitoring the Finance and Administration of the Institute.

Preliminary arrangements were completed to invite His Excellency the President Maithripala Sirisena on 21st January 2017 to participate in some important events at the TRI.

On behalf of the TRB, I take this opportunity to appreciate the dedicated services and support extended by the Directorate, Scientific, administrative and supportive staff towards all the achievements made during the year.

At this juncture, I wish to extend my gratitude to the Hon'ble Minister, Secretary and the staff of the Ministry of Plantation Industries for their valuable guidance given to the Board. Finally, I remain grateful to the TRB Members for all their guidance and support extended to the undersigned in the decision making process.

Dr M M J P Gawarammana,
Chairman,
Tea Research Board

REVIEW OF THE DIRECTOR, TRISL

General

A workshop to discuss strategic developments anticipated in each sector of the tea industry for the next five years was held on 18th February. Hon. Naveen Dissanayake, Minister of Plantation Industries was the chief guest. Many eminent personalities including Dr. Indrajith Coomaraswamy, Advisor to Ministry of development strategies, Mr.Roshan Rajadurai, Chairman, Planters Association, Mr. Anil Alwis, Chairman, Sri Lanka Tea Factory Owners Association, Mr. Anil Cook, Chairman, Colombo Brokers Association addressed the gathering. Need of a different business model for plantation sector, Colombo as the tea hub, value addition and marketing to suit the new generation were some of the key topics discussed.

Dr. I S B Abeysinghe
B Sc (Peradeniya, Sri Lanka)
Ph D (Sheffield, UK)

A meeting was held with the Hon. Minister of Plantation Industries and Secretary, MPI to discuss the new proposal to increase salaries for crop research institutes which was prepared by TRI, RRI, CRI and SRI. Director, TRI made a presentation on the new salary proposal. The Hon. Minister was in favour of the proposal and requested MPI to arrange a meeting with other relevant R & D organizations so that our request could be justified to the Salary and Cadre Commission and to the Management Services Department

In order to address problems of tea growers Hon. Minister of Plantations Industries has initiated a programme titled "Wevily Sawiya Gamata". TRI has participated its first programme in Kotapola, Deniyaya where the Hon. Ministers Mr. Naveen Dissanayake and Mr. Sagala Ratnayake attended the programmes.

Mr. Sudhanahu Jain and his colleges from Centre for Agriculture and Bioscience International (CABI) visited TRI on 9th March to have a discussion on possible collaborative project to use mobile ICT for knowledge sharing. This will be done under their mNutrition initiative programme. The goal of the mNutrition initiative is to make contributions to improve nutrition and food security of the poor, especially women by harnessing the power of mobile technologies to improve access to information on nutrition-specific behaviors as well as nutrition-sensitive health and agricultural practices especially for farmers and the rural population.

The initiative plans to reach at least 10 million beneficiaries across 10 sub Saharan African and 4 Asian countries under mAgri category. Four countries in Asia, Pakistan, Bangladesh, Myanmar and Sri Lanka fall under mAgri category.

CABI has already signed partnership agreement with Department of Agriculture, Sri Lanka and telecom operator Dialog is the mNutrition grantee in Sri Lanka. 14 crops to be covered under this project and tea is one of the crops.

CABI requested TRI assistance to strengthen the existing extension system using ICT and develop localized content and scientific validation. This system should improve knowledge transfer from TRI to the growers.

The Pesticide Technical Advisory Committee (PeTAC) Meeting was held on 7th July at the Ministry of Agriculture. The Minister of Agriculture Hon. Duminda Dissanayake and Secretary to the Ministry attended the meeting. The main topic of the discussion was the ban on Glyphosate and Gluphosinate Ammonium. The need of these two chemicals to control weeds in tea plantations were explained to the minister and he agreed to see the possibility of issuing Gluphosinate Ammonium on restricted basis. Also he assured that in future he will contact the PeTAC prior to take decision on banning pesticides since PeTAC is the legal entity when it comes to approving or banning pesticides.

A meeting was organized by the Ministry of Plantation industries in July 2017 to justify the need of Glyphosate and Gluphosinate Ammonium for the tea industry. Representatives of all crop research institutes participated at the meeting and a common document was prepared justifying the need of these two chemicals.

The issue on Glyphosate ban was taken up by two committees appointed by the Parliament. On the 21st September, at the Sectorial committee of Agriculture and Lands which was chaired by Hon. Vijitha Herath the importance of having Glyphosate for the plantation sector was highlighted by the TRI. It was decided to discuss the issue in a forum with the participation of wider audience and decided to discuss it at the Sub Committee on Agriculture under the chairmanship of Hon. Susantha Punchinilame.

At the meeting, Hon. Navin Dissnayake requested to have Glyphosate for tea industry in a restricted manner and suggested to have a phasing out programme for Glyphosate. Accordingly TRI prepared a comprehensive report on impact of banning of Glyphosate on tea industry and a phasing out programme and sent to MPI to submit a cabinet paper.

A meeting of the sectorial oversight committee on agriculture and lands was held on 8th December 2016 under the chairmanship of Hon. Susantha Punchinilame to discuss the issue on the impact of banning of Glyphosate to the agriculture sector. TRI presented the impacts of banning of Glyphosate on the tea industry. There were differences of opinions on the banning of glyphosate and its impacts. Hon. Minister requested interested parties to submit alternative proposals so that the committee could consider and make recommendations.

The EU auditors visited Sri Lanka during 14-22 September to conduct an audit on the reports that they received on the detection of pesticides in food items. Tea has been identified as one of the food items and the audit team visited TRI on 19th September and had a meeting with the staff. In general, they were interested in pesticide usage, control and monitoring mechanisms implemented to reduce pesticide residues in food products. They were satisfied with the measures taken by TRI to minimize the pesticide residue levels in tea. They were briefed on the TRI circulars and guideline on the usage of pesticides and other relevant circulars on agricultural practices to mnimise the usage of pesticides.

The sixth Symposium on Plantation Crop Research was successfully held at the BMICH during November 3-4, 2016. The theme of the symposium was “Plantation Agriculture towards National Prosperity”. The sixth symposium was ceremonially inaugurated by the Chief Guest, Hon. Deputy Minister of Plantation Industries, Mr. Wasantha Luxman Perera, on November 2, 2016 at Waters Edge hotel, Battaramulla with the participation of Mr.Upali Marasinghe, Secretary, Ministry of Plantation Industries and Dr.Saman Kelegama, Executive Director, Institute of Policy Studies who delivered the Key Note Speech. Scientists who have excelled in their research activities were honoured during this inaugural session.

Two Guest speeches made during the Technical sessions added value to the sixth symposium. They were on “Present status of the Regional Plantation Sector and its future challenges” by Mr. Roshan Rajadurai, the former Chairman, Planters’ Association and the CEO of Kelani Valley and Talawakelle PLCs and “Diversification of Plantation Sector and related industries through Nano Technological approaches” by Prof. V Karunaratne, Associate Director, Science and Strategic Relations, SLINTEC and Senior Prof. Faculty of Science, University of Peradeniya. TRI participated in a workshop on implementation of provisions of the Right to Information Act No. 12 of 2016 on 16th December 2016.

Research, Advisory and Extension Matters

The R and D work of the Soils and Plant Nutrition Division was review by the Scientific Advisory Committee comprising of Dr. Saman Dharmakeerthi, University of Peradeniya and Dr. S Wanniarachchi, University of Ruhuna on 10th March 2016.

The Research and Development work of Agronomy Division was reviewed by the Scientific Advisory Committee comprising Prof. H P M Gunasena and Prof. W A J Costa of University of Peradeniya on 16th May 2016.

The Research and Development work of Advisory and Extension Division was reviewed by Prof. Mahinda Wijeratne, University of Ruhuna on 9th August 2016.

232nd Experimental and Extension meeting was held on 29th July under the theme of "Arresting Land Degradation through Key Management Practices". Dr. Jagath Gunatilake from University of Peradeniya was invited as the guest speaker to address "Natural Hazards of Sri Lanka: Land Slides and Mitigation".

RESEARCH HIGHLIGHTS

CROP IMPROVEMENT

Breeding of new tea cultivars to improve productivity, quality and to face emerging challenges

Development of new tea cultivars
The highlight of controlled hybridization program of 2016 was the use of different Camellia sub species having diversity of amino acids to generate cultivars with variable amounts of metabolites for commercial exploitation and to withstand biotic and abiotic stresses. Around 575 crosses were made using four parental combinations. One phase 1 trial consisting promising accessions from the hand crosses made in year 2006/2007 was established at St.Coombs estate.

Estate cultivar selection program
In order to develop new tea cultivars and to conserve seedling diversity. selection of seed stocks established in Endana Estate, Kahawatta was carried out. Twenty two elite bushes were selected based on visual growth performances and LCLWT assessment.

Improved seeds as alternative planting materials for marginal tea growing areas
In order to enhance the productivity of Bi-Clonal garden at Reucastle Estate, Dehiowita, Poly–Clonal gardens at Salawa Estate, Hanwella and Rambukkanda Estate, Ratnapura reproductive phenology and breeding systems of the tea seed gardens were assessed was continued. Based on the outcomes of the study, five bi-clonal combinations and four poly-clonal combinations were identified for use in future seed gardens.

Characterization and metabolite profiling of tea germplasm
Characterization of germplasm is an important initial step towards proper utilization of genetic resources in plant breeding. Fifty four accessions selected from the exotic germplasm collection at TRI, were characterized using 14 floral traits. Results revealed that the exotic collection predominantly represents China type (72%) followed by Cambod type (20%)

LAND PRODUCTIVITY IMPROVEMENT& CROP MANAGEMENT

Tea factory firewood ash as a plant nutrient source for mature tea
The experiments were conducted at St. Coombs estate (Up country) Moragalla Estate (2015, Low country) and Kurugama Estate (2015, Mid country). The different rates of wood ash (1000, 2000 kg/ha/year) and refuse tea with or without Urea were compared with mature fertilizer mixtures VP/UM 910 and VP/UM 880. The Low country trial at Moragalla Estate showed that the application of wood ash with refuse tea and urea could increase tea yield.

Tea factory firewood ash as a potential plant nutrient source and liming material for rehabilitation grass
The results of the Mid country experiment at Kurugama Estate showed that the soil pH values in all wood ash treatments were higher than the control and grass mixture-applied treatments indicating potential use of wood ash to correct the soil pH in rehabilitating fields and reduce the cost on dolomite application.

Evaluation of the most efficient strains of PGRP under field conditions
As observed in the previous year (first year in the pruning cycle), in all the locations New Peacock Estate, Pussellawa, Ratwatta Estate, Ukuwela and Midland Estate, Rattota, the inoculated treatment with series specific consortium indigenous to the respective soil series + 33% reduction of nitrogen + 50% reduction of P from the VP/UM 910 mixture recorded made tea yields comparable to the recommended rate of VP/UM 910 fertilizer treatment.

Evaluating agronomic practices of potential fuel wood species in different regions
Experiments carried out to find out the optimum spacing for planting Gliricidia& Cassia at Ury Estate, Passara and Calliandra at St Coombs Estate, Talawakelle showed that the most suitable spacing for Gliricidia, Cassia and Calliandra when grown as energy plantations would be @1m x1m.

Study on pesticidal properties of Marikolandu (*Artemisia* spp.)
Extracts of stems, leaves and roots of Artemisia were tested (a) for herbicidal effects on Alawangupillu [*Erigeron sumatrensis* (Retz.) using lettuce [*Lectuca sativa* (L) as the standard test plant.

All extracts significantly reduced ($p<0.05$) germination and seedling growth of *L. sativa* and *E. sumatrensis* at 50% concentration compared to the control. The 50% concentration of plant extracts also showed a significant effect on pests and repellence of earthworms and leeches ($p<0.05$).

CROP PROTECTION

Identification of safe pesticides and designing IPM methods

Screening of insecticides against Tea Tortrix (Homona coffearia)
Field efficacy of Proclaim (Emamectin benzoate) was evaluated at Fernland Estate. The results showed that three concentrations (0.26g/l, 0.3g/l and 0.35g/l) significantly reduced larval density of tea Tortrix when compared with the control.

Screening of alternative nematicides as prophylactic measure at planting and post-prune treatments
During the period under review, the new nematicide, Fluopyram 400 SC at doses of 500g, 600g, 750g and 800g were screened against *P. loosi* using incubation trials under controlled conditions in the laboratory and glass house pot experiments. Results showed that Fluopyram 400 SC at 800g a.i. per ha is a potential prophylactic measure at the time of planting and as post prune treatments

The experimental data generated with the new nematicide, Fluopyram 400 SC at 800g a.i. per ha for control of *P. loosi* and *R. similis* were submitted to the TRC for consideration for an interim recommendation.

Use of Silica as a potential defense elicitor to manage Blister Blight
Confirmatory trial on testing of monomeric silica as a potential defense elicitor was completed. Monomeric silica was applied as foliar spray at concentrations 0.2%, 0.3%, 0.5% and 1% and compared with 0.2 % Copper Oxychloride and untreated control. The results confirmed that silicon treatment at lower concentration (0.2-0.3%) significantly reduce Blister Blight severity when compared to the untreated control

Screening fungicides against tea Blister Blight
Confirmatory trails of two liquid formulations (Suspension Concentrate) of Copper Oxychloride + Copper Hydroxide (20% Cu) and Tribasic Copper Sulfate (27% Cu) were completed against Blister Blight. Copper Oxychloride + Copper Hydroxide formulation at 0.14% concentration and Tribasic Copper Sulfate formulation at 0.5% concentration gave comparable control with recommended Copper Hydroxide (50% Cu) wettable powder. Trials revealed that the residue levels of the chemicals at the above concentrations were lower than the Maximum Residue Levels (MRL) stipulated by the EU (40 ppm) for Cu at 7 day pre-harvest interval.

Goal 4F (Oxyfluorfen 480g/l SC) - Pre-emergent herbicide
Goal 4F was tested as a pre-emergent herbicides at Ratwatta estate in mid country, St Coombs estate in up country and St. Joachim estate in low country. Goal 4F 700ml/ha showed promising results as a pre-emergent herbicide for weed control in tea. However conformity of maximum residue levels in made tea has to be confirmed.

Brownout (Eucalyptol 0.2%w/v -SL) – Bio herbicide
Eucalyptol wastested under field condition at up, mid and low elevations as an alternative to Glufosinate. Results revealed that there was no difference in weed control between Brownout and standard treatment. Brownout 8 l/ha is found to be promising in managing common/general weeds in tea.

CLIMATE CHANGE IMPACT ASSESSMENT

Studies on physiological responses of tea to global climate change
A study conducted to determine the biomass distribution and carbon sequestration potential of bi-clonal seedling and TRI 2025 in Mid country region revealed that carbon sequestration potential as well as relative growth rates of the bi-clonal seedling tea were higher than that of the TRI 2025 reflecting their suitability for changing climates and the ability for climate change mitigation. The carbon sequestration of the bi-clonal seedlings and TRI 2025 in Mid-country were 6.83 Mg C ha-1 yr-1 and 0.63 Mg C ha-1 yr-1 respectively.

Carbon budgeting for different tea growing regions
In order to determine the soil respiration levels in the Up-Country tea growing regions, soil respiration measurements were carried out for Mattakelle series, Nuwara Eliya series and Maskeliya soil series

The highest soil respiration was observed in the Nuwara Eliya soil series followed by the Mattakelle and Maskeliya soil series. The soil organic carbon percentage also showed a similar pattern of variation where the highest organic carbon percentage ($p < 0.0001$) was observed in Nuwara Eliya soil series (7.5 %) followed by Mattakelle Soil series (2.87 %) and it was the lowest in Maskeliya soil series (2.54 %).

Analysis of climate change in different tea growing regions
A detailed report on climate change impacts on tea and adaptation measures in Sri Lanka, India, Kenya and China was compiled and published as a FAO publication. The booklet was launched at the FAO/IGG on tea session held at Naivasha, Kenya during 19-28 May, 2016.

MECHANIZATION OF FIELD PRACTICES

An in-depth investigation on the response of physiology, growth and yield of tea (*Camellia sinensis*) to mechanical harvesting

Quantification of the impacts of mechanical harvesting
Non-selective mechanical harvesting methods found to be removing *Arimbu* shoots indiscriminately while accumulating *Banji* shoots in the plucking table. Hence, non-selective harvesting devices (non-selective shear & motorized harvester) increase the dormancy of the tea bush while damaging the Sink capacity of the tea bush.

The root starch contents at ten months after the application of treatments were found to be significantly low under motorized harvesting, followed by non-selective shear, selective shear and manual harvesting.

TEA PROCESSING TECHNOLOGY AND PRODUCT DEVELOPMENT

Development & improvement of tea machinery and factory conditions

Optimization of electrical energy efficiency in trough withering using a Real time Heat and Mass transfer mathematical model

Software package was written in python language compatible to the single board computer called "raspberry pi 2" which is used in the control system. The mathematical model was incorporated into the computer program to control process parameters. Airflow controlling unit (incorporated with VSD) and hot air supply unit were coupled with the experimental trough system. Temperature, RH & pressure sensors were installed in the withering trough and coupled to the control system.

Investigation on combined IR and Fluid bed drying in relation to quality and cost against conventional fluid bed drying

A pilot scale IR dryer was designed for pre-drying of tea. A control system has been incorporated into the design to operate heating unit at a desired and steady temperature.

Development of an effective monitoring and control system for fluidized bed drying (FBD) of Orthodox-Rotorvane tea

A PLC based monitoring & control system was designed and installed to the dryer with a view to automate drying of tea. The control system was programmed to monitor and control drying process parameters. The control arrangements in the dryer were perfected for adjusting the process parameters.

Development of Self-cleaning Sifter with multiple mesh frames of grading long leafy and wiry type teas

A self-cleaning mechanism was developed for the sorting machine, the Michie sifter, to automatically remove the clogging tea particles during sorting and obtained patent for the technique. In tea factories, four numbers of Michie sifters having different size meshes are used in completing the sorting process. Therefore, a collaborative project was commenced with M/s. Helix Engineering (Pvt) Ltd. to design and develop one single machine having all the meshes. A research grant valued Rs. 1.31 million has been awarded by National Research Council to carry out the research project.

Study on non-ferrous cast components of tea machinery and stainless steel CTC segments

Chemical analysis of vane samples, cone samples, batten samples and CTC segment samples were conducted at the Industrial Technology Institute (ITI). Hardness and microstructure of these samples were conducted at the Department of Materials Engineering, University of Moratuwa. Except one sample chemical composition of other cast copper alloy cast component samples deviated from that of gunmetal. Results revealed the importance of having good foundry practices in casting the components. Using scraps having chemical composition closer to gunmetal and adding required amount of virgin raw material after checking the chemical composition of scraps are recommended to ensure desired chemical composition.

Evaluating alternative energy sources for tea processing
A project was designed to develop woodchip feeding & controlling system and a suitable fire grate for the present air heaters. Preliminary discussions were held with the National Engineering & Research Center and the Lalan Energy Solutions (Pvt) Ltd to carry out a collaborative project on the use of woodchips as an alternative energy source for tea drying.

Development of value added tea products
Extraction of protein from spent tea
A method to extract protein concentrate using membrane filtration technique has been developed. It comprises 24% protein, 12% total ash, 0.4% ether extract, 0.4% crude fiber and 7% polyphenols. A collaborative study has been initiated with the Faculty of Agriculture, University of Peradeniya, to develop the product as an animal feed.

SOCIO ECONOMICS AND RESOURCE PLANNING

Estimating the effects of Research Expenditures on tea production in Sri Lanka
A study conducted with a view to identify the length of the lagged research expenditure on tea production and to measure the impacts of research expenditure on tea production revealed that it has taken eight years to observe the positive effect of research investment on tea production. Lagged research expenditure, lagged price and previous year productivity showed positive and significant ($P<0.05$) influence on tea productivity. Moreover, fertilizer prices showed a negative and significant ($P<0.1$) relationship with tea productivity. Finally, study suggests that Sri Lanka tea production could be increased by increasing investment in research, because generation of new technology could be rooted towards the growth of agricultural productivity.

Estimation of technical efficiency and its' determinants in the tea smallholding sector in the Low country
A study conducted to find out the determinants of technical inefficiency & technical efficiency and the constraints faced by the tea smallholders in the Low country showed that the burning constraints faced by smallholders were low green leaf price (74%), poor quality fertilizer (68%), labour shortage (50%), increased COP (38%) and poor quality of planting materials (28%).

Current status of and returns to investments in soil fertility management strategies (SFM) in the Corporate sector tea plantations in Sri Lanka
A study to investigate the current status of and returns to investments on SFM in the Corporate sector tea plantations revealed that the investments in SFM varied among regions and management companies. The investments in lateral and leader drains, terracing, forking and burying of pruning were seen cost effective and give higher returns at current input prices and had a positive relationship with tea yield. Moreover, there was a positive and significant influence of investment in burying of pruning on tea yield. However, it was found that the SFM strategies have not been adopted by the plantations as per the TRI recommendations. Findings of this research emphasis the needs for policy interventions by highlighting the importance of adopting SFM strategies in tea plantations for sustainability of the tea industry.

ADVISORY & EXTENSION ACTIVITIES

During the year 2016, several requests related to the failure of tea nurseries in Up country region were inspected and advised on how to minimize the casualty rates. Meanwhile, bush debilitation was the main issue in the low country region addressed by the advisory & extension staff in Ratnapura region. The incidence of roots-eating-ant (Deniyaya ant) (*Acropyga acutiventris*) were specially reported, from several smallholdings in the Nawalapitiya and Gampola areas of Kandy District.

Group Training programs: A total number of 233 training programs, seminars, work-shops *etc*., were conducted for the staff of the corporate sector tea plantations and the tea smallholders, in Talawakelle, Kandy and Ratnapura regions.

Group Training programs: A total number of 233 training programs, seminars, work shops *etc*., were conducted for the staff of the corporate sector tea plantations and the tea smallholders, in Talawakelle, Kandy and Ratnapura regions.

Regional Technical and Extension Forum (RTEF)
Fourteen RTEF workshops were conducted during 2016, with participation of the TSHDA covering all eight Regional Manager Regions of the TSHDA.

NVQ Level 4 Full Time Residential Training Program for Tea Field Officers
TRI conducted a 4 months residential training program leading to National Vocational Qualification (NVQ) Level 4 for the first time of the history, This NVQ training program was developed, organized and coordinated by the National Institute of Plantation Management as a part of their annual training schedule.

The Govi Mithuru; the mobile-based agro advisory service: A collaborative project of CABI, DOA, TRI and the Dialog mobile
The Advisory staff and the several scientists involved in developing the voice messages on tea cultivation and crop protection for the, agro advisory service of the Dialog mobile company in Sri Lanka; the collaborative project of the DOA and the CABI-South Asia, designed to improve the access to information on nutrition-sensitive health and agricultural practices, among farmers and the rural people, by harnessing the power of mobile technology.

ST. COOMBS ESTATE, TALAWAKELLE

A yield of 1869 kg/ha was recorded in the year 2016. Gross sale average for 2016 was Rs 558.09/kg which was Rs.90.8 above the Western High Grown elevation average and ranked first in the western high grown category. St. Coombs estates obtained all-time record price for Dust No 1 @ Rs.860/- and achieved “6 top Prices” in the auctions during 2016. The Estate made a profit of Rs. 12,299,570.21 for the year under review.

ST. JOACHIM ESTATE, RATNAPURA

Mr. Anuradha Nanayakkara resigned from the post of Superintendent of St. Joachim Estate with effect from December 15, 2016. Tea manufacture. An NSA of 469/78 was achieved in the year 2016 as against 393/09 in 2015. St. Joachim recorded a GSA above the Low grown average continuously after October 2016. However, St. Joachim Estate resulted in a loss of Rs. 9,471,675/=.

Awards and Recognitions

Dr. K M Mohotti and Mr. K K Ranaweera received National Research Council merit awards for their scientific publications for the years 2013 and 2012 respectively.

Dr. I S B Abeysinghe has been appointed as a member of the Council for Agricultural Policy (CARP) by the Hon. Minister of Agriculture (Annexure 3).

Dr. I S B Abeysinghe was invited to serve on the panel of industry specialists of the chartered accountants annual report awards competition 2016.

Dr. K M Mohotti was invited as a guest speaker to present a paper at the Third Annual Smart Plantation Management Conference which will be held in Kuala Lumpur, Malaysia on 7-8 December 2016.

G.D. Sinniah received an equipment grant from NSF worth of 1.356 million (NSF grant RG/2015/EQ/11).

G.D. Sinniah received an award for scientific excellence during 2014-2015 in the Tea Sector at Sixth Plantation Crop symposium, November 3-5, 2016, BMICH, Colombo.

G.D. Sinniah received a fellowship from Government of India, Centre for Science and Technology of the Non-Aligned & Other Developing Countries (NAM S&T Centre) Research Training Fellowship for Developing Country Scientists (RTF-DCS) 2016-17 for six months period from December 2016 to June 2017.

M. Niranjan received the award for the best presentation for the paper titled "Investigation of die back of Grevillea robusta in tea plantations of the Uva region in Sri Lanka" at the Sixth Symposium on Plantation Crop Research held during November 3-5, 2016 at the BMICH Colombo.

At the Sixth Symposium on Plantation Crop Research, the paper on "Development of self-cleaning mechanism for grading orthodox leafy teas in a reciprocating type sifter" authored by G L C Galahitiyawa, M A Chamindra and K B K Sripalika which was presented by Mr. M A Chamindra, Research Officer, Process Technology Division, TRI was adjudged as the overall best research paper of the symposium.

Dr. I S B Abeysinghe was invited to deliver a lecture on "Present status and challenges for future development of the plantation sector" by the Sri Lanka Organization of Agriculture Professionals on 9th December 2016 at National Agriculture and Communication Centre, Gannoruwa.

A NSF grant of Rs 4.571 million was given for the purchasing of Photosynthesis system with respiratory chamber (compact and portable).

A research grant of Rs. 1.31 million was awarded to the Technology Division by the National Research Council to carry out a research project titled "Development of Self-Cleaning Sifter with multiple mesh frames for grading long leafy & wiry type teas" with effect from November 10, 2016 to June 09, 2017.

M A B Ranatunga was awarded a research fellowship under United Nations University (UNU) - Kirin fellowships program to conduct a research project at the Food Research Institute, National Agriculture Research Organization (NARO), Tsukuba, Japan from April 2016 to April 2017.

Appointments

Dr W S Botheju was appointed as Deputy Director Research (Process Technology) w.e.f. 08.08.2016.

M A Chamindra and Mr K Ranaweera were appointed as Research Officers w.e.f 08.08.2016 and K W N Nadeeshani was appointed as an Experimental Officer w.e.f 08.08.2016

Ms. H B Tharangika, Ms. A P C S Pathirana, Ms. Lakshika Attanayaka, Ms. V A N Wickramasinghe, Ms. M K S Dilrukshi, Mr. A S Ghouse, Ms. W H D U Pushpakumari, Mr. D L I U Disanayaka, Ms. R A N M De Alwis, Ms. S M P R Shalika, Ms. L C Sugathapala, Ms. Kannan Pallavi and Ms. P T P Lakshani assumed duties as Technical officers (R and D) on 14th March 2016.

Mr. R M H Aravinda and Mr. H M S D Kulathunga were assumed duties as Technical officer (R and D) on 2nd and 16th May 2016 respectively.

Mr. G P Roopasinghe assumed duties as Junior Clerk of St. Coombs estate on 1st April 2016.

Dr W S Botheju assumed duties as Deputy Director Research (PT), Mr M A Chamindra and Mr K Ranaweera as Research Officers, Ms. K W N Nadeeshani as Experimental Officer and Mr. W A Nishantha as Accounting Officer.

Mr. R M Nuwan Nayanajith assumed duties as Procurement Officer with effect from 1st July 2016.

Ms. W A K Ruwani Lakmali assumed duties as the Personal Assistant to the Director with effect from 8th July 2016.

Mrs. O. Surangi Perera was appointed as Deputy Director (Administration) with effect from 4th October on acting basis.

Mr. H M C P K Jayatilake, Mr. A M E T Attanayake, Ms. G A D Gallage, Mr. I A G N Attanayake, Ms. S D K Nadeeshani and Ms. W M M I K Wijesinghe were recruited as Management assistants and Mr. J M G W Jayaweera as an Electrician and Mr. P D D Perera as Driver.

Overseas visits

Dr I S B Abeysinghe, Director, joined the Ministerial Delegation to Turkey from February 3-7, 2016.

Dr G P Gunarathne, Principle Research Officer, Soils & Plant Nutrition Division participated in the Rare Earth Awareness Program in China from March 20-25, 2016.

Mr B A D Samansiri, Principal Research Officer, Mr J C K Rajasinghe, Principle Advisory Officer and Mr K G J P Mahindapala, Advisory Officer participated in the "Seminar on Pollution – Free Tea Production" from March 25– June 19, 2016 in China.

Mr M A B Ranatunga, Senior Research Officer, Plant Breeding Division participated in the "Research Training Grant form United Nations Unity Kirin Fellowship Program 2016" in China from March 20-25, 2016.

Dr I S B Abeysinghe, Director, Dr Keerthi Mohotti, Deputy Director Research (Production) and Dr M A Wijeratne Principal Research Officer, Officer-in-Charge, TRI Low country Regional Center participated in the "FAO/IGG on Tea Intercessional meeting" from May 23-27, 2016 in Kenya.

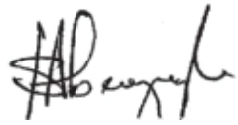
Dr I S B Abeysinghe, Director, participated in the "New Agro Chemical MRLS for Tea Imports G.C.C Countries Meeting" from July 17-21, 2016 in Saudi Arabia.

Dr. M M J P Gawarammana, Chairman, TRB represented TRI in the Ministerial Tea Delegation to China from August 1-6, 2016.

Dr Keerthi Mohotti, Deputy Director Research (Production), participated in the "Third Annual Smart Plantation Management Symposium" from December 5-9, 2016 in Malaysia.

Mr M A Chamindra, Research Officer, participated in the "3rd Annual Smart Plantation Management Symposium" from December 6–9, 2016 in Malaysia.

Dr. (Mrs) G D Sinniah, Senior Research Officer participated in the "Research Training Fellowship for Developing Country Scientist 2017" from December 18 to June 19, 2017 in India.



Dr. I Sarath B Abeysinghe
Director
Tea Research Institute of Sri Lanka

TRI STAFF MEMBERS

DIRECTORATE

Director
Dr. I S B Abeysinghe, B Sc (Peradeniya, Sri Lanka) Ph D (Sheffield, UK)

Additional Director
Dr. L S K Hettiarachchi, B Sc (Peradeniya, Sri Lanka) Ph D (Aberdeen, UK)

Deputy Director - Research (Production)
Dr. K M Mohotti, B Sc (Peradeniya, Sri Lanka) Ph D (Reading, UK) F Biol (Sri Lanka), C Biol (Sri Lanka)

Deputy Director -Research (Process Technology)
Dr. W S Botheju, B Sc (Colombo, Sri Lanka), M Phil (Peradeniya, Sri Lanka), Ph D (Peradeniya, Sri Lanka)

Personal Assistant to Director
W A K R Lakmali, B.Com (Kelaniya, Sri Lanka)

Office Staff
S Shanmuganathan, Stenographer/English
Devika Ratnayake, Stenographer /English
R J Rayappan, Management Assistant (Clerical)

General Workers
P Selvaraj
P Selvaraj
S John Patrick

ADVISORY & EXTENSION DIVISION

Head
B A D Samansiri B Sc Agric. (Peradeniya, Sri Lanka) M Phil (University of Philippines) Principal Advisory Officer

Principal Advisory Officers
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Dr. V S Sidhakaran, B Sc Agric. (Peradeniya, Sri Lanka) M Sc (PGIA Peradeniya, Sri Lanka) Ph D (TNAU, India)

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A L R U Kumara, B Sc Agric. (Peradeniya, Sri Lanka) M Sc (PGIA Peradeniya, Sri Lanka) Actg. Officer-in-Charge, Uva Extension Center, Passara
C J Liyanarachchi, B Sc Agric. (Wayamba,Sri Lanka) M Sc (PGIA Peradeniya, Sri Lanka)

Extension Officers
Haran Jayaweera, Undergraduate Level V (Open University)
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A Abeysooriya, B Sc Agric. (Peradeniya, Sri Lanka)
S P A K P Jayarathne, B Sc Agric. (Peradeniya, Sri Lanka)
P D De Alwis, B Sc Agric.(Ruhuna, Sri Lanka)
G S Pradeep, B Sc Agric (Rajarata, Sri Lanka)
H N Dayananda, B Sc Agric.(Sabaragamuwa, Sri Lanka)
H J M de Silva, B Sc Agric. (Ruhuna, Sri Lanka) – Up to May 2016
Ms.I D C Sajeevika, B Sc Agric. (Sabaragamuwa) - Up to July 2016
Mr. R J K Rajapakse, B Sc Agric. (Ruhuna) – Up to November 2016

Technical Officers
N S Ekanayake
M G M J Kumara, (Higher Diploma in Technology)

Management Assistant
A M E T Attanayaka, Management Assistant (Clerical)

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B Manonmany

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Technical Officer
P T P Lakshani, B Sc Agric. (Uva Wellassa, Sri Lanka)

General Worker
P D S S De Silva

AGRONOMY DIVISION

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E W T P Premathunga, Low Country Regional Centre, Ratnapura

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N Sridevi

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Technical Officer
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R Puwaneshwaran
K Balendran (from 01st August)

BIOCHEMISTRY DIVISION

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A S Ghouse, B Sc (Jayawardenapura, Sri Lanka)

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D Rita
K Vishvanathan
S Jegadesan
A K J Athukorala
A M U Liyanage

PLANT PATHOLOGY DIVISION

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Research Officer
M Niranjan, B Sc (Peradeniya, Sri Lanka)

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Renuka Perera

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V A N Wickramasinghe, B Sc (OUSL, Sri Lanka)

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V Rathakrishnan
A Selvanayagam
S Parameswaran

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W M S Weerawardena, B Sc Engineering (Chemical) (Peradeniya, Sri Lanka)
W M U A B Marapana, B Sc (Jayawardenapura, Sri Lanka) Low Country Regional Centre, Ratnapura
L Jayasinghe

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R Illangovan
M Mohanraj
S Shasikumar

Mechanical Workshop
A Nandasiri, Technological Officer (Mechanical) (Technical Collage, Kandy)

Mechanics
D L J Weerasooriya
M C Gabrial

General Worker
K Rajalingam

ENTOMOLOGY & NEMATOLOGY DIVISION

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P V A R Abeysekera, Mid Country Regional Centre, Kandy
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B S N Vitana, NDT Agriculture, (HARDI, Ampara), Low Country Regional Centre, Ratnapura
A K Prematunga, Low Country Regional Centre, Ratnapura
U B Herath, Mid Country Regional Centre, Kandy
P K Jayawickrama, Advisory & Extension Centre, Talgampola

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Kannan Pallavi, B Sc Chemistry (Pune, India)

General Wokers
S Hettiarachchi
V Sabarathnam
R Gunasiri
L A R Priyanjali

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R W M S K Amunugama, Library Assistant, Diploma in Library Science (Sri Lanka Library Association)

General Worker
S Parameswary

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Publication & Publicity Officer
V P Ranawakage, B Sc Agric. (Uva Wellassa, Sri Lanka.)

I A G N Attanayaka, Management Assistant (Clerical)

General Workers
A Krishnamenan
P Sivapalan

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Experimental Officer
U D Alagiyawadu

General Worker
T Kogilan

Photography Unit
K G R Niroshan, Photographer, Diploma in Photography

General Worker
A Ambiga

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N D M Karunadasa, Administrative Officer, B.Mgt (Kelaniya, Sri Lanka)
G S Ariyarathna, Public Relation / Welfare Officer, B Sc (Rajarata, Sri Lanaka)
K R M Priyanatha, Management Assistant (Clerical)
W M S R Wanasinghe, Management Assistant (Clerical)
C Jayaram, Management Assistant (Clerical)
S Dharmalingam, Management Assistant (Clerical)
A A H Chinthaka, Management Assistant (Clerical)
P P H Wijesena, Management Assistant (Clerical)
S D K Nadeeshani, Management Assistant (Clerical)
W M M I K Wijesinghe, Management Assistant (Clerical)

General Workers
N Pushparaj
V Chandrasekaran
L Vigneshwaran
A Dhiwyakumar
V Jasinthamery
M B W Samanthika
S Rejinamery

ELECTRICAL UNIT

Electrician
J M R K Bandara

General Workers
J Anthony
K Jayarathnam
L R Rajalingam
M Bernad
S Balakrishanan
R Robert Sagayam
P Thirumurugan

ENGINEERING DIVISION

C J B Abeykoon, Engineering Assistant (Civil) (Certificate in Technology)
K Pahalathantrige, Technological Officer (Civil)
W C K Fernando, Chief Plumber Mechanic (Diploma in Plumber & Pipe fitting)
P T Perera, Clerk /Typist
I W N Kumara, Clerk /Typist
R Jayraj, Carpenter

General Workers
A Loaganathan
H M Wijesekara
W C Poul
B K Jayasinghe
R Velmurugan
D A Wimalasiri
S Balakrishnan
S Thangaraj
R Pakiyanathan
P Weeramuttu
M Peiris
P Saranawanaraj
P Kalimuttu
S Sabapathi
A Loordudasan
S Sylvester
S Milton Kenady
G Kanagaraja
M Irudayaraj
G Jayapragasam
Ramasamy Ravi
K A P Dharmadasa
A Augusteen
P Letchumar
K A O Dharmadasa
S Christopher
P Paramasivam
S Muthukumar
P Vijayakumaran
D A Sirishantha

FINANCE DIVISION

M V Mohan, Accountant
W M T B Weerasekara, Accountant, Institute of Chartered Accountants of Sri Lanka
G B Jayawardena, Accounting Officer, B Sc (University of Kelaniya)
W A Nishantha, Accounting Officer
B K S Herath, Accounts Clerk
K T U Kulathnga, Assistant Store Keeper
Saman Hewasiliyan, Accounts Clerk
H P W Gunasekara, Stores Assistant
I Jayawickrama, Management Assistant (Accounting)
A A A P Amarathunga, Management Assistant (Accounting)
H B Thalgahagoda, Accounts Clerk /*cum* Cashier
H N Dharmapala, Management Assistant (Accounting)

K A D Sudath Pradeep, Management Assistant (Accounting)
T S S Kumara, Management Assistant (Accounting)
R M N M Ariyarathna, Management Assistant (Accounting)
D S C Weerasuriya, Management Assistant (Accounting)
G A D Gallage, Management Assistant (Clerical)

General Workers
G S Raju
P K Sarath
K Jegatheshwaran
P Muthukumar
S N N Samanthika
S Rajanayagam

GUEST HOUSE/ CIRCUIT BUNGALOWS/ HOSTELS

R M B D Ratnayake, Circuit Bungalow Keeper
G Weeraperuma, Guest House Keeper

General Workers
G K G Dhanushka
P Madialagan
T Pushparaj
M Vivakanandan
K Gnanasoundary
R Sekar
T Selvendran

INTERNAL AUDIT UNIT

Internal Auditor
K P Ranasinghe, BA Special (HRM) (Ruhuna, Sri Lanka)

V E Kumara, Management Assistant (Accounting)
N C Jayaweera, Internal Audit Clerk

General Worker
R Manoharan

PURCHASING UNIT

R M N Nayanajith, Procurement Officer, B.Com (Jayawardanapure, Sri Lanka)
P D S L de Silva, Clerk/Typist
H M C P K Jayathilaka, Management Assistant (Clerical)

General Workers
K Balakrishnan
T Balakrishnan

TELEPHONE EXCHANGE

K M Senewirathna Banda, Receptionist *cum* Telephone Operator
P K N Damayanthi, Receptionist *cum* Telephone Operator

General Workers
P Vythilingam
D Gabriel

TRANSPORT UNIT

S N T Fernando, Engineering Assistant (Mechanical)
R A C Lasantha, Management Assistant (Clerical)
R A C Jayasinghe, Driver
L Murugesu, Driver
W G Senewirathna, Driver
R M N Premathilaka, Driver
Ranjan Gunasekara, Driver
U K A B Uduwella, Driver
W S G W Perera, Driver
M Maradamuththu, Driver
K B V U N Gunasena, Driver
W A D P M U Attanayake, Driver
G G M Ranasinghe, Driver
S P Dammika Tharanga, Driver
T K A Kumarasinghe, Driver
H A D Neranjan, Driver
W D Wijesooriya, Driver
P D D Perera, Driver

General Workers
W M S J Weerasinghe
S L Joseph
M Thasarathan
A Muniswaran

MOTOR GARAGE

W G Wijerathna, Motor Mechanic
A P G I H Anwarama, Motor Mechanic & Mechanic

General Worker
K Rajarathnam
V Krishnamoorthy
S Kamalaruben
Mohanaselvam

LOW COUNTRY REGIONAL CENTRE, RATNAPURA

Officer-in-Charge / Principal Research Officer
Dr. M A Wijeratne, B Sc Agric. (Ruhuna, Sri Lanka) Ph D (London,UK)

Administrative Officer
B M B Basnagoda, BA-Mass Media Special (University of Colombo)

Office Staff
P V G Karunanayaka, Management Assistant, Stenographer
K Gunawardena, Technological Officer (Civil)
H K Seetha, (Certificate in entrepreneurship) (Open University)
K A S Piyatilaka, Clerk Typist
D D G S Jayasinghe, Management Assistant, B Sc Admin (Jayawardenapura, Sri Lanka)
U W K Munasinghe, Plumber Mechanic
N A Bowie, Mechanic
J M G W Jayaweera, Electrician, N C T Diploma, (Technical Collage, Badulla)
M D Sarath, Guest House Keeper
P D R De Silva, Driver
S S Sunil, Driver
P G Amarathunga, Driver
S M C M Senanayaka, Driver
G V S Jayalath, Driver
J T S Weerakkody, Driver
K M T T Bandara, Driver

General Workers
A K J Athukorala
D V S P Denagama
W M D C Perera
H A T K K Sumanaweera
I D Subasinghe
P D N B D Silva
A M U Liyanage
M Dewaraj
R Chandrakumar
K P Tissa Karunarathne
T Rajendran
K A Karunathilake
M Parwathi
K P N Darmadasa
S Manikkavasagam
M Maheswaran
S Selwendran
G K Priyantha
G G Chandrakeerthi
S S Kumara

C K S Kumara
G A M Maduranga
PUA Pathirana
R M C P Dias
G T G J Perera
N Pushparaj
P S Shiwashaktikumara
V Rishandran

MID COUNTRY REGIONAL CENTRE, KANDY

Actg. Officer-in-Charge / Advisory Officer
K R W B Kahandawa, B Sc Agric. (Peradeniya, Sri Lanka)

Office Staff
R M D K Rathnayake, Management Assistant (Clerical)
G A S Gunasekara, Accounts Clerk
W M Abeybandara, Guest House Keeper
P K Wijeratna, Driver
W D J P T Bandara, Driver
G Padmasiri, Driver
M G B S Priyashantha, Driver

General Workers
R M Upali Wijerathne
R M R J B Ratnayake
N D Wickramasinghe
P Premarathne

UVA EXTENSION CENTRE, PASSARA

Actg. Officer-in-Charge / Advisory Officer
A L R U Kumara, B Sc Agric. (Peradeniya, Sri Lanka) M Sc (PGIA Peradeniya, Sri Lanka)

Office Staff
K M T Senevirathna, Driver

General Workers
R H C Nisansala
S M P Ramyalatha
R W S C Kumara
S M Chularathne
M Ramasamy

GALLE EXTENSION CENTRE, TALGAMPOLA

Officer-in-Charge/ Advisory Officer
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Office Staff
P V D Chandrakanthi, Accounts Clerk
P S Kulasiri, Field Supervisor
M Sarath, Field Supervisor
Jagath Prasanna, Circuit Bungalow keeper
Kapila Chaminda, Driver

General Workers
D G Chandralal
W Gamini

DENIYAYA EXTENSION CENTRE, DENIYAYA

Officer-in-Charge / Advisory Officer
S P Ratnayake, B Sc Agric. (Ruhuna, Sri Lanka) MBA (Wuhan University of Teachnology, PR, China)

Office Staff
O W Jayawardena, Station Assistant
M D Chandana, Driver

KALUTARA EXTENSION CENTRE, MATUGAMA

Officer-in-Charge / Extension Officer
Haran Jayaweera, Undergraduate Level V (Open University)

Office Staff
T C Samanmali, Management Assistant
D G L Amaratunga, Management Assistant, B Sc Eco-B.M (Sabaragamuwa, Sri Lanka)
S A C Suraweera, Driver

General Workers
C Liyanapathirana
G A A N Gurusinghe
M Wijethilake
G D K Lakmini

SOILS & PLANT NUTRITION LABORATORY COMPLEX, WALAHANDUWA

M D Sarath Kumara, Field Supervisor
R Kulathunga, Management Assistant
W K J Samarasekara, Driver

General Worker
K P L U Pathiranage

RESEARCH HIGHLIGHTS

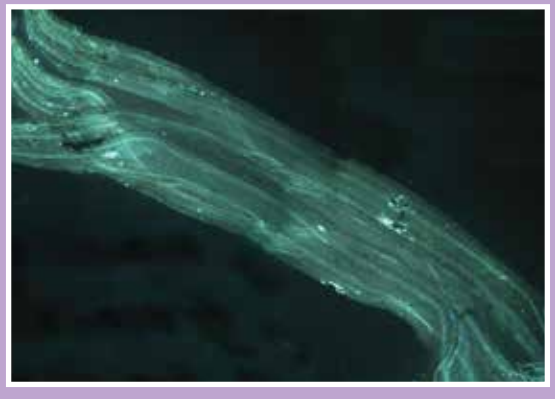
CROP IMPROVEMENT

Breeding of new tea cultivars to improve productivity, quality and to face emerging challenges

Development of new tea cultivars

Controlled hybridization program of 2016 was focused on performing wide hybridization using different Camellia sub species available in the exotic germplasm collection. Parents for the crossing program has been selected based on the diversity of amino acids *viz*. theanine and proline profiles and it is expected to produce cultivars with variable amounts of metabolites for commercial exploitation. Around 575 crosses were made using four parental combinations and 131 fruits have been harvested. Monitoring and transferring of germinated seeds to the nursery bags have been continued.

To identify widely adaptable tea cultivars for better exploitation in divers agro-ecologies, one Phase I trial that consists of accessions selected from hand crosses made from controlled hybridization programs during 2006-2007 was established at Talawakelle. These crosses were made using diverse parental materials and promising accessions were selected based on the preliminary evaluations on yield and visual growth performances. A multi-location Phase II trial was established at the TRI Regional Center, Hantane with the promising accessions selected from the Phase II trial in the Up county region.



Development of new progenies through backcrossbreeding
Selected F1 plants from hybridization program in 2013 were established in a green house. Special foliar and ground fertilizer mixtures were applied to initiate flower buds under control environment conditions to avoid seasonal variation of flower initiation. Backcrossing program was commenced using three parental combinations.

Estate cultivar selection program
Estate cultivar selection program was continued with two fold objectives *viz*. selection of promising land races for developing new tea cultivars and to conserve seedling diversity in old seedling tea fields. Evaluation of two Phase I trials were continued with promising seedlings selected from Glenanore Estate, Haputale at the TRI Regional Centers at Hanthana and Passara. Evaluations on tolerance to Shot Hole Borer was continued.

Mass selection of seed stocks established in Endana Estate, Kahawatta was carried out in collaboration with the Entomology Division. Twenty two elite bushes were selected based on visual growth performances and LCLWT assessment and propagated for further evaluations.

"TRI 5000 series" – next series of tea cultivars
Evaluations of TRI 5000 series potential cultivars on 37 adaptive trials were continued with the partnership of growers. The second cycle yield and growth performance evaluations of two trials were continued in WU2 Agro-climatic region (Dayagama West and Glasgow Estates). Results on biotic and abiotic stresses of potential TRI 5000 series cultivars were summarized and the data were being analyzed for final recommendation to the Up country wet zone.

Weekly harvesting of adaptive trials established at tea small holders lands in the Up country, Mid country, Low country and Uva regions have been continued. These grower-driven, community- based trials established will serve as nucleolus mother bush blocks for dissemination of new planting materials.

Profiling of green leaf biochemical compound *vis*. chlorophylls, carotenoids, total polyphenols, caffeine and catechins of potential TRI 5000 series cultivars in the Up country and Uva regions has been initiated.

Improved seeds as alternative planting materials for marginal tea growing areas
The research program to assess the reproductive phenology and breeding systems of teaseed gardens was continued to enhance the productivity of Bi-Clonal garden at Reucastle Estate, Dehiowita, Poly–Clonal gardens at Salawa Estate, Hanwella and Rambukkanda Estate, Ratnapura.Flowering and fruiting phenology, floral morphology and pollen biology assessments have been completed during the period under reference. Based on the outcomes of the study, five bi-clonal combinations and four poly-clonal combinations were identified for use in future seed gardens. Comprehensive efforts were taken to enhance the productivity of seed gardens and to increase availability of seeds for a constant seed supply to the growers.

Characterization and metabolite profiling of tea germplasm
Characterization of germplasm is an important initial step towards proper utilization of genetic resources in plant breeding. When compared with vegetative traits, reproductive morphology, especially the pistil traits are considered as reliable criteria in taxonomical studies of higher plants. Fifty four accessions selected from the exotic germplasm collection, were characterized using 14 floral traits to discriminate them into three major taxa. Of the material studied, 39 accessions possess geniculate type styles, four with united styles while 11 accessions recorded ascending styles representing *Camellia sinensis* var. *sinensis* (China type), *Camellia sinensis* var. asamica (Assam type) and *Camellia sinensis* sp. *lasiocalyx* (Cambod type) respectively. Results revealed that the exotic collection predominantly represents China type (72%) followed by Cambod type (20%)

Acquisition of diverse accessions to the germplasm
To broaden the genetic base of the tea germplasm, continuous efforts have been made to uplift the diversity of germplasm accessions. Under this program seventeen exotic tea accessions have been propagated during the last year.

A study aimed at identification of barriers for pollen tube germination was initiated using diverse tea germplasm accessions. Preliminary results revealed that the variations of degree of pollen tube growth depend on the accessions

Use of *in vitro* techniques to supplement the conventional tea breeding program
Research activities aimed at developing necessary tissue culture protocols to supplement the conventional tea breeding program was continued. Micro-shoots of seeds obtained from hybridization (2014) were transferred to the green house for rooting and acclimatization. Successfully rooted micro-shoots were transferred to the nursery bags and were maintained in the green house to achieve maximum growth.

The project to develop plants through direct somatic embryogenesis from leaf callus and stem nodal for facilitating mass multiplication of tea cultivars was continued. The research activities aimed at mass production of planting materials via liquid culture system was also continued.

Development of a cell culture protocol for tea
Cell cultures obtained from TRI 2043 and TRI 2024 cultivars were maintained for disease screening.

Screening of 5000 series tea cultivars for drought under Low country Wet Zone
The data were not collected as the responsible officer was injured due to the tragic bus accident. The experiment is in progress.

Screening of 5000 series tea cultivars for drought under Mid country Wet Zone
The data were not collected as the responsible officer was injured due to the tragic bus accident. The experiment is in progress.

Screening of 5000 series tea cultivars for drought under Uva region

This study was conducted with the objective of assessing the growth and distribution of root system of different accessions of tea.

A field experiment was started at Uva Advisory and Extension Centre, Passara using 5000 series accessions *viz*. 243, 199, 210, 88, 89, 21, 5, 17 and 208 with control cultivars *viz*. TRI 2025, TRI 2023, TRI 3019, DT1 and DN. The recommended agronomic practices were carried out throughout the experiment.

Destructive sampling of whole tea bushes was done and the root system was separated. The total root depth, horizontal root distribution, root length, both fresh and dry weights of the mature and feeder roots were measured. The results showed that there were no significant differences amongst cultivars /accessions in terms of root depth, root horizontal distribution, feeder roots dry weight, root length, mature roots fresh weights, mature roots dry weights and mature root length.

The experiment is in progress.

Screening of tea accessions, cultivars and seed stocks against major tea pests

Integrated pest management in tea predominantly depends on the selection of cultivars and seed stocks resistant and / or tolerant to economically important tea pests in the different Agro ecological regions as a measure of minimizing pesticide usage while protecting the environment.

Screening of tea cultivars against nematode pests

During the period under review, several potential accessions, cultivars and seed stocks for low, mid and high elevations chosen by the Plant Breeding Division were screened against *Pratylenchus loosi* and *Radopholus similis* as per the standard screening protocols at various experimental localities maintained for nematological studies.

Two sets of test cultivars (VP 89) potential for high elevations and Uva were screened against *Pratylenchus loosi* in nematode screening tanks populated with heavy densities of nematodes at the Nematology Experimental Areas at Talawakelle and Passara respectively. As per analysis of the standard parameters i.e. growth measurements *viz*. shoot and root weights (fresh and dry) and intermodal length and nematode index and root fragments in soil, test cultivars are ranked as tolerant and moderately tolerant cultivars against *Pratylenchus loosi* for Up country and Uva.

Final assessments of test cultivars of VP 89 coded as 244, 568, 612, 613, 626, 655, 696, 704, 743, 768, 860, 909, 912, 925, 951, 952, 963 and standard cultivars of TRI 2024, TRI 2025, DT 95 and TRI 4052 in Talawakele were completed.

Final assessments of test cultivars of VP 89 coded as 244, 612, 626, 655, 704, 768, 860, 909, 912, 925, 952, 963 and standard cultivars of TRI 2024, TRI 2025 and TRI 4052 in Passara were completed.

Experiments were in progress to screen test cultivars coded as 497, 582, 15, 101, 5, 210, 89, 272, 208 and standard cultivars TRI 2024, TRI 2025, TRI 4052 and DN in screening tanks at Hantana against *Pratylenchus loosi* and *Radopholus similis*.

Final ranking of the selected test cultivars for up country, mid country and Uva against *Pratylenchus loosi* and *Radopholus similis* will be submitted to the Plant Breeding Division for consideration upon completion of the data analysis.

Screening of seed cultivar against SHB
Assessments were carried out for seed cultivars of USP 2 trial for determining resistance against SHB. Among the 43 accessions of Rambukkande KEN 16/3, accessions 12, 22, 29, 31, 34, 39, 47and 52 found to be moderately resistant to SHB

Screening of accessions against LCLWT
Prune time assessments were carried out to determine tolerance level of accessions of LVP 75, LVP 76, LVP 77, LVP 78, LVP 79 and LVP 83 against LCLWT and the results are given below. Tolerance was evaluated according to the colony development in the plant at the prune time.

Resistant: colony confined to the rotted stump. No feeding marks on hard wood
Tolerant: colonized up to branches
Susceptible: colonized up to main stem
Highly susceptible: colonized up to collar region

LVP trial No.	Tolerant accessions against LCLWT
LVP 75	12, 613, 294,
LVP 76	PR297, PR160, PR173, PR10
LVP 77	PJ11, PJ54
LVP 78	19/22, 24/29
LVP 79	5D,16D,10D
LVP 83	3/2, 5/38,5/34

Screening Lines for response to applied nutrients
The objective of this experiment is to screen lines for response to applied nutrients with special reference to plant growth and nutrient status.

The field trial was carried out in the Field No.13, St Coombs estate, using selected TRI 5000 series accessions; VP 80/272, VP 80/5, VP 80/208, VP 80/99 and TRI 2025 used as the control. The four N levels and four accessions of TRI 5000 series together with TRI 2025 were arranged in a Spilt Plot Design with three replicates (5*4 factorial).

The total yield significantly varied among the lines and nitrogen levels. The line * N level interaction was not significant.

The experimental plots were pruned on July 22, 2016. The experiment is in progress.

Application of molecular technology to support genetic conservation and improvement of tea

Use of MAS in tea breeding

For the purpose of validating the molecular marker which has been developed to screen the tolerance to Blister Blight in tea, the genomic DNA was extracted from the selected plants of TRI 5000 series cultivar. The molecular analyses are in progress to correlate them with the morphological assessment on blister blight recorded from the same set of plants.

A comparison of selected biochemical parameters in between susceptible and tolerant tea cultivars for Low Country Live Wood Termite (LCLWT)

Objectives of this study are to compare selected bio-chemical parameters between tolerant and susceptible cultivars to LCLWT, differentiate the susceptible and tolerant cultivars using biochemical parameters and to generate required information for development of a new cultivar screening method based on biochemical parameters in order to identify tolerant and susceptible cultivars. Nine tea cultivars were selected from St. Joachim Estate, Ratnapura, stems were sampled and the biochemical analysis of Caffein content, Total Polyphenol content and Total Catechin content were completed for a period of 6 months (wet season). Sampling and analysis over the dry season were initiated. Similar analysis was also commenced in Kottawa area in order to ensure a better coverage of the Low country tea growing region. The experiment is in progress in collaboration with the Entomology Division.

Development of a biochemical approach to control tea Shot-hole Borer (*Xyleborous fornicates*)

Development of semio-chemicals to control insect pests is an environmental friendly approach without having a chance for the resistance development. The project has been originally initiated few years ago and Linalool has been identified as a bark volatile and caffeine as a stem chemical compound responsible for resistance development to Shot Hole Borer in tea plant. The current project is focusing on in-depth analyses to evaluate the differences in biochemical/ secondary metabolites composition during stress conditions such as drought, as the Shot Hole Borer infestation increases with the stress conditions.

As the Shot Hole Borers normally aggregate with already attacked plants and the aggregation declines with the peak population that a plant can withstand, this phenomenon in tea is assumed to be regulated by the plant secondary metabolites/ bio-chemicals. In order to identify responsible compounds, biochemical profiles of leaves, bark and stems will be evaluated in resistant and susceptible cultivars in solvent extractions and subsequently, the chemicals will be identified using HPLC. Furthermore, the volatiles should be extracted using appropriate technologies such as head space volatile extraction and identified using GC/ GC-MS.

The experiments have been carried out for 7 months, in Mahadowa Estate - Passara with Shot-hole Borer resistant and susceptible cultivars to compare the chemical profile changes in susceptible cultivars following Shot-hole Borer infestation. The GC sample analysis has been completed and HPLC sample analysis is in progress. The project is continued in collaboration with the Entomology Division and funded by the Ministry of Plantation Industries under special projects.

LAND PRODUCTIVITY IMPROVEMENT & CROP MANAGEMENT

Tea factory firewood ash as a plant nutrient source for mature tea

The main objective of this study is to investigate the suitability of tea factory wood ash and refuse tea as plant nutrient sources for mature tea. This experiments is conducted at St. Coombs Estate (Up country) Moragalla Estate (2015, Low country) and Kurugama Estate (2015, Mid country). The different rates of wood ash (1000, 2000 kg/ha/year) and refuse tea with or without Urea were compared with mature fertilizer mixtures VP/UM 910 and VP/UM 880.

Results of the Low country trial in Moragalla Estate showed that the application of wood ash with refuse tea and urea increased tea yield.

Tea factory firewood ash as a potential plant nutrient source and liming material for rehabilitation grass

The main objective of this experiment is to investigate the suitability of tea factory wood ash and refuse tea as plant nutrient sources and liming materials for rehabilitation grasses.

This experiments is conducted at Lelwela Estate (2015, Low country) and Kurugama Estate (2015, Mid country). The different rates of wood ash (1000, 2000 kg/ha/year) and refuse tea with or without Urea were compared with mature fertilizer mixtures; VP/UM 910 and VP/UM 880.

The results of the Mid country experiment at Kurugama Estate showed that the soil pH values significantly vary among treatments. All the wood ash treatments recorded comparatively higher pH values than the control and grass mixture-applied plots. The results show the potential of using wood ash to correct the soil pH in rehabilitating fields and reduce the cost on dolomite application.

There was also a significant difference among treatments with respect to soil nitrogen content. Solely wood ash-treated plots showed lower N values than the refuse tea-applied plots. There were significant differences in soil available potassium, magnesium and calcium contents among treatments. Wood ash-applied plots showed higher values than grass mixture-applied plots and control plots.

There was a significant difference in the Cation Exchange Capacity (CEC) of soil among the treatments. Higher values of CEC were observed on wood ash-applied plots. The Base Saturation of soil in the wood ash-treated plots was also higher than that of the control and grass mixture-applied plots.

A significant difference in nitrogen, phosphorous and potassium uptake was observed among the treatments. The nitrogen uptake recorded by solely wood ash treated plots was lower than that of the refuse tea and compost treated plots. The uptake of potassium was also significant, because grasses consume considerably high quantity of potassium for their growth and development. Highest value was observed with wood ash and refuse tea-applied plots as refuse tea is enriched with potassium (4.4%). But the difference in phosphorous uptake between wood ash-applied plots and the control plots was narrow.

Remediation of manganese deficiency in tea in Maskeliya soil Series

The objective of this experiment is to investigate the effect of Mn application with different N fertilizers for remediation of Mn deficiency in tea in Maskeliya soil series. Plots were demarcated in the Field No. 07, Hamilton Division, Laxapana Estate, Maskeliya. The treatments are ground application of different sources of manganese and/or nitrogen with or without foliar application of Manganese Sulphate. Plots were pruned on August 23, 2016 and the experiment is in progress.

Evaluation of the most efficient strains of PGRP under field conditions

Plant Growth Promoting Rhizobacteria (PGPR) are beneficial, free living, associative or symbiotic soil bacteria isolated from the rhizosphere of plants, which have been shown to improve plant growth and yield.

The main objective of this study is to evaluate the most efficient strains (already selected in the nursery trial) under field conditions in combination with organic and chemical fertilizers. Treatments are overall best consortia of N fixer + PSB along with 2/3 N and ½ P, Best consortia of N fixer + PSB for the soil series, along with 2/3N and ½ P, 2/3N and ½ the recommended rate of P in VP/UM 910 and the recommended rate of chemical fertilizer (VP/UM 910) and the absolute control. Field trials are being conducted at soil series level in the Mid country region.

Locations

Mature tea

Kandy series	-New Peacock Estate, Pussellawa
Matale series	-Ratwatta Estate, Ukuwela
Ukuwela series	-Midland Estate, Rattota

As observed in the previous year (first year in the pruning cycles), in all the locations having three main soil series, the inoculated treatment with series specific consortium indigenous to the respective soil series + 33% reduction of nitrogen + 50% reduction of P from the VP/UM 910 mixture recorded made tea yields comparable to the recommended rate of VP/UM 910 fertilizer treatment.

Evaluation of the effects of slow release fertilizer on soil and plant nutrient status and yield (Field experiments)

The main objective of this experiment is to study the yield response of mature tea to slow release fertilizer produced by the Nano Technological Institute (SLINTEC) and to introduce an economically viable slow releasing compound fertilizer. The different rates of slow release fertilizer at different frequencies are tested with conventional fertilizer at the following locations.

Low country-Ratnapura District

Don Pedro Estate, Panawala, Dehiowita, Block No 04, Cultivar-TRI 2026

Low country-Galle District

Moragalla Estate, Imaduwa Division, F/N 10 Cultivar-TRI 2026

Mid country-Kandy District

Kellebokka Estate, Kellebokka Division, F/N 14A, Cultivar-2023

Uva region- Badulla District

Gonamotawa Estate, Lower Division, F/N 7A Cultivar-TRI 2025

The results of the Low country experiment at Moragolla Estate showed yield significantly varied among treatments. The highest made tea yield of 4356 kg/ha/yr was recorded by 50% N from (Urea +Nano HA) + 100% K from MOP (4 splits) treatment.

Introduction of micro nutrient fortified foliar formulation based on micro nutrient status in tea growing soils

Presently, a range of foliar spray products are used in tea cultivation. Although the users are claiming positive yield responses, adverse effects of such foliar applications have been reported on the long run.

Research carried out on foliar applications of micro- nutrients are limited. The main objective of this study is to introduce useful & economical micro nutrient formulations based on micro nutrient status in different tea growing soils. Different combinations of Zn ($ZnSO_4$), Mn ($MnSO_4$) and B (H_2BO_3) are tested at the following locations.

Low country-Galle District
Homodola Estate, Udugama,
Mid country-Kandy District
Rangala Estate, Rangala,
Uva region- Badulla District
Ury Estate, Passara,

Results of the Ury estate trial showed that application of micronutrient foliar spray containing Zn+Mn and Zn+Mn+B recorded higher yield increments *viz.* 22% and 18% over the control with NPK ground fertilizer application only. Accumulation of micronutrients in the mother leaves was observed as a result of foliar application. Therefore, it is evident that Zn and Mn foliar applications together with TRI recommended ground fertilizer mixture appreciably increased mature tea yield in the Uva region. In order to obtain more precise results, this investigation needs to be continued over a pruning cycle.

Study on the influence of root architecture on nutrient uptake, growth and productivity of tea

The main objectives of this study is to understand the role of tea root characteristics in the uptake of plant nutrients such as N, P and K. Half and full dosage of VP/UM 910 mixture was tested with seven cultivars; TRI 2023, TRI 2025, TRI 3072, TRI 4071, DT1, DN and Seedling tea at immature and mature stage of growth. This experiment was established at the Field No 13, St. Coombs Estate, Talawakelle.

This experiment is in progress.

Improvement of land productivity through agronomic practices

Development of an economically viable system to eliminate /reduce soil rehabilitation period prior to replanting

Study the feasibility of reducing the time period of soil reconditioning with grasses through biofilmed biofertilizer

Experiment was started on New Peacock Estate, Gampola in 2011 to evaluate the effect of in situ rehabilitation by planting Flemingia and Gliyricidia, together with Mana grass in an old seedling tea field.

Treatments were T1-insitu planting Gliricidia and Mana in old tea in 2011 (Replanting 2013), T2- insitu planting Flemingia and Mana in old tea in 2011 (Replanting 2013), T3 - insitu planting of Gliricidia at recommended spacing 10' x 12' only in old tea in 2011 (Replanting 2013), T4 - Uprooting of tea and planting grasses in 2011 and replanting of tea in 2013 (standard) and T5- Uprooting of tea and direct replanting of tea in 2011 (control) and Gliricidia planting at recommended spacing 10' x12'.

Maintenance of tea in the new clearing and Flemingia and Gliricidia plants was in progress. Thatching with Mana grass, Gliricidia and Flemingia, weeding and manuring of tea were continued. Yield data of tea was recorded and lopings of medium shade trees were added as a live mulch.

The made tea yield was recorded as 590.0 (T1), 759.7 (T2), 692.3 (T3), 675.3 (T4) kg/ha/6 month. Except field capacity, the soil parameters tested *viz*. water holding capacity, bulk density, soil carbon and microbial biomass carbon (MBC) were not singnificanlty different among treatments. Growth performance (girth) of tea was also not significantly diferrent among the treatments. Though the soil conditions and growth performences were similar in all the treatments, there was a practical difficulty in replanting of tea by uprooting/removing the Gliricidia and Flemingia plants. This experiment was terminated as per the reccomendation of the Scientific Advisory Committee 2016.

Testing of new grass species with high biomass yield to reduce the time period of rehabilitation Houpe Estate, Kahawatta and Kottawa TRI Regional Center (2011)

Two grass species, (T1) Hybrid Napier (*Pennisetum Purpureum* x *Pennisetum americanum*) (Variety CO-3) and (T2) East Indian Lemongrass (*Cymbopogon flexuosus*), which are known to be higher biomass producers, were established to evaluate the growth performances in comparison with (T3) Guatemala (*Tripsacum laxum*) and (T4) Mana (*Cymbopogon confertiflorus*), and (T5) No Rehabilitation treatment. The experiment is carried out at two locations *viz*, Houpe Estate, Kahawatte and at the TRI Kottawa center, Galle.

Houpe Estate, Kahawatte (July, 2011)
Tea (TRI 4042) was planted in June 2013 after soil rehabilitation with above four grass species. The percentage of dead plants during and end of the drought period and growth performance of tea were recorded.

Tipping weight of tea at the time of bringing into bearing was recorded. The lowest fresh weight (236.30g per plant) and dry weight (81.41g per plant) were observed in T5 (No rehabilitation) treatment. The highest fresh (316.25g per plant) and dry weight (103.81per plant) were recorded in T1 (CO3 grass) treatment. Plucking was started in February 2016. Assessmentson soil pH, total N, K, available P and soil carbon were done at two depths of soil (0-6" and 6-12") in September 2016 i.e.3 years after planting of tea. The nutrient levels in grass-planted plots except soil N, were significantly higher than the non-rehabilitated plots. At the depth of 6-12", plots planted with CO3 grass and Mana showed significantly higher N level compared to the other treatments. Available P was not significantly different among treatments. This experiment is in progress.

TRI Regional Center, Kottawa (October 2011)
Plucking was stared at the end of 2016. Assessments on soil pH, total N, exchangeable K, soil carbon and available P were done at two depths (0-6" and 6-12") in September 2016 i.e.3 years after planting tea. At the depth of 0-6", the nutrients in grass-planted plots except soil N, were significantly higher than the non-rehabilitated plots. At the depth of 6-12", only the soil organic carbon in the grass-planted treatment was significantly higher than the non- rehabilitated plots.

There was no significant improvement of nutrients in grass-planted plots and non-rehabilitated treatment at the depth of 6-12". This experiment was in progress.

Validation of soil quality index
Data collection and analysis were completed for all the locations. However, there were some tea growing areas such as low country and Uva where the SQI values of the rehabilitated fields were not significantly higher than those of the old seedling / VP fields. Hence, re-sampling of Uva tea estates was commenced in the fourth quarter of 2016. Accordingly, five estates from the Uva region were selected for further sampling for SQI analysis.

Evaluation of different irrigation systems in tea

Development of water management techniques for tea in drought prone areas and evaluating drip and sprinkler irrigation systems for low-grown tea
Two experiments are conducted on St. Joachim Estate, Ratnapura to see the efficacy of drip and sprinkler irrigation on growth of tea. In the Experiment A, two tea cultivars, TRI 4061 and TRI 2021 were planted with and without drip irrigation in June, 2013. (This experiment was initially commenced with TRI 2023, which was later replaced with TRI 2021 due to theft of plants). Experiment B is on the evaluation of response of young tea plants to sprinkler irrigation. The experimental design is a CRD; Tea cultivars TRI 2023, TRI 2027 and TRI 4004 are used in the experiment. Growth of young tea plants was evaluated under the drip and sprinkler irrigation.

In the Experiment A, average plant girth of TRI 4061 showed a significantly higher response for irrigation (37mm *vs* 29mm). However, for the cultivar TRI 2021, girth difference for irrigated and non-irrigated plants was not significant (42mm *vs* 40mm). In the Experiment B, TRI 4004 and TRI 2023 showed higher girth under irrigation, while TRI 2027 did not show a significant difference.

Evaluating an appropriate rain water harvesting and retention method and effectiveness of rain water use for tea during dry spell
An experiment was conducted to study the efficacy of agriculture-grade thin mulch in soil moisture conservation on Kahagalle Estate, Haputale and St. Joachim Estate, Ratnapura.
Nutrient analysis showed that soil nitrogen, phosperous and potassium contents of mulched plots in the experiment at Ratnapura, were higher than those of un-mulched (control) plots. Very high phosperous content was observed in the compost-applied plots while potassium content was very low in the un-mulched (control) plots.

Measurements on the weed seed bank (per 900 cm^2) at 15cm depth at St. Joachim Estate, Ratnapura showed that there is a clear reduction in the weed seed bank under polythene, mana and mulch film thatching while there was no difference between compost mulch and the control.

Higher green leaf yield was recorded with compost at St. Joachim Estate. Tea harvesting was suspended at Kahagalle Estate trial due to continuous drought.

Evaluation of tea and coconut intercropping system in the low country tea growing areas of Sri Lanka

Land productivity analysis showed that tea mono-cropping is more economical than inter-cropping. Shade seems to be the limiting factor for higher productivity in intercropped lands. With the analysis of rainfall partitioning, it was found that coconut lands has a stronger relationship with through fall than tea mono-cropping field.

a) High Shade + Medium Shade, Houpe Estate, Kahawatte

There are seven treatments, in this experiment and it was established in 2014 June. The treatments are as follows. For all treatments, Gliricidia was used as the medium shade tree and tea cultivar was TRI 4042.

T1 *Derris microphylla* (20'x20') + Gliricidia (10'x10')
T2 *Derris microphylla* (30'x30') + Gliricidia (10'x10')
T3 *Derris microphylla* (20'x30') + Gliricidia (10'x10')
T4 *Cassia nodosa* (20'x30') + Gliricidia (10'x10')
T5 *Cassia nodosa* (30'x30') + Gliricidia (10'x10')
T6 *Cassia nodosa* (20'x30') + Gliricidia (10'x10')
T7 *Albizzia molluccana* (20'x30') + Gliricidia (10'x10')

Assessment (3^{rd}) of growth performances of high and medium shade trees and tea were recorded (2016 June). The growth of *Albizzia molluccana* was found to be higher than that of the others. The soil sampling was done for analysis of nutrients, pH and Carbon. The experiment is in progress.

Derris microphylla: Plants showed a successful growth and no pest attacks were observed up to now. Drooping habit of branches were observed. The casualties were less than the other species

Cassia nodosa: It produced higher number of branches at lower part of the stem. Branches were spreading horizontally and they provide a shade to tea. Attack of Leaf caterpillar (Yellow butterfly) was observed on immature branches. Higher number of plants was damaged by Porcupine attack.

Albizzia molluccana: The growth habit was found to be faster than Derris and Cassia. Some of the trees were attacked by Porcupine. Plants were to be thinned down to final spacing (40'x40') due to heavy shade on tea. Pollarding of the main stem was also done due to faster rate of growth.

Gliricidia sepium: A successful growth habit was observed. Some of the plants were attacked by Porcupines

b) High shade + Medium shade - Thalgaswella Estate, Thalgaswella

This experiment was established in 2014 with Derris, Cassia and Albizzia species as high shade and Gliricidia as medium shade. The shade trees were planted after planting of tea. Third assessment (3rd) on growth performances of shade trees and tea were recorded (2016 June). The high shade species T3 - *Albizzia molluccana*, and T2 - Cassia siamea showed faster growth rate than Derris spp. There was no difference in growth rate of tea under different shade trees. The soil sampling was done for analysis of nutrients, pH, Carbon, N, P and K. The experiment is in progress.

Treatments

T1 *Derris spp*. (20'x20') + Gliricidia (10'X10')
T2 *Cassia siamea* (20'x20') + Gliricidia (10'X10')
T3 *Albizzia molluccana* (20'x20') + Gliricidia (10'X10')

Derris spp: A better growth habit was observed with this species (not yet identified) than Derris microphylla at Houpe Estate. No pest attack was observed but some plants were wounded by buffalos.

Cassia siamea: Successful growth habit was observed. No pest attack was observed but some plants were showing symptoms of root disease.

Albizzia molluccana: Higher growth rate was observed. Some of the plants were dead due to buffalo attacks.

Investigating the compatibility of 'stock' and 'scion' for grafting tea to improve productivity and quality of tea

Several studies were undertaken to identify suitable scion and stock combinations for grafting tea with special reference to high yield, high quality, drought tolerance and pests and diseases resistance.

i) Investigation of compatibility of stock and scion for grafting tea with high yield and pest and disease resistance

Graft combinations with scions showing Blister Blight and Shot Hole Borer resistance and high yielding characteristic and stocks showing high rooting, drought tolerance and resistance to Nematode (*Pratylenchus loosi*) have been raised in the nursery and established in the field. The experiment was completing the second year of the second pruning cycle.Yield of graft combinations i.e. TRI 4046 on TRI 4006, TRI 3072 on TRI 4053, TRI 3072 on TRI 4006 and TRI 4006 on TRI 3072 recorded higher yield than their respective control cultivars. The experiment will be repeated with more replicates as recommended by the Scientific Advisory Committee.

ii) Investigation of compatible graft combinations for drought and yield at Balangoda area.

Selected graft combinations *viz*. TRI 4054 on DG 7, TRI 4042 on DG 7, TRI 4053 on DG 39, TRI 4054 on DG 39 and TRI 4042 on DG 39 for drought tolerance and high yield and their controls were planted in the field on Balangoda Estate. There were no significant difference among the grafted plants and their controls. However, graft combinations; TRI 4042 on DG 7 and TRI 4042 on DG 39 have shown a higher yield than TRI 4042 (control).

iii.) Identification of suitable graft combinations for vulnerable climatic conditions in the Low country

The graft combinations having drought tolerance and high yielding characteristics were field planted at the TRI Low Country Center. Plucking was started in January 2016 and yields were recorded. The combinations of TRI 4042 on TRI 4049 and TRI 4042 on TRI 3025 showed a trend of increasing yield but not significantly different from their controls.

iv.) Use of grating technology to overcome low or delay rooting of tea cuttings in the nursery

Objective of this experiment was to overcome the limitation of poor or delayed rooting of new accessions (5000 series) in the nursery.Two nursery experiments were started to evaluate the success of grafting technology using those accessions in the nursery of Agronomy Division, TRI, Talawakelle and Ratnapura (2015).

The accessions 210 and 89 were selected for Up Country and Uva and grafted to TRI 4053, TRI 3072 and TRI 3019. Selected accessions (scion) for Low country were 168 and 84 and stocks were TRI 4053 and TRI 4049. The results generated have shown significantly higher growth in terms of shoot length, number of leaves and root length of grafted plants than their controls in both experiments.

Evaluating potential fuel wood species as alternative sources of energy

Evaluating agronomic practices of potential fuel wood species in different regions

Experiments on Gliricidia & Cassia at Ury Estate, Passara (2009) and Calliandra at St. Coombs Estate, Talawakelle (2010) were in progress. The different spacing tested were T1 (1mx1m), T2 (1mx2m) and T3 (2mx 2m).

Gliricidia at Ury Estate was lopped for the third time and whole loppings, stems and tips were recorded on dry weight basis. No significant difference in dry weights of total loppings, stems and tips was found among treatments. However, the highets planting density (T1) has given higher weights of loppings than the other densities. The dry weights of whole loppings were 11.2, 3.8 & 2.1 t/ha for the treatment T1, T2 and T3 respectively. The dry weights of stems were 7.1, 2.3 and 1.4 t/ha and those of tips were 4.1, 1.5 and 0.7 t/ha for the same treatments respectively.

Whole loppings of *Cassia spp*. planted on Ury Estate were recorded as 3.4, 2.7 and 2.3 t/ha in T1, T2 and T3 and there was no significant difference among treatments. The same trend was observed on dry weight of stems *viz*. 1.24, 1.22 and 1.23 t/ha and for dry weight of tips *viz*. 2.12, 1.48 and 1.05 t/ha for the same treatments respectively.

The results observed on Calliandra lopings at St. Coombs Estate was also similar to those given above. No significant difference was recorded for the total loppings, dry weight of stems and tips i.e 8.4, 6.7, 5.9 t/ha and 6.7, 3.0, 2.3 t/ha and 15.2, 9.7, 8.2 for the treatment of T1, T2 and T3 respectively. Threfore, the most suitable spacing for Gliricidia, Cassia and Calliandra when grown as energy plantations would be @1mx1m. This experiment was terminated as per the recommendation given by Scientific Advisory Committee, 2016.

Evaluation of growth, yield, pest and disease management under organic tea cultivation
Main objectives of the investigations were to collect data on soil and crop productivity, level of natural biological control mechanisms, pest, disease and weed incidences under organic and low input tea cultivation systems. During the period under review, data were collected from the field trials of TRIORCON and BIDORCON at Talawakele for validation purposes. Prune time assessments, post prune recovery and other post prune assessments in parallel to the fifth pruning were carried out. General field operations were carried out and yield, pest and disease ratings in TRIORCON and BIDORCON trials were monitored.

Crop responses at the fifth pruning in TRIORCON trial
Data on fresh and dry prune weights, collar girth, and diameter of prune cuts under four treatments were summarized. The fresh weight of prunings was comparatively higher in conventional system compared to organic system. It may probably be due to succulence of the plant parts in conventional system. However, dry matter contents under organic cultivation system were higher than that of the conventional system perhaps because the tea bushes in organic system grow under stress with fewer inputs.

In comparison with the conventionally managed systems, superior and healthy bushes were seen in the experimental plots treated with tea waste and Neem oil cake. However, overall means of the fresh prune weights were comparatively higher in the conventional system. Interestingly, the trend in the mean dry prune weights was opposite and the organic systems were found comparatively superior. Amongst, Neem oil cake treatment exhibited the highest mean dry prune weights. In turn, greater dry matter partitioning in tea under organic systems showed their greater capacity in carbon sequestration.

The mean collar girth and number of prune cuts of tea bushes did not show significant differences although tea waste and conventional treatments exhibited the highest. Despite the low input nature in the organic tea cultivation systems, the architecture of tea bushes developed by the fifth pruning cycle has shown its sustainability. The results showed no significant difference in mean prune cut diameter between organic and conventional treatments. However, the conventional treatments recorded better results than organic treatments.

Crop responses at the forth pruning in BIDORCON trial

Among the treatments, biodynamic treatments have not favored growth and health of tea bushes when compared with conventionally managed systems. Mean fresh prune weights were comparatively higher in conventional system. As observed in the TRIORCON trial, the mean dry prune weights were comparatively superior in organic and biodynamic systems elucidating their capacity in carbon sequestration.The mean prune cut diameter and number of prune cuts of tea busheswere comparatively higher in the conventional system although the differences were not significant.

Scientific validation of pesticidal properties of Marikolandu (*Artemisia spp*.)

Marikolandu a wild plant species (*Artemisia sp*., family Asteraceae), is recommended for hedgerows (live fence) in tea plantations. Although, it is known to have natural pesticidal properties, no work has been performed to study the chemical composition and its bio efficacy against pests and diseases. The mode of action of the plant extracts in controlling weeds and repellence of insect pests was studied with a view to develop a plant extract-based formulation for practical use in integrated weed/pest management.

Extracts of stems, leaves and roots of *Artemisia* used at 50%, 100%, 150% and 200% concentrations were tested (a) for herbicidal effects on Alawangupillu [*Erigeron sumatrensis* (Retz.) using lettuce [*Lectuca sativa* (L) as the standard test plant.

Phytotoxicity of the extracts was evaluated using 5-month old nursery tea plants. Extracts were evaluated for insecticidal properties using mosquito larvae (standard test) with tea aphids and avoidance/repellence tests were performed using earthworms and leeches. Chemical constituents of the plant were analyzed using Gas Chromatography.

Water extracts of different plant-parts were prepared separately at 50%, 100%, 150% and 200% concentrations, assuming that total plant biomass would dissolve in soil water. Bioassays for herbicidal effects were conducted using lettuce [*Lactuca sativa* (L); standard test-plant] and Alawangupillu [*Erigeron sumatrensis* (Retz.); a major tea-weed] with tap water (0%) as the control. Crude extracts of aerial plant-parts (100% concentration) and a dilution series of 50%, 25%, 12.5% and 0% with tap water were assessed for insecticidal properties using mosquito larvae (standard test), tea aphids (*Taxoptera aurantii*), and avoidance/repellence of earthworms and leeches. Phytotoxicity of extracts on 5-months old tea-nursery plants was assessed. Bioassays were repeated twice in a CRD with three replicates.

Chi-square tests and probit analysis were done. Chemical constituents of A. vulgaris were identified using Gas Chromatography-Mass Spectrometry (Agilent 7890B GC-5077 MS). *Artemisia vulgaris* extracts did not show negative effects on tea plants, but showed triple-action effect on weed/pest control; (1) 50% concentration of all extracts reduced germination and seedling growth ($p<0.05$) of *E. sumatrensis*, (2) effectively controlled tea aphids ($p<0.05$), and (3) controlled/repelled nuisance pests (mosquito larvae and leeches) and even beneficial organisms (earthworms) ($p<0.05$).

Increasing concentrations of extracts enhanced toxicity on these test subjects ($p<0.05$). The GC-MS identified 6,9-Octadecadienoic and Heptanoic acids (herbicidal), Germacrene D (insecticidal) and Taraxa sterol (pest-repellent) as major chemicals in extracts. Potential exists for developing formulations using *A. vulgaris* for integrated weed/insect-pest management in tea.

All extracts significantly reduced ($p<0.05$) germination and seedling growth of *L. sativa* and *E. sumatrensis* at 50% concentration [stems 52 g/l, leaves 6.5 g/l and roots 4.7 g/l], compared to the control. Increasing concentration of the extracts enhanced phytotoxicity on test plants showing total inhibition at 200%, with no visual impact on nursery plants of tea during the initial study period. The 50% concentration of plant extracts also showed a significant effect on pests and repellence of earthworms and leeches ($p<0.05$). The results of gas chromatographic analysis on the major chemical constituents in the plant extracts of Artemisia were pending.

Artemisia exhibited both herbicidal and insecticidal properties with negative impacts on beneficial organisms such as earthworms. Hence, Artemisia used as a live fence in repelling tea pests was validated scientifically while the potentials for developing formulations for an integrated package for weed and pest management in tea were proven.

Further experimentation is in progress.

CROP PROTECTION

Identification of safe pesticides and designing IPM methods

Screening of insecticides against Tea Tortrix (*Homona coffearia*)
Field efficacy of Proclaim (Emamectin benzoate) was evaluated in Fernland Estate. Three concentrations (0.26g/l, 0.3g/l and 0.35g/l) were evaluated with standard (Atabron 50 EC 1l/900 l) and untreated control. Post treatment assessments were carried out for 4 weeks. The treatments were applied in randomized complete block design. The results showed that three concentrations significantly reduced ($p<0.05$) larval density of tea Tortrix when compared with the control and results were similar to the Atabron, the recommended insecticide. A confirmation trial was conducted in Waltrim Estate and analysis of data was in progress.

Bio efficacy of Coragen against White grub
Investigation of bio efficacy of Coragen (Clorantriniliprole 200g/l SC) against white grub in pot experiment was completed. The results showed 60% mortality of grubs at 0.2 ml/200ml. Field efficacy trial was commenced in Nayabedda Estate with Coragen at 1 ml/1l concentration, Metham sodium as the standard and with an untreated control.

Mass rearing and augmentation of Macrocentrus homonae
Mass rearing and augmentation of larval parasitoid, Macrocentrus homonae for the management of tea Tortrix larvae was continued to support the IPM program.

Isolation of biological control agents

a) Entomopathogenic nematodes (EPN)

EPN was isolated from diseased and dead white grubs collected from Calsay Estate. Identification and mass production were continued.

b) Entomopathogenic Fungi (EPF)

EPF (*Peacilomyces sp*) was isolated from diseased and dead caterpillars collected from Sommerset Estate. Laboratory bioassay was conducted to evaluate the efficacy of Peacilomyces sp. The results of the bioassay revealed 82% mortality at the sixth day after treatment and at the conidial concentration $1.2x10^8$.

Screening of alternative nematicides as prophylactic measure at planting and post-prune treatments

In tea, parasitic forms of nematode species occur in localized pockets and locations at varying levels of infestations. Hence, chemical treatment is considered not effective and economical under such scenarios. Use of a strong chemical / nematicide as a prophylactic measure at planting and post-prune treatments where the tea plants are vulnerable to be infested by parasitic nematode species is therefore included in the integrated nematode management programme.

During the period under review, out of three test chemicals and different potential doses, the new nematicide, Fluopyram 400 SC at doses of 500g, 600g, 750g and 800g were screened against *P. loosi* using incubation trials under controlled conditions in the laboratory and glass house pot experiments. For comparison, carbofuran was used as the standard chemical withan untreated control. Bio efficacy against nematode mortality, phytotoxicity effects on tea roots and shoot growth, non-target effects on soil biological components were investigated.

Results showed that Fluopyram 400 SC at 800g a.i. per ha is a potential prophylactic measure at the time of planting and as post prune treatments. It was also revealed that there was no obvious phytotoxicity effects on tea root and shoot growth while the non-target effects against microbial activity and earthworm activity be compromised.

The chemical was recommended for the incorporation in to soil in planting holes and soon after pruning as prophylactic treatments to avoid any nematode build up. As the harvest is taken long time after the treatment, chemical residues are not possible and hence, the MRLs are not applicable under such conditions.

The experimental data generated with the new nematicide, Fluopyram 400 SC at 800g a.i. per ha for control of *P. loosi* and *R. similis* were submitted to the TRC for consideration for an interim recommendation as the industry doesn't have any prophylactic treatment at present.

Testing of non-conventional nematode treatment methods such as micro wave, Infra-Red, Carbon Dioxide and Dry Ice treatments in tea as alternatives to chemical fumigants

Treatment of soil, growing media, nursery beds and surroundings to eradicate all forms of pathogens including parasitic nematode species is made compulsory under the integrated nematode management.

However, chemical fumigation poses limitations due to unavailability of suitable fumigants, poor user friendliness, environmental hazards and safety. Therefore, through a thorough literature search, few potential methods for sterilization of soils and planting media were chosen. Those include micro wave, Infra-Red, carbon dioxide and dry ice treatments as alternatives to chemical fumigants.

Several preliminary investigations were commenced using micro wave treatment for nematode infested soils with different time of exposure, soil types and moisture levels. Mortality of nematodes was assessed and further experimentations are in progress.

A project proposal has been developed to study micro wave, Infra-Red, carbon dioxide and dry ice treatments as alternatives to chemical fumigants through a PPP (Private-Public Partnership) in collaboration with the Department of Agricultural Engineering of the Faculty of Agriculture, University of Peradeniya. The objectives will be expanded to develop non-chemical methods for controlling microbial and insect contaminations of made tea and weed control.

Screening of alternative grass species for rehabilitation purposes

To strengthen the integrated nematode management strategies in tea, it is important that nematode build up in tea soils is discouraged by maintaining tea fields free of plant species susceptible to major tea nematode species. Such plant species include shade trees, cover crops, hedge-rows, inter crops etc. other than tea cultivars.

During the period under review, three potential grass species *viz*. CO_3 grass, Maha Pengiri and Lemon grass tested by the Agronomy Division for soil rehabilitation were screened against *P. loosi* and *R. similis* at Talawakele and Hantana respectively under standard study protocol including a susceptible tea cultivar. All three test grass species were proven to be non-hosts for *P. loosi* and *R. similis* whilethe susceptible tea cultivars continued to multiply nematode species. Hence, CO_3 grass, Maha Pengiri and Lemon grass are considered as non-hosts to *P. loosi* and *R. similis*.

Also, *Derris spp*. including *Derris microphyla* identified by the Agronomy Division as potential high shade species were screened against *P. loosi* and *R. similis* at Talawakele and Hantana respectively under standard study protocol including a susceptible tea cultivar. Both *Derris spp*. were proven as non-hosts to *P. loosi and R. similis*.

Generation of nematological data for development of Soil Quality Index
Data on parasitic nematodes (*P. loosi* and *R. similis*) and free living nematodes were generated for the test fields identified by the Agronomy Division. A set of data was utilized for developing the SQI and the potential of using SQI in tea replanting was studied.

Protection of vulnerable stages of tea from SHB
Laboratory bioassay was carried out on Coragen (Clorantraniporale 200 g/ L SC) to be used as alternative chemical to Fenthion. Three concentrations (10 %, 1 %, and 0.1 %) were tested with an untreated control to find out the lowest dosage that gives the 100% mortality of SHB beetle. Bioassay results showed that none of the concentrations has given the 100% mortality. Hence, field efficacy of the chemical was not evaluated.

Laboratory bioassays were carried out to test the effect of Brunolium, a fungicide against symbiotic fungus *Monocrosporium ambrosium* on the development of SHB. Three concentrations (100 %, 75 % and 50 %) were tested with an untreated control. Bioassay results showed that none of the three concentrations were effective for ensuring 100% mortality of SHB. Hence, field efficacy of the chemical was not evaluated.

Laboratory bioassays were also carried out to evaluate the effect of Tebuconazole a fungicide against *Monocrosporium ambrosium* symbiotic fungus using 3 concentrations (0.26 ml/l, 0.13 ml/ l, 0.01 ml/l) with an untreated control. Bioassay results revealed that all the three concentrations were ineffective for ensuring 100% mortality. Hence, field efficacy of the chemical was not evaluated.

Evaluation of Machine pruning on Low Country Live Wood Termite (*Glyptotermes dilatatus*) infestation
An experiment was commenced and continued to evaluate the effect of machine pruning on termite infestation in Galle.
The treatments were;
T1: Sanitary pruning + Wound dressing (Brunolium)
T2: Machine pruning + Wound dressing (Brunolium)
T3: Machine pruning + Cleaning+Wound dressing (Brunolium)

Assessment on termite infestation will be carried out at the next prune time.

Refining techniques for sampling, laboratory and field experimentation, surveys and statistical designs for studying insects, mites and nematode pests damage

No choice feeding bioassay for Low Country Live Wood Termite (LCLWT)
Evaluation of feeding rates of LCLWT in laboratory bioassay
No-choice bioassays using tea stems were continued to evaluate feeding rates of LCLWT in order to develop an early screening method.

Split stems of tolerant (TRI 2027) and susceptible (TRI 2026) cultivars were exposed to worker termites in test tubes and allowed 14 days for feeding. Forty worker termites were introduced in ach test tube. Weight loss was estimated after 14 days. Experiment is in progress.

No choice feeding bioassay for Shot-hole borer

No choice and choice bioassays were carried out for shot-hole borer and parallel to the bioassays field sampling was carried out in Rangala Estate.

Evaluation of field efficacy of new Candarsan (Bitumix) formulation

Experiment Site: TRI Kottawa, Field No.06

The experimental plots have 50 bushes each and 3 replicates with RCBD
Treatments are as follows.
T1- Bitumix Candarsan
T2-Brunolium 15%
T3- Untreated control
Number of rotted prune cuts, die back and colony forming unit will be evaluated. Assessment on termite infestation will be carried out at the next prune time

Identification & Use of semiochemicals for reducing nematode and mite pest damage

Evaluation of biochemical resistance of tea cultivars against LCLWT

Quantification of caffeine, catechin and polyphenol content in debarked stem extracts of tea cultivars were continued using colorimetric method to investigate levels of secondary metabolites of termite tolerant and susceptible cultivars. Susceptible tea cultivars (TRI 2023, TRI 4042, TRI 4055), moderately tolerant tea cultivars (TRI 3055, TRI 4053, TRI 4061, TRI 2025, TRI2027,TRI 4052 TRI 3025, TRI 3069) and tolerant tea cultivars (TRI 4049, TRI 3025, TRI 3069, TRI 2016, KP 204) were selected for the study. Experiment is in progress.

Evaluation of effect of coconut oil and rubber latex against SHB to protect stems from SHB in two sites Nayapana and Hantana Estate.

The treatments were as follows.
T1-Coconut oil 10lt/ha
T2-Coconut oil 20lt/ha
T3-Coconut oil 10lt + Adhesive
T4-Coconut oil 10lt + latex 15lt/ha
T5-Coconut oil 10lt + latex (without NH4) 15lt/ha
T6-Untreated control

Monthly assessments of SHB will be carried out.

Investigation of epidemiology of stem diseases of tea

Effect of systemic fungicides on canker causing *Botryosphaeria spp* in pruned fields

Enumeration of Botryosphaeria fungi in pruned tea field (at St Joachim Estate, Ratnapura) in response to pre and post application of systemic fungicides (Hexaconazole and Tebuconazole separately at 0.1%) was being assessed. Five pre-spray samples and 4 post-spray (at 1 month interval) samples have been collected. The results indicated a gradual reduction of Botryosphaeria fungi after each spray of both fungicides. After the 4th spraying of Tebuconazole, Botryosphaeria fungi were almost undetectable and in contrast, with Hexaconazole, Botryosphaeria fungi were detected in about 40% of the tested stem pieces. Another observational trial was commenced in a small holding at Weddagala, Kalawana area using Tebuconazole alone. The work is in progress.

Dieback of Grevillea robusta in the Uva region

Pathogenicity of three different pathogen species *viz*. *Lasiodiplodia theobromae, Lasiodiplodia pseudotheobromae* and *Neofussicoccum parvum* was confirmed on two year old Grevillea saplings. Mortality of saplings after two months from the inoculation was 30 %, 50 % and 50 % respectively for *L. theobromae, L. pseudotheobromae* and *N. parvum.* However, all saplings produced canker and dieback symptoms within a month.

Field trials to test the efficacy of fungicide injection against dieback causing fungi were completed at Mahadowa and St Coombs estates. No significant difference was observed among different treatments at both locations. These results suggest that fungicide application at later stages of infection is less effective in controlling the disease. An experiment to test the effect of wound dressing of a contact fungicide (Copper Oxychloride + Copper Hydroxide) on dieback of Grevillea tree was being continued.

Use of Silica as a potential defence elicitor to manage Blister Blight

Plant defense elicitors are low toxic plant protection products. Plants treated with elicitors generally develop resistance to host as elicitors activate induce defense response in plants, thereby protecting the plants with subsequent infection. Confirmatory trial on testing of monomeric silica as a potential defense elicitor was completed. Monomeric silica was applied as foliar spray at concentrations 0.2%, 0.3%, 0.5% and 1% and compared with 0.2 % Copper Oxychloride and untreated control. The results confirmed that silicon treatment at lower concentration (0.2-0.3%) significantly reduce Blister Blight severity when compared to the untreated control.

Screening fungicides against tea Blister Blight

Confirmatory trails of two liquid formulations (Suspension Concentrate) of Copper Oxychloride + Copper Hydroxide (20% Cu) and Tribasic Copper Sulfate (27% Cu) were completed against Blister Blight. Copper Oxychloride + Copper Hydroxide formulation at 0.14% concentration and Tribasic Copper Sulfate formulation at 0.5% concentration gave comparable control with recommended Copper Hydroxide (50% Cu) wettable powder. Trials revealed that the residue levels of the chemicals at the above concentrations were lower than the Maximum Residue Levels (MRL) stipulated by the EU (40 ppm) for Cu at 7 day pre-harvest interval.

Screening, evaluating & commercial formulation of soil-born antagonist for major root diseases and their promotion

Field testing of *Trichoderma harzianum* bio formulation against Poria root disease
The field trial at Glasgow estate to test the efficacy of already developed bio formulation of *Trichoderma harzanium* under field conditions was continued. As per the results obtained so far, disease progression in the plots treated with bio formulation was significantly lower than the un-treated control plots and comparable to that of the plots treated with systemic fungicide. A pot trial was commenced to test the efficacy of bio formulation against Black Root Disease pathogen and the experiment is in progress.

Development of a Multiplex PCR diagnostic kit to identify fungal pathogens in tea
Collection of root pathogens and characterization
The objective of this study is to develop a diagnostic PCR kit for the rapid detection of root pathogens in tea. Sample collection from the estates representing different Agro-ecological regions was carried out. Both *Poria hypolateritia* and *Rosellinia arcuata* isolates were obtained from diseased samples. Morphological and molecular characterizations of selected isolates were being continued.

Development of disease assessment keys for Blister Blight and Macrophoma canker
Disease assessment keys are important for the precise evaluation of the progression of diseases in the field. An assessment key for Blister Blight disease was developed and validated. Activities to develop assessment key and fine tune the stem canker assessment key were continued. The disease severity of canker was assessed in several locations of Ratnapura, Kuruwita, Weddagala and Kalawana area with a view to improve canker disease assessment keys.

Assessment of the microbial status of made tea, and the tea factory environment (factory machinery, water quality and worker hygiene)
Out of a total of 42 isolates obtained from made tea samples collected from upcountry sixteen potential mycotoxigenic isolates were identified. DNA was extracted from the 16 isolates and stored for further analysis. The experiments to test the ability of the *Aspergillus* isolates to produce mycotoxins were in progress.

Screening of herbicides
Goal 4F (Oxyfluorfen 480g/l SC) - Pre-emergent herbicide
This herbicide was tested with other pre-emergent herbicides at Ratwatta estate in mid country, St Coombs estate in up country and St. Joachim estate in low country. In low country trial, the treatments include four rates of Goal 4f @ the rates of 600ml, 700ml, 800ml per hectare, and Diuron powder 80% a.i. at 1.2, kg/ha (standard), Indeziflam 0.15 L/ha, Indeziflam 0.2 L/ha, Goal 2E 1.2L/ha (standard) and manual weeding as the control. Goal 4F at the rates of 700 ml/ha and 800 ml/ha performed similar to the standard treatment i.e. Goal 2E 1.2 l/ha and Diuron 1.2 kg/ha.

In St. Coombs trial, Goal 4F at the rates of 700 ml/ha, 900 ml/ha, and 1.2 l/ha was compared with the standard treatments of Diuron 1.2kg/ha and Goal 2E 1.2 l/ha. Results showed no difference in the efficacy of chemicals on weed control over the two and a half month period after spraying of herbicides.

In mid country trial, the same trend was shown as given above. Therefore, Goal 4F 700ml/ha is appeared to be promising as a pre-emergent herbicide for weed control in tea. However, it has to be tested for the maximum residue levels in made tea.

Brownout (Eucalyptol 0.2%w/v -SL) – Bio herbicide

Eucalyptol 0.2% w/v SL @ 6 l/ha, 8 l/ha, and 11 l/ha were tested under field condition at up, mid and low elevations along with Glufosinate Ammonium a Bayer product - (15% a.i.) @ 1.3 l/ha + 1.2 kg/ha Diuron (80% w/w) and Glufosinate ammonium 1.3l/ha used as standard treatments. Results revealed that there was no difference in weed management between Brownout 8 and 11 l/ha and standard treatments. Therefore, Brownout 8 l/ha is found to be promising for managing common/general weeds in tea.

Intergrated weed management

The experiment was initiated on St Joichim Estate, Ratnapura with the following treatments. T1: Black Polythene, T2: Film mulch (Agriculture polythene), T3: Goal 2E and the control. Weed dry weight after 2.5 months showed significant reduction of weed growth under different teatments compared with the control. As there was no significant difference in weed control among treatments (weed control) the cost factor should be analysed.

CLIMATE CHANGE IMPACT ASSESSMENT

Studies on physiological responses of tea to global climate change

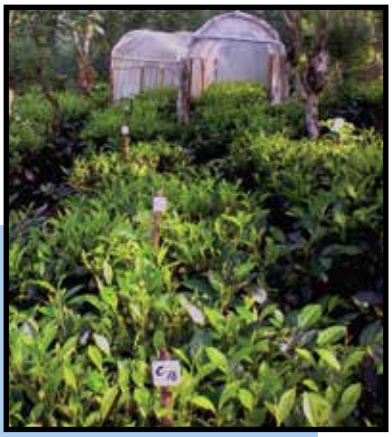
This study was conducted to determine the biomass distribution and carbon sequestration potential of bi-clonal seedling tea planted at the TRI mid-country station, Hanthana in comparison with TRI 2025. These plants were around 15 years of age at the time of sampling. Destructive sampling was done and three replicates were taken. The fractional biomass distribution was significantly different between bi-clonal seedling and TRI 2025. In bi-clonal seedling tea, significantly a higher biomass content was partitioned towards the roots and stems followed by the collar and it was the lowest towards the leaves ($p=0.0009$, cv=38.4) where as in TRI 2025, significantly a higher biomass content was partitioned towards the stems followed by collar, roots and it was the lowest towards the leaves ($p<0.0001$, cv=18.25). Carbon sequestration potential as well as relative growth rates of the bi-clonal seedling tea were higher than that of the TRI 2025 reflecting their suitability for changing climates and the ability for climate change mitigation. Accordingly, the carbon sequestration of the bi-clonal seedlings and TRI 2025 in mid-country were 6.83 Mg C/ha/yr and 0.63 Mg C/ha/yr respectively.

Another study was conducted to determine the differences of biomass partitioning, C and N stocks among different tea cultivars planted at the Uva Advisory and Extension Centre. Destructive sampling was done to determine these parameters in two-year old plants from TRI 2025, TRI 2023 and DN cultivars. Three replicates were taken from each cultivar and the uprooted plants were separated into different parts namely leaves, green twigs, brown twigs, stems, collar, mature roots and feeder roots. Accordingly, significant differences were observed in different tea cultivars ($p<0.0001$) as well as among different parts ($p<0.0001$) for fractional biomass, carbon content and nitrogen content.

The experiment is in progress.

Carbon budgeting for different tea growing regions

This study was initiated with the objective of determining the soil respiration levels and identifying any differences in the same on soil series in the Up-Country tea growing regions.



Accordingly, soil respiration measurements were carried out on selected estates to represent Mattakelle series, Nuwara Eliya series and Maskeliya soil series with the guidance of the Soils and Plant Nutrition Division of the TRISL along a natural soil moisture gradient. At the same time soil samples were collected from 0-15 cm depth to measure the soil moisture content, organic carbon percentage and soil pH.

Soil respiration values varied from 1.81 – 2.28 Mg/ha/yr but with no significant difference ($p = 0.0527$) among the different soil in the Up-Country tea growing regions. The highest soil respiration was observed in the Nuwara Eliya soil series followed by the Mattakelle soil series and it was the lowest in Maskeliya soil series. Interestingly the soil organic carbon percentage also showed a similar pattern of variation where significantly the highest organic carbon percentage ($p < 0.0001$) was observed in Nuwara Eliya soil series (7.5 %) followed by Mattakelle Soil series (2.87 %) and it was the lowest in Maskeliya soil series (2.54 %). The soil pH values were within the recommended range.

Analysis of climate change in different tea growing regions

A detailed report on climate change impacts on tea and adaptation measures in Sri Lanka, India, Kenya and China was compiled and published as a FAO publication. The booklet was launched at the FAO/IGG on tea session held at Naivasha, Kenya during 19-28 May, 2016. Several presentations on climate change impacts and suitable adaptation measures were made to the stakeholders during the extension programmes of the institute.

Preliminary investigation on the impact of temperature rise (about 2^{o}C by erecting poly tunnels in the field) on growth and yield of tea in the low country has shown that tea yield at high temperatures was reduced by around 40%. The low yield under high temperature regimes was due to reduced shoots density and extension rates.

Effects of climate change on pest incidences

Under the climate change scenarios experienced in tea grown areas, it is evident that growth, yield and quality of the crop is affected while tea bushes are exposed to unusual threats by pests and diseases at unexpected levels and times. The attributes and scientific basis however, are not very well studied except for a few cases. The objective of this project is to study and elucidate pest and disease occurrences due to climate change and to establish imbalanced status of host – pest – environment components in tea plantations for better understanding of future mitigation and management purposes.

Determination of impacts of soil temperature regimes on population dynamics of *Pratylenchus loosi* in tea plantations of Sri Lanka

The postgraduate study program on 'Determination of impacts of soil temperature regimes on population dynamics of *Pratylenchus loosi* in tea plantations' is continued.

Morphometric characterization of different *P. loosi* populations

Preparation of nematode specimens for microscopic examination was done using standard protocols. Methods described by Hooper (1986) were followed in killing, fixing and processing nematodes for mounting. Mounted specimens were observed under OPTIKA B 500 microscope for useful morphological features, described by Siddiqi (1986) and measurements were taken with Optika Vision Pro plus (Version 2.7) software. For morphometric studies, at least 8 females and 8 males of each population were measured unless stated.

The measured female morphometric parameters were L (Length), maximum body width, body width at anus, tail length, head end – vulva, head end – anus, anus – phasmid, phasmid - tail end, stylet length, conus, stylet base – DOGO, a ratio, c ratio, c' ratio, V (%), V' (%),Volume (μm^3) and Weight (μg). The measured male morphometric parameters were L, maximum body width, tail length, stylet length, stylet base – DOGO, spicule, a ratio, c ratio, Volume (μm^3) and Weight (μg). Mean volume and body weight of *P. loosi* specimens were calculated using following formulae, which were derived using a mean specific gravity of 1.084 for nematodes (Hooper, 1986).

Volume = (max. body width) 2 X Body Length / 1.7 μm^3
Body Weight = (max. body width) 2 X Body Length / 1600000 μg

Morphometric characterizations of *P. loosi* populations (PL1 –PL 6) were completed. Data tabulated and analyzed. Data of the present study were compared with existing references, Loof, 1960, Seinhorst, 1977, Inserra *et al*., 1996, Mohotti, 1998, Duncan *et al*., 1999, Inserra *et al*., 2001 and Wu *et al*., 2002. Data showed that the all the populations were closely fit morphometrics of existing references and confirmed the identity. Data will be analysed by using Canonical discriminant analysis/ Principal Component analysis and comparative results to be included in a Chapter of the Thesis.

Field Experiments

The study program was continued for collection of different *P. loosi* populations, monitoring soil temperature and rainfall and nematode symptoms in affected fields at monthly intervals. The field data monitoring was done in six locations *i.e.* Cecilton Estate (PL 1), Delmar Estate (PL 2), Hapugastenna Estate (PL3), Mahadowa Estate (PL 4), Small holder land at Nawalapitiya (PL 5) and Richiland Estate (PL 6). Data on rainfall, soil temperature and soil moisture monitored in six locations over the period of study in order to determine the variation of parameters attributable for changes of nematode behavior, population densities and resultant disease expressions.

In the fields of above six locations, TRI 2024 plants in microplots were uprooted and growth measurements, *P. loosi* populations in roots and soil, symtomological expressions were recorded. Plant height, No. of leaves, No. of fruits and flowers, shoot dry weight and fresh weight, root dry weight and fresh weight and root depth were taken as growth measurements. *P. loosi* population in roots was assessed. The total root length was measured by using the standard protocol. Soil and root respiration was measured by using the standard protocol described by Anderson, 1982. Weight of root fragments was measured using the standard protocol. Data were being analyzed.

Evaluating the impact of climate change on post-prune recovery of tea under conventional and organic managed systems

A study was carried with an objective of evaluating the impact of climate change on post-prune recovery of tea under conventional and organic managed systems.

Twenty year old tea bushes of the cultivar DT1 pruned for the fifth time at the TRI-ORCORN trial at St. Coombs estate, Tea Research Institute, Talawakelle were used for the study. Fifteen tea bushes inside (i) Fully enclosed poly tunnels (to raise ambient temperature) and (ii) Partially enclosed poly tunnels and under open/field condition were studied. Ambient temperature and soil temperature were monitored daily at three times. Rainfall of the study location was monitored during the study period. Post-prune recovery, biochemical parameters and anatomical structure of the tea leaves were assessed. Stem rotting fungal growth on prune cuts was also studied.

The dry weights of tippings and shoot extension rate assessed as indicators of post prune recovery were high in elevated temperatures and shoot extension was not significant ($p>0.05$). The total chlorophyll content and amino acid content reduced significantly ($p<0.05$) under elevated temperatures. Reduction was comparatively higher in conventional system than the organic system. The total polyphenol content at higher temperatures was more than that at the ambient temperature although the difference was not significant ($p>0.05$). Increment was similar in both organic and conventional system. Although no clear anatomical changes were evident, organically managed tea showed some adaptation by increasing epidermal layer in tea leaves significantly ($p<0.05$). Growth of fungi in cut stems leading to rotting was significantly low at elevated temperatures ($p<0.05$).

Therefore, post prune response, quality of tea and anatomical adaptations were reduced under raised temperature in both conventionally and organically managed tea, however, the reduction tend to be lower in organic system than in the conventional system.

Collection of meteorological data

This Project involves data collection, analysis as well as maintenance of agro meteorological stations of TRI Talawakelle, Ratnapura, Kandy, Deniyaya, Kottawa (Galle) and Passara stations. Monthly summary of the data on rainfall and sunshine hours were submitted to the Sri Lanka Tea Board.

MECHANIZATION OF FIELD PRACTICES

An in-depth investigation on the response of physiology, growth and yield of tea (*Camellia sinensis*) to mechanical harvesting

Quantification of the impacts of mechanical harvesting

Non-selective mechanical harvesting methods found to be removing *Arimbu* shoots indiscriminately while accumulating *Banji* shoots in the plucking table. Hence, non-selective harvesting devices (non-selective shear & motorized harvester) increase the dormancy of the tea bush while damaging the Sink capacity of the tea bush.

The root starch contents at ten months after the application of treatments were found to be significantly low under motorized harvesting, followed by non-selective shear, selective shear and manual harvesting. Those values of root starch contents were lower than that measured at five months after the imposition of treatments. The reason could be the aging of the tea bush in the pruning cycle and dry weather experienced at the time of taking measurements.

The leaf thickness, measured as the Specific Leaf Weight (SLW) at ten months after the application of treatments, decreased significantly under motorized harvesting compared with selective harvesting methods. Bushes harvested with the selective shear, however, showed low leaf thickness than the manually harvested bushes.

The impacts of motorized mechanical harvester were quantified (Table 1) and will be manually simulated as treatments in the next field experiment.

Table 1. Quantified impacts of motorized tea harvester / round

Impacts of MMH	Quantity
Removal of maintenance foliage	15 leaves / bush
Removal of Arimbu shoot as;	
Only the buds	18 Shoots / bush
Buds with fish leaf	11 Shoots / bush
Buds with one leaf	12 Shoot / bush
Total removal of Arimbu shots	41 Shoots / bush
Severity of MMH (number of shoots removed)	
Below fish leaf	28 Shoots / bush
Above fish leaf	15 Shoot / bush
Leaving a mther leaf	10 Shoot / bush
Leaving 2 leaves	4 Shoots / bush

The experiment was completed and terminated.

Simulation of the impacts of mechanical harvesting on tea bushes

The objective of this experiment was to study the effects of the impacts of motorized harvester (Table 1) on tea yield reduction. Quantified impacts were simulated separately on the tea bushes, as treatments. Hence, the treatments were as follows and laid in an RCBD with 4 replicates.

T1 – Manual harvesting (control-01)
T2 – Mechanical harvesting (control-02)
T3 – Manual simulation of the removal of maintenance foliage
T4 – Manual simulation of severity of harvesting
T5 – Manual simulation of the removal of *Arimbu* shoots
T6 – Applying all three simulations together

Yield records showed that manual harvesting recorded a significantly higher tea yield (5329 kg/ha/yr) than T2, T6 and T5 respectively. Yield reductions caused by each impact of the motorized machine, namely; severity of harvesting (T4), removal of maintenance foliage (T3) and removal of Arimbu shoots (T5) were quantified as 17%, 13% and 53% respectively, compared to manual harvesting (T1). The same values for T6 and T2 were 54% and 58% in the same order.

Results also showed that gain in the girth of the secondary branches found to be affected by the severity of harvesting (T4) and removal of *arimbu* shoots (T5) but not affected by removal of maintenance foliage (T3).

The leaf nitrogen contents did not show significant variation among the treatments and with time. However, the shoot starch reserves were low in the bushes simulated with removal of *arimbu* shoots.

The experiment was completed and terminated.

Identification of problems related to the use of motorized machines in tea fields
A field trial was started on the identification of problems related to the motorized machines used in tea fields. In this trial three motorized tea harvesters were tested in comparison with manual harvesting.

The experiment is in progress.

Popularization of tea harvesting and pruning machines in smallholdings sector
Socio-economic data collection from the recipients of machines was completed and data analysis was commenced. The surveys conducted and information collected have shown that the use of machines distributed to among selected tea factories were poorer than the smallholder societies. The use of TRI selective tea harvester, pruning and holing machines were better than the use of motorized harvesters. About 30-35% of the motorized harvesting machines were reported to be not used by the societies. The extension of plucking rounds and yield reductions with motorized harvesters, and problems associated with the use of such machines in small plots and on slopes have been the main reasons for poor adoption/use. Training needs were also identified for improving the rate of adoption of the mechanical devices. The majority of the users have reported that the cost on pruning can be markedly reduced by the use of pruning machines. The two person operated holing machine has received mixed opinions. Hence, the TRI undertook field testing of few models of holing machines supplied from China through local agents. It was found that the output of the single person operated machine was around 150 holes per hour while that of two-person operated machines varied from 150-225 holes per hour depending on the model. However, the tested machines had some deficiencies especially on safety and ergonomic aspects and hence, could not be supplied to the smallholder societies. Progress review meetings were held with the participation of all stakeholder organizations in order to plan the way-forward.

NURSERY MANAGEMENT TECHNIQUES

Testing of different media and mixtures for tea nursery bags
The nursery experiment has been completed and field performances of the plants were monitored.

Investigation of the effect of bag size on tea (*Camellia sinensis. L*) plant growth in the nursery and field.
To achieve the objective of producing a healthy and vigorous nursery plant using a minimum quantity of soil for nursery bag, a field trial was established on St. Coombs Estate, Talawakelle (2013).

Plants (TRI 4052) in the field completed 2nd year of plucking and there were no significant difference in yield among the bag sizes except 3" x 7" which recorded a significantly lower yield than the standard size (5" x 9"). The bag size; 5" x 6" showed a higher yield.

Evaluation of different netting materials placed at different heights
Experiment was started in December, 2015 using the cultivar TRI 4049. Nylon net with 70% & 80% shading and coir matting were tested at 1.8 m and 2.4 m height. Evaluation at the end of 7 months revealed that coir matting gave the highest plant growth, in terms of shoot and root development. Among the nylon shade nets, 80% shade showed a better performance at 1.8m height.

Impact of Fertigation and Slow Release Fertilizer on growth of tea nursery plants
This experiment was completed in 2015.

TEA PROCESSING TECHNOLOGY AND PRODUCT DEVELOPMENT

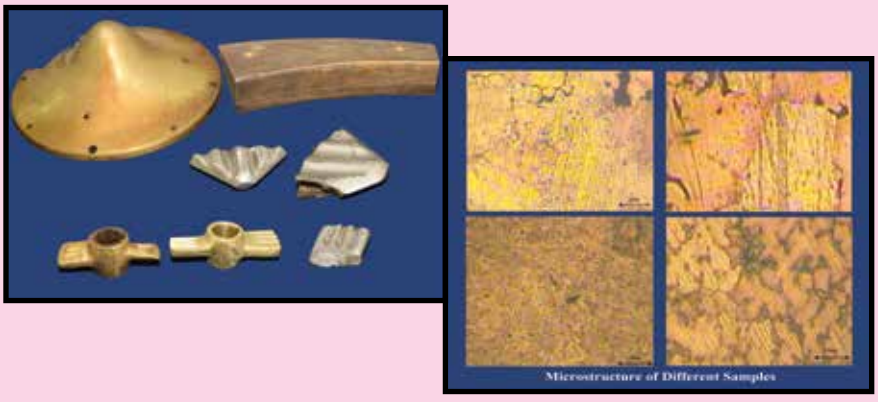
Development & improvement of tea machinery and factory conditions

Investigation on preventing the moisture absorption by teas at different stages in the low country grading process

Tea grades are exposed to grading room environment for a period of about two weeks during the grading process in the Low-country tea manufacture and moisture absorption by tea is inevitable. The study conducted to determine maximum permissible moisture content in different premium tea grades was continued with 10 different premium tea grades at 50 - 85% relative humidity at three different dry bulb temperatures (25, 30 & 35 °C) following saturated salt solution method.

Optimization of electrical energy efficiency in trough withering using a Real time Heat and Mass transfer mathematical model

Withering process is not closely monitored in most of the tea factories wasting energy and affecting quality of withered-leaf. A mathematical model was developed to predict moisture content of leaf at real time, to facilitate process controls. The project initiated in collaboration with the Department of Agriculture Engineering, University of Peradeniya to design an automatic control withering system for process parameters using the mathematical model in order to ensure required withering process parameters was continued. The National Science Foundation (NSF) continued to fund this project. Software package was written in python language compatible to the single board computer called “raspberry pi 2” which is used in the control system. The mathematical model was incorporated into the computer program to control process parameters.



Airflow controlling unit (incorporated with VSD) and hot air supply unit were coupled with the experimental trough system. Temperature, RH & pressure sensors were installed in the withering trough and coupled to the control system. Necessary modification to the program was being carried out while monitoring required input data using the sensors.

Effectiveness of introducing high efficient motors for tea processing machineries

Tea factories in Sri Lanka consume about 3.22% of the country's electricity demand for tea manufacturing processes. The main cause for higher consumption is the use of large numbers of electric motors in tea processing machineries. There are instances that old motors as well as over sized motors are still being used in the machineries.

Furthermore, motors are rewound and used when failure occurs. As a result, electrical energy consumption exceeds acceptable level in tea factories. Previous study on energy consumption has revealed that withering and rolling processes consume about 70% of the total electrical energy in tea factories. Therefore, a study was conducted to evaluate feasibility of using high efficiency motors in tea machineries used in these processes as an energy conservation measure. The results showed less specific energy consumption with the use of high efficient motor for rolling of leaf in 15" Rotorvane and 8" Rotorvane. Replacing the present standard efficient motor with high efficient motor is not feasible in the Rotorvanes due to very high cost. Installation of high efficient motors in 15" Rotorvanes becomes feasible when green leaf intake is above 16,000 kg/day and such motors can be obtained at a lower cost. The expected "CO_2" mitigation potential is marginal and is estimated to be around 1 tonne/ yr/ Rotorvane. The study further revealed that energy saving could also be achieved by proper control of feeding rate of leaf into the Rotorvanes.

Investigation on combined IR and Fluid bed drying in relation to quality and cost against conventional fluid bed drying

Specific firewood consumption for drying Orthodox-Rotorvane tea in fluid bed dryers varies between 0.7 and 1.0 kg firewood/ kg dried tea. This variation occurs due to use of inconsistent quality of firewood. Study on combined IR and fluid bed drying of Orthodox-Rotorvane tea was continued.

A pilot scale IR dryer was designed for pre-drying of tea. A control system has been incorporated into the design to operate heating unit at a desired and steady temperature. Action has been taken to purchase required items to fabricate the dryer with the control system.

Development of an effective monitoring and control system for fluidized bed drying (FBD) of Orthodox-Rotorvane tea

Fluid bed dryers (FBD) are used to dry Orthodox-Rotorvane tea in the Up-Country tea factories. Drying of tea is controlled manually by adjusting the feeding rate of wet dhools into the dryer according to tea-bed temperature at the discharge end. The tea-bed temperature fluctuates due to time lag in the feedback and as a result dried-tea moisture content varies from the acceptable level of 2.5-3.0% (w/w, wet basis). A PLC based monitoring & control system was designed and installed to the dryer with a view to automate drying of tea. The control system was programmed to monitor and control drying process parameters. The control arrangements in the dryer were perfected for adjusting the process parameters. Action has been taken to install additional Rotorvane and a Roll breaker in the St.Coombs tea factory with a view to operate the dryer with adequate dhools. Once the installation is completed, the monitoring & control system will be tested for drying tea in the FBD.

Development of Self-cleaning Sifter with multiple mesh frames of grading long leafy and wiry type teas

Michie Sifters coupled with different size meshes are used for sorting the long leafy & wiry type tea into different grades in Pure Orthodox tea manufacture. Clogging of tea particles in the mesh occurs in the sifter and as a result the sorting process is greatly affected. Therefore, workers are employed with each sorting machine to remove the tea particles clogging the mesh with a piece of wood at regular intervals. Sorting tea in this manner results in breaking and greying of tea particles. Tea grades with such particles lose their appearance and fetch lower prices compared to that with even sized black tea. Further, regular cleaning leads to sagging of meshes and results in inefficient sorting of teas. Cost of sorting is also high due to deployment of workers for cleaning of meshes. The Tea Research Institute developed self-cleaning mechanism for the sorting machine, the Michie sifter, to automatically remove the clogging tea particles during sorting and obtained patent for the technique. In tea factories, four numbers of Michie sifters having different size meshes are used in completing the sorting process. Therefore, a collaborative project was commenced with M/s. Helix Engineering (Pvt) Ltd. to design and develop one single machine having all the meshes. A research grant valued Rs. 1.31 million has been awarded by National Research Council to carry out the research project.

Study on non-ferrous cast components of tea machinery and stainless steel CTC segments

Quality of made tea and dhool production rate are affected as a result of *wear and tear* of copper alloy cast components in Rotorvanes and Orthodox rollers used in tea manufacture. Therefore, this study was conducted with an objective of finding likely causes and also to look for possible solutions.

Chemical analysis of 6 more vane samples, 3 cone samples, 3 batten samples and 2 CTC segment samples were conducted at the Industrial Technology Institute (ITI). Also, hardness and microstructure tests were conducted on the samples at the Department of Materials Engineering, University of Moratuwa. Only one cast copper alloy cast component sample was found to have chemical composition similar to that of gunmetal. Chemical composition of other cast copper alloy cast component samples deviated from that of gunmetal.

Low hardness found in samples was due to low 'Sn' content and presence of large size grains in the microstructure. Low hardness could lead to high *wear & tear*. 'Al' was found in few components and its presence could lead to failures. Fine grains in microstructure were found to contribute to the hardness. This shows importance of good foundry practices in casting the components. The results show possibilities of the use of scrap material with varying chemical compositions deviated from the gunmetal. Using scraps having chemical composition closer to gunmetal and adding required amount of virgin raw material after checking the chemical composition of scraps are recommended to ensure desired chemical composition. In addition, checking of casting temperature and casting without delay are found to be good casting practices to be adopted.

Both the CTC segment samples were found to be closer to AISI 201 stainless steel grade. However, one sample failed to have required 'Ni' and 'Cr' contents as specified in the standard.

Evaluating alternative energy sources for tea processing

Firewood is used as the main thermal energy source for withering and drying in tea factories. Proper firewood management practices are not adopted in most of the tea factories due to various reasons such as poor supply chain, unavailability of power saw and wood splitter, poor cash flow etc. As a result, firewood is excessively used and wastage increases up to about 60%. At present, many tea factories are facing difficulties in obtaining firewood. The purpose of this project is to reduce the moisture content of firewood up to about 25% before reaching the particular factory from supply locations. Consequently, wastage of firewood could be minimized and the optimum firewood output can be achieved. Further, firewood scarcity could be reduced to a certain extent.

A project on supply of biomass in different forms to various industries has been awarded to the Lalan Energy Solutions (Pvt) Ltd by the Food and Agriculture Organization of the United Nations. In this project, the Lalan Energy Solutions (Pvt) Ltd involves in making wood chips out of firewood and supplying them to tea factories through its supply centers in Galle, Ratnapura and Kurunegala. Woodchips cannot be used efficiently in the present air heaters by manual feeding and with the available fire grate system. Therefore, a project was designed to develop woodchip feeding & controlling system and a suitable fire grate for the present air heaters. With the approval of the Tea Research Board, preliminary discussions were held with the National Engineering & Research Center and the Lalan Energy Solutions (Pvt) Ltd to carry out a collaborative project on the use of woodchips as an alternative energy source for tea drying. A MOU will be signed among the above organizations before commencement of the project.

Study on the effect of spreading thickness of dhools on made tea quality in Orthodox-Rotorvane manufacture

Orthodox-Rotorvane tea manufacturing process has been changed since about a decade ago to produce tea grades meeting the customer demand. The tea grades preferred by the customers consist of smaller size particles. Therefore, tea is subjected to severe maceration during rolling process to break it into such smaller size particles. This is done by rolling leaf in Orthodox roller first and followed by maceration in Rotorvane for 2-3 times.

Due to severe maceration in Rotorvane, temperature of the leaf is increased and most of the cell sap is brought to the surface. Further, the surface area of the broken leaf increases and consequently, more oxidation reactions in tea take place. These reactions are exothermic and result in further temperature build up in tea. Therefore, a study was conducted to find out optimum spreading thickness of dhools and corresponding aeration time to maintain required levels of oxidized chemical constituents in tea ensuring good tea characters as per the consumer demand.

The highest liquor quality and price of made tea were achieved with a thickness of 2" of tea and aeration time of 2 hours and 20 minutes. Temperature build up in tea was considerably low at this spreading thickness. This would have facilitated controlled oxidation reactions that resulted in the highest liquor quality. Moderate spreading thickness of 2½" led to formation of more TF induced by high temperature build up as a result of oxidation of more polyphenols in dhools. The high TF content gave tannin effect to enzyme and affected oxidation reactions resulted in reduced direct formation of TR. Higher spreading thickness of 3" led to accelerated oxidation reactions induced by even higher temperature build up in dhool and oxidation of more polyphenols. This resulted in the loss of some amount of TF due to conversion into TR. For all the three spreading thicknesses, the optimum aeration time was found to be 2 hours and 20 minutes. At the optimum aeration time, TF % and TR/TF ratio with all the spreading thicknesses were higher than that of the values given in the literature *i.e.* 0.7% and 10 respectively, for good quality made tea. In this study, the TF% and TR/TF ratio varied between 1.03 and 1.07% and 12.7 and 15.2 respectively.

Study on the effect of dhool temperature rise in the Rotovane on made tea quality

Orthodox-Rotorvane type of tea processing is the most popular method in Up-country tea factories. Now-a-days customers prefer broken type tea grades with small size particles for producing value added products. Rotorvane (RV) is used to break the leaf into smaller size particles. Endplate of the RV is adjusted to restrict the leaf exiting area with a view to increase the breakage by increasing retention time and pressure. This practice results in severe maceration on leaf and temperature build up. High temperature affects oxidation reactions and enzyme activities in tea. And also, it could affect the made tea quality. Therefore, a study was conducted to determine the effect of temperature rise in RV during rolling on chemical and organoleptic properties of made tea at different end plate adjustment. Temperature rise in leaf was studied in RV rolling under the controlled tea manufacture. Further, an attempt was made to reduce the temperature of rolled leaf using a Ball breaker (a unit known as Beater box).

Tea leaf temperature was found to increase by 10.4 – 13.3 °F due to severe maceration in the Rotorvane. Variation in pressure application by endplate adjustment didn't influence the temperature of leaf. Higher pressure levels increased the % of BOPF and Dust grades and tea prices. Leaf temperature could be reduced by about 2.2 °F using ball breakers. However, temperature rise in the Rotorvane at higher pressure levels didn't affect TF and TR formation. The chemical analysis also showed that the temperature rise in the Rotorvane didn't affect liquor colour.

The TF% and TR/TF ratio of tea that achieved the highest price was 0.96% and 16 respectively. They are higher than those reported in the literature i.e. 0.7% and 10 for good quality made tea. Temperature rise in Rotorvane didn't affect the sensory parameters, strength and overall quality. Professional tea tasters gave higher prices for tea with more colour and strength with acceptable overall quality according to customer demand.

Miniature manufacture of green leaf samples

Around 100 Green leaf samples collected from different experiments of Agronomy, Entomology & Nematology, Plant breeding and Plant Pathology Divisions were manufactured using miniature tea manufacturing facility and the made tea samples were graded, cleaned, packed and sent to the respective divisions.

Made tea quality improvement

Introduction of a standard system to manufacture high quality green tea

With the purpose of establishing the baseline information on quality parameters of green tea (GT) products available in supermarkets of Sri Lanka, the study was continued and the organoleptic, chemical and microbiological parameters were determined in thirty locally available GT products. For better comparison of the quality attributes, another forty foreign GT samples including Japanese and Chinese products were analyzed.

Quality scores were given by a well-trained sensory evaluation panel for GT considering the size and color of the particles and the organoleptic parameters such as taste, color of the brew and the color of the infused leaves. Based on the total quality score, the samples were categorized as high quality, medium quality and low quality.

The ISO recommended chemical parameters as well as some other important parameters relevant for daily tea intake were determined in order to check their compliance to the standards. In addition, the correlation between chemical parameters especially the total polyphenols, amino acids, Theaflavins and Therubigins, total chlorophyll *etc*. and the organoleptic parameters were studied to identify the desirable levels of these chemical attributes towards a better quality score in organoleptic analysis.

The microbiological parameters of the GT products were analyzed to check their compliance to the SLS standards in collaboration with the Plant Pathology Division. As only a few samples were found to be satisfactory in terms of the microbiological parameters, further studies will be undertaken to analyze the GT samples from local GT factories.

Investigations will also be carried out to identify mode of microbial contaminations in the final product in order to propose necessary preventive actions and ensure that the GT products are clean and free of contaminations.

Development of method to detect sugar adulteration in made tea

This study was focused on the sugar adulteration in black tea. To identify the changes in quality aspects in black tea with respect to the sugar adulterations, chemical parameters including the volatile compounds and the microbiological parameters in non- adulterated and sugar adulterated black tea samples were determined.

The black tea samples were prepared by using the miniature manufacturing facility of the Biochemistry Division and the changes in the microbiological parameters were determined for a period of one month.

In addition, the changes of volatile compounds including Trans-2-hexanol, Geraniol, Linalool, Cis-3-hexanol, β-ionone etc. and some other important parameters such as pH, Theaflavins, Thearabugins, Amino acids and Total polyphenol content were determined for four batches over a period of one month.

As sugar was the only parameter which showed a significant change with respect to the sugar adulteration, further studies will be conducted to determine the sugar concentration in made tea using HPLC technique.

Development of value added tea products

Extraction of protein from spent tea

A method to extract protein concentrate using membrane filtration technique has been developed. It comprises 24% protein, 12% total ash, 0.4% ether extract, 0.4% crude fiber and 7% polyphenols. A collaborative study has been initiated with the Faculty of Agriculture, University of Peradeniya, to develop the product as an animal feed.

Development of standards for tea

Detection of Anthraquinone in Ceylon tea was one of the issues raised during the last year. As it is not a pesticide used in tea, it is important to identify the point of contamination. However, it has not been possible to analyze this chemical in tea in Sri Lanka due to unavailability of an analytical method.

Thus a methodology based on the QuEchERS extraction and clean-up followed by the GC-MS analysis in the presence of HP-5MS column were developed, optimized and validated with the relevant recovery studies. For the validation of the methodology, the parameters such as LOD, LOQ, repeatability and reproducibility in terms of RSD & CV, accuracy %, bias %, and recovery % were determined.

Further studies will be conducted for the development of this method to detect some other pesticides recommended for tea along with Anthraquinone compound from a single run through a multi-residue methodology.

Advisory and extension visits to tea factories

Process Technology staff has made 58 visits to tea factories for advising on various aspects of tea manufacture and machineries.

SOCIOECONOMICS AND RESOURCE PLANNING

Investigation on labour turn over and absenteeism in tea plantations

This project was commenced to identify severity of worker scarcity in large tea plantations, to assess the influence of worker scarcity, to identify socio-economic factors affecting the worker shortage and to suggest appropriate strategies to overcome worker shortage in large tea plantations. The severity of worker shortage in tea plantations was studied by collecting data through a questionnaire. Based on the results of the survey, estates were categorized in to different groups depending on its severity of worker shortage and the sample estates were randomly chosen from each group to collect the primary and secondary data to achieve other objectives. The sample represented 30, 12, 18 and 14 estates respectively, from Up country, Mid country, Low country and Uva regions.

The secondary data on selected workers and general information on estate work force (monthly income, worker outturn, efficiency (plucker intake/task of sundry workers), facilities provided, composition of workforce, age profile, worker requirement, worker availability) were collected from the estate records.

Primary data were also gathered from the estate managers through a questionnaire survey to identify the impacts of worker shortage on the estate (affected activities, maintenance of plucking rounds, development activities, abandoned tea lands, reduction of productivity, increase in COP, seasonality of worker scarcity, strategies followed by the estate to minimize adverse impacts of worker shortage *etc*.), regular workers/absenteeism and worker turnover and their demographic factors (gender, age, marital status, experience, No. of children / dependent), socio-economic aspects (recognition, alternative jobs, social image, addiction for alcohol, salary, fringe benefits, expenditure, borrowings) and other factors (working environment of the estate, supervisory support, lack of promotion opportunities, work load) job satisfaction, commitment to workplace and problems faced by the workers. The data collection from 11 estates in the Up country was completed.

Estimating the effects of research expenditures on tea production in Sri Lanka

Profit margin of the Sri Lanka tea industry is not attractive due to high cost of production and price decline. Since large percentage of cost is attributed to labour and fertilizer prices of which are determined exogenously, attempts to reduce cost of production depend heavily on the development and dissemination of new technologies. Also, there is a strong link between investments in research and innovation and growth of agricultural productivity. The objective of this study was to identify the length of the lagged research expenditure on tea production and to measure the impacts of research expenditure on tea production. To achieve the primary objective of the study, a supply function was developed using time series data and lagged research expenditure was included as an explanatory variable in the model. The results revealed that it has taken eight years to observe the positive effect of research investment on tea production. Lagged research expenditure, lagged price and previous year productivity showed positive and significant ($P<0.05$) influence on tea productivity. Moreover, fertilizer prices showed a negative and significant ($P<0.1$) relationship with tea productivity. Finally, study suggests that Sri Lanka tea production could be increased by increasing investment in research, because generation of new technology could be rooted towards the growth of agricultural productivity.

Estimation of technical efficiency and its' determinants in the tea smallholding sector in the Low country

Tea smallholding sector in Sri Lanka plays a significant role in the tea industry, by contributing to about 70% of the national tea production.

The average tea yield in the smallholding sector is comparatively higher than that of the Corporate sector tea plantations. However, a productivity variation was observed among tea growers in the low country area. Therefore, this study was conducted to find out the determinants of technical inefficiency & technical efficiency and the constraints faced by the tea smallholders in the Low country.

Three hundred & thirty smallholders were selected proportionately from three Districts in the Low country (Ratnapura, Galle and Matara) according to the number of smallholders in each District. A pre-tested questionnaire was used to collect the data on green leaf production, cost of production, socio economic parameters as well as the constraints faced by the growers. Maximum likelihood estimates of stochastic frontier model were estimated for green leaf yield as a function of land extent, family labour, hired labour, fertilizer quantity, chemical cost and Zn cost using both Cobb-Douglas and Trans log models. Hired labour, fertilizer quantity and Zn cost showed positive and significant effects on tea yield. The coefficients for land, family labour, hired labour, Zn cost and fertilizer quantity had (positive) values of 0.57, 0.006, 0.01, 0.01 and 0.28 respectively while the coefficient for chemical cost was -0.0006. Mean technical efficiency of tea smallholders in the Low country was 64.1 % and there was a scope of further increasing the output by 35.9% without increasing the levels of inputs.

In the inefficiency model, age, experience, education and clone were significant with coefficients of 0.04, -0.09, -0.20 and -1.83 respectively while the coefficients for occupation and intercropping were 0.008 and 0.43. Results also revealed that the burning constraints faced by smallholders were low green leaf price (74%), poor quality fertilizer (68%), labour shortage (50%), increased COP (38%) and poor quality of planting materials (28%).

Current status of and returns to investments in soil fertility management strategies in the Corporate sector tea plantations in Sri Lanka

The soil fertility status of tea lands can be upgraded and higher returns obtained by adopting soil fertility management (SFM) strategies as per the Tea Research Institute (TRI) recommendations. The objective of this study was to investigate the current status of and returns to investments on SFM in the Corporate sector tea plantations. The study achieved its objectives by descriptive analysis, multiple regression analysis and financial analysis. The secondary data were collected from a sample of 15, 35 and 14 estates, representing Mid, Up and Uva region respectively for the past ten years. Findings of the study revealed that the investments in SFM varied among regions and management companies. The investments in lateral and leader drains, terracing, forking and burying of pruning were seen cost effective and give higher returns at current input prices. Further, the results revealed that the investment in lateral and leader drains, terracing, forking and burying of pruning had a positive relationship with tea yield. Moreover, there was a positive and significant influence of investment in burying of pruning on tea yield. However, it was identified that the SFM strategies have not been adopted by the plantations as per the TRI recommendations. Findings of this research emphasis the needs for policy interventions by highlighting the importance of adopting SFM strategies in tea plantations for sustainability of the tea industry.

Application of Geographic Information System (GIS) to tea sector

Mapping of tea lands in Sri Lanka using GIS technology

The data collection on tea and rubber lands in Kalutara, Kegalle, Matara, Ratnapura and Kandy Districts by the Land Use Policy Planning Department (LUPPD) was nearing completion. The staff of the Agronomy Division, TRI, supported LUPPD in field verification and refining of maps as per the industry requirements.

SERVICES TO STAKEHOLDERS

The advisory & extension activities and the extension studies undertaken by the Advisory & Extension Division during 2016 as per the Corporate Plan of 2013-2017 are given below.

Activities of Advisory & Extension Division

The activities of the D/ADV project were confined to the main station at Talawakelle. The main activities included the maintaining of TRI auditorium to provide facilities to conduct seminars, meetings, training programs, *etc*., and maintaining of the Tea Information Centre at the TRI Talawakelle. During the period under reference, facilities were provided to conduct 45 seminars/workshops/meetings at the auditorium. The facilities of the auditorium were improved by providing a new multimedia projector and a hot/cool water dispensing unit. Moreover, updating of Tea Information centre with new display panels, light boxes, crystal boards and sample racks was completed.

Routine Advisory & Extension activities

Main Objective: To solve cultivation related problems in tea estates, educate and train tea growers and to disseminate tea information and technology to the stakeholders, mainly on a participatory manner.

Progress

The staff was able to complete the scheduled advisory & extension activities and all the requests received from both corporate sector plantations and the smallholdings. The problems identification requests received from smallholdings were dealt with the participation of the officers of the TSHDA.

The progress of the advisory & extension activities undertaken by the Advisory & Extension Division of Talawakelle, Ratnapura and Kandy are given below.

Major Activities	Talawakelle	Ratnapura	Kandy	TOTAL
Visitors to the division/centre	2356	1386	649	4391
Advisory correspondence	485	385	116	986
Advisory visits	448	122	63	633
Group training approaches	135	53	45	233
Distribution of publications	247	300	147	694
Soil Samples tested for pH	0	818	691	1509
Commercial nursery inspection	0	7	35	42
Other Visits/ Involvements in adaptive trials	17	21	27	65
Exhibitions				14

Advisory visits: The advisory & extension staff of the above regions have made the individual estate visits for identification and solve the cultivation related problems, and to assist the management to draw up development plans to their plantations. During the year 2016, several requests related to the failure of tea nurseries in up country region were inspected and advised on how to minimize the casualty rates. Meanwhile, bush debilitation was the main issue in the low country region addressed by the advisory & extension staff in Ratnapura region. The incidence of roots-eating-ant (Deniyaya ant) (Acropyga acutiventris) were specially reported, from several smallholdings in the Nawalapitiya and Gampola areas of Kandy District.

Advisory correspondence: A total of 986 advisory correspondences have been sent out on various subjects and the visit reports following the advisory visit to plantations and smallholdings.

Group training programs: A total number of 233 training programs, seminars, workshops *etc*., were conducted for the staff of the corporate sector tea plantations and the tea smallholders, in Talawakelle, Kandy and Ratnapura regions. Several, tailor-made training programs on Good Agricultural Practices were conducted by the advisory & extension staff of Ratnapura Regional Centre for the smallholders in Balangoda area where the die-back problem was prominent.

Residential training programs: The tea module of the 7-day residential training program of the NIPM, meant for school leavers was conducted at the TRI. A special training program, covering all the aspects of tea cultivation and manufacture for children of the beneficiaries of the STaRR project was also conducted at the TRI, Talawakelle. One-day familiarization program, coordinated by the Department of Commerce and Trade was conducted for the foreign delegates visited from 22 countries.

Regional Technical and Extension Forum (RTEF)
As schedule, fourteen RTEF workshops were conducted during 2016, with participation of the TSHDA covering all eight Regional Manager Regions of the TSHDA. The special issues and problems that were raised at the above fora were discussed further at the E & E Forum and the TRI-TSHDA interaction monitoring committee meetings, for further investigation and necessary policy involvements.

Regional Scientific Committee (RSC) seminars: Three seminars were organized by the Regional Scientific Committees covering Uva, Ratnapura / Kalutara, and Kandy regions.

Experiment and Extension Forum for the Smallholdings Sector
One session of the E and E forum for the smallholdings sector, with participation of the TSHDA, SLTB, SLTFOA and the officials of the Tea Development Societies, was conducted during the year 2016 at the TRI, Talawakelle. Mr C J Liyanarachchi, Advisory Officer coordinated the E & E forum for the smallholdings sector.

The main topics of the presentations made at the E & E session in 2016 were as follows.

Theme: Good Agricultural Practices catering to the current needs of the Tea smallholder sector

- Invited presentation: Strategies to minimize earth slips in tea lands (Dr Jagath Gunathilake, Faculty of Science, University of Peradeniya)
- Reasons for poor response to applied fertilizers in tea smallholdings (Dr G P Gunaratne, Head/Soils and Plant Nutrition Division, TRI)
- Artificial mulching materials for young tea (Dr N P S N Bandara, Senior Research Officer, TRI Low country Regional Center)
- Alternatives to reduce cost of the nursery (M A Hiromi Nishanthi, Advisory Officer, TRI)

Experiment and Extension Forum for the Corporate Sector

There was only one session of the Experimental and Extension Forum for the corporate sector held during the year. Dr Keerthi Mohotti, coordinated this activity.

The main topics of the presentations made at the 232nd E & E session held on July 29, 2016 at theAuditorium of the Tea Research Institute, Talawakelle were as follows.

Theme: "Arresting land degradation through key management practices"

- Guest Speech-Natural Hazards of Sri Lanka: Land Slides and Mitigation (Dr. Jagath Gunatilake, Head, Department of Geology, Faculty of Science, University of Peradeniya).
- Soil Quality Index as a Measure of Assessing Land Suitability Prior to Replanting (Dr.N P S N Bandara)
- Potentials of Plant Growth Promoting Rhizobacteria based Biofertilizers for Tea (Dr. Mrs. P LK Tennakoon)
- Use of Artificial Thatching Materials in Young Tea Fields (Dr. N P S N Bandara)

Supplying of new clonal cuttings – ADB Mother Bush program

The project was commenced in 1999 and the project period was officially completed at the end of 2015. However, the coordination of issuing of cuttings of TRI 3000 and TRI 4000 series cultivars was continued for the benefits of tea growers. This is one of the most important services offered by the Advisory & Extension Division. Mr J C K Rajasinghe continued to coordinate this service by visiting and advising on the maintenance and issuing of cuttings from mother bush sites established in different tea growing regions. Around 4.2 million cuttings have been issued to both smallholdings and corporate sector during the year against the estimated 7.1 million cuttings.

Cyber Extension activities

The main objective of the Cyber Extension project was to develop modalities to disseminate tea technology through ICTs. The following initial activities were undertaken during 2016.

- Development of the SMS gateway to send tea information through SMS
- Development of Online facilities to monitor activities of ADB Mother bushes
- Development of Voice messages for m-extension (CABI/DOA & Dialog) project

Adaptive trials for evaluating the adaptability of new technologies approved by TRC

The aim of conducting adaptive trial is to test the adaptability of already developed technologies to specific environments and farmer circumstances. To be able to achieve this objective, most of the experimental activities were on-farm and were usually farmer managed, with the researchers and extension officers providing the required technical support. It takes into accounts of the different biological and socio economic circumstances of the growers.

Objective: Evaluating growers' perception, socio-economic feasibility and practicality of new findings.

Progress
Sixty five visits were done by the advisory & extension staff to evaluate the adaptive trials of TRI 5000 series cultivars established by the Plant Breeding Division, in the corporate sector tea plantations and the smallholder lands in Morawaka, Akuressa, Soyza Estate, Pelawatta, Greenwood, Mulberry and Hanguruama Estate.

Audio Visual services
Objective: Produce video clips on technical subjects, maintain audio and video library for research, extension and educational purposes and issue AV materials produced by the TRI. Mr. Neville Ekanayake, Technical Officer of the Advisory and Extension Division provided following audio visual services.

Progress
The AV services were provided for 41 events including staff seminars, divisional review meetings, presentations, seminars at plantations, training programs, field demonstrations and the other general functions of the Institute. Assistance was given to produce a Video film on "Die-back of tea in the Low Country region". 490 DVDs with 3,020 video programs on tea cultivation and soil conservation were copied and issued among the stakeholders. Seven visits were made to purchase AV materials, for conducting audio visual programs and to assist the Wevili Saviya Exhibition. Video clips were prepared on black tea manufacture and agro-chemical use in tea for the seminar presentations. A multimedia and computer system was installed in the Library Board room.

Main photocopy service
Mr Neville Ekanayake overlooked the activities of main photocopy service of the institute. An income of Rs. 23,880.00 was obtained from the staff personal accounts and Rs. 127,565.00 from the divisional projects as photocopy charges.

Stakeholder interactive activities
Objectives
The objectives were to organize extension activities to foster the interaction with the stakeholders and promote tea technologies and the TRI activities among stakeholders, school children and general public.

Progress
Visitors to the TRI: Total of 4,391 stakeholders including students and foreign persons visited the TRI for educational and awareness purposes. The majority of visitors were school children who visited the TRI for educational purposes.

Educational exhibitions
The extension staff participated in eleven educational exhibitions, including the "Future Dreams 2016" exhibition series organized by the Department of Education, in collaboration with the Sustainable Energy Authority.

The content of the "Future Dreams 2016" exhibition has been planned with the intention of delivering new knowledge of energy and science streams to the school community, enhancing theoretical and practical knowledge of students and teachers as well as popularizing the Energy Education Program. The Ministries of Environment, Agriculture, Power and Renewable Energy, Education, Science and Technology, Skills Development and Plantation Industries took part in the exhibition.

Province	Date	Venue
North Central	23-24.09.2016	Polonnaruwa Royal College
Eastern	27-28.09.2016	Bt/ Chenkaladi Central College
Northern	02- 03.10.2016	Vavuniya Tamil Central College
Central	07- 08.10.2016	Gurudeniya Training Centre
Southern	14-15.10.2016	Sudarma Central College, Galle
Sabaragamuwa	21-22.10.2016	Pindeniya Central College, Kegalle
Western	28-29.10.2016	Panadura St John's Collage
North Western	04- 05.11.2016	Srimath Jhon Kothalawala Maha Vidyalaya
Uva	08- 09.11.2016	Haliela Central College

In addition to the above exhibitions advisory staff participated in the following exhibitions during 2016;

- “Wewili Saviya” for plantation sector inauguration program held February 28 at Morawakkorale Tea Factory in Kotapola, Deniyaya.
- “Wasa Wisa Nathi Ratak” exhibition held in the BMICH
- The advisory staff of the Kottawa, Deniyaya and Ratnapura stations participated in the "Galu Saviya" Exhibition in Galle
- The educational exhibition organized by the University of Uva Wellassa to celebrate their 10th anniversary.
- The advisory staff at Talawakelle participated in the Agricultural Exhibition held at Nuwara Eliya

Services to stakeholders

Commercial Nursery Inspection: On the request of the TSHDA, 42 commercial tea nurseries were inspected for approving the plants suitable for replanting and infilling.

Para Extension Approach (PEA) for the Corporate Tea Sector
Objectives

1. To improve the accessibility and the effectiveness of the TRI Extension system for the grass root level
2. To improve knowledge, attitude and adoption of good agricultural practices at grass root level.

The PEA activities conducted during the year 2016 were as follows.
Para Extension Approach (PEA) is a collaborative project initiated with the RPC Plantations for the benefit of the grass root level employees. The selected field staff was trained by the TRI as Para Trainers who in turn conducted extension activities for the grass root level employees (workers) of their plantations.

During 2016, three TOT programs were conducted to train the Para Trainers by the TRI staff, on Blister Blight and Tea Tortrix management and the Plucking. In turn, the Para Trainers have conducted seven Tea Field Schools for the workers in their estates. Moreover, the Para Trainers have made five visits to the demonstration sites/fields and one familiarization visits to the TRI. Finally, one evaluation/review program was conducted to evaluate the Para Trainers.

In addition to the above, initiatives were taken to implement the Para Extension Approach in the Uva region with five RPCs namely, Agrapatana Plantations PLC, Balangoda Plantations PLC, Madulsima Plantations PLC, Namunukula Plantations PLC and Maskeliya Plantations PLC.

Designing & production of extension and teaching materials
Objective
The objective was to produce educational, extension and display AV and printed materials for technology dissemination and publicity

Progress
Several extension and educational information materials were developed by the staff of advisory division for conducting extension programs, information dissemination and publicity purposes.

- One posters was prepared for smallholders on the mitigation of nematode problem in the Low Country region by Mr Janaka Mahindapala Mr Amila Jayaratne and Ms Hirun Dayananda
- A leaflet on nematode mitigation was published by Mr Janaka Mahindapala, Advisory Officer.

- Leaflets written in Sinhala language by JCK Rajasinghe, Principle Advisory Officer and Mr. C.E. Munasinghe, Extension Officer on collar canker and red ant were submitted for printing.
- Three booklets were published on soil conservation in tea fields (Sinhala and English) by Mr. J C K Rajasinghe and තේ වගාවට සරු පසක් by Ms Hiromi Nishanthi.
- Fifteen digital posters were prepared by B A D Samansiri, Asantha Abeysooriya and G S Pradeep for displaying at the Information Centre and the exhibitions)
- The Vol. 12 (1) and 12 (2) of the තේ නතු newsletter were published (Edited by Mr Janaka Mahindapala)

Mr J C K Rajasinghe, Principal Advisory Officer involved in preparing the questions for a series of Radio Quiz Programs of the TSHDA and the Head and other Advisory staff assisted the TSHDA to conduct the Radio Quiz Program in different regions.

Special Activities

Agro-chemical Usage Audit

Ms Hiromi Nishanthi, Advisory Officer, assisted the Tea Tang (Pvt) Ltd in Colombo to conduct the Agrochemical usage audit in their client tea estates. The main objective of this activity was to check the compliance of agrochemical usage to the TRI recommendations and to evaluate ongoing implementation of the food safety requirements. Seven tea factories/estates in Uva and Low country regions (Dambetenna, Haputale, Wevelkandura, Ceciliyan, New Vithanakanda, Nawalakanda and Karavita) were visited during 2016.

NVQ Level 4 Full time residential training program for tea Field Officers

In the first time of the history, TRI conducted a 4 months residential training program leading to National Vocational Qualification (NVQ) Level 4. This NVQ training program was developed, organized and coordinated by the National Institute of Plantation Management as a part of their annual training schedule. The program was held at the Low Country Regional Center at Ratnapura and Mr Janaka Mahindapala, Advisory Officer coordinated the program from the TRI. The program was commenced in November, 2016 and fourteen school leavers from different parts of the country followed this practical oriented program. The program duration assigned to grasp the technical knowledge was about (450 hrs). The participant's accommodation for entire period was provided by the TRI. The NVQ level 4 was intended to be a skill development (practical oriented) program and the participants were exposed to both practical and theoretical aspects on tea cultivation, including the management of tea nurseries and young tea fields, plucking, management of mature tea field, maintaining administrative records and handling of green leaf, *etc*.

About 30 members of the TRI staff in different disciplines contributed to the training program, as resource personnel. At the end of the training sessions, the trainees were evaluated for their knowledge and skills of the basic practices of tea cultivation and maintenance of tea fields. The final assessments were done with a series of evaluation methods such as, individual and group assignments, practical test, spots test, viva and written examinations. Finally, the participants were exposed to the other tea growing regions as well.

The *Govi Mithuru*; the mobile-based agro advisory service: A collaborative project of CABI, DOA, TRI and the Dialog mobile

The Advisory staff and the several scientists involved in developing the voice messages on tea cultivation and crop protection for the, agro advisory service of the Dialog mobile company in Sri Lanka; the collaborative project of the DOA and the CABI-South Asia, designed to improve the access to information on nutrition-sensitive health and agricultural practices, among farmers and the rural people, by harnessing the power of mobile technology. The participants of this project attended two write shops organized by the CABI in Kandy and Talawakelle and developed 98 voice messages in Sinhala, Tamil and English languages to disseminate tea technology through the mobile phones.

Special field problems attended

A serious Pink, Yellow and Scarlet Mite outbreak reported in some part of Ratnapura District including Kuruwita, Gilimalle and Nivithigala regions in July-August Period. Advisory staff immediately attended to manage the problem.

Mr Mahindapala and Dr. N.P.S. N. Bandara of Agronomy Division visited the Aranayake and Kalupahana estate in Kegalle District; the affected area with the massive earth-slips, to investigate the impacts on tea cultivation under such natural disasters. The observations were presented by Dr. N.P.S. N. Bandara at the RTEF and Monsoon Forum.

Special study programs

Mr B A D Samansiri, Head / Principal Advisory Officer, Mr J C K Rajasinghe, Principal Advisory Officer and Mr Janaka Mahindapala, Advisory Officer participated in a training on Pollution-free tea production technology for developing countries at the Zhangzhou College of Science and technology in Fujian province in China from April 25 to June 19, 2016.
The summary of the visit report and suggestions submitted to the Tea Research Board are as follows.

Establishment of small scale tea processing units for producing specific types of teas

The specific teas such as the organic teas, different levels of agro-chemical free teas and health-teas can be processed in small or medium scales. All the necessary machineries have been developed by China. Therefore, we can get their assistance to develop such small scale machineries for our needs.

Establishment of an international level education centre for black tea production

Sri Lanka has a vast knowledge accumulated over many decades on the black tea processing. This knowledge can be advantageously used for establishing a tea education centre for the Asia-Pacific and Africa region. The subjects such as basic cultivation and manufacturing aspects of black tea, world tea culture, packaging and value addition, black tea brand globalization *etc*., can be taught in this international college.

The product diversification

Other than using tea as a beverage, it can be developed in to various forms of tea food and beverages and other consumable products such as tea seed oil, tea shampoo, toothpaste containing of tea, etc. It is one of the past developing areas in the world tea industry. People prefer natural healthy products than the artificial formulations. Therefore, the tea containing food being natural products have an advantage and due to the fact that nutrient content of tea could probably be fully utilized by eating tea food, than drinking tea liquor.

Development of tea eco- tourism industry

The unique and picturesque nature of tea plantations in Sri Lanka can be capitalized by developing the tea eco-tourism. Most of the tea plantations in Sri Lanka are adopting eco-friendly policies and most of them have the necessary infrastructure and facilities and a strong human resource base necessary for establishing an eco- tourism industry. The TRI can help the industry by developing suitable models for eco-tourism in the plantation sector.

Developing and maintaining regional analytical laboratories/facilities at Talawakelle, Walahanduwa and Hantana

Objectives:

a) Main objective was to provide analytical facilities to the stakeholders for soil, foliar and fertilizer analysis and assist tea growers in site specific fertilizer application.

b) Carryout analysis of samples of regional based field trials.

The total number of analysis on soil, leaf, fertilizer and organic manure at Talawakelle, Walahanduwa and Hantane laboratories during the year under reference (2016) were 17,153, 1,124, 2,673 and 62 respectively. Out of these analyses the highest number of analysis were performed for soil pH (7,239) and soil organic carbon (4,905). The total number of analysis performed for the year 2016 was 21,012.

Other analytical services

Nematology and Entomology laboratories at Talawakele, Hantana, Ratnapura and Deniyaya extended services in nematode diagnosis to the small holder and the corporate sector estates in the Up Country, Mid Country, Uva, Low Country and Southern Province. 50 samples were analyzed in corporate and small holder sectors.

More than 30 estate root samples were tested for starch content by the Plant Physiology Division and the recommendations were given to the respective estates prior to pruning.

Thirty two black tea, sixty three green tea and five water samples were analyzed by Pathology Division for microbial quality parameters. Seven tea root samples and three soil samples were also tested for the presence/absence of pathogens.

Other training programs

During the period under review, much attention and focus were given to explore and study nematological attributes to the unusual yield decline and death of tea bushes in small holder tea lands in Balangoda, Kalawana and Deniyaya regions. Based on the data generated on nematode infestation levels, preliminary awareness programs and treatment plans were proposed to the affected tea lands while a concerted management approach is being worked out by the Entomology and Nematology Division in association with the Advisory and Extension Division.

Dissemination of IPM packages inclusive of safe use of pesticides and non-chemical pest management, nursery fumigation for strengthened pest control, several expert advices and on-farm training programs were offered to the corporate sector estates and smallholders. Also, the staff of Entomology and Nematology Divisionat Talawakelle, Ratnapura, Hantane and Deniyaya assisted in routine advisory and extension services, estate visits, seminars and Crop Clinics *etc*. and requests of organic and RA certified tea growers were attended. Awareness programs were also conducted on IPM of Tea Tortrix for managers and field staff of Watawala PLCs and Elpitiya Plantation Ltd.

PUBLICATIONS UNIT

The Publications Unit of the Institute is responsible for work related to printing, publishing and issuing of Institute's publications *viz*. Annual Report, Sri Lanka Journal of Tea Science, Tea Bulletin, periodicals, booklets, advisory circulars and guidelines. The following publications were issued during the year:

1. Te Thathu Volume 12, 1
2. Te Thathu Volume 12, 2
3. Operational Guidelines No. 01/16 – Good Operational practices in relation to reduction of chromium contamination in CTC tea
4. Advisory Circular on Fertilizer recommendation for mature tea in small holdings (SP10)
5. Annual Report 2014 - English
6. Annual Report 2014 - Sinhala
7. Annual Report 2014 - Tamil
8. Tea Bulletin Volume 24, 1, June 2015
9. Tea Bulletin Volume 24, 2, December 2015
10. TRI Update Volume 14 No.1 December 2015

The income generated by sale of following publications was Rs.239,400.00.

Name of publication	No. of copies Sold	Income Rs.
Handbook on Tea (Reprint)	63	108,750.00
Twentieth Century Tea Research in SL	08	16,000.00
Monograph No. 4	Nil	Nil
Monograph No. 5	41	14,350.00
Monograph No. 6	07	700.00
Monograph No. 7	80	8,000.00
Shoot Growth & Harvesting of Tea	18	1,800.00
Field Guide Book (English)	Nil	Nil
Field Guide Book (Tamil)	13	1,625.00
Chemical Control of Tea Pests (English)	17	2,550.00
Chemical Control of Tea Pests (Tamil)	02	100.00
Tea & Health	70	43,125.00
Tea for Health	75	7,500.00
Cost of Tea Cultivation from Nursery to the field	08	3,200.00
Nuwara Eliya Dist. Tea Dev. Plan	Nil	Nil
Advisory Circular Folder (English)	26	15,600.00
Advisory Circular Folder (Sinhala)	04	2,000.00
Advisory Circular Folder (Tamil)	Nil	Nil
Weeds of Tea Lands in Sri Lanka	29	5,800.00
Correction of Nutrient Deficiency Symptoms in Tea (English)	21	315.00
Correction of Nutrient Deficiency Symptoms in Tea (Tamil)	01	15.00
Wall Chart on Major Pests of Tea in Sri Lanka	38	3,800.00
Poster on Soil Conservation with Vetiver Grass (Eng)	12	360.00
Poster on Soil Conservation with Vetiver Grass (Tamil)	02	60.00
Tea and Rubber Intercropping System	Nil	Nil
Tea for Health (Sinhala Version)	30	3,750.00
Plucking of Tea (Sinhala Version)	Nil	Nil
Pruning of Tea (Sinhala Version)	Nil	Nil
Total		**Rs.239,400.00**

LIBRARY

The main function of the library is the collection and dissemination of information for the TRI staff for carrying out their research and extension activities. The library also renders its services to the undergraduate and students who undertake their projects at the TRI and also to the other libraries and individuals upon their requests.

The TRI library involved in the following activities during the year under review

- Acquisition, collection and maintaining of library materials.
- Lending library materials
- Maintaining a collection of News Clippings
- Photocopy Service
- Inter-Library Loan Service

Acquisition

Seventeen new books (three on payment and fourteen free of charge) were added to the current collection of 4724 books. The Library procured 27 Journals / Serials through subscription, gift and exchange. It also subscribed to 10 foreign journals. Two Ph D thesis of the TRI officials were added to the library thesis collection during the year.

Services

During the year, 446 newspaper articles were extracted and sent to the Director. Under Inter Library Loan Service (ILL), library has supplied two articles to the TRI staff. About 1887 papers from bound periodical collection and other library materials were photocopied and given to the TRI staff. Nine students from Universities and Technical Colleges used the library facilities during the year.

The TRI Library completed the National Digitization Project in collaboration with the National Science Foundation. Under this project all the TRI publications from the year 1928 to 2012 were digitized and added to the e-repository of the National Science Foundation. Online access is available at http://tri.nsf.ac.lk for full text of articles of the TRI publications *viz*. Annual Reports, Tea Quarterly, Sri Lanka Journal of Tea Science, Tea Bulletin, TRI Update, තේ තතු, Advisory Circulars, Guidelines & the E & E Proceedings.

INFORMATION & COMMUNICATION TECHNOLOGY UNIT

Updating the TRI Website

Primary objective of the TRI Website is dissemination of latest tea technology and related information to stakeholders. During the period under review following contents were updated to meet this objective.

News items of releasing the report on climate change vulnerability and adaptation strategies for tea plantations, Sixth Symposium on Plantation Crop Research and its award winners, all time record price achieved by St. Coombs factory and recent price changes of St. Coombs tea were uploaded under “What’s New” area of the homepage.

Details of TRB, CCR, CCEAS and A & M members and details of staff were also updated. Further, proceedings of 231st E & E Forum and presentations of 232nd E & E Forum were also uploaded under the page of "Extension Events" of Technology Dissemination. Vacancy advertisements for Superintendent of St. Joachim, Management Assistants, Electrician and Drivers and Registration of Suppliers for 2017 were also published.

For the benefit of website users important external website links were also included on the homepage of the website. They include Seasonal weather forecast by the Department of Meteorology (http://www.meteo.gov.lk), e-Repository of TRI scholarly literature by National Science Foundation (http://tri.nsf.ac.lk) and Report of the Working Group on Climate Change of the FAO Intergovernmental Group on Tea by Food and Agriculture Organization (FAO) of the United Nations (http://www.fao.org).

Infrastructure development and maintenance

- Desktop computers (14), notebook computers (05), full duplex laser printers (05) and 650VA UPS systems (18) were distributed among the divisions of head office and other regional/ extension centers as per procurement plan and their requirements.
- Kaspersky® Anti-Virus software was also purchased and installed in 111 desktop and notebook computers at head office.
- Fifty five major jobs under the activity of installation & troubleshooting of computers, computer accessories and LAN were completed/ carried out.

Other services

Information & Communication Technology (ICT) unit rendered following ICT related services to the other divisions, units, regional and extension centers as well as TRI estates. Those included;

- Administration & maintenance of DNS (Domain Name System), E-mail and File servers
- Providing and regular monitoring of internet access to TRI officers
- Maintenance of Finger Print Scanners located at head office and Low country Regional Centre and its software
- Maintenance of Fixed Assets Register of Computers, Accessories and Software

Outsourcing of key services of ICT unit

M/s Lanka Communication Services (Private) Limited continued its operation throughout the year. Due to exigencies of services the TRB has decided to obtain services from the service provider for another six months with effect from December 1, 2016.

TRI REGIONAL CENTRES

Low Country Regional Centre

M A Wijeratne
B Sc Agric. (Ruhuna, Sri Lanka), Ph D (London, UK)
Officer-in-Charge

Administration and staff movement

Mr. G.L.C.Galahitiyawa was re-appointed as a Senior Research Officer on contractual basis with effect from May 02, 2016. Mr, Kithsiri Palathanthrige was covering up the duties of Works Supervisor until August 2016. Mr. K. Gunawardena, Work Supervisor, was transferred from the Mid country Regional Center to the Low Country Regional Center with effect from August, 01, 2016. Mr. D.W.Vithana and Mr. J.S.K.de Silva retired from the TRI Services with effect from July 19, 2016 and August 29, 2016 respectively. Mr. S.A.C.Suraweera, Driver was transferred to Kalutara Extension Center and in his place Mr. K.M.T.T.Bandara, Driver, reported to the Low Country Center with effect from September 5, 2016. Mr. Sudath Pradeep was temporary transferred from TRI, Head Office to Ratnapura Center with effect from September 13, 2016. Mr. M.G.S. Liyanage, Experimental Officer, Agronomy Division was transferred to Head Office Talawakelle with effect from September 19, 2016. Mr. J.M.G.W. Jayaweera, Electrician was transferred from Head Office to the Low Country Regional Center with effect from November 28, 2016. Miss I D C Sajeevika, Extension Officer resigned from the TRI service with effect from July 15, 2016.

Research, Advisory and Extension activities

The TRI Low Country Regional Centre (TRI LCRC) has been conducting over 66 experiments in the field of Agronomy, Plant Breeding, Entomology & Nematology and Process Technology with special reference to low country tea growing environments. The details of those experiments and outcome have been described elsewhere in this Annual Report under different themes. The staff of the Process Technology unit has done more than 40 visits to tea factories for problem diagnosis and providing advices with regard to factory machinery and tea manufacture. The staff of the Plant Breeding Division looked after maintenance activities of 12 seed gardens in the low country region and continued to coordinate the supply of tea seeds to the stakeholders. They also maintained the tea germplasm established on St. Joachim estate.

The Advisory and Extension Division has done 94 advisory & extension visits and 46 training programmes for stakeholders. More than 177 Nos. of advisory correspondences were dispatched and 105 Nos. leaflets, wall charts, digital posters, newsletters and video films were issued by the Regional center. The number of soil samples tested for soil pH exceeded 275. The number of visitors to the Center during the year under reference was more than 260. Additionally, children from several schools visited the TRI LCRC for educational programmes.

The Regional Scientific Seminar for the Managers and Assistant Managers of Kegalle and Kalutara Districts was held at the Low country Regional Center on August 26, 2016. In addition, two Regional Technical Extension Forums were held for the extension staff of the TSHDA and members of the smallholder development societies in Kegalle and Ratnapura Districts. Training programmes on tea were held for smallholders of Dehiowita and Warakapola and for the staff and smallholders of Nandana Tea Factory. The extension staff of the TSHDA was trained on tea nursery management. A field day on nursery management and plucking was held for the field staff and workers of Pambegama Estate and a seminar on tea cultivation was conducted for the field staff of Pussellawa Plantation. Further, two training programmes were held on tea cultivation for the "LEADS" organization and the students of Weerawila and Agunakolapellassa Agricultural schools were trained on tea cultivation. A three month residential training programme was commenced at the Low country Center with effect from November 2016, for NVQ level field officers of the National Institute of Plantation Management.

The Advisory and extension staff continued to monitor the spreading of nematode infestation in Ratnapura District and awareness programmes were also held for smallholders in those regions in collaboration with the TSHDA and Nematology Division, TRI.

Other programmes / activities

Religious ceremonies were held on January 01, 2016 with the participation of all staff and workers of the station. The Chairman, TRB visited TRI Low Country Regional Center on January 27 & 28 2016 and met all the staff of the Center. The Chairman convened a meeting with leaf suppliers of the St. Joachim tea factory at the Low country Regional Center in order to increase bought leaf supply. The Chairman and the members of the TRB visited the Low Country Regional Center and the 216th TRB meeting was held at the Center on August 11, 2016. Two awareness programmes on Colombo Stock Exchange and investment in Unit Trust Fund were conducted by the Ratnapura Branch of the CSE and CeyBank respectively, for the staff of the TRI and St. Joachim estate on February 10, 2016. Dengu prevention programme, cleaning of TRI premises and fogging were done in collaboration with the Health Department officers of the region. The TRI-Low Country Regional Center Sports Club organized Annual Children's Party with the participation of its members and families for celebrating the Xmas.

Human Resource Development / Training

Dr.M.A.Wijeratne, Officer-in-Charge attended the FAO/IGG meeting on tea held at Naivasha, Kenya from May 19 to 28, 2016. Mr. K.G.J.P. Mahindapala, Advisory Officer went to China on a study tour during April 22 - May 21, 2016. Mr. M.A.Chamindra, Experimental Officer, Technology Division went to Malaysia on December 7-8, 2016 to participate in the Smart Plantation Management Symposium. Mr. Sampath Pathiranage, Research Assistant and Mr. Noel Piyasundera continued their post graduate studies leading to Ph D at the Post Graduate Institute of Agriculture (PGIA), University of Peradeniya.

Twelve students from Hardy, Naiwala Advanced Technological schools, Aquinas College and from Universities carried out their training and research projects. One student from Ruhuna University was trained at this station on tea related subjects for 4 months. A group of student from NAITA institute also completed their training at the Administration Division.

Infrastructure developments

Internal and external colour washing of C3, C-5, C-8, C-12 and C18 quarters was done. The guest house roof was painted and maintenance repairs and painting of security check point, hostel and office building were completed. The ceilings and gutters of five C and B type quarters were repaired as necessary and roof painting of D1, D2, D3, D4, D7 and D8 quarters was completed. Repairs and painting of eight garden gates were done. Moreover, general cleaning of Administration building and cleaning and polishing of laboratory premises were attended as required. Other day-to-day cleaning and maintenance operations of the layout and buildings were satisfactorily carried out.

Wirings for the new water pump, new Air Conditioner of the PABX room and vehicle garage were done. The telephone extension lines were repaired as necessary. Other routine electrical maintenance of street lights and TRI buildings were satisfactorily done.

Security services for the Low Country center were provided by Messrs. Eagle Wings Security service.

TRI Mid Country Regional Centre

K R W B Kahandawa
B Sc Agric. (Peradeniya Sri Lanka), M Sc (Peradeniya Sri Lanka)
Acting Officer-in-Charge

The TRI Mid Country Regional Centre, at Hantane, Kandy implements the research and advisory programmes of the institute in the Mid Country region. The Center is equipped with four laboratories of Soils and Plant Nutrition, Agronomy, Entomology and Nematology, together with an Advisory and Extension Division. The center is engaged in research trials and extension programmes in the Kandy and Matale Districts and part of Nuwara Eliya District.

During the first three months of the year, the administration and other staff of the Center actively engaged in providing required facilities for the officers of the Head Office who were injured and hospitalized in Kandy hospital following the tragic bus accident at the end of the previous year.

Serious drought condition was experienced in February, August, September and December months directly affecting the tea crop production and issues of ADB mother bush cuttings.

Land use pattern	**Extent (ha)**
Seedling tea	2.00
VP tea	4.5
VP (uprooted for replanting)	1.00
VP tea Young	3.5
Mother bushes	2.75
Tea nursery	0.2
Under mana grass	0.5
Fruit trees	0.4
Forestry	1.2
Marshy land	0.62
Buildings, gardens, paths and roads	5.77
Total	**22.44**

Staff movements

Mr. H.J.M. De Silva, Extension Officer retired from the TRI service with effect from May 23, 2016. Dr. H.W. Shayamali, Senior Research Officer and Ms H.M.C.G Pilapitiya, Research Officer were transferred to the TRI Mid Country Regional Centre from the Head Office with effect from August 22, 2016. Mr. K. Gunawardena, Work Supervisor was transferred to the Low Country Regional center with effect from August 01, 2016. Mr. W A D P M U Attanayake, Driver was transferred to the Head office with effect from 01st January 2016. Mr. M G B S Priyashantha, Driver was transferred to the TRI Mid Country Regional Centre from the Head office with effect from January 01, 2016. Mr. C.E. Munasinghe, Extension Officer of the Regional Center was on study leave with effect from May 23, 2016, to complete his M Phil course at the PGIA, Peradeniya.

Advisory and Extension activities

The Center organized several awareness programmes for tea growers in the mid country region on different themes. A Regional Scientific Committee seminar was organized in collaboration with Kandy District Planters Association on strategies to face the current challenges of the industry. More than 40 executives of RPCs and Government Sector tea estates participated in the seminar where the presentations were made by the TRI scientists on scarcity of work force in the Plantation Sector, alternatives to weed management without Glyphosate and possible alternatives to chemical fertilizer.

Two RTEF seminars were also held for the TSHDA staff and office bearers of the Tea Small Holdings Development Societies. Several training programmes were conducted for Faculties of Agriculture of Peradeniya and Wayamba Universities and Agriculture Schools of the Department of Agriculture and Aquinas Collage, Colombo on cultivation aspects of tea. All the programmes were coordinated and conducted by the Advisory and Extension staff of the center while attending to other routine services such as advisory visits to estates and small holdings of the region. They also participated in the exhibition conducted by the Sustainable Energy Authority, Kandy.

The 5000 series cultivar adaptive trials established by the Plant Breeding Division at Galaha, Navalapitiya, Hangurugama,and Sogama Estate were also visited regularly by the advisory staff.

Research trials

Five new herbicide trials (A24.1) focused on effective recommendations for management of weeds in tea were conducted by the staff of the Agronomy Division at Ratwatte estate, Ukuwela. Further, the recording of Metrological Data at the center was carried out by the Agronomy Division.

The staff of the Entomology Division conducted Bio-assay studies on Shot Hole Borer susceptibility for further confirmation of already recommended cultivars. In refining the techniques for studying pest damages, data were collected in laboratory bio-assays for cultivar screening for SHB susceptibility. Evaluating estate selections for resistance to Shot Hole Borer was also conducted by the Entomology staff in collaboration with the Plant Breeding Division.

Thirteen accessions were planted in screening beds, for cultivar screening against the *P.loosi* and *R.similes* and screening of alternate grass species (A45.1) and shade trees against *R.similis* were carried out by the Entomology staff during the period under reference. From experiments and field investigations 120 root and 120 soil samples were analyzed by the division for nematodes.

Studies on development of bio organic mineral compound fertilizer aiming at reducing the conventional fertilizer and Nano fertilizer trials were continued by the staff of SPND of the Centre. Experiment on the use of factory wood ash as plant nutrients for tea and rehabilitation grasses was continued at Kurugama estate, Pilimatalawa. The field study on slow releasing fertilizer was also continued at Kellebokke Estate.

Infrastructure development

Two new telephone lines were fixed for the center and the SLT lines were improved in order to ensure uninterrupted telecommunication facilities. Necessary maintenance work of auditorium, staff quarters and the vehicle fleet were also attended.

Soil conservation measures were established in the field No.03. A phase II trial of the Plant Breeding Division was established and planting and after care operations were continued.

Visitors to the station

Tea Growers	-	209
Students (higher education)	-	507
Foreign visitors	-	18
General visitors	-	20
Total	-	754

Trainees

Ms. E.G.S.S. Jayawardena, undergraduate of the Faculty of Agriculture of University of Peradeniya completed her final year research project under the supervision of Mr. K.R.W.B. Kahandawa. Two students of Agriculture School, Karapincha completed their on the job training at the Center during the year.

Crop

The Green leaf (Kg) harvested during the year 2016 is given below.

Month	Crop harvested/sold (Kg)	Rate (Rs/kg)	Income received (Rs)
January	1921	56.35	108,248.35
February	1453	53.02	77,038.06
March	872	57.42	50,070.24
April	2034	54.00	109,836.00
May	2903	58.00	168,374.00
June	2193	57.00	125,001.00
July	1837	61.00	112,057.00
August	1518	61.19	92,886.42
September	671	66.84	44,849.64
October	356	68.92	24,535.52
November	1147	68.50	78,569.50
December	2826	70.74	199,911.24
Total	**19,731**		**1,191,376.97**

Income (Rs)

Income received from sale of Green Leaf (19,731 Kg)	-	1,191,376.97
Income received from sale of VP cuttings (301,650)	-	249,220.00
Income received from sale of VP Plants (25,654)	-	615,696.00
Guest House accommodation charges	-	71,350.00
Income received from soil and fertilizer analysis	-	100,595.00
Sale of TRI Publication	-	47,765.00
Miscellaneous	-	27,038.00
Total	**-**	**2303040.97**

Uva Extension Centre

A L Rohitha U Kumara
B Sc Agric.(Peradeniya, Sri Lanka) M Sc (Peradeniya, Sri Lanka)
Actg. Officer-in-Charge

The advisory and Extension Centre in Uva is the first extension center of the institute which is situated on Gonakelle Estate, Passara. The station has been established for extension & training needs, soil analytical services and providing planting materials for the RPC estates, private estates and small holders in the Uva region. The services are provided directly to 62 RPC estates with 25,800 ha and 30,000 small holdings (11,876 ha).

The extension centre is equipped with a small scale laboratory for soil analysis. The Center has 14.30 ha of land allocated for field trials, mother bushes and demonstrations. The land use pattern of the Center is given below.

Land Use pattern (ha)

Mature tea in plucking	-	3.80
Young tea (Experimental block)	-	0.70
ADB Mother Bushes	-	2.06
Plant Breeding Phase II trial	-	0.20
Buildings/Roads	-	0.79
Forest / Scrub / Grass land	-	6.75
Total extent	**-**	**14.30**

Advisory and Extension activities

The Uva Extension center in consultation with the Head of Advisory & Extension Division conducted a large number of advisory and extension visits, training programmes, seminars, workshops, and field days for the both Corporate and Smallholding sectors in the Uva region.

Regional Scientific Committee Meeting (RSC)

RSC - Uva seminar was held at the Management Development Training Centre, Pelgahathenne on 30 September 2016. The theme of the program was “Good Agricultural Practices for sustainability” and the topics on discussion were “Drought mitigation”, “Field demonstration on irrigation and moisture conservation techniques”, “Gradual die back of *Grevillea robusta* in tea plantations of Uva” and “Integrated weed management methods for effective weed control: Alternative for Glyphosate”. Eighty two executives of the RPCs in Uva participated in the seminar and shared their views with the TRI scientists. The present situation of the Uva tea industry was analyzed critically and many strategies were evolved through the forum for overcoming the issues.

Regional Technical and Extension Forum

Two RTEF seminars were held at the centre for officials of the TSHDA and Smallholding Developments Societies. The topics discussed at the forum were, “Effect of climate change on Uva tea sector”, “Protect your tea lands from Stem Canker Disease”, “Actions to be taken for mitigating drought” and “Importance of timely agricultural practices and common mistakes done by Farmers”.

Training Programmes/ Field days

- A training program on Plucking, Pruning and Planting of teawas conducted at the TRI Uva Centre on 26.1.2016 for the Private estate owners and an another session on composting and soil conservation methods was held on 27.1.2016 for the small holders of Attampitiya area.
- A series of training programs for the small holders of Lunugala, Bandarawela, Welimada, Attampitiya and Passara area was held in March 2016 covering the subjects of plucking and safe handling of green leaf. Further, a training program on organic farming was conducted at the Uva Centre on 6.4. 2016 for the selected small holders in the Uva region.
- A training program on safe handling of pesticide was conducted for the field staff and workers of Dammeria B estate on 24.5.2016. An awareness program on good agricultural practices was conducted at Kahataruppa Vidyalaya on 11.09. 2016 for smallholders of Kahataruppa area.
- A Field day on new clearing operations was held at Gonakelle Estate on 20.10.2016 for the field staff and Kanganies. Tea pluckers were also trained at the Amba Estate on 8.12.2016.

Summary of the Advisory and Extension activities during the year are as follows.

Advisory visits	-	28
Advisory letters	-	131
Seminars/Field days/Training programs	-	18
Regional seminars	-	03
Meetings/Seminars attended	-	40
Soil samples tested for pH	-	1104
Soil samples tested for Organic Carbon content	-	353
VP cuttings issued	-	244350
VP Plants sold	-	6271
No. of Publications sold	-	48
Commercial Nursery Inspections	-	108

Adaptive trials

Participatory observations were made on two adaptive trials evaluating the commercial level adaptability of 5000 series tea cultivars established by the Plant Breeding Division at small holdings in Kandegedara and Welimada.

Field Experiments

Following field trials were maintained by the Centre under the supervision of relevant divisions of the Head office.

- UVP 9 & UVP 10 PPPB trials in Field / No.04
- Up keeping of 5000 series phase III Trial in Field No.02
- Up keeping of Germplasm in Field / No.03
- Two Seedlings trials in Field No.03 & 04
- Evaluation of 5000 series cultivars for tolerance to nematodes
- PPPB UVP 11 trial in Field / No.02
- PPPB UVP 12 and UVP 13 trials in Field / No.03
- Root study on 5000 series cultivars (Physiology Division)
- Commenced PPPB UVP 14 trial in Field / No.02
- Commenced poly clonal seed garden in Field / No.1A

ADB mother bush Project

Distribution of new tea cultivars to the tea growers is one of the most important services offered by this Center. Out of the target of 400000 cuttings, about 252,060 of cuttings were issued from the Mother Bush site at the Centre.This was about a 37% drop compared to the last year. Low demand from the commercial nusery owners and RPC estates due to prolonged dry spell in the region was the main reason.

Special Events / Meetings / Exhibitions

- Mr. A.L.R.U. Kumara participated in the District Agricultural Committee meetings chaired by the District Secretary and presented the activities carried out by the TRI for tea growers in the Uva region.
- Mr. A.L.R.U. Kumara participated in the exhibition on "Wasa Visa Nathi Ratak" held at the BMICH, Colombo on 07.03.2016. An exhibition stall was also arranged for the exhibition of Uva Wellassa University during September 8-10, 2016.
- Mr. A.L.R.U. Kumara participated in the Plantation Crop Research Symposium held at the BMICH, Colombo during November 2-4, 2016.

Visitors & trainees

Foreign	-	05
RPC Estates	-	180
Small Holders	-	217
Students	-	135
Undergraduates	-	08
Others	-	168
TRI Officers	-	92
Total	-	805

Other training opportunities

Two undergraduate students from Uva Wellassa University and one apprentice from the Hardy Higher Diploma Institute were trained at the Center on tea related subjects under the supervision of Mr. A L R U Kumara.

Infrastructure development and maintenance

- Water supply system to the center was improved by installing four Plastishell water tanks having a capacity of 14500 l
- The colour washing and major repairs of C type quarters and Conference hall were commenced

Crop harvested

Month	Green Leaf (kg)	Price (Rs.)	Amount (Rs.)
January	2529	47.87	121063.23
February	2870	53.15	152540.50
March	3516	54.91	193063.56
April	4459	56.87	253583.33
May	4382	58.61	256829.02
June	3144	55.69	174774.96
July	1105	59.08	65283.40
August	3220	60.12	193586.40
September	2836	71.61	203085.96
October	823	69.60	57280.80
	166	73.00	12118.00
	123	70.25	8640.75
November	3166	67.45	213546.70
December	3136	74.24	232816.64
Total	**35475**		**2,138,213.25**

Income

Sale of Green leaf (35475 kg)	Rs 2,138,213.25
Sale of VP Cuttings	Rs 211,380.00
Sale of VP Plants	Rs 150,504.00
Soil Analytical charges	Rs 194,895.00
Sale of Publications	Rs 11,550.00
Guest House accommodation charges	Rs 41,700.00
Sale of Firewood	Rs 91,184.00
Other	Rs 3,045.00
Total income	Rs 2,842,471.25

Special remarks on weather

The monsoons were failed and there was a prolonged dry period during June to October of this year. Further, the lowest annual rainfall (1205 mm) during the past ten years was reported in 2016. As a result, expected crop couldn't be harvested and the demand for tea shoots for nurseries was also drastically reduced.

Galle Extension Centre

T G N Mahinda
B Sc Agric. (Peradeniya, Sri Lanka), M Sc (Peradeniya, Sri Lanka)
Officer-in-Charge

General

The TRI Galle Extension centre was founded in 1961, with the primary objective of catering to the Advisory & Extension needs of the Galle region. In addition it carries out regional level adaptive and other field trials. The Center is equipped with a small scale Laboratory for the analysis of soil pH. As per the survey plan No GA/YKK/2012/66, the Center has 31.73 ha and the land use pattern was as follows.

Land utilization	**Extent (ha)**
Mature tea in plucking	7.50
New Clearing	2.44
Mother Bushes (Including immature tea)	1.09
Tea Nursery	0.50
Land for replanting / planting	2.70
Under Rehabilitation (Mana & Guatemala)	1.00
Gliricidia (Energy crop)	0.40
Tea Seed Garden	0.33
Coconut & other crops	1.50
Marshy Land	1.20
Forestry	4.17
Buildings, Gardens, Roads, Weather Station *etc*	8.90

In consultation with the Heads of Divisions at the Head Office, the Extension centre carried out Research & Extension activities in the Corporate and Proprietary Estates and Small holdings in the region.

The important extension activities carried out in 2016 by the Advisory staff of Kottawa centre are as follows.

The TOT programs were carried out in collaboration with the SPN Division for extension staff of private tea factories of the region. Staff also participated in the survey conducted by the Agriculture Economics Division, Talawakelle, on Mechanization of tea cultivation. Training program, Seminars and Field days for the TSHDA Officials & Development Officers attached to the MPI were conducted. Advisory staff also attended the "Dakshina Krushi Navodaya" annual exhibition held for five days at the State Farm, Labuduwa, in collaboration with scientific staff of the Low country Center at Ratnapura. Two-day TOT program was held for the executive and field Staff of Elpitiya Plantations PLC and this training included theoretical as well as practical aspect of tea cultivation. On the requests of small holders, the staff of the center conducted two Crop Clinics and Field days, in collaboration with other TRI centers & the TSHDA at Unanvitiya & Neluwa, Megdagama.

A mini crop clinic was organized as an outcome of the survey carried out on yield decline in Hiniduma TI region. On the instructions of the MPI, the officials of Kottawa & Deniyaya Centers participated in the "Furure Dreams", a two-day Educational Exhibition held at Sri Sumangalodaya College, Kalahe, Galle. This event was organized by the Ministry of Education. One-day training program on Nursery Management was conducted for Divineguma Officials & Small scale entrepreneurs of Nagoda AGA Division. Staff of the Center also attended two training programs " Diviyata Arunalu" organized by the NIPM for smallholders at Haupe & Ahangama and the inauguration meeting of "Janapathi Nila mehewara" mobile service held in Galle. The Officer-in-Charge attended two training programs held at the Low country center, Ratnapura, which were organized by the NIPM & Advisory & extension staff. The staff also attended the inaugural ceremony of the Distribution of Fertilizer Subsidies chaired by the Hon. Minister of Plantation Industries.

Staff movements

Mrs. P.K. Nalika Damayanthi, Receptionist-*cum*-Telephone Operator at Head Office was transferred to Kottawa w.e.f. 31.10.2016.

Advisory & Extension activities

Item	Number
Visitors to the Centre (Estates / Small holders / Students / Foreigners / Others)	656
Advisory correspondence with Estate / Small holders	148
Advisory Visits (on call & routine) to Corporate Sector & Small holding sector	58
Training programs / Seminars / Group discussions / Field Days / Demonstrations	33
Educational / Familiarization and Meetings	53
Issue of Publications / Leaflets / Pamphlets (including free issues)	583
V.P. Cuttings sold	398000
V.P. Plants sold	23826
Soil Samples tested for pH	147
Exhibitions / Crop clinics	04
Visits / Involvements in Experiments (Adaptive Trials)	22

Adaptive trials

The assessment on the performance of proven technologies under grower's perspectives is a mandatory requirement. The Centre continued to monitor established Adaptive trials in different Agro Ecological Regions in collaboration with respective research divisions. The four Adaptive trials on potential 5000 series cultivars established in four TI regions of Mawanana, Ethkandura, Kottawa & Neluwa were brought in to plucking in 2015. The yield records were collected by the land owners and the trials were periodically monitored by the TRI staff.

Research trials

Galle Extension centre carried out following trials in collaboration with respective research divisions.

Plant Breeding Division

TRI 5000 series observation plot at Field No 2, Kottawa center

The second centering was done four potential 5000 series accessions (No. 11/12, 1/10, 107, 23/5) & due for plucking. The trial is in progress.

Entomology & Nematology Division

i) The experiment on screening of new prune cut dressing (Bitumix & Candarsan) to protect the prune cuts from LCLWT infestation was established in Field No 6, Kottawa center. The experiment is in progress.

ii) The experiment on the adoption of GAPs for the management of LCLWT was established in a small holding at Karagoda, Yakkalamulla. The experiment is in progress.

iii) Study on the possibilities of preventing White grub infestation by artificial thatching in Field No 01. The experiment is in progress.

Agronomy Division

i) Evaluation of the performance of different grass species in soil rehabilitation. This field trial was completed. The second centering was done & due for plucking. Data analysis of this trial is in progress.

ii) Two species of new high shade tree, Derris spp were planted in Field No 4, at Kottawa center in 2015 for evaluating their performance under the Low country conditions. The both species are thriving well at present.

ADB Mother Bush Project

A total of 398,000 cuttings belong to 3000 & 4000 series cultivars were issued. They included 368375 cuttings harvested from one ha Mother Bushes. This was one of the main services offered by the Galle Extension Centre to the growers in the region for popularizing 3000 & 4000 series cultivars tolerant to regional specific pests & diseases. Unfavorable dry weather prevailed during the year reduced the issue of cuttings. Moreover, 34630 nursery plants were raised in the VP tea nursery. Of them, 23826 plants were sold to the tea growers and approximately 7208 plants used for replanting & infilling program of the Centre.

Visitors

The number of visitors received by the Centre was 656 and its breakdown was as follows.

Category	**Number**
Corporate Sector, Private Estates & Small Holders	558
University / Diploma students & Others	98
Total	**656**

Trainees

Students of the University of Peradenya and Advance Technological Institute, Galle completed their in-plant training at the Centre.

Infrastructure developments and maintenance
Outside walls of the old office building was color washed and the defects of the newly constructed office building were repaired by the contractor. The electrical items for the rewiring of Office building were purchased. New stereo microscope was purchased for tea pest identification. Some of the urgent repairs of labor cottages were attended and landscaping of the office premises done with available resources.

Field Development activities
Approximately, 0.3 ha of land was rehabilitated with Mana in Field No 1 & 4, 0.6 ha of land prepared in Field No 4 and 0.4 ha was replanted with TRI 2022 & 4049 in Field No 2.

Special events
The Director, TRI & the Chairman, TRB visited the station on July 01, 2016. They highly commended about the progress achieved on development activities of the Center. Staff of the Center went on the annual trip for the first time & the staff expressed their gratitude to the Director, TRI & management for granting approval for this trip.

Crop
Monthly harvested crop, price offered by the factory and monthly income were as follows:

Month	Green Leaf (Kg)	Price (Rs)	Amount (Rs)
January	2716	66.00	179256.00
February	2624	62.23	163291.52
March	2605	63.01	164141.05
April	1721	67.01	115324.21
May	2737	73.00	199801.00
June	3260	73.07	238208.20
July	2156	75.00	161700.00
August	3157	78.03	246340.71
September	2494	85.00	211990.00
October	1957	94.00	183958.00
November	4314	95.00	409830.00
December	3571	*91.00	324961.00
Total	**33312**		**25,98801.69**

* Estimated price

Annual weather
The annual precipitation was 2685 mm. It was 13.6% reduction when compared with the 10 years average and the monthly distribution was also uneven. There were no significant changes observed in annual sunshine hours and evaporation.

Income
Total income of the Centre with its activities and the income breakdown were as follows

Activity	Income (Rs)
Sale of Green leaf	25,98801.69
Sale of VP Cuttings	363425.00
Sale of VP Plants	571824.00
Analytical charges for soil pH	15650.00
Sale of Publications	8370.00
Guest House accommodation charges	36250.00
Miscellaneous income	11085.00
Total income	**3605405.69**

Deniyaya Extension Centre

S P Rathnayake
B Sc Agric. (Ruhuna, Sri Lanka)
MBA (Wuhan University of Technology, PR, China)
Officer- in -Charge

General

The TRI Deniyaya Extension Centre is primarily an Advisory and Extension center equipped with a small scale laboratory for soil pH, Carbon & Nematodes analyses on a total of 5.00 acres in extent. The land use pattern of the Centre in acres is as follows:

New clearings (bearing)	0.3
New clearings	0.4
Under Rehabilitation (Mana)	1.0
Mother Bushes block (earmarked)	1.0
Buildings, gardens & roads	2.3
Total extent (Acres)	5.0

The Extension Centre, in consultation with the Heads of Divisions at Head office, carried out a large number of field investigations in the Low grown plantations situated in Matara and Hambantota Districts and rendered its services by conducting advisory & extension visits, training programmes in the form of field days, workshops and seminars *etc* for both the corporate and small holder sector stakeholders. The training programmes were on tea nursery, soil & shade management, bush debilitation in Deniyaya region (management of pests & diseases) & the way forward, tea productivity improvement through Good Agricultural Practices (mainly the soil conservation & soil fertility management and proper harvesting of tea) and awareness on weather station & meteorological data collection. The first Regional Technical and Extension Forum (1st RTEF for the year 2016) was held at Deniyaya Extension Centre for the small holder sector with the participation of TRI & TSHDA Officials, focusing mainly on tea land productivity improvements (mixed-cropping with coconut, cinnamon & pepper) and extension approaches.

Staff movements

Mr. R.J.K. Rajapaksha / Extension Officer, attached to Deniyaya / TRI was resigned from services of the TRI with effect on 30th November 2016.

Advisory and Extension activities

No	Item	Number
1	Visitors to the division *(from Estate / Students / Foreigners / Smallholders / Others)*	1174
2	Correspondence (Advisory, Extension & Administrative)	510
3	Advisory visits (on call & routine) to Corporate sector & Smallholder sector and Extension visits	97
4	Training programs / Seminars / Group Discussions / Field days/ Demonstrations / Educational / Familiarizations & Meetings	59
5	Issue of Publications / Leaflets / Pamphlets	1461
6	Soil Samples tested for pH	496
7	Soil Samples tested for C%	08
8	Soil Samples tested for Nematodes	103
9	VP Cuttings sold	-
10	Green Leaf sold	1295 kgs
11	Commercial Nursery Inspection	54
12	Exhibitions	02
13	Visits / Involvements in experiments (Research Trials)	10
14	VP Plants issued	-

Awareness campaign on TRI recommended fertilizer mixtures & pesticides
Two programmes were successfully organized for the benefit of the tea small holders & the Agro-chemical dealers of the region with the assistance of the National Fertilizer Secretariat, Regional Office, Matara.

Mobile Extension service for the stakeholders of Kotapola STI range, Matara
The Officers of TRI Deniyaya, Galle, Talawakelle & Hantane attended one programme mainly focusing on nursery management, soil fertility improvement, pest & diseases management and the shade management

Tea Smallholder land productivity improvement programme
This was initiated in Deniyaya region with the collaboration of the TSHDA, Matara & the Coconut Development Board, Regional Office, Matara. Tea, Coconut, Cinnamon & Pepper as a mixed-cropping system was to be introduced to the selected tea small holder lands in the region and as a result, one site at Waralla has already been completed.

Project on mechanization of tea harvesting in tea small holdings sector
Mr S.P. Rathnayake, Advisory Officer attached to the Advisory and Extension Division, in his capacity as the Coordinator of the above project, successfully organized the regional level interactive sessions to obtain the feedback of the beneficiaries of the project and completed a survey on Socio- Economic impacts of the project.

Adaptive trials
Two Adaptive trials on 5000 series cultivars were established and monitored in Smallholder lands in Morawaka & Akuressa of Matara District in collaboration with the Plant Breeding Division and the TSHDA. One Adaptive trial on Machine harvesting (Battery operated plucking machine, petrol driven plucking machine & TRI Selective tea harvester) was established and monitored at a Proprietary estates at Morawaka by using the machines allotted for TRI Deniyaya center under the Mechanization project.

Two observation trials on new cultivars (5000 series) were also established at TRI Deniyaya, center and monitored in collaboration with the Plant Breeding Division.

Research trials
Following trials are being carried out by Deniyaya center in collaboration with the respective Research Divisions

Plant Breeding Division
i) 5000 series: LVP phase III trials at Indola, Kiruwanagaga and Deniyaya estates.
ii) Trial on improved seedlings at Kiruwanaganga estate & Warapitiya Small holder's land

Entomology & Nematology Division
i) 5000 series cultivar monitoring trial at Deniyaya, TRI

Visitors
A total of 1,174 personnel visited the Deniyaya Advisory & Extension Centre and the breakdown is as follows:

Estate Managers and Smallholders	**484**
University / Diploma students and others	**690**

Training opportunities
One B Sc. Agric. student from the Faculty of Agriculture, University of Ruhuna, completed his industrial training under the supervision of Mr. S.P. Rathnayake.

Two Diploma Students (ATI, Labuduwa) completed their Research reports under the supervision of Mr. S.P. Rathnayake.

Infrastructure developments and maintenance
As per the approved budget of 2016, constructions of a Security hut and terracing of a leader drain were initiated and planned to be completed by the end of February 2017. Also, the routine maintenance and repairs of staff quarters, office and other buildings, cleaning and maintenance of layout and repairs and services of Institute's vehicle were satisfactorily attended.

Income

The total income of the Centre with its activities and the income breakdown is as follows:

Activity	**Income (Rs.)**
Sale of Green Leaf	106206.00
Income from sale of publications	28305.00
Income from Testing of soil samples for pH	27645.00
Income from Testing of soil samples for Carbon	2040.00
Miscellaneous income	57040.00
Total	**221236.00**

Labour force

Number on check-roll - 2

Kalutara Extension Centre

Haran Jayaweera
Officer-in-Charge

General

The TRI Kalutara Extension Centre, Niwithigalakelle, Mathugama is located in a premises of the Rubber Research Institute and is primarily an Advisory and Extension Centre equipped with a small scale laboratory that mainly provides the services for soil pH analysis.

Extension Centre in consultation with the Heads of Divisions at Head office carried out large number of field investigations in the low grown plantations situated in Kalutara, Gampaha and Colombo Districts. The Extension Centre rendered its services by conducting advisory visits, and training programs in the form of field days, workshops and seminars *etc*. for Tea growers, Trainers and workers to develop their skills and improve the knowledge on new and existing technologies. Many Training programs in the form of field days, workshops and seminars were successfully conducted outside the Centre for the corporate sector estates as well as for tea smallholders. Tea productivity improvement through good agriculture practices (GAPs), Soil Conservation, Shade Management and Pest and Disease Management were the themes received high priority.

The other scheduled programs such as Regional Technical and Extension Forums (RTEF) were held at the Kalutara Extension Centre for the Smallholder sector with the participation of the TRI, TSHDA, SLTB officials and the members of Tea Development Societies. Measures to be adopted prior to a drought of low country tea cultivation, alternative method of weed management, control of canker, application of artificial mulching in tea small holdings, application and preparation of compost and suitability of 5000 series cultivars for small holdings of low country were the major subject areas deliberated in these programs.

The Regional Scientific Committee (RSC) seminar for the corporate sector stakeholders in the Ratnapura and Kalutara Districts was organized jointly with the TRI Low Country Regional Center. The Officer-in-Charge actively participated in District Agriculture Committee and District Development Committee held at the District Secretariat Office. Also the staff of the Center actively participated in the Plantation Crop Research Symposium, and the Factory and Leaf collector inspections and cluster meetings of tea manufactures and smallholders. With request of the TSHDA, the staff of the Center actively participated in the radio programs for the corporate sector as well as tea smallholders in collaboration with the TSHDA and SLTB.

The staff of the Extension Centre successfully conducted training programs on plucking for the corporate sector estates as well as for tea smallholders to improve the quality of made tea. The Officer-in-Charge actively participated in the mini crop clinic at Baddegama and Neluwa organized by the TRI Kottawa center.

The extension staff of the Centre also conducted Commercial Nursery training programs organized by the TSHDA. The Officer-in-Charge attended the survey on mechanization in the tea smallholdings and factories with the help of the Deniyaya Center.

Advisory and Extension activities

Item	Number
Advisory correspondences	155
Advisory visits (corporate sector & smallholding sector)	45
Training programs/ Seminars/ Field days/ Group Discussions/ Crop clinics/ Demonstrations	22
Issue of publications/ leaflets/ pamphlets	69
Soil samples tested for pH	95
Commercial nursery inspections	20
Mechanization survey	18
Adaptive Trial	18
Meeting Attended	45

Adaptive Trials and new initiatives

Adaptive trials were established in three small holdings in Pelawatta, Horana and Meegahatanna in Kalutara District on TRI 5000 series in collaboration with the Plant Breeding Division and the TSHDA.

Experiments

I. Trial on mechanical harvesting at Soyiza Estate was commenced in collaboration with Agronomy Division.

II. Investigation was done on nematode attack in tea at Mahakalupahana in collaboration with Entomology division Talawakelle and Ratnapura.

Demonstration Plot

Demonstration plot of TRI 4000 and TRI 5000 cultivars were established in collaboration with the Plant Breeding Division of Ratnapura to educate the stakeholders and general public.

Visitors

A total of 140 personnel visited the Kalutara Extension Centre and the breakdown was as follows.

Category	Number
Corporate Sector Estates	16
Small holders	110
University Student	02
Agriculture School Student	02
School Student	10
Total	140

Infrastructure developments and maintenance

The routine maintenance and repairs of laboratory, office and lecture hall, cleaning and maintenance of layout and repairs and services of the office vehicle were satisfactorily attended.

Income

Total income of the Centre with its breakdown is as follows.

Activity	Income
Sale of Publication	8,645.00
Soil Analysis for pH	13,210.00
Sale of Green Leaf	3,427.00
Total	25,282.00

AWARDS, GRANTS, STUDY PROGRAMS, PUBLICATIONS AND SPECIAL PRESENTATIONS

ADVISORY AND EXTENSION DIVISION

Study Programmes

Mr B.A.D Samansiri, Head / Principal Advisory Officer, Mr J C K Rajasinghe, Principal Advisory Officer and Mr Janaka Mahindapala, Advisory Officer participated in a training on Pollution-free tea production technology for developing countries at the Zhangzhou College of Science and technology in Fujian province in China from April 25 to June 19, 2016.

Mr. C.E. Munasinghe, Extension Officer TRI MCRC was granted 22 months study leave commencing from 23rd May, to complete his M Phil course at PGIA, Peradeniya.

Publications

Samansiri, B.A.D,W.A.D.P. Wanigasundera and R. Wijekoon (2016). Potential use of mobile phones for technology dissemination (m-Extension) in tea smallholding sector of Sri Lanka. In: Proceedings of the Sixth Symposium on Plantation Crop Research - "Plantation Agriculture towards National Prosperity". Dr. V.R.M. Vidhanaarachchi, Dr. H.M.I.K. Herath, Dr. M.K. Meegahakumbura, Dr. A.D.N.T. Kumara and Ms. M.K.F. Nadheesha (Eds). Coconut Research Institute, Lunuwila, Sri Lanka. 167-179

Mr Mahindapala published feature articles on Die Back of tea in Dianamina, Lankadeepa and Divayina news papers.

Sidhakaran V.S. (2015), Contributory factors for the decline of tea yields in the up country planting region: Corporate tea, Tea Bulletin Vol 24 (2): 7 – 10.

The article submitted to Plantation Magazine, Vol. 2 of NIPM by Mr Mahindapala was accepted for publication.

Special Presentations

Mr B.A.D. Samansiri made a presentation on the "Potential of using mobile phones for technology dissemination in the tea Smallholding sector in Sri Lanka" at the Sixth Symposium on Plantation Crop Research held from 2-4 November 2016, in Colombo

Dr. V.S. Sidhakaran made a special presentation on “Management of Rush Crop in tea Plantations” at the Managers Meeting (Lindula Region) of Watawala Plantations PLC on 30/3/2016.

Mr. J.C.K. Rajasinghe, Mr. Bandara Kahandawa, Mr. C E Munasinghe and Mr.Muditha Kumara conducted a special workshop and field demonstration on “soil and leaf sampling” for 120 students of Wayamaba University of Sri Lanka at the TRI Mid Country Regional Center on 03/01/2016.

Mr. J.C.K. Rajasinghe delivered a lecture on ‘Protecting tea cultivation from droughts in Uva’ at the RTEF held on November 21, at the TRI Passara Station.

Ms Hiromi Nishanthi made a presentation on the "Alternatives for reducing the cost of nursery plants (තේ තවානේ පිරිවැය අඩුකර ගැනීමට විකල්පයක්) for the E & E small holder sector.

Miscellaneous activities

Mr B.A.D. Samansiri continued to serve as a member of the Publication and Presentation Panel, member of Agro Chemicals & Machineries Screening Committee of the TRI.

Mr B.A.D. Samansiri continued to serve as a member of the editorial committee of the Journal of National Institute of Plantations Management, a member of the Board of study of National Diploma in Plantation Management of the NIPM, and a member of the Board of study of Induction Course of Planter Trainees of the NIPM.

Mr B.A.D. Samansiri serves as a member of the technical experts committee of the "Planter" Magazine published by the S M P Publications.

Mr B.A.D. Samansiri, Mr Janaka Mahindapala, Ms Hiromi Nishanthi, and Mr C J Liyanarachchi assisted the NIPM in preparing the training modules and lesson plans for the NVQ level IV Field Officer program.

Mr J.C.K. Rajasinghe continued to serve as the coordinator of ADB Mother Bush project, collected information from all mother bush sites and prepared a report on their performance for the Tea Research Board.

Mr. J.C.K. Rajasinghe, Mr. Bandara Kahandawa, Mr. C E Munasinghe and Mr.Muditha Kumara jointly prepared a document on the modernizing of the TRI exhibition stall for future exhibitions to be submitted to the Tea Research Board.

Dr. V.S. Sidhakaran continued to serve as the Convener / Secretary of Consultative Committee on Estates & Advisory Services of the TRI and the Coordinator of Extension – Research linkage forum. One session of the Extension – Research Linkage Forum, which was coordinated by Dr. V.S. Sidhakaran was held during the year 2016.

Two advisory & monitoring visits to St. Coombs Estate were done by the team consisting of Dr. V.S. Sidhakaran, Dr. NPSN Bandara & Mr Palitha Abeysekara during 2016

Dr. V.S. Sidhakaran prepared and submitted a proposal on Business Development and outreach activities for the TRI. He also prepared and submitted a guideline on 'Land suitability inspection after rehabilitation"

Mr Janaka Mahindapala continued to be the editor of Te Thathu newsletter of the TRI.

Mr T.G.N. Mahinda, Advisory Officer coordinated preparation of the manuals for distance learning of the module of tea cultivation and processing for the NIPM Diploma in Plantations Management program.

Mr S.P. Rathnayake continued to serve as the coordinator for the Mechanization project and the coordinator for the TRI Bulletin & TRI Update

Mr K.R.W.B. Kahandawa continued to serve as the convener of Advisory and Extension forum and the convener of the Advisory and Extension forum and a meeting of the forum was held on August 18, at the TRI Mid Country Center.

Ms Hiromi Nishanthi, Advisory Officer coordinated two RTEF seminars for the TSHDA/ Smallholding sector in Nuwara Eliya region. She also coordinated the program of "Advance Certificate Course in Plantation Management 2016, organized by the NIPM.

A web application to manage Mother Bush Project was developed & demonstrated jointly by Mr. Muditha Kumara and Mr. J.C.K. Rajasinghe.A computer-based project management application software was developed by Mr. Muditha Kumara,Technical Assistant attached to the division.A web application was developed for caller information and problem identification jointly by Mr. Muditha Kumara and Mr. J.C.K. Rajasinghe.

Ms Hirun Dayananda, Extension Officer participated in developing the curriculum on plantation crops / technologies for technology stream of A/L students.

AGRICULTURAL ECONOMICS DIVISION

Study programmes

K.W.N. Karunaratne attended a workshop on Statistical Analysis held at the PGIA on March 20, 2016.

H.W. Shyamalie participated in the stakeholder workshop organized by the Socio - Economic Policy Analyst Group on September 13, 2016 at the SLCARP, Colombo.

Publications

H.W. Shyamalie, H.M.C.G. Pilapitiya and B.M.N.C. Karunarathna. 2015. Comparative advantage of Sri Lankan Tea Industry. Tea Bulletin. . ISSN 1012-3962.

H.W. Shyamalie, B M N C Karunarathna H M C G Pilapitiya and N N K Wellala, 2016. Estimating effects of research and extension expenditures on tea production in Sri Lanka. Proceedings of 6th Symposium on Plantation Crop Research. November 3-5, 2016. BMICH, Colombo.

H.W. Shyamalie, B M N C Karunarathna, H.M.C.G. Pilapitiya and N.N.K. Wellala, 2016. Current status of investments on soil fertility management strategies in the Corporate Sector tea plantations in Sri Lanka. Proceedings of 6th Symposium on Plantation Crop Research. November 3-5, 2016. BMICH, Colombo.

H.W. Shyamalie, H M C G Pilapitiya, B M N C Karunarathna and N.N.K. Wellala, submitted an article on Labour Shortage in Tea Plantations: How Big the "Crisis" Is? for the TRI Update.

H.W. Shyamalie prepared an article on "Improvement of labour productivity for sustainable tea plantations" for the Tea Bulletin.

Special Presentations

Dr. H.W. Shyamalie presented a paper on Break-even labour productivity for different scenarios at the Consultative Committee on Estates and Advisory Services held on April 22, 2016.

Dr. H.W. Shyamalie delivered lectures at the Auditorium of the Tea Research Institute, Talawakelle on cost of tea cultivation for the trainees of Advance Certificate Course in Plantation Management on June 29, 2016 and on research monitoring and evaluation for newly recruited TRI staff on August 10, 2016.

Dr. H.W. Shyamalie presented a paper on cost management in tea plantations at the Regional Scientific Committee meeting held on August 26, 2016 at the Low country Regional Center, Ratnapura. She also presented a paper on Current status of investments on soil fertility management strategies in the corporate sector tea plantations in Sri Lanka at the Sixth Plantation Crop Research Symposium, held on November 2-4, 2016 at the BMICH, Colombo 7.

B.M.N.C. Karunarathna presented a paper on estimating effects of research and extension expenditures on tea production in Sri Lanka at the Sixth Plantation Crop Research Symposium, held on November 2-4, 2016 at the BMICH, Colombo 7.

Dr. H.W. Shyamalie, K.W.N. Karunaratne, C Pilapitiya and N.N. Wellala presented the progress of activities of Agricultural Economics Division to the Scientific & Advisory Committee on November 9, 2016 at the Tea Research Institute, Talawakelle and also to the Consultative Committee on Research on December 14, 2016 at the Sri Lanka Tea Board, Colombo.

Dr. H.W. Shyamalie presented a paper on "මැදරට කුඩා තේ වතු හිමියන් මුහුණ දෙන ගැටළු හා ඒවා මග හැර ගන්නා ක්‍රම පිළිබඳ ආර්ථික විද්‍යාත්මක විමසුමක්" at the RTEF seminar held on November 17, 2016 at the Regional Center, Hantana. She also presented a paper on "Challenges in Mid Country tea plantations and how to overcome the challenges" for the RSC seminar held on December 19, 2016 at the Regional Center, Hantana.

Miscellaneous activities

The Agricultural Economic Division prepared following reports.

Database on Survey of Research and Experimental Development (R&D) in Sri Lanka – 2015 to the National Science Foundation

Information for the National Review of the Status of S & T in the Tea Sector (NASTEC)

A report on progress of contract farming system in Pettigala Estate

A report on Contributions of tea research to the Tea Industry in Sri Lanka (2010-2015)

A report on Break-even Labour Productivity in Tea Plantations for Consultative Committee on Estate & Advisory Services

Reports on estimation of the value of a tea bush in Pundaluoya smallholder property, Manikkawatte Estate, Rozella and Nayabedde Estate

A report on Determination of Rate of Replanting in the Tea Sector

A report on Labour scarcity in tea plantations in Sri Lanka

A report on Analyzing cost components in St .Coombs Estate

A report on impact of banning of Glyphosate and removal of fertilizer subsidy for tea plantations for the Ministry of Plantation Industries

H.W. Shyamalie and N.N. Wellala attended a meeting with the management of Balangoda Plantations Ltd held on June 8, 2016

H.W. Shyamalie served as a panelist for the session on Inclusivity and Social Welfare at the Tenth Annual Research Forum of Sri Lankan Agricultural Economics Association, held on December 8-9, at the Institute of Policy Studies (IPS) and Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI).

H.W. Shyamalie and KWN Karunarathne participated in the consultative clinics on Organizational Results Framework held on July 19, 2016 and on October 18, 2016 at the DPMM office, Central Bank of Sri Lanka, Colombo.

N.N. Wellala organized a one day training program for the selected contract farmers in Pettigala Estate on September 20, 2016 with the assistance of the staff of Advisory & Extension Division, Ratnapura.

H.W. Shyamalie participated in the third executive committee meeting of SAEA held on October 5, and the Fourth meeting held on November 29, at the Department of Agricultural Economics and Business Management, Faculty of Agriculture, University of Peradeniya.

H.W. Shyamalie participated in the Tenth Annual Research Forum of Sri Lanka Agricultural Economics Association, held on December 8-9, at the Institute of Policy Studies (IPS) and Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI).

H.W. Shyamalie participated in the meeting on preparing activity plan for the year 2017 on December 15, 2016 at the Ministry of Plantation Industries, Colombo. She also attended the Eighth Sri Lanka Biennial Conference on Science and Technology (BICOST-VIII) held on November 24-25, 2016 at Gateway Hotel, Katunayake.

H.W. Shyamalie and C Pilapitiya participated in the discussion on Market Segmentation, Targeting and Positioning of Domestic Tea Market in Sri Lanka on December 26, 2016 at the Department of Agricultural Economics and Business Management, Faculty of Agriculture, University of Peradeniya.

AGRONOMY DIVISION

Study programmes

Mr Sampath Pathiranage continued his postgraduate study at the Post Graduate Institute of Agriculture, University of Peradeniya.

Dr N.P.S.N. Bandara attended the workshop on Mobile-based extension conducted by CABI International on 12th and 13th August, 2016

Dr. N.S.P.N. Bandara followed Digital Marketing specialization non-credit course offered by the University of Illinois in September, 2016.

Dr. N.P.S.N. Bandara participated in the Monsoon Forum sessions organized by DOM & RIMES.

Ms L.A.S.P. Jayasinghe, Mr U P Abeysekera and Mr M G S Liyanage involved in the training programme for students of Faculty of Agriculture, Jaffna University on July 18-20, 2016.

Mr. M.G.S. Liyanage participated in the workshop on new nozzle technology held at the TRI, Talawakelle on March 15, 2016.

Ms W.H.D.U. Pushpakumari participated in a workshop on Effective Research Proposal Writing on October 7, 2016 at NSF.

Ms. S.N. Wijesekera attended a training seminar on 'Safety in Chemical, Food and Microbiological Laboratories.

During the year, one graduate trainee and three NDT students were trained at the division.

Publications

Wijeratne, M.A. and Ratnayake, S.P. (2015). Energizing smallholders for mechanizing labour intensive field practices in tea. Tea Bulletin. 24 (1): 1-10.

Wijeratne, M.A., Gamage, A.J. and De Costa, W.A.J.M. (2016). Role of shade trees in tea: Low country perspective. Tea Bulletin. 25 (1/2) (In Press).

Wijeratne, M.A., Punyawardena, B.V.R, Pathiranage, S.R.W., Amaratunga M.K.S.L.D. Banda, E.V.G.N.J. and Pushpakumara S.M.V. (2015) Categorization and mapping of tea growing Divisional Secretariat Divisions of Sri Lanka based on their Agro-ecological potential for tea cultivation. Sri Lanka Journal of Tea Science, Vol 80 (In Press).

De Costa, W.A.J.M, Wijeratne, M.A. and Herath, D.R.K.B.K (2015) Carbon trading and its application to the tea industry of Sri Lanka. Sri Lanka Journal of Tea Science, Vol 80 (In Press).

Bhagat, R M, Wijeratne, M.A., Bore, J.K. and Wenyan Han (2016). Report of the working group on climate change of the FAO Intergovenrmental Group on Tea. Pp 86.

Bandara, N.P.S.N., Abeysekara, U.P.,Navarathna, N., Prematunga., A.K., Liyanage, M.G.S., Premathunga, E.W.T.P.,Vithana,D.W., Gunarathna,G.P., and Premathilaka, K.G. (2016) "Validation of a soil quality index for tea lands", Proceedings of 232nd Experiments and Extension Forum, Tea Research Institute of Sri Lanka,Talawakelle, July, 29, 2016. Pp15-24.

Bandara, N.P.S.N., Vithana, D.W., Premathunga, E.W.T.P., Liyanage, M.G.S., and Madhubasini, T.G.P. (2016). Use of artificial materials in young tea fields. Proceedings of 232nd Experiments and Extension Forum, Tea Research Institute of Sri Lanka, Talawakelle, July 29, 2016. Pp40-49.

Bandara, N P S N තේ වගාව සඳහා තුනී කෘත්‍රිම කෘෂිකාර්මික වසුන් යොදා ගැනීම Proceedings of E & E Sinhala forum held on November 25, 2016

Pathiranage, S R W (2016) Physiological aspects governing tea yield variation under manual and mechanical harvesting of tea, at the Sixth Symposium on Plantation Crop Research at BMICH, Colombo on December 4, 2016.

Liyanage,M.G.S. and Premathungha,E.W.T.P. (2015). “Leave out of Soft Herbs in your tea field” .Thei Tathu’, A newsletter, Tea Research Institute of Sri Lanka, December 2015, Vol 12, No 2,ISSN 1391-6785 p.4 - 6.

Liyanage, M.G.S., Premathilaka K.G. and Premathunga E.W.T.P. (2016). “Invetigation on soil rehabilitation of old tea lands with Two Alternative Grass species in the Low Country Wet Zone”. Proceeding of the sixth Symposium on Plantation Crop Research, BMICH, Colombo, Sri Lanka. November 2-4, 2016 Vol 1. Pp 113-123.

U V A Buddhika, G Seneviratne, E M H G S Ekanayake, D M N Senanayake, A D lgalavithane, N Weeraratne, A P D A Jayasekera, W L Weerakoon, A Indrajith, H M A C Gunaratne, R K G K Kumara, M S D L De Silva, I R Kennedy (2016). Biofilmed biofertilizers application in Agroecosystems., In Chapter 6 of the Handbook of microbial bio-resources Edited by Gupta V K , Sharma G D , Tuphy M G , Gaur R. pp 96-106

Special Presentations

Dr. M.S.D.L. De Silva conducted two training programmes for the executives and field officers of Maturata and Watawala PLC Ltd, on November 29 and December 16, 2016 and two awareness programs for Bogawana Estate, Bogawantalawa and Talawakelle Estate in August 2016. She also addressed at two RTEF seminars on integrated weed management methods at Kandy / Matale and Kottawa on November 17 and November 22, respectively. Dr. M.S.D.L. De Silva also made presentations on “Integrated weed management in tea and alternatives to Glyphosate ” at the RSC seminars, Ratnapura on August 26, at Passara on September 30 and in Kandy on December 19, 2016.

Dr. M.A. Wijeratne conducted field training programmes on shear harvesting and addressed estate managers and smallholders on the subjects of climate change impacts on tea, soil fertility improvements and mechanization of tea field operations in various forums organized by the TRI, TSHDA and corporate sector estates.

Dr N.P.S.N. Bandara made presentations on Validation of a soil quality index for tea lands and Use of artificial thatching material in tea (E & E Forum, July 2016), නියඟ හානි අවම කර ගැනීම සඳහා ජල සම්පාදනය (RTEF, Ratnapura) Mitigation of drought in Uva tea growing areas (RSC, Uva) කඳුකර නාය යෑම් සහ අවධානම අවම කර ගැනීම, අරණායක නාය යාම ආශ්‍රයෙන් නිරීක්ෂණ හා යෝජනා (RTEF, Ratnapura), තේ වගාව සඳහා කෘත්‍රිම කෘෂිකාර්මික වසුන් යොදා ගැනීම (E & E sinhala) සහ නියඟයට පෙර සහ පසු තේ වගාව කළමණාකරණය (RTEF, Galle).

Dr. N.P.S.N.Bandara also made a presentation on land slides in Aranayake area for the Monsoon forum in October 2016.

Mr S.R.W. Pathiranage made a presentation on Physiological aspects governing tea yield variation under manual and mechanical harvesting of tea at the sixth Plantation Crop Research Symposium held in Colombo in November, 2016. He also made presentations on Mechanization of tea fields for Pussellawa PLC (June 8, 2016) and on Shade management in tea plantations for the Smallholder Plantation Entrepreneurship Development Program (December 7, 2016).

Mr M.G.S Liyanage made presentations on Investigation on soil rehabilitation with two alternative grass species in the Low country Wet Zone at the sixth Plantation Crop Research Symposium held in Colombo in November 2016 and Weed management in tea for the students of Advance Certificate Course in Plantation Management on June 30, 2016.

Mr M.G.S. Liyanage made presentations on Alternative methods to control weed in the Low country (RTEF meeting, Matugama on 31/ 05/2016), Use of artificial mulching material in tea (RTEF meeting, Matugama on 20/12/2016), Alternative weed control methods (RTEF, Ratnapura 29/12/2016), Weed management in tea for the NIPM students (Ratnapura, 16-17/12/2016), Shade management in tea for small holders (Matugama, 6/ 12 /2016) and Weed management in tea for NIPM students (Talawakelle, 9/12/2016).

Mr. M.G.S. Liyanage conducted field demonstration on integrated weed management in tea for RSC seminar conducted at Low country Center, (28/7/2016), weed management in tea for field staff of Pussellwa plantation (8/6/2016), weed identification in tea fields for the NIPM students at Ratnapura (16/12/2016) and use of cover crops, mulching materials and chemicals for weed control in tea fields for the NIPM students at Ratnapura (17/12/2016).

Ms L.A.S.P. Jayasinghe addressed on 'Grafting Techniques for tea' at the RTEF, Kandy on April 19, 2016.

Miscellaneous activities

All the officers of Agronomy attended the fifth Scientific Advisory Committee (SAC) meeting held on May 16, 2016 at TRI, Talawakelle.

M.S.D.L. De Silva was appointed as committee member of the research evaluation panel of Plant Breeding and Physiology w.e.f. January, 2016

Dr. M.A. Wijeratne PRO, Officer-in-Charge of the TRI Low country Regional Center continued his services as a member of the Faculty Board of Agriculture, University of Ruhuna and member of the REDD+ Advisory and Coordination Board (previously named as Programme Executive Board). He also served as a member of the Advisory Committee of the SLSI for drafting standards for sustainably produced fuel wood in Sri Lanka, the CARP Committee on Agricultural Machinery and Equipment for development of national priorities and the Judge Panel of the PGIA Annual Congress-2016.

Dr. M.A. Wijeratne served in the committee appointed by the Ministry of Environment for formulating Cleaner Production Policy and Strategy for Plantation Sector in Sri Lanka and continued as the Chairperson of the Publication and Presentation Panel of the TRI and an editor of TRI publications. He also supervised the post-graduate study programmes of Mr. Sampath Pathiranage (Research Assistant, Agronomy Division) and J.H.N Piyasundera (Research Officer, Plant Breeding Division) leading to Ph D.

Dr. M.A. Wijeratne attended the FAO/IGG meeting on tea held at Naivasha, Kenya from 19th to 28th May 2016 and he authored the Chapter on Sri Lanka in the FAO/IGG Report of the Working Group on Climate Change.

Dr. N.S.P.N Bandara and Dr. M.S.D.L De Silva attended a discussion on SQI at the Ministry of Plantation Industries on September 23, 2016. He also attended the Monsoon Forum at the Dept. of Meteorology in May, 2016.

Mr. S.R.W. Pathiranage supervised a final year undergraduate from the University of Ruhuna.

A NSF grant of Rs 4.571 million was given for the purchasing of Photosynthesis system with respiratory chamber (compact and portable).

Staff of the Agronomy Division entertained university students, school children, students from schools of agriculture, foreign dignitaries and academics and served as resource persons in extension programs.

The Agonomy Divisions has undertaken data collection, analysis as well as maintenance of agro meteorological stations of Deniyaya, Hantane (Kandy), Kottawa (Galle), Passara, Ratnapura and Talawakelle stations. Monthly summary of the data on rainfall and sunshine hours were submitted to the Sri Lanka Tea Board.

BIOCHEMISTRY DIVISION

Study programmes

Ms. S.A.D.P.S. Jayawardhane participated in a one day training program on "Effective proposal writing" at the NSF, Colombo.

Ms. M.S.C. Fernando participated in a one day workshop on May 6, 2016 on "Chemical Handling and Laboratory Safety" organized by Institute of Chemistry – Ceylon.

Mr. E.N.U. Edirisinghe attended a workshop on "Chemical Laboratory Accreditation" organized by the Institute of Food Science and Technology in Sri Lanka on May 12, 2016.

Ms. H.B. Tharangika attended a workshop on "Safety in Chemical, Food and Microbiological Laboratories" conducted by the ITI on August 24-25, 2016.

Mr. A.S. Ghouse attended a seminar on "Environmental challenges for sustainable development: Role of Chemists" organized by the College of Chemical Sciences, Institute of Chemistry on August 18-19, 2016.

Ms. M.S.C. Fernando participated for 5 days workshop on "Separation techniques in natural product research", organized by the IFS, from September 19-23, 2016.

Ms. L.M.O.D.K. Lansakara, an undergraduate from the University of Kelaniya, completed one month training in the Biochemistry Division, from January 25, 2016- February 25, 2016.

Ms. M.D.A.D. Premasiri from HNDT Naiwala, completed her industrial training phase 1 in the Biochemistry division from April 25, 2016 to October 25, 2016.

Ms. W.A.H.T. Wanniarachchi, final year student from Dept. of Food Science and Technology, Faculty of Agriculture, University of Ruhuna, completed her research project from July 25, 2016 – December 31, 2016.

Two students from the Faculty of Agriculture, University of Jaffna, completed 2 days training in the Biochemistry Division from July 14– 15, 2016.

Ms. C. Kobika, final year student from the Dept. of Food Science and Technology, Faculty of Applied Science, University of Sabaragamuwa, commenced her research project from September 20, 2016.

Publications

S.A.D.P.S. Jayawardhane, N.A.J.C. Gunarathna, P.L.N. Lakshman, B.M. Jinendra, G.A.A.R. Perera, K.M. Mewan, N.C. Weerakoon and M.S.C. Fernando (2016). Development of a method for the detection of Sugar adulteration in black tea. Proceedings of the Sixth Plantation Crop Research Symposium held on November 2-4, 2016 at the BMICH, Colombo.

S.A.D.P.S. Jayawardhane, K.P.C. Madushanka, K.M. Mewan, S.K. Jayasinghe, D.G.N.P. Karunajeewa and E.N.U Edirisinghe (2016). Determination of quality characteristics in different Green Tea Products available in Sri Lanka supermarkets. Proceedings of the Sixth Plantation Crop Research Symposium held on November 2-4, 2016 at the BMICH, Colombo.

G.A.A.R. Perera, A.M.T. Amarakoon, D.C.K. Illeperuma and E.N.U. Edirisinghe (2016), Applying membrane filtration technique in manufacturing cold water soluble instant tea, Proceedings of the Sixth Crop Research Symposium held on November 2-4, 2016 at the BMICH, Colombo.

Special Presentations

Ms. M.S.C. Fernando served as a resource person and delivered a lecture on “Tea Chemistry” at the awareness program for national quality week at Unilever Ceytea Factory, Agarapathana.

Ms. M.S.C. Ferandno, Ms. S.A.D.P.S. Jayewardhana, Mr. E.N.U. Edirisinghe and Ms. N.C. Weerakoon participated in the Sixth Plantation Crop Research Symposium.

Ms. M.S.C.Fernando and Ms. S.A.D.P.S. Jayewardhana made oral presentations on Development of a method for the detection of sugar adulteration in Black tea and determination of quality characteristics in different Green Tea products available in Sri Lanka supermarkets respectively.

Miscellaneous activities

Ms. M.S.C. Fernando covered up the duties of the Officer-in-Charge of Biochemistry Division with effect from January 27, 2016 as Dr. K.M. Mewan was on medical leave.

The following new research proposals / applications were submitted to the Ministry of Plantation Industries (MPI) and IBMBB/ UOC.

1. Development of molecular marker/s for the screening of Shot Hole Borer (*Xyleborous fornicates*) resistant tea cultivars (MPI)

2. Development and validation of LC-MS/MS based biochemical analytical methods to detect chemical contaminations/ adulterations in tea (MPI)

3. Integrated "GENOMICs" approach to elucidate drought induced genes and their networks associated with drought tolerance in *Camellia sinensis* L. (Tea) (IBMBB Collaboration)

Delegates of Korea Tea and Tao Research Institute, students from the Faculty of Agriculture, University of Rajarata, University of Peradeniya, University of Jaffna, University of Sabaragamua, Mel's Academy and Agriculture School, Anuradhapura, officials from the Sri Lanka Tea Board and students from the Provincial Health Training Center, Galle and the NVQ students visited Biochemistry Division during 2016.

ENTOMOLOGY AND NEMATOLOGY DIVISION

Awards & Recognitions

The editors of Fungal Genetics and Biology have highly recognized Dr. K. Mohotti being a co-author of the article 'An inordinate fondness for Fusarium: Phylogenetic diversity of fusaria cultivated by ambrosia beetles in the genus Euwallacea on avocado and other plant hosts' based on citation since 2013 up until June 2016 according to data from Scopus.

Study programmes

Mrs. P. G. D. S. Amarasena, Research Officer continued her postgraduate study program (Ph D) on 'Determination of impacts of soil temperature regimes on population dynamics of Pratylenchus loosi in tea plantations of Sri Lanka' at the Postgraduate Institute of Agriculture, University of Peradeniya under supervision of Dr K Mohotti.

Publications

Mohotti K. M. and Mohotti A. J. (2016). CODE OF ETHICS IN BIOLOGICAL RESEARCH: A Guide for Biologists, Supplementary Booklet, Institute of Biology Sri Lanka, 36pp.

Mohotti K. (2016). Biochar usage in tea plantations as a smart agriculture practice: case studies from Sri Lanka. Proceedings of the 3rd Annual Smart Plantation Management Symposium, Kuala Lumpur, Malaysia, 7-8 December 2016.

Senanayake, P D and Kulathunga S D.(2015) Potential entomopathogenic fungus for shot-hole borer control in tea cultivation. NSF Research Summit Conference proceedings; Empowered by Research and innovation. BMICH Colombo. Sri Lanka 123pp

Weerasekara W.A.T.H., Marambe B., Gunawardana M., Mohotti J., Sivananthawer T. and Mohotti K. (2016). Identification of Herbicidal and Insecticidal Properties of Artemisia vulgaris (L.): A Hedgerow-Plant in Tea Plantations. Annual Sessions of the FAuRS 2016, University of Peradeniya.

Bandara N. P. S. N., Prematilake K. G., Gunaratne G. P., Abeysekara U. P., Navaratne N., Vithana D. W., Prematunga A. K., Prematunga E. W. T. P. and Liyanage M. G. S.(2016). Soil Quality Index as a measure of assessing land suitability prior to replanting. Proceedings of the 232nd E & E Meeting held on 29 July 2016, 15-25.

Special Presentations

Dr K.M.Mohotti was invited to make a guest speech at the third Annual Smart Plantation Management Symposium held in Kuala Lumpur, Malaysia during 7-8 December 2016 where he delivered a talk on 'Biochar usage in tea plantations as a smart agriculture practice: case studies from Sri Lanka'.

Miscellaneous activities

The laboratories and demonstration areas at Talawakelle, Ratnapura, Deniyaya and Hantane served smallholders, corporate sector tea growers and University students in training on entomological, nematological issues and organic tea cultivation aspects.

Nature Farming Research and Demonstration Area continued to assist in the tree planting program and campaigns in the TRI premises for esthetic, beatification and conservation purposes.

Dr K.M. Mohotti joined the Sri Lankan delegation to Kenya to attend the Tea Science Symposium (23 – 24 May 2016) and 22nd Food & Agricultural Organization (FAO) Inter-Governmental Group (IGG) on Tea Conference (25- 27 May 2016) in Naivasha, Kenya.

Dr K.M. Mohotti served in the post of Deputy Director Research (Production) while continuing as the Convener Secretary to the Tea Research Board, Convener Secretary to the Experiments and Extension Forum (E & E), Nematologist, Thrust and Project Leader of the projects A 1.4, 2.4, 3.4, 4.4, 32.3, 45.1, 45.2, 50.3 and C/Nem conducted by the Entomology and Nematology Division, Coordinator, TRI Pesticide Residue Monitoring Committee and a Member, Agro-Chemical and Machinery Screening Committee. He also assisted in conducting the Mid Term Review of the TRI Corporate Plan 2013 - 2017 by formally evaluating the R & D projects for presentation to the Tea Research Board.

Dr K.M. Mohotti facilitated the TRI program under the theme: "Science Behind Tea" covering tea cultivation practices, land selection and sustainable crop, environment, nutrient and pest management strategies, monitoring of International Standards and pesticide residues, harvesting and processing, value addition, health benefits of tea, social and ethical aspects to conduct the Study Abroad Training Program Offered to Students of the Michigan State University, USA organized by the Agriculture Education Unit, University of Peradeniya during 3-7 June, 2016 at the TRI, Talawakelle. He organized the Staff Orientation Program for Newly Recruited Officers at TRI on 10 August 2016.

Dr K.M. Mohotti also engaged in the following assignments.

Represented the Institute at PeTAC Sub Committee and Committee meetings on behalf of the Director.
Represented the Institute at the EU Audit team visiting Sri Lanka to study and evaluate pesticide residue issues in the agricultural exports to the EU.
Assisted the Director in handling quality matters emerged in connection with pesticide residue issues *i.e*. MRLs, heavy metals, Anthroquinon, rare earth elements, microbial contaminations *etc*. where the industry and exporters were facilitated with technical support.
Was a member of committees at the MPI on registration of small holder and RPC lands, unproductive land survey and preparation of Tea Quality Charter for tea production and processing.
Assisted the Coconut Research Institute in organizing the sixth Symposium on Plantation Crop Research under the theme "Plantation Agriculture towards National Prosperity" at the BMICH during November 3-4, 2016.
Member of the Expert External Review Committee of the Field Crops Research and Development Institute (FCRDI) of the Department of Agriculture nominated by the National Science & Technology Commission.
Chairperson of the National Plant Protection Committee of the Council for Agricultural Research Policy, Sri Lanka.
Council member of the Institute of Biology (IOB) of Sri Lanka and the Chairman, National Steering Committee of GEF / SGP of UNDP.
Member of Working Committee on Indigenous Knowledge of the National Science Foundation, member and Visiting Lecturer of Board of study Plant Protection, Crop Science and Agriculture Engineering of the Post Graduate Institute of Agriculture, Peradeniya.
Resource Person of Training Course on Pest Management for pest control service personnel at the Agriculture Education Unit, University of Peradeniya.

Dr K.M.Mohotti facilitated Institute's CSR activities in connection with environmental projects, tree planting and awareness training programs with the TRI and St Coombs Estate community and neighborhood estates in consultation with the Public Relations Officer of the Institute.

PLANT BREEDING DIVISION

Awards / Grants

M.A.B. Ranatunga was awarded a research fellowship under United Nations University (UNU) - Kirin fellowships program to conduct a research project at the Food Research Institute, National Agriculture Research Organization (NARO), Tsukuba, Japan from April 2016 to April 2017.

Study programmes

M.A.B. Ranatunga and J H N Piyasundara continued their postgraduate degrees.

J.D. Kottawa-Arachchi participated in a workshop on "Phenotyping and Genotyping Mutants for Abiotic Stress" Organized by the SLCARP at RRDI, Bathalagoda.

J.D. Kottawa-Arachchi and K K Ranaweera participated in a workshop on "Current Status and Future Direction of Plant Breeding Research in Sri Lanka" Organized by the SLCARP at RRDI, Bathalagoda on 17-18 October.

Publications

Jeganathan B.,Punyasiri P.A.N., Kottawa-Arachchi J.D., Ranatunga M.A.B., Abeysinghe I.S.B., Gunasekare M.T.K., Bandara B.M.R. (2016). Genetic variation of flavonols quercetin, myricetin, and kaempferol in the Sri Lankan Tea (*Camellia sinensis* L.) and their health-promoting aspects. International Journal of Food Science,Volume 2016, Article ID 6057434

Thuwaraki B., Ranatunga M.A.B., Kottawa-Arachchi J.D., Sumanasinghe V.A. (2016). Characterization of a new tea (*Camellia sinensis*) hybrid progeny based on SSR markers and morphological traits. Proceedings of the Peradeniya University International Research Sessions, Sri Lanka, Vol. 20: 383

Piyasundara J.H.N., Gunasekare, M.T.K., Wickramasinghe I.P., Wijeratne, M.A., Ranatunga, M.A.B., Mudalige, A.K., (2016). Assessment on flowering and fruiting phenology of tea Seed Gardens in Sri Lanka: Towards the enhancement of productivity; Proceedings of the Sixth Symposium of Plantation Crop Research, Vol. 1; 3-14pp

Ranatunga, M.A.B. (2015). Tea growers have good perception on TRI 3000 and TRI 4000 series cultivars. TRI Update 14 (1):1-2

Kottawa-Arachchi J.D. and Ranatunga M.A.B. (2015). Application of fermentation properties of tea cultivars for black tea processing. TRI Update 14 (1):2-3

Sinniah G.D., Wasantha Kumara K.L., Karunajeewa D.G.N.P., Ranatunga M.A.B. (2016) Development of an assessment key and techniques for field screening of tea (*Camellia sinensis* L.) cultivars for resistance to Blister Blight. Crop Protection 79 (2016) 143-149.

Mahasen A. B. Ranatunga, Hidekazu Ito, Yasuhiro Uwadaira and Akifumi Ikehata (2016) Determination of total polyphenol content in Green and Black teas including known cultivars using a Vis-NIR Spectroscopy. Proceedings of the Fifth Asian Near-Infrared Symposium and 32nd Japanese NIR Forum. Eds. Akifumi Ikehata, Satoru Tsuchikawa and Sumio Kawano. Kagoshima, Japan November 30-December 3, 2016. Pp242-243.

Special Presentations

J.D. Kottawa-Arachchi made a presentations titled "Tea Breeding and Future Challenges" in a workshop on "Current Status and Future Direction of Plant Breeding Research in Sri Lanka" Organized by the SLCARP at the RRDI, Bathalagoda on 17-18 October.

J.D. Kottawa-Arachchi made a presentation on his Post-graduate research proposal titled "High throughput genotyping to expedite genetic characterization and dissection of important agronomic traits of tea" under Indo-SL Joint Research Program-2016 at the CCR meeting held on 14th December, 2016 in Tea Board, Colombo.

J.H.N. Piyasundara made a presentation on "Assessment on Flowering and Fruiting Phenology of Tea Seed Gardens in Sri Lanka: Towards the enhancement of productivity" at the Sixth Symposium of Plantation Crop Research held in Colombo. He also made a presentation on "TRI 5000 Series Adaptive Trials" for the RTEF Kalutara held at the TRI Mathugama center in December 2016.

J.D. Kottawa-Arachchi, K.K. Ranaweera, J.H.N. Piyasundara and A.K. Mudalige conducted training program on theory and practices of tea breeding to a group of students from the NIPM in November 2016.

J.H.N. Piyasundara and A.K. Mudalige conducted presentation / demonstration on usage and identification of tea cultivars for a group of small holders of "Ladalu Mahimaya Program".

A.K. Mudalige and A.M.U. Liyanage participated in the Mini crop clinics at Unanvitiya and Neluwa in September 2016.

Miscellaneous activities

J.D. Kottawa-Arachchi participated in the RTEF meeting and the ADB mother bush site managers meeting at the TRI Regional Center, Hantane.

J.D. Kottawa-Arachchi participated in a special meeting on "Finalizing the Revised National Priorities of Plant Breeding Research in Sri Lanka" held at the SLCARP, Colombo on 21 November, 2016.

J.D. Kottawa-Arachchi, K.K. Ranaweera, J.H.N. Piyasundara and A.K. Mudalige participated in the Sixth Symposium of Plantation Crop Research held in Colombo in November 2016.

PLANT PATHOLOGY DIVISION

Awards / Grants

G.D. Sinniah received an equipment grant from NSF worth of 1.356 million (NSF grant RG/2015/EQ/11).

G.D. Sinniah received an award for scientific excellence during 2014-2015 in the Tea Sector at Sixth Plantation Crop symposium, November 3-5, 2016, BMICH, Colombo.

G.D. Sinniah received a fellowship from Government of India, Centre for Science and Technology of the Non-Aligned & Other Developing Countries (NAM S & T Centre) Research Training Fellowship for Developing Country Scientists (RTF-DCS) 2016-17 for six months period from December 2016 to June 2017.

M. Niranjan received the award for the best presentation for the paper titled “Investigation of die back of Grevillea robusta in tea plantations of the Uva region in Sri Lanka” at the Sixth Symposium on Plantation Crop Research held during November 3-5, 2016 at the BMICH Colombo.

Mr U.G.D.W. Dayarathne of Hardy advanced Technological Institute, Ampara completed his 6 months industrial training at Plant Pathology Division.

Ms K.G.N.M. Gamage, student of Uva Wellassa University completed her final year research project during Septemeber-December 2016 at Plant Pathology Division.

Study programmes

G.D. Sinniah attended a workshop on mobile based agriculture extension conduct by CABI during August 30-31, 2016.

N.H.P. Liyanage, G.D. Sinniah, M Niranjan and D.G.N.P. Karunajeewa attended a two day training programme on ELISA techniques conducted by Plant Virus Indexing Center from November 15-16, 2016. M Niranjan attended a one day training seminar on microbiology laboratory accreditation organized by the Institute of Food Science & Technology, Sri Lanka on February 24, 2016.

M. Niranjan attended workshops on nozzle technology organized by Department of Agriculture on March 15, 2016 and research proposal writing organized by NSF on October 7, 2016.

N.H.P. Liyanage attended workshops on "Future directions in Agricultural Bio Technology Research in Sri Lanka" at SLCARP on August 19, 2016 and Climate change mitigation conducted by the SWITCH Asia on November 18, 2016.

D.G.N.P. Karunajeewa attended a ten-day certificate course on fundamentals Molecular Biology and Biotechnology organized by the Agricultural Biotechnology Centre, University of Peradeniya.

Mr Malitha Madusanka Fernando and Mr U G D W Dayarathne of Hardy advanced Technological Institute Ampara completed their six months industrial training from April-October 2016 at Plant Pathology.

Ms K.G.N.M. Gamage, student of Uva Wellassa University completed her final year research project from September-December 2016 at Plant Pathology Division.

Publications

Niranjan M and Sinniah GD (2016). Investigation of die back of *Grevillea robusta* in tea plantations of the Uva region in Sri Lanka. Proceedings of Sixth Symposium on Plantation Crop Research, November 2-4, BMICH, Colombo, Sri Lanka. Volume 2. 133-142.

Pradeepa, NHL, Weerasena, OVDSJ, Liyanaarachchi, CJ, Karunajeewa DGNP, Mahindapala KGJP, Wijesundera, RLC and Abeysinghe, ISB (2016). Development of species specific ITS markers for the detection of *Botryosphaeria dothidea* and *Lassiodiplodia theobromae* of tea. In Proc. Sixth symposium on Plantation Crop Research. November 2-4,, 2016, BMICH, Colombo, Sri Lanka. Volume 2, 101-107.

O'Donnell K., Libeskind-Hadas R., Hulcr J., Bateman C., Kasson M.T., Ploetz R.C., Konkol J.L., Carrillo D., Campbell A., Duncan R.E., Liyanage P.N.H., Eskalen A., Lynch S.C., Freeman S., Mendel Z., Sharon M., Geiser D.M., Aoki T., Cosse A.C., Rooney A.P. 2016 Invasive Asian Fusarium - *Euwallacea ambrosia* beetle mutualists pose a serious threat to forests, urban landscapes and the avocado industry. Phytoparasitica, (in press).

Niranjan M and Sinniah GD (2015). Recent die back of *Grevillea robusta* in tea plantations in Uva region: a pathological perspective. Tea Bulletin 24(2). 11-16. – Released in 2016.

Jayawardena SADPS, Madushanka KPC, Mewan KM, Jayasinghe SK, Karunajeewa DGNP and Edirisinghe ENU (2016). Determination of quality characteristics of different green tea products available in Sri Lankan supermarkets. Proceedings of Sixth Symposium on Plantation Crop Research, 02-04th November, BMICH, Colombo, Sri Lanka. Volume 2. 03-14.

Special Presentations

N.H.P. Liyanage made presentations on integrated management of low country stem canker at the RTEF meetings held at Mathugama on May 31, 2016 and at Haliela on June 9, 2016.

N.H.P. Liyanage made presentations on "Integrated management of Blister Blight disease" for Estate managers and field staff of Elpitiya Plantation on September 23, 2016 and for estate Managers and field staff of Mathurata Plantations Group on December, 1 2016.

N.H.P. Liyanage made a presentation on "Integrated management of Tea disease" for youth in beneficiary families (SPEnPD project) on December 8, 2016.

G.D. Sinniah delivered lectures on "Tea disease management" to the NIPM students on 30th June 2016 and to the executives and the field staff of Mathurata Plantation on November 29, 2016.

G.D. Sinniah made a presentation on "Dieback of Grevillea robusta in Uva region: A warning sign" at RSC, Uva region on September 30, 2016.

GD Sinniah delivered a lecture on "Management of Blister Blight" to Managers and Assistant Managers of Tangakelle Estate on November 22, 2016.

PLANT PHYSIOLOGY DIVISION

Study programmes

One HNDT student completed his industrial training while another HNDT student and one undergraduate started their training at the Plant Physiology Division. One postgraduate student completed her data collection and sampling at the Plant Physiology Division.

Publications

Wijeratne, T.L. (2016). Assessing and reducing the environmental impact of tea cultivation. In. V. S. Sharma and M. T. K. Gunasekera (Eds.). Global Tea Science: Current Status and Future Needs. Swaston, Cambridge, Burleigh Dodds Science Publishing Limited, UK. (*in press*).

Wijeratne, T.L., Wijeratne, M.A. and De Costa, W.A.J.M. (2016). Carbon sequestration potential of tea plantations as an adaptation. Briefing notes. Proceedings of the Fifth Asia Pacific Climate Change Adaptation Forum 2016 held in Colombo Sri Lanka from October 17-19, 2016. pp. 30.

Wijeratne, T. L. (2016). Estimation of carbon sequestration by Sri Lankan tea plantations and its variation with future climate change. Research Briefs. PGIA News 02(01), University of Peradeniya, Sri Lanka.pp.9-10. Available online at www.pgia.ac.lk /newsletter /magazine /index4. html#page/9.

Special Presentations

A. W. L. C. Sugathapala attended a seminar on "Chemical Handling and Laboratory Safety" organized by the Institute of Chemistry Ceylon on May 6, 2016.

T. L. Wijeratne delivered a presentation on "The activities that can be done to improve the productivity in tea lands with disorganized shade" at the Regional Technical and Extension Forum, Nuwara Eliya on July 04, 2016. (අක්‍රමවත් සෙවන සහිත තේ ඉඩම්වල ඵලදායීතාවය ඉහළ නැංවීම සඳහා ගත හැකි ක්‍රියාමාර්ග).

T. L. Wijeratne and V. P. R. P. V. Pathirana attended a workshop on "INFORM database" organized by the SLCARP on December 06, 2016.

Miscellaneous activities

Dr. (Mrs) T. L. Wijeratne continued to serve as an alternate member for Programme Executive Board of the UNREDD programme, Sri Lanka. She also continued to serve as an Assistant Coordinator for INFORM database and the Convenor / Secretory of the Experiments and Extension Forum of the Tea Research Institute of Sri Lanka.

One Indian visitor, Rajarata University students and Jaffna University students were entertained by detailing the divisional activities.

More than 30 estate root samples were tested for starch content by the Plant Physiology Division and the recommendations were given to the respective estates prior to pruning.

PROCESS TECHNOLOGY DIVISION

Awards / Grants

Mr. M.A.Chamindra received an award for the Overall Best Research Paper presented at the sixth Symposium on Plantation Crop Research, 2016.

A research grant of Rs. 1.31 million was awarded to the Technology Division by the National Research Council to carry out a research project titled "Development of Self-Cleaning Sifter with multiple mesh frames for grading long leafy & wiry type teas" with effect from November 10, 2016 to June 09, 2017.

Publications

Galahitiyawa G L C, Chamindra M A and Sripalika K B M, Development of self-cleaning mechanism for grading orthodox leafy teas in a reciprocating type sifter. Proceedings of the Sixth Symposium on Plantation Crop Research. November 2-4, 2016. pp.65-77

Koneswaramoorthy S and Raveendran K, Study on use of cast copper alloy components for Rotorvanes and Rollers, Proceedings of the sixth Symposium on Plantation Crop Research. November 2-4, 2016. pp.49-54

A guideline on "Good operational practices in relation to reduction of chromium contamination in CTC tea", 2016.

Special Presentations

Mr. M.A. Chamindra made a presentation on "Development of self-cleaning mechanism for grading orthodox leafy teas in a reciprocating type sifter" at the sixth Symposium on Plantation Crop Research held from November 2-4, 2016.

Mr.S. Koneswaramoorthy made a presentation on "Study on use of cast copper alloy components for Rotorvanes and Rollers" at the sixth Symposium on Plantation Crop Research held from November 2-4, 2016.

Mr. M.A. Chamindra participated in the "Symposium on Smart Plantation Management" at Hotel Westin, Kuala Lumpur, Malaysia.

Miscellaneous activities

Process Technology staff has made 58 visits to tea factories for advising on various aspects of tea manufacture and machineries.

Mr. G.L.C Galahitiyawa served as a member of the TEC for purchasing Colour Separator to Kalubowitiyana Factories Limited. Mr. G L C Galahitiyawa also served as a member of the Advisory Committee for matters relating to manufacture of tea and tea factories at the Sri Lanka Tea Board and as a member of the Examination Panel of the Board of Study on professional Tea Manufacture programme of the NIPM.

He also served as a member of the curriculum development committee for developing a syllabus for National Vocational Qualification of the tea factory officers. Mr. G.L.C. Galahitiyawa was a member of the Special committee of the Ministry of Plantation Industries on matters relating to Tea Shakthi Factories.

Mr. M.A Chamindra served as a member of Special Committee meeting on Kraft Liner Board Sacks at the SLSI. He also conducted a workshop on tea manufacture to the CEOs, Consultants of Tea Manufacture, Superintendents and Assistant Superintendents of Mathurata Plantation.

SOILS AND PLANT NUTRITION DIVISION

Study programmes

S.Raguraj and O.G.K.A Gunaratne attended a workshop on "Atomic Absorption Spectrometry" at College of Chemical Science, Institute of Chemistry of Ceylon on August 16, 2016.

Ms. R.K.A Amali attended a training seminar on "Safety in Chemical, Food and Microbiological Laboratories" at the Industrial Technological Institute (ITI) August 24-25, 2016.

Publications

Advisory Circular SP 10 on "Fertilizer recommendation for mature tea in small holdings" was issued on July 2016.

P.L.K. Tennekoon, RMCP Rajapaksha and LSK Hettiarachchi (2016). Potentials of plant growth promoting Rhizobacteria based microbial inoculants for tea (*Camellia sinensis* (L.) O. Kuntze), Proceedings of the sixth symposium on Plantation Crop Research, 2-4 November 2016.

S. Raguraj, R.S. Dharmakeerthi, O.G.K.A. Gunaratne and W.M.S. Wijethunge (2016). Evaluating the suitability of foliar application of micro nutrient combinations for mature tea (*Camellia sinensis* (L.) O. Kuntze), Proceedings of the sixth symposium on Plantation Crop Research, November 2-4, 2016

Special Presentations

Mr.W.M.S. Wijayatunga conducted a lecture on "Different compost making methods" for tea small holders in Uva, at the at the Passara center on April 07, 2016.

Dr. G. P. Gunaratne made a presentation on "ඒකාබද්ධ පෝෂක කළමණාකරණයක් හරහා සරුසාර අස්වැන්නක් " at Regional Technical and Extension Forum at Kottawa station on June 16, 2016. He also made a presentations on " Soil fertility and Fertilizer Use" for the students of Advanced certificate course in Plantation Management at the TRI, Talawakelle, June 30, 2016 and for the youth in the beneficiary families of the Small Plantation Entrepreneurship Development Program (SpEnPD) at the TRI, Talawakelle, on December 10, 2016.

Mr.W.M.S. Wijayatunga participated in Mini Crop Clinic and extension campaign at Unanvita, Neluwa on September 29-30, 2016.

Dr. G.P. Gunaratne and Mr.WMS Wijayatunga made presentation on “Soil fertility Management and Fertilizer Use” for the students of NVQ5 certificate course at the Ratnapura Center on December 23 & 28, 2016.

Dr. G.P. Gunaratne made presentations on “නව පොහොර නිර්දේශය, පොහොර පරිහරණය, ප්‍රවාහනය සහ ගබඩා කිරීම” at Regional Technical and Extension Forum at Ratnapura Center on December 29, 2016 and on “කුඩා තේ වතු ඉඩම්වල පොහොරවල අඩු අස්වනු ප්‍රතිචාරයට හේතුව පසෙහි සාරත්වයද? පොහොර මිශ්‍රණයද? පොහොරවල ප්‍රමිතියද? පර්යේෂණාත්මක විෂ්ලේෂණයක්” at the E & E forum, TRI Talawakelle on December 25.

Miscellaneous activities

Auto Titrater unit, pH meters (2 Nos), Analytical Balance (2Nos) and One Desk top computer have been purchased.

Eight students (Undergraduates & Agriculture Diploma) were trained.

TRI ESTATES

St.Coombs Estate- Talawakelle

Superintendent

M M L Jayathilaka B Sc Management (University of Sabaragamuwa – Sri Lanka)

Staff List

Clerical Staff	**Designation**
Mr. R.A.D. Kalum	Chief Clerk
Mrs. M.G.D. Dilrukshi	Senior Assistant Clerk
Mr. K Rajkumar	Junior Assistant Clerk
Mr. G.P. Roopasinghe	Junior Assistant Clerk
Mr. R. Krishankumar	Store Keeper *cum* Clerk

Field Staff	**Designation**
Mr. N Illangeswaran	Field Officer
Mr. S Suresh	Field Officer
Mr. S D Perera	Assistant Field Officer
Mr. P Bakthkumar	Junior Assistant
Mr. R. Sathyaraj	Junior Assistant Field Officer

Factory Staff	**Designation**
Vacant	Head Factory Officer
Mr. S.M. Sunil Shantha	Senior Assistant Factory Officer
Mr. P. Mohotti	Assistant Factory Officer
Mr. M. Sarath Kumar	Junior Assistant Factory Officer
Mr. S. Sivam	Factory Mechanic
Mr. G.N.L. Kumara	Junior Assistant Factory Officer
Mr. P. Nishanthan	Junior Assistant Factory Officer

Drivers	**Designation**
Mr. K Selvaraj	Driver
Mr. S Christpoher	Driver
Mr. T Ramanathan	Driver
Mr. R Udayakumar	Driver
Mr. D Sundareson	Driver

Medical	**Designation**
Mr. S F Jayasinghe	Estate Medical Practitioner
Mr. D Puniyamoorthy	Welfare Officer
Mrs. G N Sylvester	Creche Attendant
Mrs. K Jothy	Creche Attendant
Mrs. T Ponmany	Creche Attendant

General

M/s. Forbes & Walkers Tea Brokers (Pvt) Ltd., continued to function as the broker for sale of St. Coombs made tea to the Colombo tea auction during the year under review. Mr. Senarath Pahathkumbura, Visiting Agent visited the estate on December 31, 2016.

Staff movements

Office

Mr. G.P. Roopasinghe, appointed as a Junior Assistant Clerk from April 01, 2016 and Mrs. H.M.B.P.K. Badra Jayathilake, Chief Clerk resigned from the service w.e.f April 4, 2016.

Factory

Mr. E.M. Dayaratne, Head Factory Officer was suspended from the service w.e.f. July 2015 and the disciplinary inquiry was in progress. Mr. P. Nishanthan was appointed as a Junior Assistant Factory Officer w.e.f. 15.06.2016

Field

Mr. R. Sathyaraj was appointed as a Junior Assistant Field Officer w.e.f 02.06.2016 and Mr. I.W.M.D. Alahakoon, Filed Officer resigned from the service w.e.f December 23, 2016.

Land use as at 31st December 2016 (ha)

	St. Coombs	Lamiliere	Total
Seedling tea	1.10	1.00	2.10
VP tea	87.06	46.50	133.56
Total tea extent	88.16	47.50	135.66
ADB Project	11.39	2.62	14.01
TRI experiment area	2.50		2.50
Nurseries	1.20	0.10	1.30
Total extent in bearing	103.25	50.22	153.47
Housing	2.09		2.09
Buildings/Roads	34.28	14.70	48.98
Ravines & Wastelands	32.16	1.00	33.16
Total	171.78	65.92	237.70

Cultural Operations

The Following fields were pruned during the year 2016.

Division	Field No	ha
Upper	1, 3A	10.50
Lower	8, 11B, 14	11.32
Lamiliere	4B,7, 9A ,12	11.40

All field practice including fertilizer applications were done as per the estimate following the TRI guidelines

ADB Mother Bush Project

Around 359,000 VP shoots from TRI 3000 and 4000 series cultivars were issued to the tea smallholders and to the corporate sector estates.

Crop and yield

	2016 Crop	Yield	2015 Crop	Yield
St. Coombs	169,852	1937	181,140	2288
Lamiliere	82,005	1740	98,224	2113
Total	251,857	1869	279,364	2227
Bought Leaf	106,895		97,136	
Out Grower			16,878	
Grand Total	**393,378**	**1869**	**393,378**	**2227**

A yield of 1869kg/ha was recorded in the year 2016

Factory and Manufacture

- Gross sale average for 2016 was Rs. 558.09/kg which was Rs.90.8 above the Western High Grown elevation average.
- The estate with its leaf standard and factory improvements secured the St. Coombs as the first in the rank of the western high grown category in 2016

Top Price

St. Coombs estates obtained all time record price for Dust No 1 @ Rs.860/- and achieved "6 top Prices" in the auctions.

Weather Conditions

Rainfall of 1344.7 mm was recorded on 162 wet days in the year 2016

Working Results

The Estate made a profit of Rs.12,299,570.21 for the year under review.

St. JOACHIM ESTATE

Superintendent

Anuradha Nanayakkara B Sc (Wayamba University, Sri Lanka)

	Name	Designation
Office	Mrs. Nilani Koralage	Chief Clerk
	Mrs. P.V.C. Gunarante	Senior Asst. Clerk
	Mrs. .K.M.G.L. Dias	Jnr.Asst.Clerk
	Miss. W.K. Prasanika	Jnr Asst. Clerk
Factory	Mr. S.K. Edirisinhge	Head Factory Officer
	Mr. A.G.D. Hemantha Kumara	Snr Asst. Factory Officer
	Mr. J.R.Yapa	Asst. Factory Officer
	Mr. D.A.J. Pushpakumara	Asst. Factory Officer
	Mr.P.P. Wickremaratna	Asst. Factory Officer
	Mr. Rohana Premalal	Jnr.Asst. Factory Officer
	Mr.W.N. Perera	Jnr.Asst. Factory Officer
	Mr. RavindraVitharana	Jnr.Asst. Factory Officer
Field	Mr.V. Ariyaraj	Jnr.Asst.Field Officer
	Mr.J. Senadeera	Asst.Field Officer
Medical	B.C.K. Perera	E.M.A
Stores	Mr. M.W. Jayasekera	Storekeeper/Clerk
Trasnport	Mr.J. Kumara	Lorry Driver
	Mr.N. Jayamaha	Suptd's Driver
	Mr.W.G.D. Amarasinghe	Lorry Driver
	Mr.A.M.A.H. Dharshana	Lorry Driver
	Mr.D.V.D. Jagath	Lorry Driver
	Mr.C. Perera	Lorry Driver

General

Ms. Forbes & Walker Tea Brokers (Pvt) Ltd continued to be the Brokers of St. Joachim teas.The following development works were carried out in the St. Joachim Factory.

- Repairs to Tempest Drier, Chamber and 5 Pass Shola Heater.
- New Conveyor Belt was purchased for the Senvec BTR Colour Sorter.

St. Joachim tea factory continued to carry ISO 22000 / FSMS Product Certification for the Manufacturing Process for 3 years since January 28, 2016. The estate Dispensary was taken over by the Regional Health Authority on 03/10/2016. Two hectares in the Field No.06 were handed over to the National Gem & Jewelry Authority for gem mining.

Staff movements

Mr. Anuradha Nanayakkara resigned from the post of Superintendent of St. Joachim Estate with effect from December 15, 2016 and continued to overlook the St. Joachim Estate w.e.f from December 16, 2016.

Mrs. B.C.K. Perera, EMA, resigned from St. Joachim Estate with effect from November 2016.

Social welfare activities

- Awareness programme for workers on World Tuberculosis day March 02, 2016
- Divineguma Development programme was conducted with the assistance of Grama Niladari and Divinaguama Officers on May 2, 2016.
- Mothers Awareness programme was held with the assistance of Midwife on the May 6, 2016.
- Awareness Programme was held on Child Abuse & Domestic Violence in collaboration with the Department of Probation & Child Care Service on November 17, 2016.

Land use as at 31st December 2016 (ha)

	ha
Total tea in bearing	50.15
Tea in Capital	8.00
TRI Coconut area	3.89
V.P. Nursery	1.58
Immature Rubber	3.20
Mature Rubber	5.12
Mature Rubber (Intercrop area)	3.68
Paddy fields	8.74
ADB Fields N.C. Tea	13.01
Field No. 06 Gem Land	2.00
Housing Project (Fld No.05)	1.00
TRI Buildings & Exp. Area f.No.9	12.02
Buildings Roads Jungle & Patna	29.59
	141.98

As per a Bush Count undertaken in October 2015, the effective hectarage is given below.

V.P. Tea Bearing Estate	-	10.68 ha
ADB Land released for Plucking	-	8.88 ha
TRI Fields	-	6.06 ha
Total effective hectarage	-	25.62 ha

Crop

The production on St.Joachim Estate in 2016, compared to the previous year was as follows.

A).Tea (made tea kg)

Year	Estate Crop (Kg)	Bought Crop (Kg)
2016	23,059	179,242
2015	31,060	172,213
Variance	-8,001	+7,029

Estate crop continues to decrease as the effective bush count reduced year on year. There has been an increase of 7029 kg of Bought Leaf compared to the last year.

B). Rubber

Year	Estate Crop (Kg)	YIELD
2015	43	4.22
2016	NIL	NIL

The rubber tapping was discontinued due to Rubber market crisis.

Cultural operation
The normal GAPs were undertaken in the estate.

Tea new clearing & re-supplies
Tea New clearing & re-supplying in 2016 were as follows.

Field No	Total No of plants put out
3C	4,500
Factory Block	400
8F	13,250
Total	**18,150**

Nursery plants
A total of 47882 number of nursery plants were sold during the year and 18,150 plants were issued to the estate.

ADB mother bush project
A total of 43,000 shoots were issued to smallholders and the Corporate Sector estates.

Tea manufacture
An NSA of 469/78 was achieved in the year 2016 as against 393/09 in 2015. St. Joachim recorded a GSA above the Low grown average after October 2016 continuously.

Total production (Made Tea)
The quantity of leaf manufactured at St. Joachim Tea Factory showed a decrease of 972 Kg in 2016 as against the previous year.

Weather & Rainfall

Rainfall of 3,019.90 mm was recorded on 141 wet days, as against 3,727.85 mm on 160 wet days in 2015.

Trading Results
The working results of St. Joachim Estate resulted in a loss of Rs.9,471,675/=.

ADMINISTRATION AND FINANCE

Special highlights

1. Human Resource Development and Capacity Building
a) Staff strengthening and motivation

Staff Recruitments

Name	Designation	Date
H M S D Kulatunga	Technical Officer	02.05.2016
H B Tharangika	Technical Officer	14.03.2016
A P C S Pathirana	Technical Officer	14.03.2016
L Attanayaka	Technical Officer	14.03.2016
V A N Wickramasinghe	Technical Officer	14.03.2016
M K S Dilrukshi	Technical Officer	14.03.2016
A S Ghouse	Technical Officer	14.03.2016
W H D U Pushpakumari	Technical Officer	14.03.2016
R A N M De Alwis	Technical Officer	14.03.2016
S M P R Shalika	Technical Officer	14.03.2016
L C Sugathapala	Technical Officer	14.03.2016
K Pallavi	Technical Officer	14.03.2016
P T P Lakshani	Technical Officer	14.03.2016
A P G I H Anwarama	Motor Mechanic & Mechanic	01.04.2016
N M Piyasena	Technical Officer	01.06.2016
R M N Nayanajith	Procurement Officer	01.07.2016
W A K R Lakmali	Personal Assistant to Director	08.07.2016
V P R P V Pathirana	Technical Officer	01.08.2016
S D K Nadeeshani	Management Assistant	01.11.2016
W M M I K Wijesinghe	Management Assistant	01.11.2016
G A D Gallage	Management Assistant	01.11.2016
I A G N Attanayaka	Management Assistant	01.11.2016
A M E T Attanayaka	Management Assistant	01.11.2016
H M C P K Jayathilaka	Management Assistant	15.11.2016
P D D Perera	Driver	01.11.2016
J M G W Jayaweera	Electrician	01.11.2016

Resignations

Name	Designation	Date
P A S Laxman	Driver	08.01.2016
P N Navodani	Management Assistant	29.01.2016
D L I U Dissanayaka	Technical Officer	20.08.2016
I D C Sajeevika	Extension Officer	15.07.2016
L Attanayaka	Technical Officer	15.07.2016
L S Sugathapala	Technical Officer	18.07.2016
M K S Dilrukshi	Technical Officer	15.07.2016
S M P R Shalika	Technical Officer	31.08.2016
U A Wickramasinghe	Engineering Assistant (Electrical)	30.11.2016

Retirements

Name	Designation	Date
B Thilakararatne	Procurement Officer	02.04.2016
A P V Kalyani	Stenographer / Typist (English)	10.06.2016
H J M De Silva	Extension Officer	23.05.2016
L Loordudasan	General Worker	12.06.2016
J S K De Silva	Electrician	29.08.2016
D W Vithana	Extension Officer	19.07.2016
P Paramasiwam	General Worker	23.12.2016
R Illangovan	General Worker	23.12.2016

Promotion

Name	Designation	Date
Dr W S Botheju	Deputy Director Research (Process Technology)	08.08.2016
M A Chamindra	Research Officer	08.08.2016
K K Ranaweera	Research Officer	08.08.2016
K W N Nadeeshani	Experimental Officer	08.08.2016
D L I U Dissanayaka	Technical Officer	14.03.2016

Overseas Training / Seminars / Conferences

Dr I S B Abeysinghe, Director, joined the Ministerial Delegation to Turkey from February 3-7, 2016.

Dr G P Gunarathne, Principle Research Officer, Soils & Plant Nutrition Division participated in the **Rare Earth Awareness Program** in China from March 20-25, 2016.
Mr B A D Samansiri, Principal Research Officer, Mr J C K Rajasinghe, Principle Advisory Officer and Mr K G J P Mahindapala, Advisory Officer participated in the "Seminar on Pollution – **Free Tea Production**" from March 25– June 19, 2016 in China.

Mr M A B Ranatunga, Senior Research Officer, Plant Breeding Division participated in the "**Research Training Grant form United Nations Unity Kirin Fellowship Program 2016**" in China from March 20-25, 2016.

Dr I S B Abeysinghe, Director, Dr Keerthi Mohotti, Deputy Director Research (Production) and Dr M A Wijeratne Principal Research Officer, Officer-in-Charge, TRI Low Country Regional Center participated in the "**FAO/IGG on Tea Intercessional meeting**" from May 23-27, 2016 in Kenya.

Dr I S B Abeysinghe, Director, participated in the "**New Agro Chemical MRLS for Tea Imports G.C.C Countries Meeting**" from July 17-21, 2016 in Saudi Arabia.

Dr. M M J P Gawarammana, Chairman, TRB represented TRI in the **Ministerial Tea Delegation** to China from August 1-6, 2016.

Dr Keerthi Mohotti, Deputy Director Research (Production), participated in the "**Third Annual Smart Plantation Management Symposium**" from December 5-9, 2016 in Malaysia.

Mr M A Chamindra, Research Officer, participated in the "**3rd Annual Smart Plantation Management Symposium**" from December 6–9, 2016 in Malaysia.

Dr.(Mrs) G D Sinniah, Senior Research Officer participated in the "**Research Training Fellowship for Developing Country Scientist 2017**" from December 18 to June 19, 2017 in India.

2. **Infrastructure Developments and maintenance**

Infrastructure developments
Maintenance work
The colour washing of Administration and Laboratory building Entrance, A type bungalow 10 & 11, B type bungalow 01, C type bungalows 36, 23, 15, 52, 31, 11, 46, 25, D type bungalows 06 & 53,E type bungalow 07 and Camellia hostel, 05 Rooms, TRI Montessori and Auditorium, Roof painting of Laboratory building andexternal colour washings of Administration and Laboratory building was completed as per the annual programme. All repair works of these buildings were also carried out during colour washing. Construction/repair work of internal road and painting of all name boards of the office were completed. Renovation works on office complex (stage two) at Kottawa center were completed. Around 90% of the renovation work of water treatment plant at head office, Talawakelle had been completed.

Water supply
Around 140 jobs were undertaken by the staff during the year 2016. They include maintenance work of existing plumbing lines, laying new lines and repairs to the raw water pipe lines. Filtration plant and sedimentation & storage tanks were cleaned.

Electrical unit
Around 153 jobs were completed by the electrical unit during the year 2016. Maintenance work was undertaken at 48 staff quarters (A type 15, B type 05, C type 15 & D type 13) Other maintenance works of senior staff hostel, junior staff Camellia hostel & junior staff ladies hostel, guest house, motor garage, mechanical workshop, filter plant insulation wiring (3 phase line), new wiring for multimedia unit at the Board Room and St. Coombs Estate were also completed.

Telephone Exchange
The maintenance works undertaken during 2016 include, repairing and replacing of Telephone Instruments, general maintenance and servicing of the PABX system and other telephone lines (Job cards 94), wiring and installation of MSAM (Multiple Service Access Node) line system, repairing of new UPS and installation of new fax receivers. In addition, wiring and fixing of new telephone lines for the ADSL system at Hantana Regional Centre were completed.

Procurement activities
Department Procurement Committee (Major & Minor)
Nine Departmental Procurement Committee (Minor) Meetings were organized for the purchase of both foreign and local items such as chemical and glassware, machinery and laboratory equipment, agricultural inputs for tea cultivation, printing of books and periodicals, spare parts for machinery, laboratory equipment, office equipment and stationeries, fuel and lubricants, building materials and accessories for hardware and electrical items, Firewood and fertilizer and *etc*.

Ten Departmental Procurement Committee (Major) Meetings were organized for the purchase of FT-NIR Machine, HPLC Machine and Photosynthesis Meter, repairs to fire heater machine, sale of 08 old vehicles, insurance coverage for buildings and vehicles, purchase of a new passenger bus and provision of security service to the head office and regional centers.

Transport & Motor Garage
One vehicle was rehabilitated and repaired with a cost of Rs. 650,000.00 and day-to-day transport requests, schedule and weekend transport services were satisfactorily provided to facilitate Research & Development activities of the institute and for the staff welfare. Routine maintenance and day-to-day repairs of the vehicle fleet were also attended. Overhauling of engines, service and lubrication, replacement of tyres & tubes and other miscellaneous repairs on wear and tear of vehicles were satisfactorily attended. The estimated cost of local repairs was about Rs.3,500,000.00.

Vehicle fleet mileage done	- 863,888 km
Motor bicycle mileage done	- 36,730 km

No of services of vehicle	- 43
No of changing of tyres & tubes	- 68
No of other repairs	- 210
No of repair to gear boxes	- 03
Total No of repairs – 2016	**- 324**

Board of Survey
Board of Survey was carried out to identify disposable / unserviceable items in the regional & extension Centers, Divisions and Units ofthe TRI and old disposable items were sold through a public auction held on December 28, 2016.

TEA RESEARCH BOARD
STATEMENT OF FINANCIAL POSITION AS AT 31st DECEMBER 2016

	Note	SLPSAS 2016 Rs. '000	SLPSAS 2016 Rs. '000	SLAS 2015 Rs. '000
ASSETS				
Current Assets				
Cash and Cash Equivalents	07		62,593	23,446
Short-term Investments			67,174	63,175
Trade and Other Receivables	08	83,284		67,312
Less:- Provision for Bad Debts		151		110
			83,133	67,202
			212,900	153,823
Inventories/Stocks	09	52,150		26,967
Deposits and Prepayments	10	3,765		8,426
Excess & Shortages	11	7		76
			55,922	35,469
Total Current Assets			268,822	189,292
Non-Current Assets				
Capital work-in-progress	12		17,157	13,171
Property, Plant & Equipment	13	1,238,200		1,175,842
Less:- Accumulated Depreciation		778,291		743,885
			459,909	431,957
Intangible Assets	14		2,404	2,404
			462,313	434,361
Total Non-Current Assets			479,470	447,532
Total Assets			**748,292**	**636,824**
LIABILITIES				
Current Liabilities				
Creditors and Payables	15	19,277		15,337
Accrued Expenses	16	18,555		18,866
Short-term Borrowings	17	49,636		29,557
Short-term Provisions	18	7,084		7,224
Employee Benefits	19	2,651		3,089
			97,203	74,073
Non-Current Liabilities				
On Going Projects	20	2,907		6,410
Provision for Gratuity	21	174,477		165,717
Petrol Deposit Refundable	22	20		19
Long Term Borrowings	23	29,474		10,667
			206,878	182,813
Total Liabilities			304,081	256,886
Total Net Assets			**444,211**	**379,938**
NET ASSETS/EQUITY				
Grants & Reserves	24		284,950	214,304
Tea Research Fund			159,261	165,634
Total Net Assets/Equity			**444,211**	**379,938**

The accounting policies on pages 24 to 26 and notes on pages 05 to 23,27,28,29 form an integral part of these Financial Statements
The Board of Directors is responsible for the preparation and presentation of these Financial Statements. These Financial State--ments were approved by the Board of Directors and signed on their behalf.

.....
Chairman - TRB

Certified by:-

.....
Accountant
For Senior Accountant

.....
Director - TRI

TEA RESEARCH BOARD
STATEMENT OF FINANCIAL PERFORMANCE FOR THE YEAR ENDED 31ST DECEMBER 2016

	Note	SLPSAS 2016 Rs. '000	SLAS 2015 Rs. '000
Revenue			
Government Funds (Recurreent)	25	338,000	341,321
Deferred Income (Capital)	25	54,855	47,732
Other Income	26	27,440	23,048
		420,295	**412,101**
Add: P/L from Two Estates	27	5,859	(10,056)
		426,153	**402,045**
Expenses	28		
Personal Emoluments		262,471	258,618
Travelling		8,457	7,745
Supplies and Consumables		17,307	18,590
Repairs & Maintenance		25,388	24,240
Contractual Services, Transport, Utility & Services		33,559	26,976
Electricity & Heating		15,332	16,644
Communications		3,713	2,013
Research and Development		31,155	32,395
Depreciation		31,542	25,100
Other Expenses		3,438	2,382
Finance Cost		390	645
Total Expenses		**432,752**	**415,348**
Surplus/(Deficit) before Adjustments		(6,599)	(13,303)
Prior Year Adjustments		226	**(674)**
Net surplus/(Deficit) for the period		(6,373)	**(13,977)**

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TEA RESEARCH BOARD
CONSOLIDATED CASH FOLW STATEMENT FOR THE YEAR ENDED 31ST DECEMBER 2016

		2016 Rs. '000	2015 Rs. '000
Cash Inflow / (Out Flow) from Operating Activities			
Net Surplus / Deficit for the year		(6,599)	(13,977)
Adjustment for			
Prior year Adjustment	225		674
Provision for Gratuity	19,486		16,743
Depriciation	37,131		30,527
Interest Income on Investment	(4,121)		(3,819)
Accounting Profit from Sale of Fixed Assets	(5,196)		(501)
Deferred Income (Recurrent & Capital)	(394,154)		(390,353)
		(346,629)	(346,729)
Operating Cash Inflow / (Out Flow) befroe Changes inWorking Capital		**(353,228)**	**(360,706)**
Changes in Working Capital			
Increase / Decrease in Inventories	(25,183)		(1,314)
Increase / Decrease in Trade. Deposits & Other Receivables	(15,932)		4,216
Increase / Decrease in Excess & Shortage	69		(1)
Increase / Decrease in Creditors & Other Payables	3,940		(2,599)
Increase / Decrease in Refundable Deposit	1		(1)
Increase / Decrease in Deposits & Prepayments	4,661		
Increase / Decrease in Accrued Expenses	(311)		-
Increase / Decrease in short term Provisions	**(140)**		-
Increase / Decrease in Employee Benefits	(438)		-
		(33,333)	301
		(386,561)	(360,405)
Less: Gratuity Paid	(10,726)		**(6,790)**
Interest Received	4,121		-
		(6,605)	(6,790)
Net Cash Inflow / (Out Flow) from Operating Activities		**(393,166)**	**(367,195)**
Cash Inflow /(Out Flow) from Investing Activites			
Proceeds from Sale of Fixed Assets	7,920		501
Disposal of Fixed Assets	(2,724)		-
Interst on Investing Activities	(3,999)		3,819
Purchase of Fixed Assets	(57,107)		(49,926)
Increase in WIP	(3,985)		(3,309)
Increase in On-going Projects	(3,502)		3,295
Net Cash Inflow / (Out Flow) from Investing Activites		(63,397)	(45,620)
Net Cash Inflow / (Out Flow) from Operating & Investing Activites		(456,563)	**(412,815)**
Cash Inflow / (Out Flow) from Financing Activites			
Grants Received from Treasury	455,108		420,995
Grants Received from Other Sources	1,716		817.00
Loan Obtained	70,032		33,000
Loan Repaid	(47,016)		(55,905)
Brokers Advance	228,656		59,794
Brokers Advance Repaid	(212,786)		(55,237)
Net Cash Inflow / (Out Flow) from Financing Activites		495,710	403,464
Net Increase / (Decrease) in Cash and Cash Equivalents		39,147	**(9,351)**
Cash & Cash Equivalents at beginning of the year		**23,446**	**97,574**
Cash & Cash Equivalents at end of the year		**62,593**	**88,223**

TEA RESEARCH BOARD
STATEMENT OF CHANGES IN EQUITY FOR THE YEAR ENDED 31ST DECEMBER 2016

Rs'000

	Tea Research Fund	Revaluation Reserves	Grants & Reserves	Total Equity
Balance as at 01/01/2016	165,634	-	214,304	379,938
Prior year adjustment	226	-	-	226
Amounts received to Grant & Reserves	-	-	464,800	464,800
Amount transferred to Deffered Income	-	-	(394,154)	(394,154)
Surplus / (Deficits) for the year	(6,599)	-	-	(6,599)
Balance as at 31/12/2016	159,261	-	284,950	444,211

Schedule A

TEA RESEARCH BOARD

ST.COOMBS & LAMILIERE ESTATES WORKING ACCOUNT FOR THE

PERIOD 1ST JANUARY TO 31ST DECEMBER 2016

2015 Rs. Cts	2015 Kg's		2016 Kg's	2016 Rs. Cts	2016 Rs. Cts
		REVENUE			
		Tea sales Gross Proceeds			
162,314,411.08	327,537.50	Tea Sales Ex. Brokers(Gross)	287,252.20	166,002,536.58	(Note 1)
27,374,393.01	65,840.50	Tea sales Local & Graties	71,499.80	30,930,256.00	
189,688,804.09	**393,378.00**		**358,752.00**		**196,932,792.58**
		Add			
(233,420.73)		ADB Profit / Loss (Sales of VP Cuttings)		(709,651.61)	
2,382,829.15		Miscellaneous Income		1,652,354.80	
381,322.63		Deferred Income		381,322.63	
2,530,731.05		**Total Income**			1,324,025.82
192,219,535.14					**198,256,818.40**
		EXPENDITURE			
		Less: Estate Expenditure			
48,137,532.93		General Charges		48,447,832.30	
14,193,268.85		Field Work & Cultivation		15,876,423.90	
64,780,010.93		Production		61,324,002.43	
40,360,727.81		Bought Leaf(Including Transport Charges)		49,619,018.50	
6,769,807.97		Outgrower			
174,241,348.49					**175,267,277.13**
		Administration & Finances			
5,036,033.02		Bonus and Holiday Pay		4,575,899.68	
2,253,900.90		Depreciation		2,642,705.11	
7,289,933.92					**7,218,604.79**
		Sales Tax & Disribution Expenses			
2,427,922.65		Brokerage,Handling charges & Sales Expenses		2,446,653.30	
2,427,922.65					2,446,653.30
183,959,205.06		**Total Expenditure**			**184,932,535.22**
8,260,330.08		**Profit /(Loss) For the Year**			**13,324,283.18**
(748,815.77)		**Less:** Over Value Unsold Tea 2015			(427,768.66)
7,511,514.31		**Profit/(Loss) transfered to TRI Operating A/C before Adjustment**			**12,896,514.52**
118,932.42		Prior Year Adjustments			164,175.00
7,630,446.73		**Profit/(Loss) transfered to TRI Operating A/C after Adjustment**			**13,060,689.52**

(Note.1) 9,856.10 kgs unsold Teas valued COP Rs. @ 527.55

Schedule B

TEA RESEARCH BOARD

ST.JOACHIM ESTATE WORKING ACCOUNT FOR THE

PERIOD 1ST JANUARY TO 31ST DECEMBER 2016

2015 Rs. Cts	2015 Kg's		2016 Kg's	2016 Rs. Cts	2016 Rs. Cts
		REVENUE			
		Tea sales Gross Proceeds			
75,546,753.07	-	Tea Sales Ex. Brokers(Gross)	191,714.00	94,982,233.05	(Note. 01)
5,735,310.03	-	Tea sales Local & Graties	10,587.00	4,386,850.19	
81,282,063.10	**-**		**202,301.00**		**99,369,083.24**
		Add			
(1,116,172.39)		Profit/Loss from Nursery		62,807.06	
8,500,496.01		Sale of Green Leaf		7,616,974.30	
420,111.32		Miscellaneous Income		1,260,162.48	
10,105.00		Income From Rubber		-	
(639,384.45)		Profit/Loss from ADB Shoots		(893,854.00)	
855,719.27		Deferred Income		855,719.52	
8,030,874.76					8,901,809.36
89,312,937.86		Total Income			**108,270,892.60**
		EXPENDITURE			
		Less: Estate Expenditure			
3,137,658.69		General Charges		3,336,914.84	
3,039,835.85		Field Work & Cultivation		3,118,134.34	
5,862,389.96		Productio n		4,564,899.54	
45,201.76		Expenditure on Rubber		8,634.66	
87,601,846.82		Bought Leaf (Including Transport Charges)		97,754,469.97	
99,686,933.08					**108,783,053.35**
		Administration & Finances			
2,070,527.74		Bonus and Holiday Pay		1,866,520.48	
3,173,404.10		Depreciation		2,946,065.50	
5,243,931.84					**4,812,585.98**
		Sales Tax & Disribution Expenses			
1,376,609.30		Brokerage, Handling charges & Sales Expenses		1,611,541.68	
1,376,609.30					**1,611,541.68**
106,307,474.22		**Total Expenditure**			**115,207,181.01**
(16,994,536.36)		**Profit /(Loss) For the Year**			**(6,936,288.41)**
(834,223.94)		Less: Over Value Unsold Tea 2015			(101,432.78)
(17,828,760.30)		**Profit/(Loss) transfered to TRI Operating A/C before Adjustment**			(7,037,721.19)
142,357.27		Prior Year Adjustment			60,641.81
(17,686,403.03)		**Profit/(Loss) transfered to TRI Operating A/C after Adjustment**			**(6,977,079.38)**

(Note.01) 35 kgs unsold Teas valued NSA Rs. @ 483.23

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கணக்காய்வாளர் தலைமை அதிபதி திணைக்களம்
AUDITOR GENERAL'S DEPARTMENT

මගේ අංකය / எனது இல. / My No. PLA/B/TRB/16/1 | ඔබේ අංකය / உமது இல. / Your No. | දිනය / திகதி / Date 16 October 2017

The Chairman,
Tea Research Board.

Report of the Auditor General on the Financial Statements of the Tea Research Board for the year ended 31 December 2016 in terms of Section 14(2) (c) of the Finance Act, No. 38 of 1971.

The audit of financial statements of the Tea Research Board for the year ended 31 December 2016, comprising the statement of financial position as at 31 December 2016 and the statement of financial performance, statement of changes in equity and cash flow statement for the year then ended and a summary of significant accounting policies and other explanatory information was carried out under my direction in pursuance of provisions in Article 154(1) of the Constitution of the Democratic Socialist Republic of Sri Lanka read in conjunction with Section 13(1) of the Finance Act, No. 38 of 1971 and Section 15 of Tea Research Board Act, No. 52 of 1993. My comments and observations which I consider should be published with the Annual Report of the Board in terms of Section 14(2) (c) of the Finance Act, appear in this report. A detailed report in terms of Section 13 (7) (a) of the Finance Act, was issued to the Chairman of the Board on 05 July, 2017.

1.2 Management's Responsibility for the Financial Statements

The management is responsible for the preparation and fair presentation of these financial statements in accordance with Sri Lanka Public Sector Accounting Standards and for such internal control as the management determines is necessary to enable the preparation of financial statements that are free from material misstatements whether due to fraud or error.

1.3 Auditor's Responsibility

My responsibility is to express an opinion on these financial statements based on my audit. I conducted my audit in accordance with Sri Lanka Auditing Standards consistent with International Auditing Standards of Supreme Audit Institutions

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(ISSAI 1000-1810). Those Standards require that I comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatements.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatements of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the Board's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the Board's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by management, as well as evaluating the overall presentation of financial statements. Sub-sections (3) and (4) of Section 13 of the Finance Act, No. 38 of 1971 give discretionary powers to the Auditor General to determine the scope and extent of the audit.

I believe that the audit evidence I have obtained is sufficient and appropriate to provide a basis for my audit opinion.

1.4 Basis for Qualified Opinion

My opinion is qualified based on the matters described in paragraph 2:2 of this report.

2. Financial Statements

2.1 Qualified Opinion

In my opinion, except of the matters described in paragraph 2:2 of this report the financial statements give a true and fair view of the financial position of the Tea Research Board as at 31 December 2016 and its financial performance and cash flows for the year then ended in accordance with Sri Lanka Public Sector Accounting Standards.

2.2 Comments on Financial Statements.

2.2.1 Sri Lanka Public Sector Accounting Standards

The following observations are made.

(a.) Sri Lanka Public Sector Accounting Standard 03

According to a decision taken in the year 2016 to release the lands with gem deposits that had been accounted, and located in the St. Joachim Estate, Hidellana, Ratnapura belonging to the Board, to the National Gem and Jewellery Authority in order to be auctioned for mining for gemstones, the said lands had been released to the National Gem and Jewellery Authority in the year 2017. However, information in that connection had not been disclosed in the financial statements in terms of Section 12 of the Standard.

(b.) Sri Lanka Public Sector Accounting Standard 07

(i) Assets valued at Rs. 57,209,881 were still in use despite being fully depreciated, due to failure in reviewing the useful life of the non-current assets annually in terms of Section 65 of the Standard. Action had not been taken accordingly to revise the estimated error in terms of Sri Lanka Public Sector Accounting Standard 03

(ii) Lands and buildings are assets separable from each other, and they should be classified separately in terms of Section 50 of the Standard. Nevertheless, lands and buildings of which the net value amounted to Rs. 226,166,964, shown in the financial statements as at 31 December of the year under review, had not been so classified. Accordingly, the accuracy of the depreciation on the buildings could not be verified.

2.2.2 Accounting Policies

If the accounting system utilized for the preparation of financial statements does not disclose the manner in which any specific accounting affair should be dealt with, the Best Practice should be more appropriately adopted therein and an accounting policy

should be formulated, followed and stated. Nevertheless, the Board had not taken action accordingly in connection with the accounting of following assets.

(a) Amortization and accounting of intangible assets valued at Rs. 2, 404,163 shown in the statement of financial position as at the end of the year under review.

(b) Recognition of the tea cultivation costing Rs. 178,385,689 shown in the statement of financial position as at the end of the year under review, separately after being classified as mature and immature cultivation. The said value had been computed without considering the prevailing biological situation by examining the physical existence of the said tea cultivation.

2.2.3 Accounting Deficiencies

The following observations are made.

(a.) The cost of the water purification unit completed in the year under review by spending a sum of Rs. 11,727,594, had been shown under work in progress, instead of being accounted as non-current assets.

(b.) The cost of living allowance should be added to the basic salary, and the contribution to the Provident Fund in respect of the staff and the labourers should be computed thereon. However, due to failure in doing so during the period January 2006 to 30 May 2012, a sum of Rs. 37,316,860 should have been credited to the Employees' Provident Fund as at 31 December 2016, but provisions had not been made therefor in the financial statements of the year under review. The said sum had been settled on 28 February 2017.

(c.) As the final stock of made tea remained unsold in the year at the tea factories, had been accounted as sales on credit in computing the sales income, instead of being disclosed in the accounts, the tea sales income, and the debtor balance of the year, had been overstated by a sum of Rs. 5,216,710.

(d.) The machinery of the Lamilier Estate given to an external party on lease by the Board, had been sold to a lessee in the year 2003 at a value of Rs. 1,010,100. However, the cost of the said machinery had not been eliminated from the accounts even up to the end of the year under review.

(e.) The value of 5654 plants in the lands belonging to the Board, identified as biological assets, had not been evaluated and brought to accounts.

2.2.4 Unexplained Differences

According to the accounts of the St. Coombs Estate for the year ended as at 31 December 2016, a sum of Rs. 256,641 had been shown as being receivable from the Tea Smallholdings Development Authority. However, according to the accounts of the Authority, the sum amounted to Rs. 340,300.

2.3 Accounts Receivable and Payable

Of the miscellaneous debtors of the Board totalling Rs. 2,853,977 by the end of the year under review, 26 per cent of the debtors equivalent to a sum of Rs. 730,905 had been older than 05 years, but no productive measures had been taken by the management to recover those balances.

2.4 Non-compliances with Laws, Rules, Regulations, and Management Decisions

The instances of non-compliances with Laws, Rules, and Regulations, etc. observed during the course of audit, are as follows.

Reference to Laws, Rules, Regulations, and Management Decisions.	Non-compliance
(a.) Section 13.3 of Chapter II of the Establishments Code of the Democratic Socialist Republic of Sri Lanka	An acting appointment should be made as a temporary measure only and until a substantive appointment is made. Nevertheless, acting appointments had been made with respect to the

		posts of residential engineer of the Board, senior accountant, and 08 posts of divisional head, for a period of 01-07 years. A sum of Rs. 2,648,179 had been paid during the 07 preceding years as acting allowances.
(b.)	Financial Regulations of the Democratic Socialist Republic of Sri Lanka.	
(i)	Financial Regulation 104 (2)	Although 05 vehicles belonging to the Institute had met with accidents in the year under review in 06 instances, reports on losses and damages had not been presented to the Auditor General in terms of Financial Regulations.
(ii)	Financial Regulation 316 (2)	Records of the articles lodged in, or withdrawn from safe custody, should be maintained by the officer responsible. However, such records had not been maintained with respect to the cash lodged in the vault of the Institute.
(iii)	Financial Regulation 396	Action had not been taken in terms of the Financial Regulation on 14 cheques issued but not presented and valued at Rs. 117,940 that had exceeded the period of validity despite being issued with respect to 03 bank accounts.
(c.)	Paragraph 9.14 of the Public Enterprises Circular, No. PED/12, dated 02 June 2003.	A Manual of Procedures providing rules and regulations on Human Resource Management should be prepared, and approval of the Secretary to the Treasury should be obtained thereon. However, the Board had not done so.

2.5 Transactions Not Supported by Adequate Authority

Approval of the Board of Directors had been received on 17 March 1995 on the procedure for making payments at the retirement over the vacation leave unavailed by the officers. However, approval of the Treasury had not been obtained thereon. A sum of Rs. 213,634 had been paid in the year under review to 06 retired officers in respect of unavailed vacation leave.

3. Financial Review

3.1 Financial Results

According to the financial statements presented, the financial result of the Board for the year under review had been a deficit of Rs. 6,599,148 as compared with the corresponding deficit of Rs. 13,302,192 for the preceding year, thus indicating an improvement of Rs. 6,703,044 in the financial result as compared with the preceding year. The increase in the profit of the St. Coombs Estate by a sum of Rs. 5,266,067 and the decrease in the loss by a sum of Rs. 10,648,682 sustained by the St. Joachim Estate in the year under review, had mainly attributed to the said improvement.

The analysis of the financial result of the year under review and 04 preceding years revealed that a financial deficit had resulted in from the year 2012 to 2016. However, when the employee remuneration and the depreciation for non-current assets had been adjusted to the financial result, the contribution of the Board in the year 2012 amounting to Rs. 142,812,049, had continuously improved in the year 2016, and reached Rs. 227,982,026.

3.2 Analytical Financial Review

The ratio of profits of the ADB Project relating to the St. Coombs Estate and St. Joachim Estate had been unfavourable in the year under review, and the said ratio had been (415) per cent and (48) per cent respectively, whereas those ratios had been (139) per cent and (13) per cent respectively in the preceding year. The annual decrease in the quantity of clonal cuttings sold by the said Project, had caused the deterioration of the ratio.

3.3 Legal Cases Instituted by or against the Board

The following observations are made.

a) As 05 officers who had proceeded abroad by obtaining full-pay study leave and never returned, had not acted as per the agreement entered into with the Board, cases had been filed in Courts even before 6 years to recover the bonds amounting to Rs. 18,552,991.

b) A case had been filed by an external party in the year 2012 to acquire a plot of land by naming the Board as the third defendant, and an employee of the Board had filed another case in the year 2015 against the Board requesting reinstatement in the position that he had held previously.

4. Operating Review

4.1 Performance

The objectives of the Tea Research Board established under the Tea Research Board Act, No.52 of 1993, as amended by the Act, No. 30 of 2003 with emphasis on conducting researches in order to uplift the productivity and quality of tea production in a profitable manner, are as follows.

- 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 ;

- To conduct, assist and encourage, research, into the economic viability of the tea industry in Sri Lanka including future economic trends in such industry;

- To maintain and administer the Tea Research Institute situated at Talawakale, and its substations, in accordance with the rules of the Board ;

- ❖ To establish and maintain, relationships with research institutions, in Sri Lanka and abroad;

- ❖ To conduct, in the discharge of its functions, joint study programmes, seminars or symposia, with foreign research institutions and research institutions in Sri Lanka; to promote investment in tea research ; to advise the Minister on appropriate policies in relation to the tea industry.

The progress of the performance in respect of the researches and other activities conducted by the Board in achieving the said objectives, are as follows.

a) According to the Corporate Plan for the period 2013-2017, it was expected to conduct 185 researches. Due to various limiting factors, 38 researches equivalent to 20 per cent, had either been abandoned halfway, or postponed.

b) Seven researches commenced by incurring a sum of Rs. 14,629,986 from the research and development grants received annually from the Treasury, had not yielded the expected objectives, and been halted halfway. It was revealed in the audit examination that the scarcity of human resources had mainly affected thereto.

c) In the wake of the resignation of the officer in charge of the Biometry Unit established for providing statistics required for researches, the said Unit had remained closed since the year 2013. Due to failure in recruiting an officer with expertise in that field, the Unit could not be restart to the end of the year under review.

d) According to the Corporate Plan for 2013-2017, it had been planned to implement 04 projects by the Biochemistry Division to study the health benifits and antioxidant benefits of tea, but only one project had been implemented whilst 03 projects had been postponed. Three projects planned on the value added manufacture of tea, had not been implemented, whilst 2

projects had been abandoned. The scarcity of human resources in this field had also attributed to the non-implementation of the projects.

e) Of the amount of Clonal Cuttings estimated to distribute during the 3 preceding years through the mother bush programme conducted by the Advisory and Extension Division for distribution of newly released tea cultivars, the amount of Clonal Cuttings distributed had only been 67 per cent, 58 per cent, and 59 per cent respectively; hence, the progress of this programme had not reached the expected target.

f) Of the provision amounting to Rs. 100,000,000 made by the Treasury for the Mechanization Project implemented in the year 2013 to address the dire scarcity of labour, a main issue in the tea industry, a sum of Rs. 48,000,000 had been received by the year 2014, and a sum of Rs. 44,848,107 had been spent therefrom by the end of the year under review. As the harvest had been damaged due to the machines distributed under the said project, and those machines could not be used on slopes, the objectives expected from the project had not been achieved productively. Hence, it is observed that utilization of the funds of the Board on a procedure relating to mechanization and changing of attitudes in order to find solutions for the increasing scarcity of labour, is more productive. Furthermore, 2 researches planned to be conducted in different areas by the Agri Economics Division for the identification of socio-economic measurements in order to avert the scarcity of labour, had not been implemented in the year under review as well.

g) The following observations are made on the St. Coombs and St. Joachim Estates, and the factory managed by the Board.

   (i) According to the information made available to the audit, the quantity of sale of tea and the production costs in respect of each estate as compared with the preceding year, are as follows.

Description	St. Joachim Estate		St. Coombs Estate (Including the Lamilier Estate)	
	2016	2015	2016	2015
Input of Green Tea Leave (Kg)	955,943	955,206	1,596,530	1,780,384
Production of Tea (Kg)	202,301	203,273	358,752	393,378
Sales of Tea (Kg)	202,266	201,727	348,896	388,417
Cost of Production (Rs. per Kg)	487.42	436.15	508.67	481.10
Average Net Sales (Rs. per Kg.)	483.23	393.09	541.91	475.93
Made Tea Outturn Ratio (per cent)	21.16	21.2	22.47	22.09

- Standard Made Tea Outturn Ratio 21.5

The following observations are made in this connection.

- Although the tea sales income of the St. Coombs Estate for the year under review had increased as compared with the preceding year, the amount of sales had decreased by 09 per cent. Furthermore, the decrease in the productivity of the tea estates belonging to the St. Coombs Tea Factory by 17 per cent as compared with the preceding year, had attributed to the decrease in the tea production thereof.

- As the productivity of labour, usage of firewood, and electric units of both factories, had not reached the expected level, the production cost per kilogram of tea had increased as compared with the preceding year. Moreover, the production cost per unit of the St. Joachim Estate, had exceeded the average net sales price.

(ii) According to the Action Plan of the St. Coombs Estate, and the St. Joachim Estate, the usage of green leaf had been 2,120,306 Kg and 1,836,826 Kg respectively, whereas the actual usage had been 1,596,530 Kg and 955,943 Kg respectively, thus indicating a variance of 24 per cent and 52 per cent. As such, the amount of made tea had also varied in a manner proportional thereto.

h) The following matters are observed on the nurseries being maintained at the St. Coombs Estate, and the St. Joachim Estate with the objective of providing standard tea plants.

(i) About 34 per cent of the number of plants nursed at the tea plants nursery maintained at the St. Joachim Estate during the 2 preceding years, had been unsuccessful. Failure to follow the instructions given to maintain the nurseries had mainly attributed thereto.

(ii) Due to failure in properly maintaining the nursery at the St. Coombs Estate, 23,495 plants had been disposed of in the year under review causing a loss of Rs. 659,687.

4.2 Management Activities

The following observations are made.

a) The books of the library at the head office of the Board had not been physically verified since the year 1978. As for the books not returned out of the books borrowed during the 20 preceding years (1985-2016), action had not been taken either to get those books back or settle the value.

b) Prior to releasing an advance to an external institution for a certain activity, it is necessary to verify that it is feasible for the relevant activity to be carried out. Contrary to that, a private institution had been granted an advance of Rs. 110,124 in the year 2011 for the purchase of a Water Still Unit to be used at the regional office in Mathugama. However, the said institution had been closed, but no action had been taken to settle that value.

c) Action had not been taken up to 30 June 2017 to take over the ownership of 08 vehicles used by the Board and the lands where the regional offices of Deniyaya, and Kottawa had been built.

d) Lands in extent of 05 hectares belonging to the St. Joachim Estate, had been encroached by external parties over a period of 26 years. Action had not been taken to acquire those lands back to the Board.

e) Paddy lands in extent of 8.74 hectares belonging to the St. Joachim Estate had been cultivated by tenant farmers, and action had not been taken to recover the portion of income receivable to the Board therefrom. Furthermore, action had not been taken to count and record the number of trees in the rubber and coconut estates.

f) Action had not been taken by the management to calculate and account the value of the stock balance of the chemicals that had been kept in the stores at each research division after being purchased for research activities.

4.3 Underutilization of funds

Sums of Rs. 8,151,671 and Rs. 9,500,000 received from the Treasury for the Uplifting the Living Standards Project and the Mechanization Project in the years 2013 and 2014 respectively, had not been utilized even in the year under review.

4.4 Idle and Underutilized Assets

The following observations are made.

a) As the stock of medicines valued at Rs. 201,408 kept in the custody of the Medical Assistant of the St. Coombs Estate had remained unused for a period of 04 years, that stock had been disposed of from being used.

b) A quarters of category "A", 11 quarters of category "D", and 07 quarters of category "E" belonging to the Board had remained idle without being occupied.

c) The plant capacity of the St. Coombs, and St. Joachim estates had been 8,000 and 15,000 Kilograms of Green Leaf per day respectively. However, it was observed that the average actual utilization of those plants had been 5,000, and 6,253 Kilograms per day representing 62 per cent and 17 per cent respectively.

d) Of the 04 roller machines installed at the inception of the factory, only 02 machines are utilized in the production process at a time whilst the other 02 machines are observed to often remain underutilized. Moreover, the Savage Cutter machine had also been disposed of from being used, whilst the E.C.P. 4 Drier machine had remained unused over a period of 16 years.

e) As the drier machines using firewood had been utilized at the St. Joachim Factory, the drier machine that used fuel had remained idle. Due to the decrease in the quantity of green tea leave received by the factory, the Stake Extractor, had not been used for a period of 03 years.

4.5 Staff Administration

The approved cadre and the actual cadre of the Board as at 31 December 2016 stood at 443 and 253 respectively. Accordingly, 190 posts had fallen vacant. The following observations are made in this connection.

a) Of the 87 approved posts of the executive grade, 38 posts remained vacant. Twenty three posts of the employees had been internal promotions, and due to the lack of qualified officers in accordance with the Scheme of Recruitment for those posts, recruitments could not be made for a period of 05 years.

b) Ninety seven non-executive posts remained vacant, and the number of approved posts of the Research and Development Technology Officer, and the Extension Officer included therein had been 50 and 24 respectively. Of that,

33 and 17 posts representing 68 per cent had remained vacant. Hence, the research and Extension activities of the Board could not be completed within the targeted period as planned.

c) The post of Officer in Charge (OIC) is not included in the approved cadre of the Board, but 08 officers had discharged the duties belonging to that post, and acting appointments had been made in respect of the said posts, thereby paying a sum of Rs. 1,278,320 as allowances from the year 2010 up to the year under review.

d) One hundred and twelve employees already in service after being recruited on temporary or casual basis in accordance with the Public Administration Circular, No. 25/2014, dated 12 November 2014, had been granted permeant appointments with effect from 24 October 2014 (105 posts of primary grade, and 07 posts of Management Assistant). Nevertheless, the number of posts of Labourer approved under PL-1, had been 65 as at 31 December 2016, but the actual cadre had been 104, thus the excess number of employees had been 39.

4.6 Control of Vehicles

The following observations are made.

a) The engine of a vehicle that had been removed from being used, was fixed to another vehicle. However, action was not taken on the registration certificates of those vehicles in accordance with the directives of the Commissioner of Motor Traffic.

b) A Pajero Jeep remained idle for a period of 05 years without being repaired completely.

5. Accountability and Good Governance

5.1 Internal Audit

An Internal Audit Unit had been established in the Board, but no examination relating to the financial or physical performance had been conducted on the main function of the Board being research activities.

5.2 Budgetary Control

As variations ranging from 13 per cent to 100 per cent had been observed between the budgeted income and expenditure, and the actuals, it was observed that the budget had not been made use of as an effective instrument of management control.

5.3 Unresolved Audit Paragraphs

The following observations are made.

a) In order to reimburse a monthly labour allowance for the maintenance of quarters of the Director, Deputy Director and officers in charge of the Regional offices, the approval of the Board of Directors had been granted on 24 May 2007. This Labour allowance had been computed by adding production bonus, overtime, attendance allowance etc. to the daily labour salary and the Board had reimbursed Rs. 1,790,177 for 10 officers in the first 09 months of the year 2016. However, approval of the Line Ministry and the Treasury had not been obtained for this purpose, and instructions had been issued to obtain the approval at the meeting of the Committee on Public Enterprises held on 19 November 2014 as well.

b) Action had not been taken to obtain the approval of the Treasury in connection with the privileges such as leave, quarters and non-recovery of charges for water and electricity consumption which had been granted by the Board to the staff superseding the relevant circulars and the other similar institutions.

c) As the machines imported by the Institute in the year 1982 by incurring a sum of Rs. 4,142,173 for processing tea, had not been suitable for the relevant project, the machines remained idle. Despite being informed that action would be taken to write off this value from the books on the approval of the Treasury, the said value had not so far been removed from the accounts, and shown as work in progress instead.

6. Systems and Controls

Deficiencies in systems and controls observed during the course of audit were brought to the notice of the Chairman of the Board from time to time. Special attention is needed in respect of the following areas of control.

Areas of Systems and Controls	Observation
(a) Accounting	Failure to revalue and account the assets fully depreciated.
(b) Control of Assets	Failure to take over the ownership of the vehicles and regulate the repairs properly.
(c) Maintenance of Books and Registers	Failure to maintain the Register of Fixed Assets in an up-to-date manner, non-inclusion of the assets belonging to the Board into the Register of Fixed Assets. Although a register should have been maintained on the receipt books in accordance with G.A. N-20, the regional office in Ratnapura had not done so.
(d) Budgetary Control	Observation of significant variances between the budgeted and actual expenditures.
(e) Research Activities	Poor regulation of research activities.

(f) Stores Control	Instead of storing the chemicals purchased for researches at a centralized store, thereby issuing in required quantities, those chemicals had been kept in the stores of the research divisions. Hence, the same chemical had been stored at several places in various quantities, and certain chemicals had become expired whilst redundant stocks had been maintained.

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