Tea Research Institute of Sri Lanka
Talawakelle

ANNUAL REPORT 2022

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Sri Lanka

Annual Report 2022

ISSN: 1012-3954

Publisher	: Tea Research Institute of Sri Lanka
Layout Design	: Dr. M A B Ranatunga and W H T C Silva
Cover Design	: Dr. M A B Ranatunga and K G R Niroshan
Photographs	: K G R Niroshan
Printers	: Lanka Offset Printers

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TEA RESEARCH INSTITUTE OF SRI LANKA

The Tea Research Institute of Sri Lanka (TRI) 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.

BOARD OF MANAGEMENT

TEA RESEARCH BOARD OF SRI LANKA

The TRI is governed by the Tea Research Board (TRB) 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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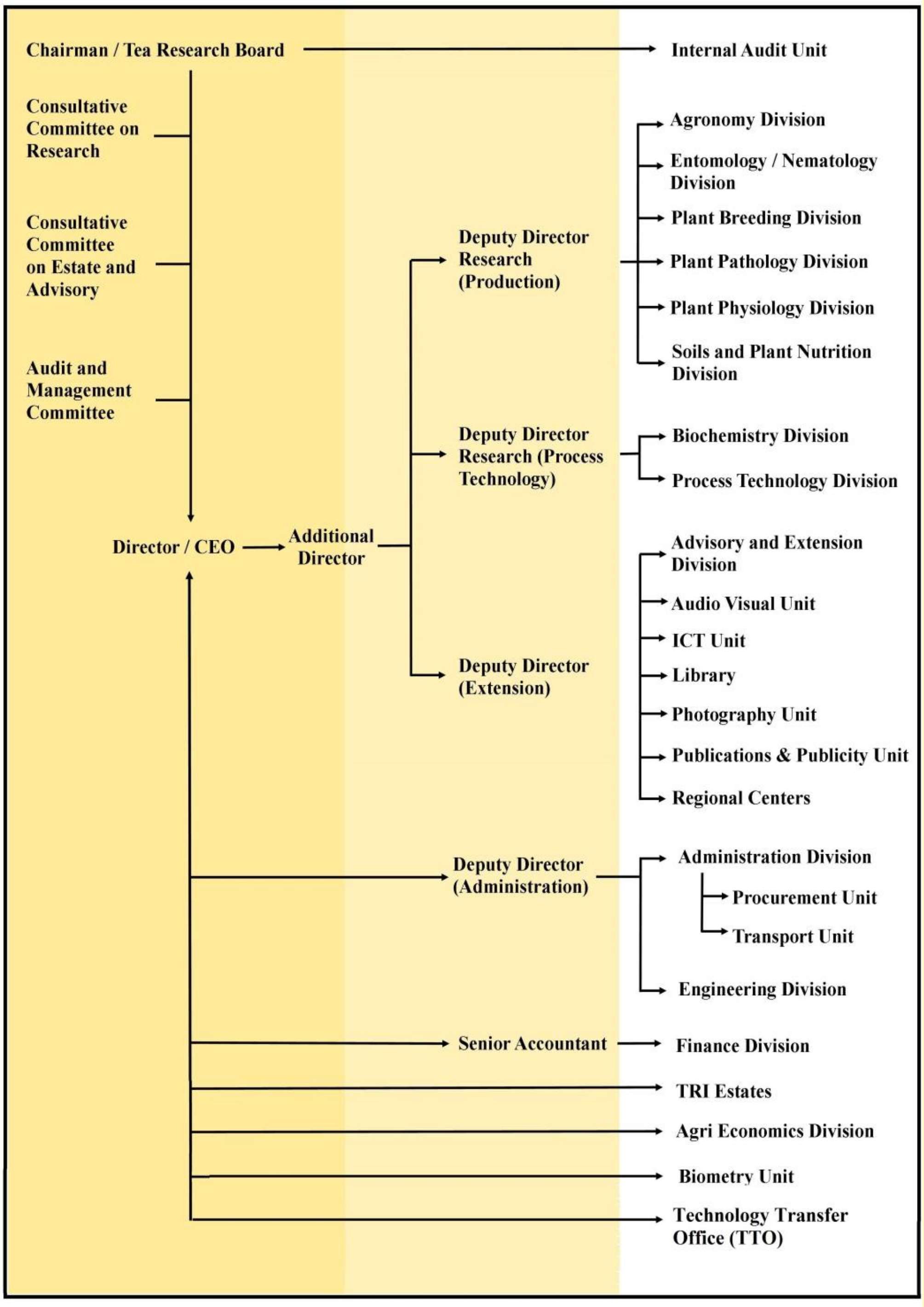
ORGANIZATIONAL STRUCTURE OF THE TRI



REVIEW BY THE CHAIRMAN OF TEA RESEARCH BOARD

Mr. C S Lokutetti
Chairman
Tea Research Board
(From April 2022)

It is with great pleasure I present the 2022 Annual Report of the Tea Research Institute (TRI) of Sri Lanka. On behalf of the Tea Research Board, the undersigned assumed duties as the Chairman, Tea Research Board (TRB), from April, 2022. I wish to express my sincere gratitude to the former Chairman of the TRB, Dr. M W N Dharmawardene and members of the Board for their valuable guidance and advice extended to the TRI during 2022. Activities of 2022 were planned with the recommendations of the Consultative Committee on Research (CCR), Consultative Committee on Estates and Advisory Services (CCE & A), the Audit and Management Committee and performed with the strength of the Directors of the TRB.

The tea industry in Sri Lanka continued to face various challenges during the year 2022 as well. After successful management of COVID 19 pandemic in the country, restrictions imposed by health authorities were lifted gradually facilitating normal work routines. However, the entire agriculture sector in Sri Lanka was affected with shortage of inorganic inputs including fertilizer and agro chemicals in 2022. Amidst various efforts on increasing availability of organic inputs, the tea industry had no exceptions and suffered with shortage of inorganic fertilizers and other inputs during first two quatres of the year. With the guidance of the TRB, TRI made every effort to support the industry by rapid screening and facilitating timely availability of organic inputs compensating productivity decline. Also, from the 2nd quarter of 2022, the tea industry faced serious challenges due to shortage of fuel in the country. Almost all activities from field to the factory got hampered during the fuel crisis, however, comparatively, tea industry managed the situation with minimum disturbances. However, with all difficulties, the country recorded total tea production of 251.5 million kg a decrease of 48 million kg compared to 2021.

Due to these issues, the TRI faced many challenges in finding appropriate scientific recommendations and technologies for the industry. Therefore, the Board continued to guide the institute to work in line with the emerging issues being faced by both the tea plantation and tea small holding sectors and to find appropriate technologies. Major findings of the Evidence based study on national yield decline in tea production carried out by TRI under the guidance of the TRB, highlighted the importance of infilling of vacancies of tea fields which accounts around 30% as a key measure to resolve the problem. Therefore, TRB urges here, that all stake holders of the industry including the line ministry should now join together to plan the way ahead on a National Infilling Programme as a high priority together with the TRI on improving productivity of tea lands.

Being the second oldest Tea Research Institute in the world, TRI is heading towards the centenary celebrations in 2025. TRI has been the forefront of the tea industry in Sri Lanka since its inception from 1925. However, TRB felt that when setting next centenary goals of the TRI, it is important to make efforts in promoting an excellent research culture at the institute. Organizations are nowadays increasingly recognizing the importance of the role of research integrity by promoting research culture *viz,* the formal and informal ethics, standards, protocols and policies researchers follow in their environments.

Broadening choice of tea cultivars for growers in the Uva region, 03 high yielding TRI 5000 series cultivars TRI 5002, TRI 5005 & TRI 5006 with drought tolerance, quality, and resistance to blister blight and tolerance to nematodes have been recommended and released for with the Technology Release Committee meeting recommendation during 2022.

Under the guidance of the CCR of the TRB, TRI initiated a nationally important study on Net Out Turn (NOT) in 2022 to resolve a critical issue in the tea industry. With the guidance of the CCR, a study protocol and action plan has been finalized and work initiated with the target of submitting final report in 2023.

A mobile laboratory with modern analytical facilities developed by the TRI was launched for the benefit of tea growing community, on 9th September 2022 at the Low Country Research, Advisory & Extension Center under the patronage of Honorable Minister of Plantation Industries as a special project funded by the line ministry. This mobile laboratory was designed by the TRI with a view to providing efficient analytical services to the doorstep of tea growers.

During 2022, TRI staff participated in the "Sahakampanaya" awareness programmes conducting in all tea growing regions promoting higher green leaf standards to secure benefits to growers and tea processors.

TRB was successful in licensing a long-awaited TRI patent on "Process for the preparation of Tea Wine" (Patent no. 13621) for commercial manufacturing. Though, the patent was granted in 2005, previous attempts were not successful in identifying a potential commercial partner. However, after a rigorous evaluation, International Distilleries Ltd., has been identified as the commercial partner and it is expected to enter into an agreement and licensing during January 2023.

Strengthening the human resources, TRB facilitated recruitment of 34 officers including 29 Technical Officers (R & D), one Senior Accountant, two guest house keepers and two hostel keepers during 2022. Also, 16 officers including the Director retired after completion of successful long-term service at the TRI and on behalf of the TRB, I wish them a happy retired life.

In view of offering dedicated and timely service to the tea growers in the Mid Country region, TRI Research, Advisory and Extension Center at Hantana was renovated and laboratory facilities have been upgraded. Also, during 2022, field development activities of TRI Advisory and Extension Center initiated expanding mother bush areas aiming offering better service for tea small holders in the region.

During the year, nine meetings of the TRB were held and the Board continued to guide the management by strictly imposing administrative and management decisions by following up on the same through consultative committee on Audit and Management. Similarly, the Board continued to follow up issues related to Research and Extension programme of the institute and matters pertaining to two Estates through the Consultative Committee on Research and Consultative Committee of Estate and Advisory Services respectively.

The performance of St. Coombs and St. Jaochim Estates were appreciable during the year and recorded profits of LKR Mn 61.06 and 47.87 respectively during 2022. Upgrading of St. Jaochim factory as a model factory for conducting research on process technology completed for the benefit of tea producers and manufactures in the low country. The Board continued to highlight on the sustainability of the two TRI Estates by introducing economically viable models appropriate to the present context.

In view of disseminating recent research findings of TRI efficiently and effectively to stakeholders and General Public, TRI with the guidance of TRB is planning to organize a TRI Open Day in middle of 2023. It is expected to conduct series of events i.e. field demonstrations, seminars, stakeholder interactions, guided factory tours and laboratory visits *etc*. This will be the first ever open day at the TRI history. Also, in line with Centenary Celebrations of the TRI to mark the 100 years in research excellence demonstrated nationally and globally, TRI is planning to organize a National Symposium on Tea during end 2023. The objective of the symposium is to disseminate recent research findings, technological innovations and information on market trends among stakeholders. It is expected to invite all research groups in Sri Lanka working on tea from Universities and Research Institutes to participate for the Symposium. The target audience is all stakeholders in tea industry including policy makers, growers, manufacturers, tea brokers and general public. The symposium will be conducted in hybrid mode and proceedings will be published.

On behalf of the Board, I wish to appreciate the dedicated services of the Director and all staff of the TRI and for being supportive in implementing the Board decisions. At this juncture, I wish to extend my gratitude to the Honorable Minister, Secretary and staff of the Ministry of Plantation Industries for their guidance to the Board. Finally, I remain grateful for the valuable contributions of TRB members and their guidance extended to the Chairman in decision making process.

Mr. C S Lokuhetti
Chairman
Tea Research Board

REVIEW OF THE DIRECTOR, TRI

Dr. L S K Hettiarachchi
Director/ CEO
BSc (Peradeniya, Sri Lanka)
PhD (Aberdeen, UK)

The tea industry in Sri Lanka continued to face various challenges during the year 2022 as well. After successful management of COVID 19 pandemic in the country, restrictions imposed by health authorities were lifted gradually facilitating normal work routines. Shortage of agrochemicals in plantation sector during the year affected tea industry as well. In line with Government's consideration on (i) foreseeable impacts of limitations of electricity, fuel and transport difficulties thus the smooth function of public life and (ii) readiness to the anticipated food shortage in the country, the Chairman, TRB and Director, TRI made contingency plans to ensure uninterrupted work at the Institute in all possible ways, including cost cutting, savings and alternate strategies. However, since it was inevitable that the closure of R and D laboratories, monitoring of experiments, functioning of Advisory and Extension service and Analytical service laboratories and also the requirement of essential services to facilitate laboratories, experimental plots and the Head-quarters, Regional Centers and the two Estates situated in remote locations, TRI continued with carefully identified activities, being the only R & D organization with least interruptions.

The Director, Heads of Divisions and Advisory and Extension staff in all the Regional Centers attended the awareness cum training workshop on 'Collective approach by TRI, TSHDA, SLTB and NIPM on strategic cost management' under the theme 'Good to Great' held at NIPM, Athurugiriya. The Honourable State Minister graced the occasion and the TRI, TSHDA and SLTB jointly made presentations on the subject area with a view to uniformly disseminating the information among stakeholders.

The Honorable Minister, Secretary, Additional Secretary, Chief Accountant and other senior members of the Ministry of Plantation and Mr Jagath Ravisinghe, Acting Chairman TRB called over to the TRI Head Office on 16th March 2022. The VIP delegation called over the laboratories, experimental areas and met all staff and workers, Heads and senior staff and trade Unions to discuss matters in relation to smooth functioning of the Institute, grievances and avenues to improve the life and work of the Institute.

Drs L S K Hettiarachchi, K M Mohotti and M A Wijeratne participated at the working group deliberations and the 24th FAO IGG on Tea Forum held virtually on 23rd February 2022 representing TRI along with other stakeholders. The provisional report covering decisions of the working groups on 'MRLs', 'Trade and Quality', 'Climate change', 'Organic and Sustainable Tea' and 'Statistics' will be submitted to the Board once released by the FAO IGG on Tea Secretariat to review the progress and work plans.

The Director, TRI attended the project launch and the first Technical Advisory Committee meeting of the project on Agroforestry in Tea and Coconut plantations in Sri Lanka to be executed by IUCN Sri Lanka as the project implementation body. The Honorable Minister and Secretary of the Ministry of Plantation graced this occasion. The technical facilitation for the preliminary studies has been given by the Netherlands Enterprise Agency (RVO), Wageningen University and Research (WUR) and Agriculture Faculty of the University of Peradeniya through the Embassy of the Netherlands in Sri Lanka. The TRI and CRI were chosen to provide guidance on potential agroforestry models for the pilot testing project and IUCN and RVO members also called over TRI to discuss the technical inputs for the tea sector.

The Director, TRI attended the meeting convened by the Ministry of Plantations seeking financial assistance from SLTB to CTRM 2030 initiative put forwarded by the CTTA. Out of the Rs. 45 million sought from the SLTB, a sum of Rs. Ten million is allocated for the purpose of strengthening capacity of TRI to facilitate the industry requirements.

The Director, TRI attended the meeting convened by the line Ministry for the "Development of Walahanduwa Estate" as a demonstration site in Galle using novel technologies' in order to provide technical guidance to the SLSPC. TRI has been advised to provide technical guidance to the SLSPC where mechanized tea fields, mother bush areas with TRI recommended new cultivars and commercial tea nurseries *etc.* are considered as useful interventions.

Director TRI, staff at Head Office and its Regional Centers participated at the virtual event organized by the FAO in commemorating the 'International Tea Day 2022' titled "Celebrating Tea around the world, from field to cup" on the 23rd May 2022. The program covered aspects in relation to recognizing the long history, and in-depth cultural and economic significance as to the consumption of tea around the world and production and processing being a main source of livelihoods for millions of families, particularly in developing countries. The celebration envisages to promote the sustainable production, consumption and trade of tea, and offers an opportunity for the actors at global, regional and national levels to ensure that the tea sector continues to play a role in reducing extreme poverty, fighting hunger and safeguarding natural resources.

The second progress review meeting of the collaborative pilot project on "Geochemical Approach for the Verification of the Origin of Ceylon Tea" jointly conducted as per the tripartite agreement among Sri Lanka Atomic Energy Board (SLAEB), the Sri Lanka Tea Board (SLTB) and the Tea Research Institute (TRI) of Sri Lanka was held virtually on 17th the June 2022. Dr. L S K Hettiarachchi, Director, Dr. K M Mohotti, Deputy Director Research (Production), Dr K G N Piyasena, Head, Biochemistry Division and Dr. M A B Ranatunga, Head, Plant Breeding Division participated from TRI and presented the progress of sample collection work. It was also emphasized that 75% of the samples have been collected and planned to complete rest by September 2022. SLEAB summarized the progress of sample analysis and as at today, Isotope Ratio Mass Spectrometry (IRMS) analysis of 126 Sri Lankan black tea samples and 64 foreign tea samples completed. It was noted that both sample collection and analysis work has been affected owing to the prevalent fuel and energy crisis in the country and possible remedial measures were discussed.

TRI participated at the occasion of the 65th anniversary of the establishment of diplomatic relations between China and Sri Lanka through online platform. The three-day forum was organized by the Foreign Affairs Office of the People's Government of Yunnan Province (YFAO), Yunnan Academy of Agricultural Sciences (YAAS) and Department of Agriculture (DOA), Ministry of Agriculture, Sri Lanka. The theme was "Agricultural Science and Technology for Poverty Alleviation" aiming to develop exchanges and cooperation between Yunnan Province of China and Sri Lanka in the field of agriculture and agricultural science and technology. The seminars also envisaged to promote in-depth cooperation between Yunnan and Sri Lanka in agriculture through the topics of Tea Culture and Tea Technology, Research and Industrial Development of Tropical Economic Crops *i.e.* Sugarcane and Mango and Agricultural Science and Technology for Poverty Alleviation. Dr. L S K Hettiarachchi, Director, TRI made presentations tilted 'Introduction of Tea & Its

History in Sri Lanka' & 'Tea Cultivation and Processing Technologies' while Dr. M A B Ranatunga, Head, Plant Breeding, TRI made a presentation on 'Tea breeding protocol in Sri Lanka'.

Director, TRI and Dr K Raveendran Head, Process Technology Division participated at the meeting convened by SLSI on standards (1474: 2013; 1492: 2014 & 1548: 2016 on Kraft line board sacks for bulk packaging tea; Multiwall paper sacks for bulk packaging of tea & Composite kraft board sacks for packaging of bulk tea respectively) and their specifications in relation to tea packaging along with the officials of the Sri Lanka Standard Institution and CTTA, with a view to formally deliberating on proposed revisions to identify less costlier sacks.

Director, TRI participated at the 105th PeTAC meeting held online where the TRB's PA representative's requisition for the issuance of Glyphosate to the tea sector being crucial in managing weeds in tea lands in the absence of cost effective and safer herbicide/s was tabled and PeTAC in principle agreed to submit a cabinet paper and considered importation of Glyphosate through able organizations favourably.

TRI met with JICA team and reviewed the work progress on its component "Verification survey using NIR technology" in the collaborative project with Kawazaki Kiko, Japan and SLTB as against the original work plan. The Kawasaki Kiko agreed to submit the final report of the project for TRI to study and propose modifications if any and continuation of progressive activities to differentiate made tea quality in the different regions and seasons using the NIR technology where necessary. Also, TRI invited them to come up with R & D proposals to design smart units/user friendly field kits etc. to test and determine green leaf quality and moisture.

The Chairman, TRB and Director, TRI took part in the 2nd session of the National program titled "Quality improvements in pluckable shoots through empathy for virtues" at the ITN TV program on 01st September 2022.

A long-awaited mobile laboratory with modern analytical facilities developed by the TRI was launched for the benefit of tea growing community, on 9th the September 2022 at its Low Country Research, Advisory & Extension Center. Honorable Dr Ramesh Pathirana, Minister of Plantation Industries was the chief guest at the launching event held in conjunction with the 42nd Experimental & Extension (E & E) Forum for the Regional Managers, Assistant Regional Managers and Tea Inspectors attached to Tea Small Holding Development Authority (TSHDA) and the Office bearers of Tea Small Holders Development Society. After inspecting the analytical facilities available in the mobile laboratory, Hon. Minister participated in the E & E forum and interacted with the participants. During the interaction and his brief address, Hon. Minister Dr Ramesh Pathirana, Minister of Plantation Industries emphasized the need for collective approach by all stakeholders to uplift the leaf standard and quality of made tea. Also, Hon. Minister assured participants the government's support in supplying chemical fertilizers at a reasonable price for the smallholders in order to improve yield and making fuel available for the stakeholders to use machineries. This mobile laboratory was designed by the TRI with a view to providing efficient analytical services to the doorstep of tea growers. The funds for the mobile unit were allocated by the Ministry of Plantation Industries under a special project in 2021. Traditionally, tea growers/stakeholders deliver soil, leaf and fertilizer samples to the TRI laboratories for analysis. The mobile laboratory will not only be used for analytical services, but also for other outreach activities of the TRI targeting both tea smallholders and stakeholders. The TRI's mobile laboratory is equipped with facilities for soil nutrient and root starch content determination, identification of pests & diseases and public address system.

TRI represented at the Annual General Meetings of the Tea Exporter's Association (TEA), Planter Association (PA) and Ceylon Tea Traders Association (CTTA) on 02nd, 23rd and 30th September 2022 respectively.

The Chairman TRB, Director and Deputy Director (Research) , TRI participated at the Tripartite meeting with the SLTB officials at its Auditorium in Colombo 03 on 7th October 2022 where the industry stakeholders deliberated on the current issues as to production level, processing and exports.

The Chairman, TRB and Director, TRI took part in the 2nd session of the National program titled "Quality improvements through empathy for virtues" at the ITN TV program on 1st September 2022.

Director TRI, along with the staff of Process Technology, and Advisory and Extension Divisions participated in the "Sahakampanaya awareness program where higher green leaf standards had been promoted to secure benefits to growers and tea processors. Parallely, Director, TRI also participated at the TV programs conducted on the scientific basis of harvesting green leaf standards.

TRI represented at the Annual General Meeting of the Sri Lanka Tea Factory Owner's Association (SLTFOA) on 30th October 2022 where HE the President and Hon. Minister of Plantation Industries graced the occasion as the Chief Guest and Guest of Honor respectively.

TRI participated in the preliminary stakeholder consultation workshop on strengthening the tea industry sustainability in Sri Lanka where Sustainability Need Assessment (SNA) was conducted for the tea industry and gathered stakeholder insights for the formulation of the policy and investment acceleration.

TRI also attended the forum on development of a tea policy to improve international competitiveness of tea organized by the ADB with the support of the MPI. In this line, the views of Chairmen of TRB, SLTB and TSHDA were presented along with the forward plans of the CTTA Road Map 2030 and salient findings of the Six Year Strategic Plan of the MPI developed by the University of Peradeniya as for the determination of the contents to be included in the tea policy document.

TRI participated at the 125th celebrations of the M/s A Baur & Company (Pvt) Limited whose engagement in agroinputs viz. fertilizers and agrochemicals to the tea sector has been praiseworthy. At the meeting, TRI was recognized as the main technical arm for the Company to continue with tea industry facilitation since inception.

TRI participated in restitution workshops on 'Implementing Geographic Indication (GI) system for Ceylon tea' organized at regional level by the SLTB. The objectives of the workshops were in view of introducing the GI concepts to a wider audience in the industry, collectively validate the key features of the Ceylon tea, propose different options to define specific Ceylon tea quality within the Book of Specifications (BoS) and discuss potential implications of each specification involved.

RESEARCH, ADVISORY AND EXTENSION MATTERS

The 93rd meeting of the Consultative Committee on Research (CCR) of the Tea Research Board (TRB) was held on 15th November 2022.

The Action Plan of the Institute for 2022 was prepared in par with (i) the Institute Strategic Plan 2019 – 2023 comprising of the thematic areas operated under Basic, Applied and

Service projects at Divisional and Interdisciplinary levels to cater to the industry issues of current relevance, (ii) Treasury approved recurrent and capital Budgetary provisions and (iii) by paying attention to the Strategic Plan for 'Tea Industry Development in Sri Lanka 2021 – 2025' of the Ministry of Plantation & the State Ministry of Company Estate Reforms, Tea and Rubber Estates Related Crops Cultivation and Factories Modernization and Tea, Rubber Export Promotion.

Prof. Emmanuel Frossard, of ETH University, Zurich during his visit to TRI to organize the collaborative R & D project with the ETH Zurich, Switzerland and the University of Peradeniya made a project proposal presentation titled 'Can organic farming practices increase nitrogen (N) use efficiency and decrease N losses in mature tea (*Camellia sinensis* L. (O.) Kuntze) plantations in Sri Lanka? with significance to the global and national relevance in precision and sustainable agriculture.

Prof. Alistair Hetherington, Melville Wills Professor of Botany, University of Bristol, UK and the project partner of the TRB approved research collaboration on "Improving Drought Resistance and Water Use Efficiency of Tea in Sri Lanka" (Acronym: WUE) by the TRI with the University of Bristol, the Royal Botanical Gardens at Kew, United Kingdom and the Faculty of Agriculture, University of Peradeniya, Sri Lanka attended to the following research activities during 16th - 21st March 2022.

1. Photosynthetic measurements of test cultivars in tea germplasm collections in Talawakelle and Passara with additional physiological parameters.
2. Sample preparation for stable isotope analysis facility at the University of Sheffield, UK and delivery of dried samples to the UK.
3. Measurement of leaf stomatal density and size by using microscopy and dental image facility to compare with the manual stomatal impressions with the assistance of the University of Peradeniya, and
4. Data analysis and correlations of the DSI protocol and additional parameters with the assistance of the University of Peradeniya.

Staff of Plant Breeding and Plant Physiology Divisions and the University of Peradeniya team associated with Prof Alistair Hetherington to maximize field data recording during the dry spells. Director, TRI and Prof. Alistair Hetherington signed the Light Touch MOU in view of co-operating and identifying the opportunities to improve academic and research ties between the two institutions for their mutual benefit besides the WUE project activities until the quadripartite MOU is signed between the University of Bristol, Royal Botanical Gardens, Kew, UK and the Faculty of Agriculture, University of Peradeniya, Sri Lanka as per the Ministry approvals.

Three workshops on strategic cost component management approaches in key agronomic practices to suit the present-day context under resource limited environments were conducted by the TRI for the Plantation Executives of the Balangoda and Madulshima PLCs and the contents delivered in the sessions have been well received and commended by the participants.

TRI convened and conducted two progress review meetings on the study protocol of the NOT (Net Out Turn) survey jointly with the SLTB & TSHDA and the data gathered so far internally, and with the SLTB and TSHDA officials was critically reviewed on 18th and 26th July 2022 respectively, in view of obtaining maximum support to expedite field assistance agreed upon through SLTB & TSHDA regional staff. In order to meet the revised deadline on submission of the technical report by TRI as of end 2023 for the consideration on regulatory purpose, TRI prepared a monthly work program in line with the action plan of the project for SLTB & TSHDA to follow suit. The special Consultative Committee on Research meeting was also convened on 28^{th} July 2022 to present the status quo of the NOT studies and present the proposed sampling strategy and study protocol of the commercial scale investigations, with a view to clarifying the issues raised at TRB.

TRI convened the Regional Scientific Committee (RSC) - Ratnapura, Kegalle and Kalutara via online where Director, TRI made the key note address, emphasizing the adaptable strategic cost management approaches to the executive planters in the corresponding regions. The presentations covering current interests on integrated soil fertility management strategies and their economic benefits, mechanization of tea field operations and its economic benefits were made by Drs. V Sidhakaran, S R W Pathiranage, M A Wijeratne and Mrs H W Shaymalie respectively.

Having noted the reports on misuse of different fertilizer mixtures allegedly distributed among tea growers especially the small and medium scale holders, TRI issued a cautionary note specifying the scientific basis of the tea fertilizer mixtures and adherence to different mixtures for respective growth stages and yield categories in tea.

TRI provided technical justifications to Japan as to the continued detection of MCPA residues in made tea exported to Japan, despite increase of the MRL (Maximum Residue Limit) from 0.01 to 0.06 ppm on the basis of the technical dossier submitted by TRI to MHLW (Ministry of Health, Labor and Welfare) in Japan . As such detections are apparently considered as violations as for tea imports to Japan, stakeholders have been advised for restricted and rational use of MCPA in tea plantations..

TRI organized and successfully concluded its 42^{nd} Experiments & Extension Forum for the small-scale tea growers on 09^{th} the September, 2022 at its Research, Advisory and Extension Centre, Ratnapura, with the theme been "Strategic Plant Nutrient Management for Uplift the Small Holding Sector (කුඩා තේවතු ක්ෂේත්‍රයේ උන්නතිය සඳහා උපාය මාර්ගික ශාක පෝෂක කළමනාකරණය)". Tea growers from Galle, Matara, Kalutara, Ratnapura, Badulla, Kandy, Nuwara Eliya, Matale and Kegalle districts took part in the event. The Senior Officials from Tea Small Holdings Development Authority (TSHDA), Sri Lanka Tea Board (SLTB) and Federation of All island Tea Smallholding Development Societies were also present.

Director, TRI delivered the key note address wherein current trends in world tea market, cost components of tea cultivation and processing, and strategic cost component management in tea cultivation with rational use of plant nutrient use was deliberated. Smallholders' role in current tea markets, identification of proper strategies for integrated plant nutrient management has been discussed during the technical session. Mrs M A H Nishanthi, Advisory Officer, Advisory & Extension Division and Dr (Mrs) H W Shyamalie, Head, Agricultural Economics Division made the presentations on i) Integrated plant nutrient management approaches to improve nutrient use efficiency and ii) Economic benefits of integrated plant nutrient management strategies respectively.

Director & Deputy Director (Research) TRI along with the Agronomy, Plant Pathology & Entomology Division's scientists joined the STaRR project team to examine tea fields established using TRI guidance based on SQI determination of the lands and planted with CO3 grass during soil rehabilitation period.

TRI utilized the Mobile laboratory facility launched to offer analytical and extension services in Galle area on 9^{th} November 2022. Four programs had been completed at Talgampola, Kottawa, Narawala, Halvitigala and Thawalama on 9^{th}, 14^{th}, 18^{th} and 22^{nd} November 2022 respectively where large numbers of rural and distant stakeholders especially small and medium scale tea growers had been benefited especially on soil pH testing and appropriate fertility management recommendations.

TRI undertook the agrochemical audit as to repeated detections of Hexaconazole residues in made tea in Nawalapitiya area. On submission of the results, SLTB issued a cautionary note cum guideline on strict precautionary measures to all RPCs for strict compliance, as it revealed irrational usage of the fungicide and the absence of proper records on agrochemical usage in both RPC and smallholder sector for the traceability.

RESEARCH HIGHLIGHTS

CROP IMPROVEMENT

Release of New TRI 5000 Series Cultivars for Uva

Three potential high yielding TRI 5000 series cultivars (TRI 5002, TRI 5005 & TRI 5006) with drought tolerance, quality, resistance to blister blight and tolerance to nematodes have been recommended and released for Uva Region with the Technology Release Committee recommendation.

Establishment of New Mother Bush Areas

A total of 22 ha of mother bush area, was established with TRI 5000 series and selected TRI 4000 and 3000 series cultivars, covering all tea growing regions to facilitate dissemination of shoots/cuttings among growers. Land preparation for establishment of mother bushes and nursery propagation commenced in selected locations with the funds approved by Ministry of Plantation under a special project.

Optimization of Light Conditions for Photoautotrophic Micropropagation of Tea on Liquid Cultures

Photoautotrophic micropropagation utilizes *in vitro* plant's ability to perform photosynthesis in carbon free medium for the development of hardened plants cost effectively. In concluding R & D activities, light intensity of 30 μmol m^{-2} s^{-1} Photosynthetic Active Radiation (PAR) and Red light only or Red: Green: Blue 1:1:1 light quality is identified as suitable for photoautotrophic micropropagation (sugar free medium) of tea. Light intensity of 30 μmol m^{-2} s^{-1} PAR and Red: Green: Blue 1:1:1 ratio light quality with 15g/L sucrose liquid MS medium is also identified as suitable for photo mixotrophic micropropagation of tea.

Conservation and Utilization of Old Seedling Teas: A Viable Option for Adaptation to Climate Change

The project was established with the overall objective to develop a broader and inclusive understanding of the genetic diversity in OSTs in Sri Lanka, identify diversity "hotspots" and develop conservation strategies. The project will have direct and indirect impacts to the Institute's tea breeding program and the local tea industry as a whole to maintain the sustainability.

LAND PRODUCTIVITY IMPROVEMENT AND CROP MANAGEMENT

Estimating Crop Response to Macro Nutrients (N, P, K, S and P) at Agro-ecological Region (AER) Level

The study conducted to investigate the suitability of tea factory fire wood-ash mixed with refuse tea/compost as plant nutrient source for mature tea under growers' conditions were completed.

Application of Soil Quality index (SQI)

Soil Quality Index (SQI) analysis conducted in tea small holder lands enabled 188 sites (66% success rate) or 71.2 hectares to have access on the suitability for direct planting with the aim of encouraging replanting among tea growers, and ensuring productivity and profitability. Furthermore, field validation exercise of the SQI in small holder tea lands, conducted in collaboration with the STaRR project team, enabled qualifying 285 fields for the SQI determination, representing four districts.

Evaluation of Plant Growth Promoting Rhizobacteria (PGPR) Microbial Formulations for Low Grown Tea

PGPR microbial formulations were evaluated for tea nurseries in low-country tea growing regions. Results showed 50% reduction of N and replacement of DAP with ERP in the recommended T65 mixture was possible with application of dual inoculants formulated with respective series specific microbial strains.

Evaluation of Effects of Application of Different Rates Of Slow Release Fertilizer at Different Frequencies on Soil and Plant Nutrient Status and Yield

The main objective of this study is to study yield response of mature tea to slow-release fertilizer produced by Sri Lanka Institute of Nano Technology Institute (SLINTEC) under growers' condition with a view to introducing economically viable slow releasing compound fertilizer. Research and adaptive trials on the use of slow releasing compound fertilizer (NANO urea hybrid) have been completed.

Development of Water Management Techniques for Tea in Drought Prone Areas and Evaluating Drip and Sprinkler Irrigation Systems for Low-Grown Tea

Establishment of two experimental sites to evaluate the efficacies of drip and sprinkler irrigations on growth of tea in drought prone areas and the evaluation on sprinkler irrigation was also conducted in a system where tea inter-planted with coconut in collaboration with an external partner and Tea Small Holder Federation.

Evaluating an Appropriate Rain Water Harvesting and Retention Method and Effectiveness of Rain Water Use for Tea

The project established in 2021, continued with the assessment of converting a rehabilitated tea field with new planting with TRI 4049 cultivars.

CROP PROTECTION

Development of Nano pesticides for Managing Pests and Diseases

Micro-encapsulated *Beauveria bassiana* and nano hexaconazole were developed by the SLINTEC for the experimentation at TRI, Laboratory bioassay commenced to evaluate bio-efficacy of micro-encapsulated *B. bassiana* against SHB has been completed. Bio efficacy of Nano hexaconazole against fungal symbiont (*Fusarium ambrosium*) of Shot -hole borer was commenced using 4 concentrations (1%, 2%,4%, 8%) with an untreated control to find out the minimum concentration that inhibit the fungal growth. This experiment continued.

Establishment of Bio-Efficacy and Residue Data for a Nano-Copper Fungicide

With the objective of developing integrated management strategies to control major tea diseases, screening nano-copper formulation against blister blight disease in tea established. It was found that the levels of Cu residue in the final product, i. e. made tea processed in the miniature scale, after copper sulphate pentahydrate (ICC60) sprayed at 0.3%. Therefore, the levels of copper residue in copper sulphate pentahydrate treated samples were lower than 40 ppm, the Maximum Residue Limit (MRL) allowed by European Union (EU) for copper.

TRI Develops New Bio-Pesticides

Development and promotion of use of biopesticides in integrated pest and disease management have been targeted to address the issues in relation to overuse of synthetic pesticides and align with policy on transforming Sri Lanka's economy into a green socio-economy with sustainable solutions to climate change. With the objective of commercializing biopesticides for tea, three *Trichoderma* and *Pseudomonas* based biocontrol agents and *Beauveria* and *Metarhizium* based entomopathogens were developed and mass multiplied to manage diseases and insect pests, respectively.

A Microbial Processing Plant equipped with a modern bioreactor was established under a special project category through direct treasury funds. Its operations were commenced successfully with a view to mass multiplication of bio pesticides for field experimentation and strengthening commercialization potential. .

Bio-Efficacy of Two Isolates of *Metarhizium* against White Grubs, Up Country and Low-Country Live Wood Termite

Bio-efficacy of two isolates of *Metarhizium* was evaluated against White grubs, Up country live wood termite and Low country live wood termite. Promising results were achieved with the study.

Integrated Weed Management (IWM)

As part of IWM approaches, investigations in relation to the screening of Avenger AG Optima Burndown herbicide, and screening of Glufosinate Ammonium herbicide progressed during the year under review.

Evaluation of Sustainable, Organic and Low-input Farming Systems for Tea

Evaluation of sustainable, organic and low input farming systems for tea in view of generating information on sustenance of soil and crop productivity and level of natural biological control mechanisms and pest, disease and weed incidences continued. Primary objective of the project is to evaluate pest, disease and weed management under sustainable, organic and low input farming systems, scientific validation to biological and natural pest, disease and weed management practices, development of user friendly sustainable biological and natural pest, disease and weed management methods. Soil sampling for in-depth studies at ETH Zurich, Switzerland was also continued with the TRIOCON trial established in St. Coombs Estate, Talawakelle.

CLIMATE CHANGE IMPACT ASSESSMENT

Having foreseen the possible impacts of adverse weather conditions in the different agroecological regions of tea growing areas, and long-term data analysis, the guidelines for the preparedness to minimize effects have been made. With the aim of assessing the impact of global climate change on productivity and profitability of the tea industry several projects were implemented and evaluation, assessing of the results have been in progress.

Investigation of Pest and Disease Response of Tea to Global Climatic Change

To study the life cycle of Shot hole borer at different temperatures under the laboratory conditions the above project was implemented for the determination of the variation of life cycle of Shot-hole borer (*Xyleborus fornicatus*) at different temperature ranges and experiment will continue as a replicated trial based on the results generated from the preliminary study.

Analysis of Climate Change, Identifying Vulnerable Tea Growing Regions and Seasonal Weather Forecasting for Different Tea Growing Regions in Sri Lanka

In collaboration with the Department of Meteorology and TRI Talawakelle (Up country), Kandy (Mid-country) and Ratnapura (Low country), rainfall and temperature data records were analyzed, with forecasting and sharing with TRI Advisory and Extension Division and its Advisory Officers for the use in outreach activities.

Screening of Organic Fertilizers to Incorporate in Integrated Nutrient Management (INM) Strategies in Tea

Chemical fertilizers act as beneficial inputs and lead to higher crop productivity levels. However, irregular or irrational use of chemical fertilizers are associated with many negative impacts such as reduction in soil inhabited beneficial microbes, degradation of soil properties and reduction in crop yields over time *etc*. which in turn would lead to unfavorable economic as well as environmental concerns. In order to reduce the dependency on chemical fertilizer use , this study was carried out as a collective effort by the TRI, with the aim of promoting organic fertilizer rich in nitrogen content for the use in integrated nutrient management approaches and sustainability of tea cultivation.

MECHANIZATION OF FIELD PRACTICES

Development and Introduction of a Motorized Selective Tea Harvester

An innovative project was commenced on the “Development and Introduction of Motorized Selective Tea Harvester/s Suitable for Tea Lands in Sri Lanka (2021-2023)” with special funds allocated by the Treasury. A sum of Rs 35 million was initially approved for the three-year period. During the year under reference two partners selected for the project (Arthur C Clerk Center Institute for Modern Technologies and B and N Optiums (Pvt) Ltd) continued with designing and fabrication of prototypes of motorized selective-tea harvesters. The activities of the project were monitored by the Project Advisory and Monitoring Committee and the technologies being developed by the two partners were primarily tested at TRI Low Country Research, Advisory and Extension Center and at TRI headoffice Talawakelle.

TEA PROCESSING TECHNOLOGY AND PRODUCT DEVELOPMENT

Introducing New Tea processing Technologies for the Industry

Commercial applicability of the automated control system developed by TRI for the withering process, had apparently revealed 30% reduction of energy consumption in the validation endeavours as well.

System Modification to the Currently Available Furnaces Used in Tea Industry

A Far-Infrared (FIR) experimental dryer with control system was designed and a prototype unit was fabricated. A control system was developed to operate the unit.

Development of Combustion Control System to Air Heaters

A combustion control system that was designed and developed to control combustion of firewood in the Hot Water Generator at St. Coombs Factory in 2021 was successfully tested and validated.

Development of a Model Factory for tea processing Research and Development Projects

Work has been initiated to develop the St Joachim Tea Factory in Ratnapura district as an Experimental Process Technology Development Factory for tea processing R & D activities. Improvement to machinery, infrastructure facilities, and renovations were completed and continues its operations with the new machineries.

Establishment of Geographical Indicators for Ceylon and Regional Teas

In order to ensure the "Ceylon Tea" brand in the global tea market and establish geographical indicators for Ceylon and its provisionally recognised Regional Teas, Geochemical approach using Stable Isotope Signatures and Trace Element Analysis was launched and the preparation of database initiated as per the Tripartite agreement among SLTB, SLAEB and TRI. The important chemical constituents, which influence the flavor of black tea such as polyphenols, caffeine, sugars, organic acids, volatile flavor compounds, and amino acids related information collection and analysis was also carried out.

Establishment of Inherent Sugar Concentrations in Black Tea: Low and Mid Elevations

Statistically validated data set on the maximum permissible inherent concentration of Fructose, Glucose, Sucrose in made teas covering Low and Mid-elevation factories were established and accordingly the maximum permissible levels of inherent concentrations of Fructose, Glucose, Sucrose in made teas have been conveyed to the Sri Lanka Tea Board for the formulation of regulations.

Investigation of Health Promoting Effects of Sri Lankan Tea cultivars

With the financial assistance of CARP, the above study continued as for the earlier work focusing on the investigation of health-promoting effects of Sri Lankan Tea Cultivars. In this study, harvestable tea shoots were collected from 15 tea cultivars during the wet and dry seasons. Altogether 60 tea extracts including freeze-dried black tea brew and methanol extract of freeze-dried fresh tea shoots were used.. Elastase, xanthine oxidase, nitrous oxide, and ORAC bioassays were carried out using freeze-dried tea brew and methanol extracts. Data analysis related to the study is in progress.

SOCIO ECONOMICS AND RESOURCE PLANNING

Identification of Typology and Trajectories of Tea-Based Farming Systems by Modeling Land Use and Land Cover Dynamic Changes in Low-Country Region

This study was conducted to identify tea-based farming systems in the Low Country region (Ratnapura), Sri Lanka and to evaluate the performance of present farming systems. Study results reveal that the necessity for strong intervention on revitalization of existing tea-based farming policies and move towards the need-based target-oriented approach. Furthermore, this study emphasizes the importance of considering the diverse structure of socioeconomic settings of farm households in implementing farming technologies. Also, the revelations suggest to make policy implications for the development of tea intercropping systems, considering the heterogeneity of tea-based farming practices in non-traditional areas.

Alternative Worker Deployment Model (AWDMs)

Introduction of AWDMs to tea plantations is expected to be an appropriate concept to minimize negative impacts of labour shortage, improve the abandoned tea lands and to earn an additional income to workers. A survey was conducted to identify the level of implementation and the performance of the AWDMs in plantation sector. It was found that reasons for the failures of AWDMs are due to labour scarcity (level of Estate labour scarcity / family labour availability), Estate productivity (low yielding tea lands), managerial policies and labour demotivation. Although most of the Estates have implemented different kinds of AWDMs, status of these systems is not in a satisfactory level. Furthermore, it has been identified that the proper management and closer monitoring are essential for the successful promotion of any type of AWDMs.

Impact of Product Innovation towards Firm Performance in the Sri Lankan Tea Industry

The study commenced in 2019 as part of fulfillment of a post graduate study, comparing competitiveness and impact of product innovation towards Tea-based firm performance in Sri Lanka and Japan successfully completed. This study pinpoints the need of promoting production of tea-based radical innovations in Sri Lanka rather than focusing only on incremental innovations. Sri Lanka, as a major tea producer and exporter in the world, priority should be given supply tea to the mass market. Therefore, while encouraging, teas exported for mass markets should be value added through incremental innovations within the country, much attention should be given to increase the product range through tea based radical innovations in order to assure the sustainability of the industry in the long run.

SERVICES TO THE STAKEHOLDERS

Public - Private Partnership Extension Approach

The extension approach of public - private partnership model wherein partner/collaborative organizations work together on a project having mutually benefited interests and objectives continued. Responsibilities in terms of time, resources, knowledge and expertise are shared among collaborating organizations.

Tailor-made Training Programmes

Tailor-made Training Programme is a collaborative initiative by the TRI and Regional Plantation Companies, with the objective of improving the technical competency of executives, field staff and plantation workers. Sixteen tailor-made training programmes have been organized and conducted for seven Regional Plantation Companies during the year covering the subjects of tea harvesting, pruning, foliar application, uprooting, replanting and aftercare, soil and leaf sampling, tea nursery management, soil conservation and soil fertility management, strategic cost management, good agricultural practices and tea manufacturing.

Para Extension Approach

Para Extension Approach (PEA) is a grassroots-level extension approach implemented as a collaborative project of TRI and RPC Estates. The innovative field staff groups in plantations are trained as Para Trainers (PT) and to function as change objective is to improve the accessibility of TRI recommendation to the supervisory employee level and to create an effective grass+roots level technology dissemination system within Estate. Thirteen programmes were conducted and 130 workers covered during the year.

Cyber Extension

To ensure cost effective and efficient dissemination of TRI recommendations and information to tea growers including other the stakeholders and thereby improving awareness and adoption, the cyber extension activities were initiated and TRI call centre, SMS gateway providing technical support to the growers. The technical content provided to "Dialog Govimithuru" Tea channel by the TRI.

AWARDS, RECOGNITIONS AND SPECIAL PRESENTATIONS

Mr. K K Ranaweera, Research Officer and Ms. HWMMM Jayarathne, Technical Officer (R and D), Plant Breeding Division participated IAEA regular programme of Technical Cooperation 2020/2021 on "Supporting Genetic Improvement of Tea" at the "Vienna International Centre in Seibersdort, Austria for 09 months Fellowship from 19th April 2022 to 27th January 2023 and 03 months fellowship from 1st August 2022 to 31st October 2022 respectively.

Dr. M A Wijeratne, Head, Agronomy Division and Dr. Mrs H W Shyamalie, Head, Agricultural Economics Division, TRI have been appointed to the Board of Studies in Crop Science and Agricultural Economics respectively at the Post Graduate Institute of Agriculture (PGIA), University of Peradeniya for the period 16 January 2022 - 15 January 2025.

Drs. (i) Mrs P G D S Amarasena, (ii) Sampath Pathiranage and (iii) Noel Piyasundara, Senior Research Officers attached to Entomology and Nematology, Agronomy and Plant Breeding Divisions respectively and (iv) Mrs. Samanthika Weerawardena, Research Officer, Process Technology Division, TRI received the PhD degree certificates (i-iii) and M Phil (iv) at the General Convocation held on 23rd February 2022 at the University of Peradeniya.

Drs C J Liyanaarachchi, Advisory Officer, Advisory and Extension Division and Ms H M C G Pilapitiya, Research Officer, Agricultural Economics Division were awarded the PhD degrees after successfully completing the thesis work from The University of the Philippines Los Baños in January 2022 and The University of Saga, Japan in February 2022 respectively.

Drs J D Kottawa Arachchi, Research Officer, Plant Breeding Division and Mrs L A S P Jayasinghe, Research Officer, Agronomy Division were awarded the PhD degrees after successfully completing the thesis work from the CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, India and The University of the Philippines Los Baños respectively.

The Ministry of Agriculture has nominated Dr K M Mohotti, Deputy Director Research (Production) to serve as a member of the appeals panel under the Plant Protection Act No. 53 of 1999 by recognizing his technical expertise to obtain expert technical advice in the fields of entomology, plant pathology, microbiology, mycology, virology and nematology in connection with the act for a period of one year with effect from 2nd May 2022.

TRI was awarded with external funds to join the R&D project on 'Design and Implementation of Microenvironment Conditions for Tea and Ornamental Foliage Plants using Precision Agriculture Systems Powered by Solar Photovoltaics' from the University Research Council (URC) of the University of Peradeniya which is a competitive funding source. The objectives and aims of the project are to pilot scale designing of précised light transmission and microenvironment (heat) to tea nurseries for acceleration of callusing, early establishment, rooting and growth. Dr K M Mohotti, Deputy Director Research

(Production) will serve as one of the Co-investigators of the Project among eminent University academics. TRI anticipates to make use of the solar energy as a tool to promote Carbon neutral tea production and as an avenue to minimize external inputs and increase efficient resource use efficacy in the tea sector. Soil solarization in tea nurseries, utilization of excess energy in factory operations, motor pumps for irrigation, pest repellent equipment and harnessing filtered solar energy ranges as shaded conditions induced through Solar Photovoltaics' for specialty tea production at field level are other R & D interventions in this study proposal.

Dr L S K Hettiarachchi Director, TRI was invited by Prof Jiang Renhua, Director General, TRI CAAS to attend and deliver a 25 minutes presentation to the plenary session at the forthcoming 4th Global Forum for Directors of Tea Research Institutes, scheduled be held in late November 2022, covering latest developments in tea science and technology in Sri Lanka.

Appointment as a member in Fertilizer Advisory Committee (FAC) of the Ministry of Agriculture has been extended for Dr K M Mohotti, Deputy Director Research (Production), TRI with effect from 13th October 2022 for another year by the Hon. Minister of Agriculture.

The paper presented by the research team lead by Drs Mrs G D Sinnaih and Mrs P D Senanayake, TRI adjudged as the best presenter at the 42nd Annual Sessions of the Institute of Biology Sri Lanka held on 30th September 2022.

INSTITUTIONAL IP POLICY

The Institutional IP Policy was drafted and submitted to the Tea Research Board and obtained its approval provisionally and circulated among TRI staff prior to implementation.

PATENTS

During the year 2022 amendments were submitted to two previously filed patent applications namely "Mathematical model-based control system for trough withering of tea", and Method of formulating talc-based *Trichoderma asperellum* (Tric 33) wettable powder, method of preparation and method of application for tea disease management and plant growth enhancement

DEVELOPMENT OF MANAGEMENT INFORMATION SYSTEM (MIS)

The proposed MIS shall be fully integrated system interconnecting divisions/units/offices and also Regional and Extension Centers, with operational requirements and also provide analytical tool for the purpose of information analysis. Furthermore, it provides a platform with a modular architecture where it has a higher level of flexibility to changes and capable of adding new services and features. With the collaboration with the service provider i.e. software development team, M/s. Sri Lanka Telecom (Servicers) Limited., completed the entering master data to Human Resource, Payroll, Procurement, Finance and Accounting, Inventory, Staff Transport, Fault and Service and Expenses Reimbursement modules during the year.

Memorandum & Understandings (MOU)s AND RESEARCH GRANTS

Memorandum of Understanding signed between the Tea Research Institute of Sri Lanka and Sri Lanka Institute of Nano Technology (Private) Limited (SLINTEC) to carry out a research project on “formulation of nano Hexaconazole and nano bio pesticide using *Beauveria bassiana*” and “to study the effectiveness of these interventions for the control of blister blight and shot hole borer respectively in tea plantations”.

Memorandum of Understanding signed between the Tea Research Institute of Sri Lanka and The Smallholder Tea and Rubber Revitalization Project (STaRR) to carry out “Upgrading the Laboratory facilities of Tea Research Institute of Sri Lanka to offer Soil Quality Index analytical facilities to Identify suitable smallholdings for direct tea replanting under Smallholder Tea and Rubber Revitalization project (STaRR)”

Memorandum of Understanding signed between the Tea Research Institute of Sri Lanka and University of Bristol, the Royal Botanical Gardens at Kew, United Kingdom and the Faculty of Agriculture, University of Peradeniya, Sri Lanka to carry out a research project on “Improving Drought Resistance and Water Use Efficiency of Tea in Sri Lanka”.

Memorandum of Understanding signed between the Tea Research Institute of Sri Lanka and National Productivity Secretariat on “Productivity Promotion Project of Sri Lanka Tea Research Institute”

Memorandum of Understanding signed between the Tea Research Institute of Sri Lanka and The Swiss Federal Institute of Technology in Zurich, Group of Plant Nutrition, Institute of Agricultural Sciences (ETH Zurich) and the Faculty of Agriculture, University of Peradeniya, Sri Lanka (UoP) to carry out an in-depth research project on “Can organic farming practices increase nitrogen (N) use efficiency and decrease N losses in mature tea (*Camellia sinensis* L. (O.) Kuntze) plantations in Sri Lanka”

Memorandum of Understanding signed between the Tea Research Institute of Sri Lanka and National Engineering Research & Development Centre on project titled “Development and Fabrication of Smart Agricultural Sprayer”

Memorandum of Understanding signed between the Tea Research Institute of Sri Lanka and Arthur C Clarke Institute for Modern Technologies with an aim on promotion of “Modern Technologies and Tea Research Institute for Research & Development and Resource Sharing”.

SPECIAL PROJECTS

Development & Introduction of a Motorized Selective Tea Harvester Suitable for Tea Lands in Sri Lanka (GL 389)

A new project was commenced on the “Development and Introduction of Motorized Selective Tea Harvester/s Suitable for Tea Lands in Sri Lanka (2021-2023)” with special funds allocated by the Treasury. A sum of Rs 35 million was initially approved for the three-year period. During the year; documentation for hiring technical assistance was initiated, approximately 90% works related to the sourcing and designing works of 8 units of 2 prototypes were continued, Documentation for the procurement of plucking machines / trimmers in progress and finalization of the protype with the ACCIMT Pvt. Ltd. and OPTIMUS Pvt Ltd., continued and the purchase of harvesters for field testing also completed.

Establishment of Tea Seed Gardens to Increase the Production of Improved Seeds as a Source of Planting Materials in Drought Prone Areas (GL 390)

A new project was commenced on "Establishment of tea seed gardens to increase the production of improved seeds as a source of planting materials in drought prone areas" with special funds allocated by the Treasury. A sum of Rs 11.6 million was approved for the period of five-year.

The objective of the project is to establish new seed gardens to cater the increasing demand for improved seeds adapting to drought conditions in coming decades. TRI has identified that it is necessary to expand seed gardens to Uva and Mid-country regions which are more vulnerable to drought effects in the future.

Propagation of nursery plants continued in 04 sites, 10 new seed gardens have been established and MoUs for establishment of 09 gardens signed with TSHDA and RPCs. Furthermore, maintenance activities continued at 09 gardens established in Wilpita Estate, Akuressa, Homadola Estate, Udugama, TSHDA, Hanthana, Endana Estate, Kahawatta, Vogan Estate, Matugama and Lelwala Estate, Wanduramba and TSHDA sites at Welimada, Hali-Ela and Passara continued during the year.

Development and Applications of Bio-Pesticides to Manage Major Disease and Insect Pests

Development and promotion of use of biopesticides in integrated pest and disease management has been targeted to address the issues in relation to over-use of synthetic pesticides and to align with policy on transforming Sri Lanka's economy into a green socio-economy with sustainable solutions to climate change. With the objective of commercializing biopesticides for tea, three *Trichoderma* and *Pseudomonas* based biocontrol agents and *Beauveria* and *Metarhizium* based entomopathogens were developed and mass multiplied to manage diseases and insect pests, respectively. Renovation and rearrangement of a bioprocessing laboratory has been carried out with Treasury funding. A patent application (No.21988) was filed for *Trichoderma* based biopesticide.

During the year 2022, procurement of bioreactor with accessories and utilities completed and installed. Refurbishing of the bio pesticide laboratory completed and pilot plant for microbial processing was formally opened for its activities. In collaboration with NERDC initiated a mini-project for fabrication of "Mixer" and works continued..

Optimized procedure for of mass multiplication of *Beauvaria* sp. & *Metarhizium* is being continued and a pot-trial to evaluate bio efficacy of *Beauvaria* sp. against white grubs was completed. *Trichoderma* and *Pseudomonas* bio pesticides were produced for experiments using lab facilities. Establishing and monitoring field experiments for entomopathogenic fungi to cover wet and dry season; Mid-country dry zone and establishing trials to test effect of application of bio control agent/entamo-pathogenic fungi to planting holes were continued.

STUDY PROGRAMMES

Overseas

Mr. S Raguraj and Ms. R K Amali, Research Officers continued their post graduate studies leading to PhDs at the University of Puthra, Malaysia through SLCARP funds commenced effectively 09th September 2019.

Mr. M Niranjan, Research Officer, Plant Pathology Division TRI commenced his PhD study programme at the Graduate School of Environmental and Life Sciences, Okayama University, Japan effective from 01st October 2021 (Awarded MEXT scholarship) titled "Identification of disease resistance locus in plants using genome analysis technology and utilizing them in plant breeding programs"

Mr. A L R U Kumara, Advisory Officer, Advisory and Extension Division TRI was granted full paid study leave for his PhD studies at Sekolah Pengajian Siswazah School of Graduate Studies, University of Putra, Malaysia. The study commenced on 13th November 2021 from the SLCARP funds with the research component titled "Community development agribusiness based extension model for the sustainability of medium scale tea Estates in Sri Lanka".

Local

Mr. K K Ranaweera Research Officer, Plant Breeding Division successfully defended his postgraduate research leading to PhD on 19th September 2022 and submitted the final thesis to PGIA, University of Peradeniya.

Mr. K G J P Mahindapala, Senior Advisory Officer of Advisory and Extension Division continued his PhD study programme at the PGIA, University of Peradeniya from TRI funds.

Mr. T G N Mahinda, Senior Advisory Officer, Advisory and Extension Division TRI was granted full paid study leave (PhD level) for 3-year period with effect from 11th October 2021 to commence his post graduate studies at the PGIA, University of Peradeniya from TRI funds with the research component titled "Development of model/s to improve the efficacy of tea grower societies for technology transfer and transform farmer behavior".

Ms. M M N Damayanthi, Research Officer, Plant Physiology Division TRI continued her PhD studies at the PGIS, University of Peradeniya, Sri Lanka which was commenced effectively 01st August 2019.

ST. COOMBS ESTATE

The Estate made a profit/loss of Rs. 61 Mn for the year.

ST. JOACHIM ESTATE

The Estate made a profit/ loss of Rs. 47 Mn for the year.

I thank the Chairman and the Board of Management for their continuous support, advice and guidance extended to me during the year to carry out my duties. My great appreciation to TRI staff for extending their fullest cooperation to achieve the goals set in the strategic plan.

Dr. L S K Hettiarachchi
Director/Chief Executive Officer
Tea Research Institute of Sri Lanka

TRI STAFF MEMBERS 2022

DIRECTORATE

Director / CEO
Dr. L S K Hettiarachchi, BSc (Peradeniya, Sri Lanka) PhD (Aberdeen, UK) – (Up to December 2022)

Acting Additional Director / Deputy Director Research (Production)
Dr. K M Mohotti, BSc Agric (Peradeniya, Sri Lanka) PhD (Reading, UK) FBiol (Sri Lanka) C Biol (Sri Lanka)

Deputy Director Research (Process Technology)
Vacant

Deputy Director (Extension)
Vacant

Deputy Director (Administration)
Capt. (Rtd) D S M Vithanage, BA in Defense Studies (KDU, Sri Lanka) MPM (SLIDA, Sri Lanka), PDSM, Dip in Mkt (SL), MISSM

Senior Accountant
S R Wickramasinghe, BSc (Sp) Accountancy and Finance Management (Sri Jayewardenapura, Sri Lanka), MBA in Finance (Colombo, Sri Lanka) ICASL - Final II (From March 2022)

Personal Assistant to Director
W A K R Lakmali, BCom (Sp) Entrepreneurship (Kelaniya, Sri Lanka)

Stenographer / English
D Ratnayake

Management Assistant
R J Rayappan (Clerical)
H M B S Gunasinghe (Station)

General Worker
P Selvaraj
S Jhon Patrick
A Ambiga

ADVISORY AND EXTENSION DIVISION

Head of Division

Dr. V S Sidhakaran, BSc Agric (Peradeniya, Sri Lanka) MSc (PGIA Peradeniya, Sri Lanka) PhD (TNAU, India)

Senior Advisory Officer

K G J P Mahindapala B Sc Agric. (Peradeniya, Sri Lanka) M Sc (PGIA Peradeniya, Sri Lanka) PG. Dip. (Applied Statistics) TRI Low-Country Research, Advisory and Extension Centre, Ratnapura

T G N Mahinda, B Sc Agric. (Peradeniya, Sri Lanka) MSc (PGIA Peradeniya, Sri Lanka) TRI Low Country Research, Advisory and Extension Centre, Ratnapura

S P Ratnayake, B Sc Agric. (Ruhuna, Sri Lanka) MBA (WHUT, China) – up to October 2022

Dr.C J Liyanarachchi, BSc Agric. (Wayamba, Sri Lanka) M Sc (PGIA Peradeniya,Sri Lanka) PhD, (Los Banos, Philippines)

M A H Nishanthi, B Sc Agric. (Peradeniya, Sri Lanka) M Sc(PGIA Peradeniya, Sri Lanka)

Advisory Officer

K R W B Kahandawa, B Sc Agric. (Peradeniya, Sri Lanka) M Sc (PGIA Peradeniya, Sri Lanka) Officer-in-Charge, TRI Mid-Country Research, Advisory and Extension Centre, Hantane

A L R U Kumara, B Sc Agric. (Peradeniya, Sri Lanka) M Sc (PGIA Peradeniya, Sri Lanka)

P K R C E Munasinghe, B Sc Agric. (Wayamba, Sri Lanka) MPhill (PGIA) Head, TRI Advisory and Extension Centre, Deniyaya

H I G S Piyaruwan, BSc Agric in Soil Science (Ruhuna, Sri Lanka) – up to Jan 2022

A R M A M Rathnayake, BSc Engineering in Food and Biochemical Engineering (Moratuwa, Sri Lanka) – up to Dec 2022

Extension Officer

H Jayaweera, MBA (AeU, Malayasia) Officer-in-Charge, TRI Advisory and Extension Centre, Matugama

A Abeysooriya, BSc Agric (Peradeniya, Sri Lanka) Officer-in-Charge, TRI Advisory and Extension Centre, Passara

S P A P K Jayarathne, BSc Agric (Peradeniya, Sri Lanka) TRI Low Country Research, Advisory and Extension Centre, Ratnapura

P D De Alwis, BSc Agric (Ruhuna, Sri Lanka) Officer-in-Charge, TRI Advisory and Extension Centre, Kottawa

G S Pradeep, BSc Agric (Rajarata, Sri Lanka) MSc (PGIA Peradeniya, Sri Lanka)

K G N M Gamage, BSc in Tea Technology and Value Addition (Uva Wellassa, Sri Lanka) - TRI Advisory and Extension Centre, Passara

R Muralithasan, BSc Agric (Jaffna, Sri Lanka), MSc (PGIA Peradeniya, Sri Lanka)

K A M Premamali, BSc Agricultural Science and Management (Sabaragamuwa, Sri Lanka)- TRI Advisory and Extension Centre, Kottawa

H E M U C S Ekanayake, BSc Agricultural Technology and Management (Peradeniya, Sri Lanka) -TRI Mid-Country Research, Advisory and Extension Centre, Hantane
K G L Koswaththa, BSc Agricultural Science and Management (Sabaragamuwa, Sri Lanka)
H B Tharangika, BSc in Food Production and Technology (Wayamba, Sri Lanka) - TRI Advisory and Extension Centre, Deniyaya
J K A D Kalhari, BSc Agric (Rajarata, Sri Lanka) - TRI Advisory and Extension Centre, Matugama
K G M J W Gunapala, BSc Agric (Rajarata, Sri Lanka) - TRI Mid-Country Research, Advisory and Extension Centre, Hantane
P Weththasinghe, BSc Agricultural Resource Management and Technology (Ruhuna, Sri Lanka) - TRI Advisory and Extension Centre, Kottawa - (From December 2022)

Technical Officer (Audio Visual)
N S Ekanayake (Up to December 2022)

Management Assistant (Clerical)
A M E T Attanayake

General Worker
B Manonmany
K Gnanasoundary

AGRICULTURAL ECONOMICS DIVISION

Head of Division
Dr. H W Shyamalie, BSc Agric (Peradeniya, Sri Lanka) MSc (PGIA Peradeniya, Sri Lanka) PhD (CSKHPKV, India)

Senior Research Officer
Dr. H M C G Pilapitiya, BSc Agric (Ruhuna, Sri Lanka) MSc (PGIA Peradeniya, Sri Lanka) PhD (SAGA, Japan)

Experimental Officer
K W N Nadeeshani, BSc (Peradeniya, Sri Lanka) MSc (PGIS Peradeniya, Sri Lanka)

Technical Officer (Research and Development)
R M A T Rathnayake, Higher National Diploma in Agricultural Production Technology (Sri Lanka School of Agriculture, Kundasale)

General Worker
P D S S De Silva

AGRONOMY DIVISION

Head of Division

Dr. M A Wijeratne, BSc Agric (Ruhuna, Sri Lanka) PhD (London, UK) Head, TRI Low - Country Research, Advisory and Extension Centre, Ratnapura

Principal Research Officer

Dr. N P S N Bandara, BSc Agric (Peradeniya, Sri Lanka) PhD (Adelaide, Australia), TRI Low-Country Research, Advisory and Extension Centre, Ratnapura

Senior Research Officer

Dr. S R W Pathiranage, BSc Agric (Ruhuna, Sri Lanka) MSc (PGIA Peradeniya, Sri Lanka) PhD (PGIA, Peradeniya) TRI Low Country Research, Advisory and Extension Centre, Ratnapura

Research Officer

L A S P Jayasinghe, BSc Agric (Wayamba, Sri Lanka) MSc (PGIA Peradeniya, Sri Lanka)

Experimental Officer

M G S Liyanage, BSc Agric (Peradeniya, Sri Lanka) MSc (PGIA Peradeniya, Sri Lanka)
S N Wijesekara, TRI Mid-Country Research, Advisory and Extension Centre, Hantane
E W T P Premathunga, TRI Low-Country Research, Advisory and Extension Centre, Ratnapura

Technical Officer (Research and Development)

E M G P B Ekanayake, Higher National Diploma in Agricultural Production Technology (Sri Lanka School of Agriculture, Kundasale)
R B L Hemakumara, Higher National Diploma in Agricultural Production Technology (Sri Lanka School of Agriculture, Kundasale) TRI Low Country Research, Advisory and Extension Centre, Ratnapura (From March 2022)
M T S Sewwandi Perera, Higher National Diploma in Technology (Agriculture) (SLITA)
U K R Kumari, Higher National Diploma in Technology (Agriculture) (SLITA)
B L D S M Fernando, National Diploma in Engineering Science (NDES), Institute of Engineering Technology (Electrical - Electronics and Communication)
T G O N Gunawardhane, Higher National Diploma in Agricultural Production Technology (Sri Lanka School of Agriculture, Gampaha) TRI Low Country Research, Advisory and Extension Centre, Ratnapura (From March 2022)

General Worker

N Sivasubramaniam
R Ganeshan

BIOCHEMISTRY DIVISION

Head (Attending Duties)/ Principal Research Officer
Dr. K G N P Piyasena, BSc (Sp) Chemistry (Peradeniya, Sri Lanka), MPhil (PGIS Peradeniya, Sri Lanka) PhD (PGIS Peradeniya, Sri Lanka)

Technical Officer (Research and Development)
E N U Edirisinghe, National Diploma in Agriculture (Technical College, Kuliyapitiya) BSc in Plantation Management (Wayamba, Sri Lanka)
A A B Abeyrathne, BSc in Food Science and Technology (Peradeniya, Sri Lanka)
W S Jayasinghe, BSc in Tea Technology and Value Addition (Uva Wellassa, Sri Lanka)
S M J U Bandara, BSc in Export Agriculture (Uva Wellassa, Sri Lanka)
P A M Jayawardana, BSc Agric. in Food and Postharvest Technology (Rajarata, Sri Lanka)
J Jeyandran, B Sc in Tea Technology and Value Addition (Uva Wellassa, Sri Lanka)

General Worker
A Mahendran
G Selavaraj (Up to Dec 2022)
S Rajendran

ENTOMOLOGY AND NEMATOLOGY DIVISION

Head – (Attending Duties)/ Senior Research Officer
Dr. R D P D Senanayake, BSc Agric (Peradeniya, Sri Lanka) MSc (PGIS Peradeniya, Sri Lanka), PhD (Kelaniya, Sri Lanka)

Senior Research Officer
Dr P G D S Amarasena, BSc Agric (Peradeniya, Sri Lanka) MSc (PGIA Peradeniya, Sri Lanka) PhD (PGIA Peradeniya, Sri Lanka)

Research Officer
A M P Sammani, BSc Agric (Rajarata, Sri Lanka)

Experimental Officer
B S N Vithana, National Diploma in Technology (Agric) (HARDI, Ampara) TRI Low-Country Research, Advisory and Extension Centre, Ratnapura
U B Herath, TRI Mid-Country Research, Advisory and Extension Centre, Hantane
P K Jayawickrama, Soils and Plant Nutrition Laboratory Complex, Walahanduwa

Technical Officer (Research and Development)
B M G K Godavita, BSc in Tea Technology and Value Addition (Uva Wellassa, Sri Lanka), TRI Low-Country Research, Advisory and Extension Centre, Ratnapura
B Jananey, BSc in Food Production and Technology (Wayamba, Sri Lanka)
N A I M Nissanka, BSc in Biological Science (OUSL)
L R U L Senavirathna, BSc (Sp) in Zoology (Kelaniya, Sri Lanka)

G K W H Dharmadasa, Higher National Diploma in Agricultural Production Technology (Sri Lanka School of Agriculture, Kundasale)
P A D S Sumathipala, Higher National Diploma in Agricultural Production Technology (Sri Lanka School of Agriculture, Kundasale)
S P R Wijewardhana, Higher National Diploma in Agriculture (Advanced Technological Institute, Gampaha)
M K D Damayanthi, Higher National Diploma in Agricultural Production Technology (Sri Lanka School of Agriculture, Angunakolapelessa) TRI Low-Country Research, Advisory and Extension Centre, Ratnapura (From December 2022)

General Worker
S Hettiarachchi – (Up to December 2022)
V Sabarathnam
R Gunasiri
L A R Priyanjali

PLANT BREEDING DIVISION

Head of Division
Dr. M A B Ranatunga, BSc Agric (Peradeniya, Sri Lanka) MSc (TNAU, India) PhD (Peradeniya, Sri Lanka)

Senior Research Officer
Dr. J H N Piyasundara, BSc in Natural Science (OUSL) M Phil (Peradeniya, Sri Lanka)
PhD (PGIA, Peradeniya) TRI Low-Country Research, Advisory and Extension Centre, Ratnapura
Dr. J D Kottawaarachchi Senior Research Officer BSc in Natural Science (OUSL)
M Phil (Peradeniya, Sri Lanka) PhD (CSK Himachal Pradesh Krishi, Palampur)

Research Officer
K K Ranaweera, BSc Agric (Ruhuna, Sri Lanka) M Phil (Peradeniya, Sri Lanka)

Experimental Officer
A K Mudalige, Diploma in Agriculture, (Sri Lanka School of Agriculture, Labuduwa) BSc Agric (Sabaragamuwa, Sri Lanka) TRI Low Country Research, Advisory and Extension Centre, Ratnapura

Technical Officer (Research and Development)
C J Ratiyalage, Higher National Diploma in Technology (Agric) (Advanced Technological Institute, Labuduwa) BIS in Agricultural and Plantation Engineering (OUSL) MSc (Peradeniya, Sri Lanka)
H W M M M Jayarathne, Higher National Diploma in Agriculture (Advanced Technological Institute, Gampaha) TRI Mid-Country Research, Advisory and Extension Centre, Hantane (From December 2022)

G D N N Dayarathna, BSc in Botany (Peradeniya, Sri Lanka)
J M K Udayangani, Higher National Diploma in Agriculture (Advanced Technological Institute, Gampaha)

General Worker
B K Jayanthi
K Vishvanathan
S Jegadesan

PLANT PATHOLOGY DIVISION

Head of Division
Dr. G D Sinniah, BSc (Eastern, Sri Lanka) PhD (PGIS Peradeniya, Sri Lanka)
Senior Research Officer
M Niranjan, BSc (Peradeniya, Sri Lanka) MSc (Kelaniya, Sri Lanka)

Experimental Officer
D G N P Karunajeewa, National Diploma in Agriculture (Technical College, Dambulla), BIS in Agriculture (OUSL)

Technical Officer (Research and Development)
R P V T Chandralal, B Sc in Tea Technology and Value Addition (Uva Wellassa, Sri Lanka)
K L S C Gunawardana, BSc in Botany (South Eastern, Sri Lanka)

General Worker
R P Perera

PLANT PHYSIOLOGY DIVISION

Head (Attending Duties) / Principal Research Officer
Dr. T L Wijeratne, BSc Agric. (Peradeniya, Sri Lanka) MSc (Peradeniya, Sri Lanka) PhD (Peradeniya, Sri Lanka)

Research Officer
D M S Navaratne, BSc (Peradeniya, Sri Lanka) MPhil (Peradeniya, Sri Lanka)
M M N Damayanthi, BSc Agric. (Peradeniya, Sri Lanka) MPhil (Peradeniya, Sri Lanka)

Experimental Officer
V Sidhakaran

Technical Officer (Research and Development)
A D I U Jayawardana, BSc in Tea Technology and Value Addition (Uva Wellassa, Sri Lanka)
N M Vithanage, Higher National Diploma in Agriculture (Advanced Technological Institute, Gampaha)

General Worker
R Puwaneshwaran
R Velmurugan

PROCESS TECHNOLOGY DIVISION

Head of Division
Dr. K Raveendran, BSc in Chemical Engineering (Moratuwa, Sri Lanka), M Eng in Energy Technology (AIT, Thailand), PhD in Chemical and Process Engineering (Moratuwa, Sri Lanka)

Senior Research Officer
Vacant

Research Officer
M A Chamindra, BSc in Plantation Management (Wayamba, Sri Lanka) MSc (PGIA Peradeniya, Sri Lanka) TRI Low-Country Research, Advisory and Extension Centre, Ratnapura
W M S Weerawardena, BSc in Chemical Engineering (Peradeniya, Sri Lanka) Post Graduate Diploma in Energy Technology, (Moratuwa, Sri Lanka) MPhil (PGIA, Peradeniya)

Experimental Officer
L Jayasinghe

Technical Officer (Research and Development)
U G D P Ranathunga, National Diploma in Technology (Chemical Engineering Technology), (Moratuwa, Sri Lanka)
E P D N M Wijewardhana, National Diploma in Technology in Electrical Engineering Technology (Moratuwa, Sri Lanka)
Mr K A C L Kodithuwakku, Higher National Diploma in Agricultural Production Technology (Sri Lanka School of Agriculture, Karapincha) TRI Low-Country Research, Advisory and Extension Centre, Ratnapura (From May 2022)
W M I Sathsarani, BSc in Tea Technology and Value Addition (Uva Wellassa, Sri Lanka) TRI Low-Country Research, Advisory and Extension Centre, Ratnapura (From December 2022)

General Worker
S Shasikumar
M Mohanraj

MECHANICAL WORK SHOP

General Mechanic
N A Bowie, TRI Low-Country Research, Advisory and Extension Centre, Ratnapura
V Sivakumaran

General Worker
K Rajalingam

SOILS AND PLANT NUTRITION DIVISION

Head of Division /Senior Research Officer
Dr. L R M C Liyanage, BSc Agric (Peradeniya, Sri Lanka) MPhill (Peradeniya, Sri Lanka) PhD (UPM, Malaysia)

Research Officer
W M S Wijayatunge, BSc (Peradeniya, Sri Lanka) MSc (PGIS Peradeniya, Sri Lanka) TRI Mid-Country Research, Advisory and Extension Centre, Hantane - (Up to December 2022)
S Raguraj, BSc Agric (Jaffna, Sri Lanka) MSc (PGIA Peradeniya, Sri Lanka)
R K A Amali, BSc (Sp) Chemistry (Sri Jayewardenepura, Sri Lanka) MSc (Colombo, Sri Lanka)

Experimental Officer
Dr. P L K Tennakoon, BSc Agric (Peradeniya, Sri Lanka) MSc (Dharwad, India) PhD (Peradeniya, Sri Lanka) TRI Mid-Country Research, Advisory and Extension Centre, Hantane
W T B D Priyantha, BSc (Sri Jayewardenepura, Sri Lanka) Soils and Plant Nutrition Laboratory Complex, Walahanduwa – (Up to December 2022)
J R Y Abeywardane, Soils and Plant Nutrition Laboratory Complex, Walahanduwa
P K Jayawickrama, Soils and Plant Nutrition Laboratory Complex, Walahanduwa - (Up to December 2022)
O G K A Gunaratne, Diploma in Agriculture (Sri Lanka School of Agriculture, Kundasale) Advanced Certificate Programme in Laboratory Technology (OUSL) TRI Low-Country Research, Advisory and Extension Centre, Ratnapura

Technical Officer (Research and Development)
S K Weerathunga, Higher National Diploma in Technology (Agric) (Advanced Technological Institute, Galle) BIS Hons (OUSL)
S P S K Wijesinghe, BSc Agric (Rajarata, Sri Lanka)
M G K Madushani, BSc (Sri Jayewardanapure, Sri Lanka)
N C Weerakoon, Diploma in Agriculture (Sri Lanka School of Agriculture, Kundasale) BSc in Plantation Management (Wayamba, Sri Lanka) - (From December 2022)
B M T T K Seanarathne, Higher National Diploma in Agricultural Production Technology (Sri Lanka School of Agriculture, Kundasale)
B V R Sanali, Higher National Diploma in Agricultural Production Technology (Sri Lanka School of Agriculture, Angunakolapelessa)
R M N S Bandara, Higher National Diploma in Agricultural Production Technology (Sri Lanka School of Agriculture, Angunakolapelessa)
D N Kahawewithana, BSc (Colombo, Sri Lanka) (From May 2022)
D R Gamage, BSc General (Sri Jayewardanapure, Sri Lanka) TRI Mid-Country Research, Advisory and Extension Centre, Hantane (From December 2022)

General Worker
D Silvester
V Rathakrishnan
S Parameswaran

SOILS AND PLANT NUTRITION LABORATORY, WALAHADUWA

Management Assistant (Clerical)
R Kulathunga

Driver
W K J Samarasekara
General Worker
K P L U Pathiranage

INFORMATION AND COMMUNICATION TECHNOLOGY UNIT

Network Administrator (Attending Duties) /Experimental Officer
U D Alagiyawadu, Higher Diploma in Information Technology (Colombo, Sri Lanka)

Technical Officer (Research and Development)
W M M S H Paranayapa, Higher National Diploma in Technology (Agriculture) (SLITA)

General Worker
T Kogilan

LIBRARY

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

General Worker
S Parameswary

PHOTOGRAPHY UNIT

Photographer
K G R Niroshan, Diploma in Photography (The National Photographic Art Society, Sri Lanka)

PUBLICATIONS AND PUBLICITY UNIT

Publications and Publicity Officer
W H T C Silva, BBM in Entrepreneurship and Management (Uva Wellassa, Sri Lanka) MDS (FGS, Colombo, Sir Lanka) Diploma in Graphic Design (Esoft Metro Campus, Sri Lanka)

Management Assistant (Clerical)
I A G N Attanayaka, Diploma in Computer Studies (IDM, Sri Lanka)

General Worker
A Krishnamenan
P Sivapalan

TECHNOLOGY TRANSFER OFFICE

Manager
Dr. M A B Ranatunga, BSc Agric (Peradeniya, Sri Lanka) MSc (TNAU, India) PhD (Peradeniya, Sri Lanka) Head, Plant Breeding Division

TTO Assistant
A R M A M Rathnayake, BSc Engineering in Food and Biochemical Engineering (Moratuwa, Sri Lanka) Advisory Officer, Advisory and Extension Division -up to Dec 2022

ADMINISTRATION DIVISION

Senior Administrative Officer
K P K A Sewwandi, BSc in Business Administration (Sp) Business Economics (Sri Jayewardenepura, Sri Lanka), Intermediate (ICASL)

Administrative Officer (Admin)
N D M Karunadasa, BBM (Sp) Marketing, (Kelaniya, Sri Lanka), MA (Economics) (Kelaniya, Sri Lanka)

Administrative Officer (Human Resource Development)
S H S Chandrachapa, BBM (Sp) HRM (Kelaniya, Sri Lanka) Higher Diploma in Computer Science (Infortec International, Sri Lanka) Diploma in Counseling Psychology (Mental Health Foundation, Sri Lanka)

Public Relations / Welfare Officer
G S Ariyarathna, BSc in Health Promotion (Rajarata, Sri Lanka)

Management Assistant (Clerical)
K R M Priyantha
C Jayaram
R A C Lasantha
W M M I K Wijesinghe

General Worker
N Pushparaj (Up to December 2022)
A Dhiwyakumar
V Jasinthamery
M B W Samanthika
S Rejinamery
A Selvanayagam
N Sridevi

ELECTRICAL UNIT

Engineering Assistant (Electrical)
S H P Dayaratne, Higher National Diploma in Engineering (HNDE) (Institute of Advance Technological Education, Sri Lanka) - (From March 2022)

Electrician
General Worker
K Jayarathnam (Up to December 2022)
M B Mariyadas
R R Sagayam
P Thirumurugan
P Madialagan

ENGINEERING DIVISION

Resident Engineer (Attending Duties) / Engineering Assistant (Civil)
C J B Abeykoon, National Certificate in Technology (Technical College, Kegalle), National Certificate in Draughtsmanship (Technical College, Kandy) Diploma in Advanced Constructions Management (CIDA, Sri Lanka)

Technological Officer (Civil)
S T M S N Tennakoon, National Certificate for Industrial Technicians (Civil Engineering) (Collage of Technology, Kandy)

Management Assistant
I W M N Kumara, (Clerical)
General Worker
B K Jayasinghe
D A Wimalasiri
S Balakrishnan (Up to December 2022)
S Thangaraj (Up to December 2022)
R Pakiyanathan
P Weeramuttu (Up to December 2022)
M Peiris
P Sarawanaraj
P Kalimuttu
S Sabapathi
S Sylvester
S M Kenady
G Kanagaraj
M Irudayaraj
G Jayapragasam
R Ravi
A Augusteen
P Letchumar
S Christopher
S Muthukumar (Up to December 2022)
P Vijayakumaran
D A Sirishantha
L Vigneshwaran
T Balakrishnan

GUEST HOUSES/ CIRCUIT BUNGALOWS/ HOSTELS

Guest House Keeper
G Weerapperuma, Talawakelle
P Parthiban (NVQ 3)
J Naasaran (NVQ 3)

General Worker
G K G Dhanushka
T Pushparaj
M Vivakanandan
R Sekar
T Selvendran

PROCUREMENT UNIT

Procurement Officer
R M N Nayanajith, BCom (Sri Jayewardenepura, Sri Lanka)

Management Assistant
P P H Wijesena (Clerical)

General Worker
K Balakrishnan
K Balendran

TELEPHONE EXCHANGE

Telephone Operator cum Receptionist
M P Karunarathna

General Worker
P Vythilingam Pillai
D Gabriel

TRANSPORT UNIT

Engineering Assistant (Mechanical)
D T Gunawardane National Diploma in Engineering Science (NDES), Institute of Engineering Technology

Management Assistant (Station)
S S Kumari

Driver
R M N Premathilaka
K B V U N Gunasena
G G M Ranasinghe
S P D Tharanga
T K A Kumarasinghe
W D Wijesooriya
P D D Perera
A P G A Anwarama
C P Karunanayaka
D Rathnakumar
N Pratheepan
G G J J Galahitiyawa

R Dineshkumar
A J M A Jayasekara
W M D N Wijesinghe
General Worker
W M S J Weerasinghe (Up to December 2022)
S L Joseph
M Thasarathan
A Muniswaran

MOTOR GARAGE

Motor Mechanic
A P G I H Anwarama (NVQ 4)

General Worker
V Krishnamoorthy
Mohanaselvam

FINANCE DIVISION

Accountant
M V Mohan, (APFASL)
W M T B Weerasekara, (APFASL)

Accounting Officer
W A Nishantha
M S K R Jayalath, B B M (Sp) HRM (Kelaniya, Sri Lanka), Intermediate (ICASL)

Stores
Vacant

Management Assistant
A A A P Amarathunga, (Accounting)
R M N M Ariyarathna, (Accounting)
D S C Weerasuriya, (Accounting)
H P P Sanjeewa, (Accounting)
H M C P K Jayathilaka, (Clerical)
G A D Gallage, (Clerical)
I G N D Bandara, (Data Entry)
J A P S Jayasinghe, (Cashier)
S D K Nadeeshani (Clerical)

General Worker
G S Raju

P K Sarath
K Jegatheshwaran
P Muthukumar
S N N Samanthika
S Rajanayagam

INTERNAL AUDIT UNIT

Internal Auditor
B R P H Karunathilake, BSc (Sp) in Finance, (Sri Jayewardenapura, Sri Lanka)

Internal Audit Officer
I G N C Jayaweera, AAT Final (Association of Accounting Technicians Sri Lanka)

Management Assistant (Accounting)
D M R L Disanayake

General Worker
R Manoharan

TRI LOW- COUNTRY RESEARCH, ADVISORY AND EXTENSION CENTRE, RATNAPURA

Head
Dr. M A Wijeratne, BSc Agric (Ruhuna, Sri Lanka) PhD (London, UK)

Administrative Officer (Admin)
B M B Basnagoda, BA (Sp) Mass Media (Colombo, Sri Lanka)

Technological Officer (Civil)
K Gunawardena

Management Assistant
K A S Piyatilaka, (Clerical)
K A D S Pradeep, (Accounting)

Electrician
J M G W Jayaweera, National Certificate of Technology – Electrical and Electronics Engineering (Technical Collage, Badulla) – (From March 2022)

Plumber Mechanic

Guest House Keeper
M D Sarath

Driver
P D R De Silva
S M C M Senanayaka
G V S Jayalath
J T S Weerakkody
K M T T Bandara

General Worker
A K J Athukorala – (up to November 2022)
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 T Karunarathne
K A Karunathilake
M Parwathi
K P N Darmadasa
S Manikkavasagam
M Maheswaran
S Selwendran
G K Priyantha
G G Chandrakeerthi (Up to December 2022)
S Sureshkumar
C Sanjeevakumara
G A M Maduranga
P U A Pathirana
R M C P Dias
G T G J Perera
N Pushparaj
P S Shiwashaktikumara
V Rishandran

TRI MID - COUNTRY RESEARCH, ADVISORY AND EXTENSION CENTRE, HANTANE

Officer-in-Charge/ Advisory Officer
K R W B Kahandawa, BSc Agric (Peradeniya, Sri Lanka) MSc (PGIA Peradeniya, Sri Lanka)

Management Assistant
R M D K Rathnayake (Clerical)

Electrician
J M R K Bandara

Guest House Keeper
W M A Weerawanni

Driver
G Padmasiri
M G B S Priyashantha
U K A B Uduwella
W A D P M U Attanayake

General Worker
R M J B Ratnayake
W R G N D Wickramasinghe
A D G S Premarathne

TRI ADVISORY AND EXTENSION CENTRE, DENIYAYA

Head/ Advisory Officer
P K R C E Munasinghe, BSc Agric. (Wayamba, Sri Lanka) MSc (PGIA, Peradeniya, Sri Lanka)

Management Assistant (Station)

Driver
M D Chandana

Guest House Keeper
R G Shiran (NVQ 3)

TRI ADVISORY AND EXTENSION CENTRE, KOTTAWA

Officer-in-Charge/Extension Officer
P D De Alwis, BSc Agric. (Ruhuna, Sri Lanka)

Management Assistant (Station)
Y C N Gunarathne
W S T Wijesinghe – (From August 2022)

Field Supervisor
P S Kulasiri (Up to December 2022)

Guest House Keeper
K M Jagath Prasanna

Driver
K W Kapila Chaminda
General Worker
D G Chandralal
W Gamini

TRI ADVISORY AND EXTENSION CENTRE, MATUGAMA

Officer-in-Charge/ Extension Officer
H Jayaweera, MBA (AeU, Malayasia)

Management Assistant (Clerical)
A A H Chinthaka
T C Samanmali

Driver
S A C Suraweera

General Worker
G A A N Gurusinghe
M Wijethilake
G D K Lakmini

TRI ADVISORY AND EXTENSION CENTRE, PASSARA

Officer-in-Charge/ Extension Officer
A Abeysooriya, BSc Agric (Peradeniya, Sri Lanka)

Driver
K M T Senevirathna

Guest House Keeper
M Ramasamy (NVQ 3)

General Worker
R H C Nisansala, National Diploma in Plantation Management, NIPM
S M P Ramyalatha
R W S C Kumara
S M Chularathne

RESEARCH HIGHLIGHTS

CROP IMPROVEMENT

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

Towards meeting the objectives of the TRI Corporate Plan, the following activities were carried out under the applied research theme of "Breeding for Crop Improvement" and the progress of each project are reported under relevant thrust and project.

The main focus of thrust A1, A 2, A 3, and A 4 was on incorporating desirable attributes, which is not present in the existing high yielding cultivars to increase the grower acceptability. It is also intended to implement an agro-ecology based cultivar recommendation to facilitate growers to choose best possible cultivars for their specific localities more confidently. Thrust A 5 was focused on developing improved seeds as an alternative planting material targeting resource limited growing areas. The focus of the thrust A 51 was to characterize and utilize germplasm for crop improvement. Thrust A 52 was focused on development of tea cultivars specifically suitable for small growers who cannot afford to use high input or modern agricultural practices.

Thrust A 1. Development of high yielding tea cultivars suitable for three agro-ecological regions in the Up-Country with high quality, resistance to blister blight, shot-hole borer, nematodes, *Poria* and collar canker (*Phomopsis*)

Project A 1.1. Developing suitable cultivars through hybridization, non-conventional breeding methods and selection

Controlled Hybridization Programme

2022 Programme

Controlled hybridization was performed using Gamma irradiated pollens of TRI 2043. Total 499 crosses (399 using irradiated pollen and 100 with untreated pollen) have been carried out during the period. However, all crosses made with irradiated pollen aborted by end of July, 2022 and success of pollination carried out with untreated pollen was also very low due to the low percentage germination. The sucrose test was conducted to determination of germination percentages of pollen.

Details of the crosses are given in Table 1.

Table 1. Details of Crosses - Hybridization Programme 2022

Parental Combinations	No. of crosses	No of successful crosses
Crosses made with irradiated pollen		
A: PBGT 41 x TRI 2043	278	0
B: PBGT 49 x TRI 2043	67	0
C: PBGT 48 x TRI 2043	54	0
Controls		
PBGT 41 x TRI 2043	87	9
PBGT 49 x TRI 2043	10	0
PBGT 48 x TRI 2043	3	1

2021 Programme

Controlled hybridization was performed using Gamma irradiated pollens of TRI 2043 cultivar and 144 crosses carried out. All crosses made with irradiated pollen aborted prematurely.

2020 Programme

Hybridization programme of 2020 could not be performed due to low germination percentage (<12%) of pollen due to the dry weather prevailed during the peak flowering period (January to March).

2019 Programme (Backcross Breeding)

Bringing into bearing operations continued with 88 hybrid seedlings generated from 2019 programme, planted in field No. 9, St. Coombs Estate.

2018 Programme (Backcross Breeding)
1st Cycle harvesting at weekly intervals continued.

2017 Programme
1st Cycle harvesting at weekly intervals continued.

2016 Programme
1st Cycle harvesting at weekly intervals continued.

Hybrid plants of 2014 and 2015 Programme
1st Cycle harvesting at weekly intervals continued.

Hybrid plants of 2012 and 2013 Programme
2nd Cycle harvesting at weekly intervals continued.

Hybrid plants of 2004, 2005, 2006, 2007 and 2008 Programme
Harvesting at weekly intervals and monitoring operations continued. Selected accessions are being evaluated in Phase I trials at TRI regional centers, Hantane, Passara and Ratnapura (See Projects A 2.1, A 3.1 and A 4.1 for more details).

MAB Ranatunga, JD Kottawa-Arachchi, KK Ranaweera, CJ Ratiyalage, HWMMM Jayarathne, N N Dayarathne and J M K Udayangani

Evaluation of accessions in Phase I and II trials
Details of the Phase I trials are given in Table 2.

Table 2. Details of Accessions under Evaluation in the Up-Country: Phase I - Field No. 13, St. Coombs Estate

Trial No.	Year of planting	Origin#	No. of Accessions tested	Standard cultivars	Remarks
VP 92	2011	D, E, F, G	74	TRI 3019, TRI 4052	3rd Cycle harvesting continued
VP 93	2011	H	24	TRI 2025, TRI 3072, TRI 4052, PK2	3rd Cycle harvesting continued

Table 2. Cont..,

VP 94	2015	L	119	K 136, TC 10, TRI 4071, TRI 4052, DEL 40, DUN 7, TRI 2025	2nd Cycle harvesting continued
VP 95	2016	K	88	TRI 2025, TRI 3019, TRI 4052	2nd Cycle harvesting commenced
VP 96	2020	O	84	TRI 26. TRI 2043, TRI 3055	Bringing into bearing operations continued.

Origins of accessions under evaluation

D *Hybrids 2004 Talawakelle selections* (crosses made in 2004 using cultivars TRI 777, TRI 3013, TRI 3016, TRI 3017, TRI 3019, PK 2, KEN 16/3, DT 95, MT 18, DG 7)

E *Hybrids 2005 Talawakelle selections* (crosses made in 2005 using cultivars TRI 777, TRI 3013, TRI 3016, TRI 3017, TRI 3019, PK 2, DT 95, DT 1, N2, China, Yabukita)

F *Hybrids 2002-2003 Ratnapura selections* (crosses made in 2002-2003 using cultivars TRI 3052, TRI 3055, TRI 62/9, TRI 4053, TRI 4047, TRI 4004, TRI 2043, TRI 4061, TRI 2016, KP 204, KEN 16/3, H 1/58)

G *Hybrids 2004-2007 Ratnapura selections* (crosses made in 2002-2003 using cultivars TRI 3052, TRI 3055, TRI 62/9, TRI 4053, TRI 4047, TRI 4004, TRI 2043, TRI 4061, TRI 2016, KP 204, KEN 16/3, H 1/58, S 106)

H *Old seedling selections* (Selections from Labookelle, Liddesdale, Pedro and Fairlawn Estates)

K *Hybrids 2006 Talawakelle selections* (crosses made in 2006 using cultivars ASM 4/10, TRI 2016, TRI 4078, TRI 2025, TRI 777, PK 2, B 275, MT 18, TRI 3013, DT 95, KEN 16/3, China, TRI 3019, DG 7, TRI 3016)

L *Hybrids 2007 Talawakelle selections* (crosses made in 2007 using cultivars China, Yabukita, S 106, W 14, DEL 40, C 103, TRI 62/3, PING 2/1, TRI 2077)

O *Hybrids 2013/2014 Talawakelle selections* (crosses made during 2013 and 2014 between cultivars TRI 3055 and TRI 2043)

MAB Ranatunga, JD Kottawa-Arachchi, KK Ranaweera, CJ Ratiyalage, HWMMM Jayarathne, N N Dayarathne and J M K Udayangani

Estate Cultivar Selection Programme

Fairlawn Selections (VP 93)

3rd Cycle harvesting continued.

Glenanore Selections

2nd Cycle harvesting continued at Hantane and Passara stations (See under Projects A 2.1 and A 3.1 for more details).

MAB Ranatunga, JD Kottawa-Arachchi, KK Ranaweera, CJ Ratiyalage, HWMMM Jayarathne, N N Dayarathne and J M K Udayangani

Use of radiation induced mutation in genetic improvement of tea
Funding agency: International Atomic Energy Authority (IAEA), Vienna
Total of 1636 seeds from three cultivars (TRI 2025, TRI 2043 and KEN16/3) were treated with gamma rays at different doses from 25 Gy to 150 Gy. Out of different doses, 25Gy was the most successful dose. Total of 87 treated seeds were survived and propagated in nursery bags and agronomic parameters are being monitored.

Radiation facility at the Horticulture Crop Research Institute, (HORDI) Gannoruwa has been used for the project.

MAB Ranatunga, KK Ranaweera, CJ Ratiyalage, HWMMM Jayarathne, N N Dayarathne, JMK Udayangani, Jagath Senanayake, HORDI, Gannoruwa and Shoba Sivasankar Head, Plant Breeding and Genetics Section, IAEA

Project A 1.2. Screening lines for resistant to Blister blight and *Poria* Screening of VP 96 Phase I for blister blight resistance
Screening activity of vegitatively propagated Phase I population of TRI 3055 X TRI 2043 consisting 84 accessions and TRI 2043 and TRI 3055 has been initiated. The experiment is being continued.

GD Sinniah, DGNP Karunajeewa, RPVT Chandralal, KLSC Gunawardana and Plant Breeding Division

Project A 1.3. Screening lines for resistance/ tolerance to SHB for Up-Country
Experimental plots are being maintained by the the Plant Breeding Division and assessments will depend on the availability of natural infestation of SHB at prune time.

NAIM Nissanka, PADS Sumathipala, SPR Wijewardana, MKD Damayanthi, AMP Sammani and RDPD Senanayake

Project A 1.4. Screening cultivars against *Pratylenchus loosi* for Up-Country

Experiment : N 1A (2022/2023)
Location : Nematology Experimental Area, Tea Research Institute, Talawakelle

Objectives: Screening lines for resistance/ tolerance to the root lesion (*P. loosi*) nematodes for Up-Country regions and to rate the cultivar resistance against the nematode species enabling Plant Breeder to make relevant inclusions and revisions in TRI Advisory Circulars.
Nine test cultivars (612, 626,244, 925, 743, 952, 613, 704 and 703) and five standard cultivars (DT1, DT95, TRI 4052, TRI 2025 and TRI 2024) were raised in Nematology nursery at Talawakelle for the next screening trial against *P. loosi* nematodes. For testing and screening new cultivars for the region, *P. loosi* nematode population build up is continued in the screening tanks at Talawakelle. Nematode populations were assessed in timely intervals.

PGDS Amarasena, UB Herath, BMGK Godavita, B Jananey, GKWH Dharmadasa, and LRUL Senevirathna

Thrust A 2. Development of high yielding tea cultivars suitable for agro-ecological regions in the Mid-Country Wet Zone with high quality, resistance to drought, shot-hole borer, blister blight, stem canker and nematodes.

Project A 2.1. Developing suitable cultivars through hybridization, non conventional breeding methods and selection

Evaluation of accessions/breeding lines in Phase I and II trials

Details of Phase I and Phase II trials are given in Table 3 and 4 respectively.

Table 3. Details of Accessions under Evaluation in the Mid-Country: Phase I, TRI, Hantane

Trial No.	Year of planting	Origin#	No. of Accessions tested	Standard cultivars	Remarks
MVP 13	2012	D, E, F, G	43	TRI 3019, TRI 4071	2nd Cycle harvesting continued
MVP 14	2014	I	26	DN, TRI 2025	2nd Cycle harvesting continued
MVP 15	2014	L		TC 10, DEL 40, GF 7/6, LLEF 2, TRI 62/3, TRI 2137	2nd Cycle harvesting commenced

#Origins of accessions under evaluation

D *Hybrids 2004 Talawakelle selections* (crosses made in 2004 using cultivars TRI 777, TRI 3013, TRI 3016, TRI 3017, TRI 3019, PK 2, KEN 16/3, DT 95, MT 18, DG 7)

E *Hybrids 2005 Talawakelle selections* (crosses made in 2005 using cultivars TRI 777, TRI 3013, TRI 3016, TRI 3017, TRI 3019, PK 2, DT 95, DT 1, N2, China, Yabukita)

F *Hybrids 2002-2003 Ratnapura selections* (crosses made in 2002-2003 using cultivars TRI 3052,TRI 3055, TRI 62/9, TRI 4053, TRI 4047, TRI 4004, TRI 2043, TRI 4061, TRI 2016, KP 204, KEN 16/3, H 1/58)

G *Hybrids 2004-2007 Ratnapura selections* (crosses made in 2002-2003 using cultivars TRI 3052, TRI 3055, TRI 62/9, TRI 4053, TRI 4047, TRI 4004, TRI 2043, TRI 4061, TRI 2016,

I *Old seedling selections* (Selections from Glenanore Estate)

L *Hybrids 2007 Talawakelle selections* (crosses made in 2007 using cultivars China, Yabukita, S 106, W 14, DEL 40, C 103, TRI 62/3, PING 2/1, TRI 2077)

Table 4. Details of Accessions under Evaluation in the Mid-Country: Phase II, TRI, Hantane

Trial No.	Year of planting	Origin#	No. of Accessions tested	Standard cultivars	Remarks
MVP 16	2016	A, B, C	21	TRI 3019, TRI 4006, TRI 4078	1st pruning carried out in June 2022

Origins of accessions under evaluation

Average cycle yield and pruning weights of accessions in MVP 16 is given in Table 5

Table 5. Summary of cycle yields of best ten accessions in MVP 16 trial

Cultivar/Accession	Avg. yield MT/kg/ha	Difference between means of TRI 4006	Pruning weight kg/plant
704	4148.8	976.2a	2.06
952	3963.7	791.1a	2.34
626	3648.5	475.9a	1.90
963	3628.1	455.5a	1.61
743	3583.9	411.3a	1.93
703	3549.4	376.8a	2.04
244	3528.6	356.0a	2.12
TRI 3019	3418.7	246.1a	1.80
700	3249.9	77.3a	2.80
TRI 4006	3172.6	-	1.38
LSD	1123.40	-	1.27
CV%	18.12	-	34.14

Mean values with same letters are not significantly different at $p = 0.05$

Among the tested accessions, seven accessions recorded higher cycle yield and pruning weight per plant than standard cultivar TRI 4006. Selected accessions were propagated in the nursery at TRI, Hantane for establishment of new multi-location adaptive trials in 2023.

A *VP 39 selections* (crosses made in 1980/ 1981 using clones TRI 777, TRI 2025, TRI, 2026, ASM 4/10, DT1 and DN)

B *VP 43 selections* (crosses made in 1982/ 1983 using clones TRI 777, TRI 2025, TRI 2024, TRI 2023, TRI 2043, TRI 2142, TRI 62/9, ASM 4/10, DT 1, DN, CY 9, DT 95, H 1/58, DG 39 and China types)

C *VP 44 selections* (crosses made in 1984, using clones TRI 777, TRI 2025, TRI 2142, TRI 2143, ASM 4/10, DN, CY 9, DT 1 and DG 39)

Project A 2.3. Screening lines for resistance/ tolerance to SHB for Mid-Country

Assessments at the 1st pruning were carried out to select resistant cultivars for SHB in MVP 15 and MVP 16 trials of Plant Breeding Division. Among the tested accesions in MVP 16 trial, 06 accessions were moderately resistant, 09 accessions were moderately susceptible and 06 accessions were found to be susceptible to SHB. In MVP 15 trial, 14 accesions were moderately resistant, 21 accesions were moderately susceptible while 16 accesions were susceptible to SHB.

NAIM Nissanka, PADS Sumathipala, SPR Wijewardana, MKD Damayanthi, AMP Sammani and RDPD Senanayake

Project A 2.4. Screening cultivars against *Pratylenchus loosi* and *Radopholus similis* for Mid-Country

Experiment **:** N1B (2022/2023)
Location **:** TRI Mid-Country Regional Centre, Hantane

Objectives: Screening lines for resistance/ tolerance to the root lesion (*P. loosi*) and burrowing (*R. similis*) nematodes for Mid-Country regions and to rate the cultivar resistance against the nematode species enabling Plant Breeder to make relevant inclusions and revisions in TRI Advisory Circulars.

Screening tanks were prepared for next set of cultivars and raising of nursery plants were initiated with five test cultivars (703, 704, 244, 612 and 925) and standard cultivars.

PGDS Amarasena, UB Herath, BMGK Godavita, B Jananey, GKWH Dharmadasa and LRUL Senevirathna

Project A 2.8. Screening of TRI 5000 series tea cultivars for drought under Mid-Country wet zone conditions (2013)

Objective of this study was to identify drought tolerant accessions for Mid-Country wet zone using yield and some important physiological parameters in response to drought.

The data collection has been continued at the exsiting field experiment at Field No. 2, TRI Mid-Country Regional Centre, Hantane which consisted of known cultivars (TRI 2025 and TRI 4042) and six accessions (Code Nos: 15, 62, 139, 10/1, 12/11 and 23/5).

Although the measurements were taken at different levels of soil moisture, collecting sufficient data was not possible due to malfunctioning of the instruments such as portable Infrared Gas Analyzer (IRGA), porometer and four decimal balance. Soil moisture content together with some physiological parameters such as rate of photosyntesis, rate of transpiration relative water content (RWC) and stomatal conductance were measured. Leaf samples were also collected to determine the total soluble sugar content. Yield components were measured using 0.3 x 0.3 m^2 quadrate. The average gravimetric soil moisture content varied as 19.6% 17.6%, 18.1%.18.7% and 19.0% during the five attempts of data collection. As the soil moisture levels were too close due to unfavorable weather, calculation of drought susceptibility index was not possible. No significant differences were observed in RWC (p= 0.05) among different accessions as well as between the known cultivars at average soil moisture level (18.6%) across all the attempts of data collection (Figure 1).

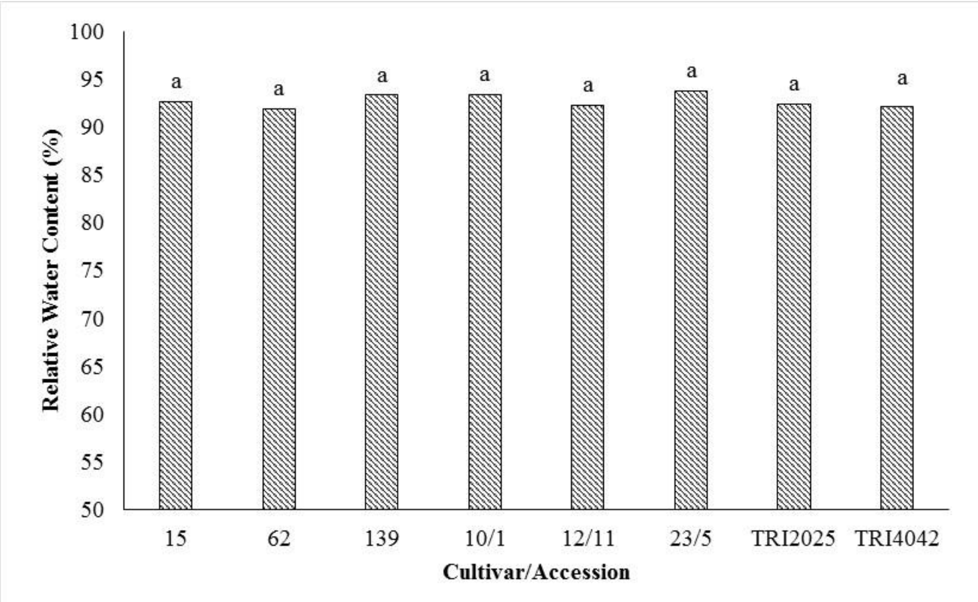


Figure 1. Change in average relative water content among different accessions and known/standard cultivars at average soil moisture level (18.6%) across all the attempts of data collection (Bars with same letters are not significantly different at p=0.05).

The measurements of gas exchange parameters were only possible at 19.6% soil moisture level as the IRGA was malfunctioning in other attempts. Stomatal conductance was significantly different amongst cultivars/accessions at all moisture levels. At 19.6% soil moisture level, cultivar TRI 2025 and accession 15 showed significantly (p= 0.05) the highest stomatal conductance whereas accession 23/5 and 62 showed the lowest stomatal conductance (Figure 2).

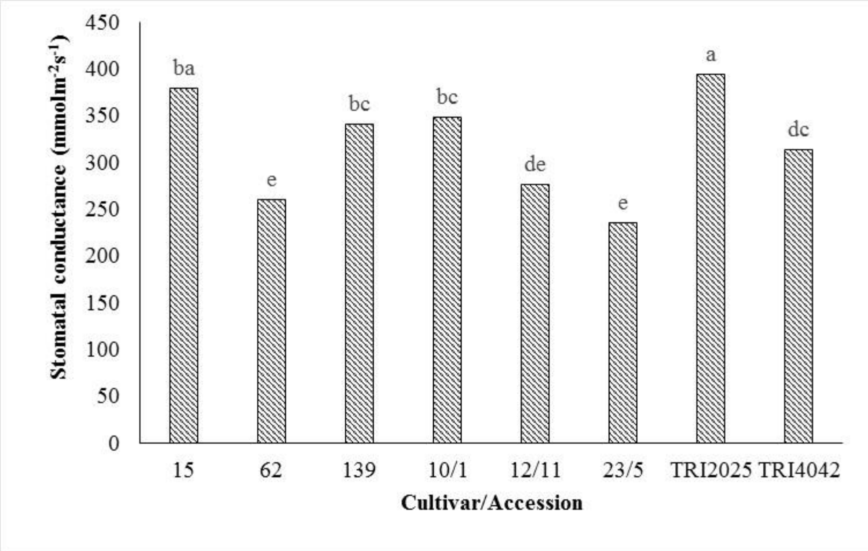


Figure 2. Change in stomatal conductance among different accessions and known/standard cultivars at 19.6% soil moisture level (Bars with same letters are not significantly different at p=0.05).

Rate of transpiration was significantly different among cultivars/accessions at 19.6% moisture level. At 19.6% soil moisture level, cultivar TRI 2025 and accession 15 showed significantly (p= 0.05) the highest rate of transpiration whereas accessions 23/5 and 62 showed the lowest rate of transpiration (Figure 3).

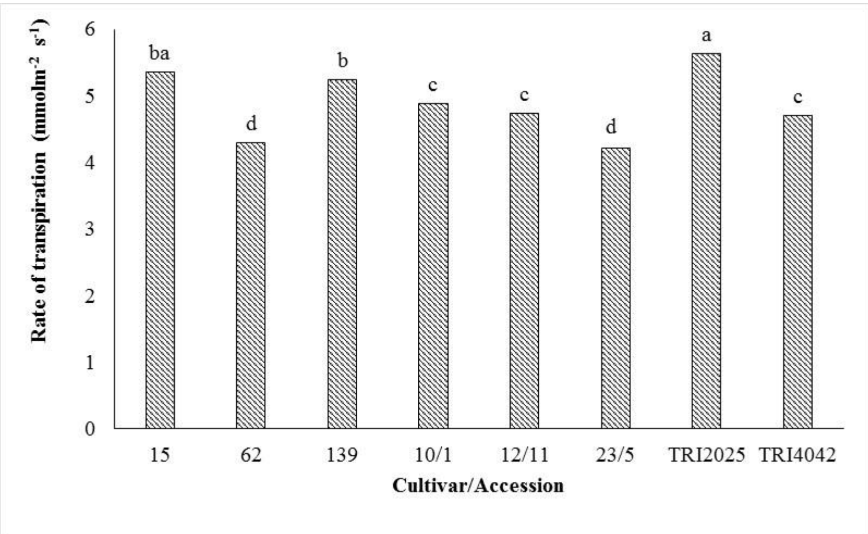


Figure 3. Change in rate of transpiration among different accessions and known/standard cultivars at 19.6% soil moisture level (Bars with same letters are not significantly different at p=0.05).

Rate of photosynthesis was significantly different among cultivars/accessions at 19.6% moisture levels. At 19.6% soil moisture level, accession cultivar TRI 2025, 139 and 10/1 showed significantly (p= 0.05) the highest rate of photosynthesis whereas accession 23/5 and 62 showed the lowest rate of photosynthesis (Figure 4).

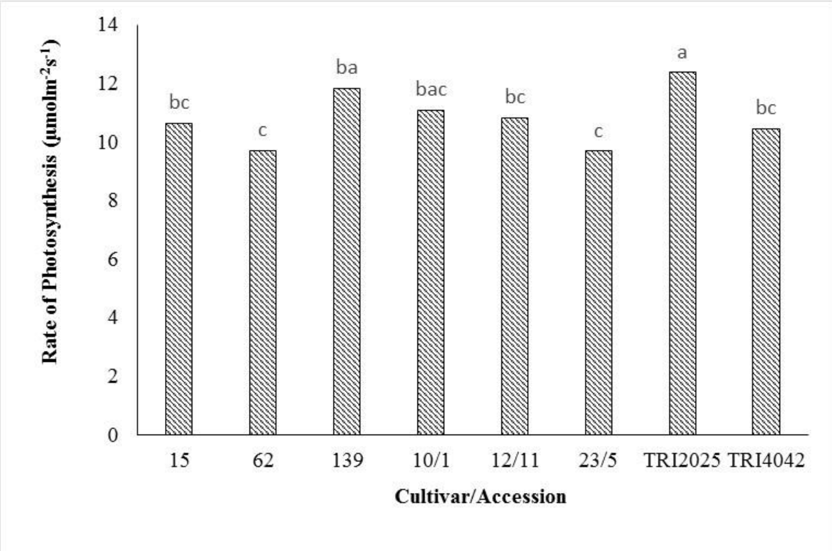


Figure 4. Change in rate of photosynthesis among different accessions and known/standard cultivars at 19.6% soil moisture level (Bars with same letters are not significantly different at p=0.05).

The experiment is in progress.

DMS Navaratne, ADIU Jayawardhane, NM Vithanage, MMN Damayathi and TL Wijeratne

Thrust A 3. Development of high yielding tea cultivars suitable for agro-ecological regions in Uva (Mid-Country semi-dry zone) with high quality, resistance to drought, shot-hole borer, blister blight, stem canker and nematodes

Project A 3.1. Developing suitable cultivars through hybridization, non-conventional breeding methods and selection

Evaluation of accessions in Phase I and II trials

Details of Phase I and Phase II trials in the Uva region are given in table 6 and 7 respectively.

Table 6. Details of Accessions under Evaluation in the Uva: Phase I

Trial No.	Year of planting	Origin#	Location	No. of Accessions tested	Standard cultivar/s	Remarks
UVP 11	2012	D, E, H	TRI Passara Field No. 02	43	TRI 4042	2nd cycle harvesting continued
UVP 12	2014	I	TRI Passara Field No. 03	22	TRI 2023, TRI 2025, DN	2nd cycle harvesting commenced
UVP 13	2014	J	TRI Passara Field No. 03	15	TRI 2025, TRI 3019	2nd cycle harvesting commenced

Origins of accessions under evaluation

D *Hybrids 2004 Talawakelle selections* (crosses made in 2004 using cultivars TRI 777, TRI 3013, TRI 3016, TRI 3017, TRI 3019, PK 2, KEN 16/3, DT 95, MT 18, DG 7)

E *Hybrids 2005 Talawakelle selections* (crosses made in 2005 using cultivars TRI 777, TRI 3013, TRI 3016, TRI 3017, TRI 3019, PK 2, DT 95, DT 1, N 2, China, Yabukita)

H *Old seedling selections* (Selections from Labookelle, Liddesdale, Pedro and Fairlawn Estates)

I *Old seedling selections* (Selections from Glenanore Estate)

J *Hybrids 2006 Talawakelle selections* (crosses made in 2006 using cultivars TRI 3016, TRI 3019, TRI 4071, KEN 16/3, MT 18, B 275, China)

Table 7. Details of Accessions under Evaluation in the Uva: Phase II

Trial No.	Year of planting	Origin#	Location	No. of Accessions tested	Standard cultivars	Remarks
UVP 14	2015	A, B, C	TRI Passara Field No. 02	21	TRI 2025, TRI 4071	2nd Cycle harvesting commenced

Origins of accessions under evaluation

A *VP 39 selections* (crosses made in 1980/ 1981 using clones TRI 777, TRI 2025, TRI, 2026, ASM 4/10, DT 1 and DN)

B *VP 43 selections* (crosses made in 1982/ 1983 using clones TRI 777, TRI 2025, TRI 2024, TRI 2023, TRI 2043, TRI 2142, TRI 62/9, ASM 4/10, DT 1, DN, CY 9, DT 95, H 1/58, DG 39 and China types)

C *VP 44 selections* (crosses made in 1984, using clones TRI 777, TRI 2025, TRI 2142, TRI 2143, ASM 4/10, DN, CY 9, DT 1 and DG 39)

Average cycle average yield and pruning in UVP 14

Table 8. Cycle yields average of best nine accessions in UVP 14

Cultivar/ Accession	Avg. Cycle yield MT/kg/ha	Difference between means of TRI 4071	Pruning weight kg/plant
612	2742.5	770.8a	1.46
925	2714.3	742.6a	2.03
613	2281.8	310.1a	1.95
696	2274.0	302.3a	1.35
626	2245.4	273.7a	1.43
703	2220.9	249.2a	1.45
952	2219.1	247.4a	1.72
244	2124.7	153.0a	1.60
568	2004.1	32.4a	0.98
TRI 4071	1971.7	-	1.33
LSD	909.11	-	1.05
CV%	22.63	-	35.18

Mean values with same letters are not significantly different at $p = 0.05$

Among the tested accessions, two accessions recorded higher cycle average yield than standard cultivar TRI 2025. Selected accessions were propagated in the nursery at TRI, Passara for establishment of new multi-locations adaptive trials in 2023.

Recommendation and release of new series (TRI 5000 Series) cultivars for Uva

Evaluation of TRI 5000 Series has been completed and Technology Release Committee (TRC Meeting was held on 24th January, 2022. Threecultivars (TRI 5002, TRI 5005 and TRI 5006) have been recommended and released for Uva region.

MAB Ranatunga, JD Kottawa-Arachchi, KK Ranaweera, CJ Ratiyalage, HWMMM Jayarathne, N N Dayarathne and JMK Udayangani

Project A 3.3. Screening lines for resistance/ tolerance to SHB for Uva region

Experimental plots are being maintained by the Plant Breeding Division and assessments will depend on the availability of natural infestation of SHB.

NAIM Nissanka, PADS Sumathipala, SPR Wijewardana, MKD Damayanthi, AMP Sammani and RDPD Senanayake

Project A 3.4. Screening cultivars against *Pratylenchus loosi* for Uva region

Experiment : N1B (2019/2020)

Location : TRI Advisory and Extension Centre, Passara

Objectives: Screening lines for resistance/ tolerance to the root lesion (*P. loosi*) nematodes for Uva region and to rate the cultivar resistance against the nematode species enabling Plant Breeder to make relevant inclusions and revisions in TRI Advisory Circulars.

For testing and screening new cultivars for the region, *P. loosi* nematode population build up is continued and nematode populations were assessed in timely intervals. Six test cultivars (Codes as 37, 31, 13, 8,7 and 3) and three standard cultivars (TRI 2025, TRI 2024 and TRI 4052) were introduced to cultivar screening tanks at Passara for screening against *P. loosi.*

PGDS Amarasena, UB Herath, BMGK Godavita, B Jananey, GKWH Dharmadasa and LRUL Senevirathna

Thrust 4. Development of high yielding cultivars with yield potential of 7000 kg made tea per hectare for agro-ecological regions in Low-Country with resistance to drought LCLWT, SHB, stem canker and nematodes

Project A 4.1. Developing suitable cultivars through hybridization, non-conventional breeding methods and selection

Evaluation of Hybrid populations

Hybrid Seedlings (2004/2005 planting): Crosses carried out during 2002-2003 at St. Joachim 5th Cycle harvesting commenced / Monitoring continued

Hybrid Seedlings (2008 planting): Crosses carried out during 2004-2007 at St. Joachim - 4th Cycle harvesting commenced / Monitoring continued

MAB Ranatunga, JHN Piyasundara and AK Mudalige

Evaluation of accessions in Phase I

Details of Phase I trials are given in Table 9.

Table 9. Details of Accessions under Evaluation in the Low-country: Phase I
All trials are located in Field No. 2, St. Joachim Estate, Ratnapura.

Trial No.	Year of planting	Origin#	No. of Accessions tested	Standard cultivars	Remarks
LVP 87	2011	D, E, F	56	TRI 2026, TRI 4042, TRI 4049	2nd cycle harvesting continued
LVP 88	2014	J	28	TRI 4042, KEN 16/3, DG 39	1st cycle harvesting continued
LVP 89	2017	M, G	40	TRI 2026, TRI 4042, TRI 4049	1st Cycle yield recording continued
LVP 90	2017	N	12	TRI 2026, TRI 4042, TRI 4049	1st Cycle yield recording continued
LVP 91	2018	O	96	TRI 2043, TRI 3055, TRI 4042	1st Cycle yield recording continued

Origins of accessions under evaluation

D	Hybrids 2004 Talawakelle selections (crosses made in 2004 using cultivars TRI 777, TRI 3013, TRI 3016, TRI 3017, TRI 3019, PK 2, KEN 16/3, DT 95, MT 18, DG 7)

E	Hybrids 2005 Talawakelle selections (crosses made in 2005 using cultivars TRI 777, TRI 3013, TRI 3016, TRI 3017, TRI 3019, PK 2, DT 95, DT 1, N 2, China, Yabukita)

F	Hybrids 2002-2003 Ratnapura selections (crosses made in 2002-2003 using cultivars TRI 3052, TRI 3055, TRI 62/9, TRI 4053, TRI 4047, TRI 4004, TRI 2043, TRI 4061, TRI 2016, KP 204, KEN 16/3, H 1/58)

J	Hybrids 2006 Talawakelle selections (crosses made in 2006 using cultivars TRI 3016, TRI 3019, TRI 4071, KEN 16/3, MT 18, B 275, China)

G	Hybrids 2004-2007 Ratnapura selections (crosses made in 2002-2003 using cultivars TRI 3052, TRI 3055, TRI 62/9, TRI 4053, TRI 4047, TRI 4004, TRI 2043, TRI 4061, TRI 2016,

M	Vegetatively propagated progenies of 16 individual seedlings (OP) selected in 2015/2016 from the seedling adaptive trial at Endana Estate, Kahawatta

N	Vegetatively propagated progenies of 12 individual seedlings (OP) selected in 2015/2016 from seed trial (LSP 1) at St. Joachim Estate Ratnapura

O	Hybrids 2013/2014 Talawakelle selections (crosses made during 2013 and 2014 between cultivars TRI 3055 and TRI 2043)

Evaluation of accessions in Phase II

Details are given in the Table 10.

Table 10. Details of Accessions under Evaluation in the Low-country: Phase II
All trials are located in Field No. 2, St. Joachim, Ratnapura.

Trial No.	Year of planting	Origin#	No. of Accessions tested	Standard cultivars	Remarks
LVP 75 -I	1997	VP 37	11	TRI 2023,	High No. of
LVP 75 - II	1997	LVP 42	21	TRI 2025, TRI 2026, TRI 2027	Vacancies. Remaining bushes up rooted and the area
LVP 75- III	1997	LVP 28	05	TRI 2025, TRI 2027	will be reserved for mother bush
LVP 75 - IV	1997	Pettigala Selections	08	TRI 2023, TRI 2025, TRI 2026, TRI 2027	expansion project
LVP 76*	1999	LVP 42	22	TRI 2023, TRI 2025, TRI 2027	7th Cycle harvesting continued
LVP 77*	1999	LVP 46	13	TRI 2023, TRI 2025, TRI 2027	7th Cycle harvesting continued
LVP 78*	1999	Pettigala Selections	18	TRI 2023, TRI 2025, TRI 2027	7th Cycle harvesting continued

LVP 79*	1999	Assam Introductions	06	TRI 2023, TRI 2025, TRI 2027	7th Cycle harvesting continued
LVP 83	2000	LVP 46	18	TRI 2023, TRI 4042	Promising accessions already propagated in the nursery. High No. of Vacancies. Remaining bushes up rooted and the area will be reserved for mother bush expansion project

* Promising accessions propagated in the nursery for further

Origins of accessions under evaluation

VP 37	Selections obtained after open pollination of clones TRI 777, TRI 2025, DT 1 and TRI 2043 (1980)
LVP 28	Bi-clonal seed selections of Aislaby (TRI 2025 x TRI 2023) stock at St. Joachim Estate, Ratnapura (1983)
LVP 42	Polyclonal seed selections of Urumiwela and Karandupona stocks, at Parambe Estate, Kegalle (1989)
LVP 46	Polyclonal seed selections of Urumiwela and Karandupona stocks, at St. Joachim Estate, Ratnapura (1990)
Pettigala selections	bi-clonal seed selections of Vykumbura (TRI 2026 x DN) stocks, at Pettigala Estate, Balangoda (1984)
Assam Introductions	Introductions from Assam, India in 1988.

Evaluation of accession in Phase III

TRI 5000 series commercial evaluation trials – Phase III

Performances of four commercial evaluation trials established at TRI Kottawa, Cecilton, Indola and Deniyaya Estates have been monitored. These trials are managed by TRI Kottawa and respective Estates.

TRI 5000 series observation plots

Performances of four observational plots established at TRI Kottawa, TRI Deniyaya, Balangoda and Kiriwanaganga Estates have been monitored. Trials are managed by respective TRI Regional centers and Estate managements.

MAB Ranatunga, JHN Piyasundara and AK Mudalige

Project A 4.2. Screening lines for resistance to stem canker

Selected plants from TRI 5000 series accessions and recommended tea cultivars showing canker resistance and susceptibility (reference plants) have been maintained for bioassay using artificial inoculation until they achieve sufficient stem thickness for wounding.

GD Sinniah, DGNP Karunajeewa and Plant Breeding Division

Project A 4.3. Screening lines for resistance/tolerance to SHB and LCLWT for Low-Country

Experimental plots are being maintained by the Plant Breeding Division and assessments will depend on the availability of natural infestation of SHB/LCLWT at the prune time.

BS Vitana, AMP Sammani and RDPD Senanayake

Project A 4.4. Screening cultivars against *Pratylenchus loosi* and *Radopholus similis* for Deniyaya

Experiment **:** N1B (2020/2021)

Location **:** TRI Advisory and Extension Centre, Deniyaya

Objectives: Screening lines for resistance / tolerance to the root lesion (*P. loosi*) and burrowing (*R. similis*) nematodes for Low-Country regions to rate the cultivar resistance against the nematode species enabling Plant Breeder to make relevant inclusions and revisions in TRI Advisory Circulars. For testing and screening new cultivars for the region, nematode population build up in screening tanks at Deniyaya has been continued. Test and standard cultivars are being maintained in the nursery for next screening.

PGDS Amarasena, UB Herath, BMGK Godavita, B Jananey, GKWH Dharmadasa and LRUL Senevirathna

Project A 4.7. Screening of TRI 5000 series tea cultivars for drought under Low-Country wet zone condition (2013).

Objective of this study was to identify drought tolerant accessions for Low- Country wet zone using most important plant physiological parameters.

This study was conducted using TRI 5000 series adaptive trial (phase III) in a smallholding land at Siridola Estate, Palawella in Ratnapura using known cultivars; TRI 2026, TRI 4042, TRI 4049 and nine accessions; 29, 93, 168, 195, 278, 741, 751, 23/5 and 12/11. Soil moisture content was measured along with leaf relative water content (RWC).Yield components were also measured using 0.3 x 0.3 m^2 quadrat. Leaf samples were also collected to determine the total soluble sugar content and proline content as well. The measurements were taken at two moisture levels namely 15.14% and 20.49%. However, calculation of drought susceptibility index was not possible due to malfunctioning of the instrument (four decimal balance).

The chemical analyses of the samples are in progress.

DMS Navaratne, ADIU Jayawardhane, NM Vithanage, MMN Damayathi and TL Wijeratne

Thrust A 5. Development of bi- and ploy- clonal seed stocks for drought prone areas in different agro-ecological regions

Project A 5.1. Development of bi-and poly-clonal seed stocks for drought prone areas in different agro-ecological regions

Evaluation of seed stocks for commercial scale planting

Long term performances of three seed trials (LSP1- Field No. 2A. St. Joachim, Ratnapura, Endana Estate, Kahawatta and Small holder land at Sitthangala, Warapitiya) have been monitored. Monitoring activities outside TRI Stations severely affected due to fuel crisis/ transport difficulties prevailed in first three quarters of the year.

Bi-clonal and Poly-clonal seed gardens

Establishment and Maintenance of tea seed gardens

- Nine new Poly –clonal tea seed gardens were established in year 2022 under Special project GL 390. Details are included under project GL 390.
  Maintenance activities of four Poly-clonal tea seed gardens (Salawa, Halpe, Rambukkanda and Kiriporuwa) have been continued by the division. However maintenance activities of gardens located outside TRI Stations severely affected due to fuel crisis / transport difficulties prevailed in first 3 quarters of the year)
- Sapumalkanda Group (managed by Lalan Rubber (Pvt) Ltd. is willing to manage the two gardens located at Sapumalkanda and Reucastle Estates. However, it is necessary to undergo rejuvenation of seed bearers and infilling in both gardens. The rejuvenation of trees will be carried out under the special project GL 390 with the collaboration of Sapumalkanda Group
- Bringing into bearing activities of following nine new gardens established during 2012 – 2021 have been continued with the collaboration of respective TRI Stations / Estates
  Eight Poly-clonal gardens: TRI Kottawa, TRI Ratnapura (2 gardens), TRI Hantane, TRI Passara, Kiriwanganga Estate Deniyays, Carolina Estate Watawala, and Wilpita Estate – Akuressa, One Bi-clonal garden:Keeripitiya Estate, Deniyaya

Distribution of improved seeds among the growers

Plant Breeding Division continued to link the growers to the respective seed gardens as per their requests. However, seed collection and distribution severely affected due to fuel crisis / transport difficulties prevailed in first three quarters of the year, especially during peak fruiting season (April to August) in Low Country where majority of the tea seed gardens have been established. Therefore, we were unable to attend majority of the requests and planning to fulfill the requirement in the next year (2023).

- Twelve requests received in 2022 and 15 kg of tea seeds have been distributed among the stakeholders
- Twenty four kg of seeds were collected for experimental / demonstration purposes
- Eight kg of seeds that were collected from Keeripitiya Garden were propagated in Kiriwanganga Estate nursery by the Estate

- Sapumalkanda Estate initiated seed propagation in the nursery by using seed collected from the Garden.

MAB Ranatunga, JHN Piyasundara, AK Mudalige, KK Ranaweera, CJ Ratiyalage and H WMMM Jayarathne

Project A 5.3. Screening seed cultivars for resistance/tolerance to SHB

Experimental plots are being maintained by the Plant Breeding Division and assessments will depend on the availability of natural infestation of SHB at the prune time.

AMP Sammani, NAIM Nissanka, PADS Sumathipala, MKD Damayanthi, SPR Wijewardana and RDPD Senanayake

Thrust A 51. Germplasm conservation, characterization and evaluation

Establishment and maintenance of field gene banks

Maintenance activities of two field gene banks at Talawakelle and Ratnapura have been continued.

MAB Ranatunga, JHN Piyasundara, AK Mudalige, CJ Ratiyalage and HWMMM Jayaratne

Thrust A 52. Development (Screening) of tea cultivars specifically suitable for small growers who cannot afford to use high-input or modern agricultural practices

The key objective of this thrust was to develop new tea cultivars suitable for small growers who cannot afford to use high-input or modern agricultural practices in their lands

Plant Breeding Division has continued to monitor 15 trials planted in 2012/ 2013.and management/maintenance has been carried out by respective smallholders;

Three trials in Kalutara district (Meeghathenna, Horana and Pallawatta), five trials in Galle District (Neluwa, Unanitiya, Ihalakeebiya, Thagampola and Batapola), two trials in Matara district (Akuressa and Morawaka), two trials in Ratnapura district (Pallawela and Ehaliyagoda), one trial in Badulla district (Hali-ella), one trial in Kandy district (Hewaheta) and one trial in Nuwara-elliya district (Kothmale).

Yield component assessment was conducted in five trials (Horana, Pellawatta, Neluwa, Morawaka and Pallawela) in 2022.

MAB Ranatunga, JHN Piyasundara, AK Mudalige, CJ Ratiyalage, HWMMM Jayarathne

High throughput genotyping to expedite the genetic characterization and dissection of important agronomic traits of tea

Funding agency: Ministry of Science and Technology

The main objective of the study is to expedite the genetic characterization and dissection of important agronomic traits of Tea Germplasm of Sri Lanka *via* high throughput genotyping.

The project was successfully completed and final report was submitted to the funding agency. Follow up action and High-throughput genotyping of Sri Lankan accessions are being continued.

Molecular diversity analysis and biochemical profiling of Sri Lankan tea (*Camellia sinensis* (L.) O. Kuntze) genotypes

The objectives of this study were molecular and biochemical characterization of potential cultivars of Sri Lankan tea germplasm and establishing correlations between marker –trait association for identification of potential genotypes to expedite genetic improvement of tea. Microsatellite markers, genomic SSRs (gSSRs), expressed sequence tag based SSRs (EST-SSRs) and single nucleotide polymorphism (SNP) have been developed and applied to tea plant characterization. SSR markers with high polymorphism would be useful for identification of the economically important tea cultivars, studying evolutionary or domestication history, phylogenetic relationships and genetic diversity analysis, and map construction and marker-assisted trait selection.

MAB Ranatunga, JD Kottawa-Arachchi (Plant Breeding Division), RN Attanayake (Department of Botany, University of Kelaniya), MTK Gunasekare (Ministry of Plantations) AMT Amarakoon (Department of Chemistry, University of Kelaniya and RK Sharma (CSIR-IHBT, India)

Variation of catechin and caffeine content in exotic collection of tea [*Camellia sinensis* (L.) O. Kuntze] in Sri Lanka

Constituents such caffeine, gallic acid and flavan-3-ols; catechin, epicatechin (EC), epicatechin gallate (ECg), epigallocatechin (EGC) and epigallocatechin gallate (EGCg), contained in fresh leaf of 131 accessions (exotic origins, old seedling selections, improved cultivars and un-adapted accessions were performed using High Performance Liquid Chromatography (HPLC). Variations in metabolites among cultivars as well as between seasons were determined. Among the flavan-3-ols, EGCg was the most abundant followed by EGC, ECg and EC. Hierarchical clustering of 131 accessions based on metabolite diversity resulted two major clusters. Indian introductions clustered with well-known high quality cultivars indicating the potential utilization of those in high quality black tea production. Exotic accessions with low caffeine contents (< 20 mg g^{-1}) were grouped in a separate cluster indicating that there is a potential of using those promising genetic resources for the development of low caffeine tea. Present study revealed that the selected exotic tea accessions rich in bioactive compounds such as catechins and caffeine content could be utilized in producing speciality teas with enhanced quality and medicinal properties.

Morpho-molecular genetic diversity and population structure analysis to enrich core collections of tea germplasm in Sri Lanka and India

The objectives of the present study were to perform phenotypic and genotypic characterization of Sri Lankan and Indian tea germplasm and identify diverse accessions to accelerate tea breeding programmes in Sri Lanka and India. Total of 171 tea accessions comprising of 94 Sri Lankan and 77 Indian accessions were used. Among the 16 morphological descriptors of Sri Lankan accessions, first six PCs accounted for 79.05 % of the total phenotypic variation. As revealed by the scatter plot, two different groups of accessions were identified (Figure 6). All the accessions originated from Korea formed a separate cluster (A) whereas majority of TRI developed cultivars formed another cluster (B) along with several Indian introductions.

In this study, 28 polymorphic SSRs were used to assess the genetic diversity and population structure of 171 tea accessions. Based on the Neighbor-joining tree cluster analysis, all Sri Lankan accessions were grouped in a single cluster whereas Indian accessions were grouped in two distinct clusters. Five different methods, Gower's distance method was the most appropriate method for development of core subsets. Selected twenty one Sri Lankan core accessions consisted of eleven introductions, five TRI developed cultivars and five Estate selections. Selected eighteen Indian core accessions consisted of eleven accessions belong to China types, two Assam types and five Indian recommended cultivars.This is the first study presenting a detail comparison of tea germplasm of both countries. The results will be useful for tea crop improvement programme and conservation and utilization of tea germplasm in India and Sri Lanka in future.

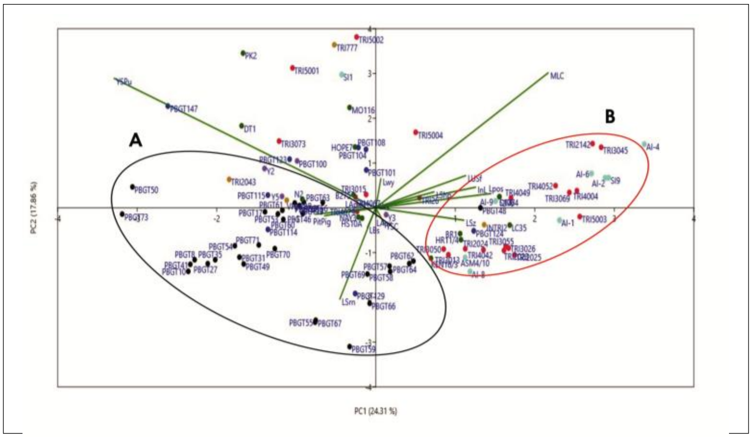


Figure 6: PCA scatter plot explaining the morphological variance among 94 Sri Lankan tea germplasm accessions.

JD Kottawa-Arachchi, MAB Ranatunge (Plant Breeding Division, Tea Resaerch Institute, Talawakelle)
RN Attanayake, AMT Amarakoon (University of Kelaniya)
MTK Gunasekare (Ministry of Plantations)
HK Chaudhary, VK Sood, R Katoch and DK Banyal (CSK-Himachal Pradesh Agriculture University, India), and RK Sharma (CSIR- Institute of Himalayan Bio-Resource Technology, India)

Genetic analysis and linkage mapping of pigments of tea

Funding agency: Sri Lanka Council for Agriculture Research Policy, Ministry of Agriculture

The project was successfully completed and final report has submitted to the funding agency. Follow up actions are being continued.

MAB Ranatunga, JD Kottawa-Arachchi, TL Wijeratne (Plant Physiology Division), RN Attanayake (Department of Botany, University of Kelaniya) and AMT Amarakoon (Department of Chemistry, University of Kelaniya)

Establishment and maintenance of field gene banks

Maintenance of two field gene banks at Talawakelle and Ratnapura has been continued.

Safe duplication of core collection of tea germplasm at TRI, Hantane and TRI Passara

Establishment of core collection of tea germplasm at TRI Regional Station, Passara has been completed. Land preparation was carried out at TRI Regional Stations at Hantane.

MAB Ranatunga, JD Kottawa-Arachchi, JHN Piyasundara, AK Mudalige, CJ Ratiyalage and HWMMM Jayaratne

Project B 128. Use of in *vitro* techniques to supplement the conventional breeding Programme

Multiplication of stem nodal cuttings of new cultivars in dynamic liquid cultures has been continued.

Bringing into bearing operations of field planted tissue culture plants have been continued.

MAB Ranatunga, KK Ranaweera and HWMMM Jayarathne

Development of somatic embryogenesis and single cell regeneration protocol for tea

The production of chimeric mutant plants is a major bottleneck for perennial crops and trees such as coffee and tea.

The Plant Breeding and Genetics Laboratory (PBGL), Seibersdorf, International Atomic Energy Authority, Vienna has been working on developing regeneration protocol for single cells isolated from coffee leaves for mutagenesis. A project has been initiated to develop similar protocols for tea in collaboration with PBGL under a fellowship offered in the project on “Supporting Genetic Improvement of Tea”. PBGL has developed protocols, media compositions, and relevant expertise for in *vitro* single-cell mutagenesis and regeneration through indirect somatic embryogenesis for Arabica coffee. The coffee protocol has been modified to develop callus using tea leaves. Initially hard callus was developed and transferred to a medium for the formation of friable callus leading to formation of single cell suspension cultures, which will be used for mutation inductions. Currently cultures are maintained under growth room conditions to obtain friable callus.

Also, direct somatic embryos have been generated from sections of tea leaves, and it has been a huge success in the direct embryogenesis of the tea leaf. Embryos were obtained within one week of initiation of cultures and embryos were treated with gamma rays for mutation induction. The protocols developed for direct and indirect somatic embryogenesis have been applied to known tea varieties, and the cultures are being maintained in the laboratory of tissue culture in the Plant Breeding Division of the.

KK Ranaweera and HWMMM Jayarathne and MAB Ranatunga

D/Breed. Activities of Plant Breeding Division

GL 365 (ASMSC): Advanced propagation method for tea cuttings - Collaborative research with the Jiffy products Pvt. Ltd. Sri Lanka and Plant Breeding, Agronomy and Advisory Divisions.

Bringing into bearing operations have been continued with 78 plants planted in 2020 in Field No. 2A, St. Joachim Estate, Ratnapura.

Bringing into bearing operations have been continued with 61 VP plants (21-TRI 3072, 20-TRI 4052 and 20- TRI 5002) propagated in Jiffy pellets and controls.

Bringing into bearing operations have been continued with 20 seedlings (Ten plants each KEN 16/3 and TRI 2022) propagated in Jiffy pellets and controls.

HWMMM Jayarthne, AK Mudalige, JHN Piyasundara and MAB Ranatunga

Project GL 390. Establishment of tea seed gardens to increase the production of improved seeds as a source of planting materials in drought prone areas – 15 Gardens

A proposal submitted for the above project to the Ministry of Plantation was accepted and approved for funding in 2021.

The objective of the project is to establish new seed gardens to cater the increasing demand for improved seeds among growers. TRI has identified the necessity of establishing seed gardens in Uva and Mid-country regions which are believed to be more vulnerable to drought effect in the future. It is intended to establish seed gardens in TRI regional centers, RPC Estates and lands belongs to TSHDA regional centers in order to ensure proper dissemination of improved seeds to all stakeholders.

Nine new Poly-clonal Tea Seed Gardens have been established in year 2022. The details are included in Table 11.

Table 11. Details of the Poly-clonal Tea Seed Gardens established in year 2022 under GL 390 project

Location	Date of establishment	Parental Cultivars
Homodola Estate, Udugama	19.05.2022	TRI 2016, TRI 2022, TRI 2025, TRI 3055, KEN 16/3, S 106, KP 204
TSHDA, Rathnasiri Wickramanayaka National Training Centre, Uduwela.	30.05.2022	TRI 2016, TRI 2022, TRI 2025, TRI 2043, TRI 3019, TRI 3055, KEN 16/3
Endana Estate, Kahawatte	29.06.2022	TRI 2016, TRI 2022, TRI 2025, TRI 3055, KEN 16/3, S 106, KP 204
Vogan Estate, Matugama	25.07.2022	TRI 2016, TRI 2022, TRI 2025, TRI 3055, KEN 16/3, S 106, KP 204
Lelwala Estate, Wanduramba	27.07.2022	TRI 2016, TRI 2022, TRI 2025, TRI 3055, KEN 16/3, S 106, KP 204
TSHDA, Weilimada	25.10.2022	TRI 2016, TRI 2022, TRI 2025, TRI 2043, KEN 16/3
TSHDA, Hali Ela	25.10.2022	TRI 2016, TRI 2022, TRI 2025, TRI 2043, TRI 3055, KEN 16/3, S 106
TSHDA, Passara	26.10.2022	TRI 2016, TRI 2022, TRI 2025, TRI 2043, TRI 3055, KEN 16/3, S 106
Rayigam Estate, Ingiriya	01.11.2022	TRI 2016, TRI 2022, TRI 2025, TRI 2027, TRI 3055, KEN 16/3, S 106

Propagation of nursery plants continued in four nurseries (Plant breeding nurseries at Talawakelle and Ratnapura and nurseries of TRI Regional Centers at Deniyaya and Passara).

JHN Piyasundara, MAB Ranatunga, AK Mudalige, KK Ranaweera, C J Ratiyalage and HWMMM Jayarathne

Project GL 395. Expansion of mother bush areas with new tea cultivars – 14 ha

A proposal submitted for the above project to the Ministry of Plantation was accepted and approved for funding in 2022.

TRI successfully continued establishment of 22 ha of mother bushes of new tea cultivars covering all tea growing regions under special project (GL 340) funded by Ministry of Plantation during 2017-2021. The objective of the project which commenced in 2022 is to expand the mother bush areas to fulfill the future demand of cuttings of new cultivars. The expansion has been carried out in St. Coombs Estate. Talawakelle, St. Joachim Estate. Ratnapura, TRI Hantane, TRI Passara and TRI Kottawa.

Land preparation for establishment of mother bushes and nursery propagation commenced in all the locations except TRI, Passara. Work has been initiated to acquire 2ha of land from Gonakelle Estate, Passara for establishment of mother bushes.

Plant Breeding Staff, Advisory staff and Superintendents of St. Coombs and St. Joachim Estates

Project NRC - 20 - 123. Conservation and Utilization of Old Seedling Teas (OST): A Viable Option for Adaptation to Climate Change
Funding agency: National Research Council (NRC)
A grant of LKR 3.44 Mn received from NRC to conduct the above project for a period of 2 years.

The objective of the project is to develop a broader and inclusive understanding of the genetic diversity in OSTs in Sri Lanka and to identify diversity "hotspots" and to develop conservation strategies. The outcome of the project will have direct and indirect impacts to the Institute’s tea breeding programme and the tea industry of Sri Lanka as a whole to maintain the sustainability of the tea industry.

There are 62 tea Estates managed by seven tea Regional Plantation Companies in Uva region. Out of them, 25 Estates have been selected based on the highest percentage (more than 60%) of seedling tea fields and approximate age (more than 70 years old) of seedlings as per the experience of staff representing all agro-ecological regions in the Uva region.

Bush assessment was carried out using transect and point sampling method. In each field, 10 m x 10 m quadrates were placed along a transect, randomly but separated by a distance of at least 50 m. Within each quadrate, 5 m × 5 m subplot was laid at a corner within the plot. Morphological diversity was assessed inside the sub plot. Bush assessment has been completed in Spring Valley (IM 1a), Shawlands (IM2b), Mahadowa (IU2), Udaveriya (IU3b), Wewesse, Nahavilla, Dammaria B (IU3c), Warwick (IU3d), Welimada (IU3e). The project has been continued and morphological data collected is being analyzed. Radar chart (Figure 7) summarizes diversity of seedlings available in IU3c AER. As illustrated, diversity is high in Wewessa Estate compared to Dammaria B and Nahavilla Estates.

Data are being analyzed for other AERs.

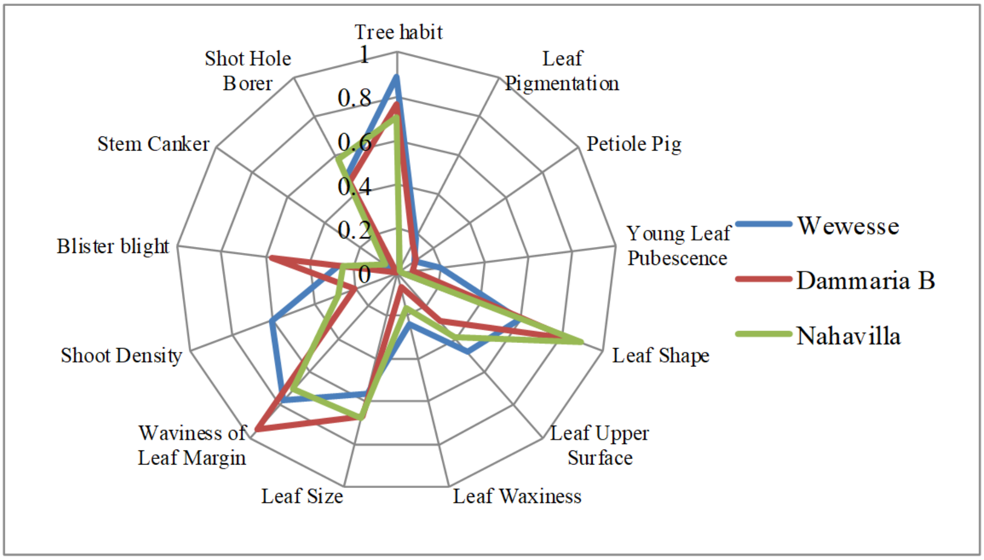


Figure 7. Old seedling diversity of Estates in IU3c AER – parameters indicated in the diagram not clear. Also need to mention them in the text for clarity re: morphological diversity measurements and bush assessments including referred biotic stresses

MASK Pemarathne and MAB Ranatunga

LAND PRODUCTIVITY IMPROVEMENT AND CROP MANAGEMENT

Integrated Approach to Soil Fertility Management

Thrust A 15. Development of regional (AERs) and/or site - specific fertilizer/ dolomite recommendations

Project A 15.1. Estimating crop response to macro nutrients (N, P, K, S and P) at Agro-ecological region (AER) level

a) Tea factory firewood ash as a potential plant nutrient source for mature tea (Adaptive trial)

Based on results of research trials, the wood ash at the rates of 500, 1000 kg ha^{-1} $year^{-1}$ with refuse tea or compost at 20 MT $ha^{-1}year^{-1}$ along with urea at 270N kg ha^{-1} $year^{-1}$ and present TRI inorganic fertilizer recommendation (VPLC 880) have been selected as treatments for adaptive trials to validate them under farmers' condition.

The main objective of this study was to investigate the suitability of tea factory fire wood ash mixed with refuse tea/compost as plant nutrient source for mature tea under growers' conditions. This experiment was commenced at Kiruwanagange Estate, Kirilipana Low-Country in January 2019.

Effect of application of wood ash on soil pH

The soil pH is shown in Table 1. The soil pH values measured with distilled water and $CaCl_2$ solution varied significantly among treatments ($p \leq 0.05$). Application of wood ash at 1000kg/ha/yr levels have increased soil $pH_{(water)}$ as well as $pH_{(CaCl2)}$ significantly compared to the current inorganic fertilizer recommendation. The higher pH values in both 0-15cm and 15-30cm depths were recorded with the wood ash 1000kg/ha/yr with refused tea 20t/ha/yr application which could be attributed to the liming effects of wood ash.

Table 1. Effect of application of wood ash on soil pH

Treatments	0-15 cm depth		15-30 cm depth	
	Soil $pH_{(water)}$	Soil $pH_{(CaCl2)}$	Soil $pH_{(water)}$	Soil $pH_{(CaCl2)}$
Wood ash (WA) (500kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	4.25b	3.69b	4.32ab	3.73ab
Wood ash (WA) (1000kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	4.36ab	3.78b	4.43ab	3.80ab
Wood ash (WA) (500kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	4.61ab	3.93ab	4.65a	3.93ab
Wood ash (WA) (1000kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	4.91a	4.11a	4.88a	4.04a
Current recommendation (VPLC880)	4.01b	3.68b	3.99b	3.65b
LSD	0.62	0.32	0.60	0.32
CV%	5.06	3.02	4.85	3.01

All wood ash treatments showed significantly increased soil $pH_{(water)}$ as well as $pH_{(CaCl2)}$ at 15-30cm depth compared to the current recommended control. Urea hydrolysis followed by nitrification could increase the soil acidity in all urea applying treatments. However, alkaline nature of wood ash treatments may have neutralized the acidity which was not occurred in inorganic fertilizer treatment.

Irrespective to the inability of the application of fertilizer during the said period, differences of soil pH among treatments could be attributed to the residual effects of application of wood ash to the field which had the potential of maintaining soil pH at desirable range for tea.

Effect of application of wood ash on soil available Phosphorous (P) and Potassium (K)

The soil available P and K at both soil depths tested are shown in Table 2. There were no significant differences among treatments ($p \leq 0.05$) on soil available P and K at both soil depths.

Table 2. Effect of application of wood ash on soil available P and K

Treatments	Soil P (mg/kg)		Soil K (mg/kg)	
	0-15cm depth	15-30cm depth	0-15cm depth	15-30cm depth
Wood ash (WA) (500kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	70a	59a	110a	103a
Wood ash (WA) (1000kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	64a	26a	140a	135a
Wood ash (WA) (500kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	114a	105a	110a	96a
Wood ash (WA) (1000kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	89a	65a	96a	88a
Current recommendation (VPLC880)	56a	46a	130a	127a
LSD	65.5	82.3	72.6	72.4
CV%	32.4	49.2	22.3	23.7

Effect of application of wood ash on soil available Mg and Ca

The concentrations of soil available Mg and Ca are shown in Table 3. The concentration of soil Mg was significantly increased with the application of wood ash either with compost or refused tea ($p \leq 0.05$). Wood ash is a rich source of mineral Mg and this could be the reason for higher Mg in wood ash treatments. However, except Wood ash (WA) (1000kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr) all other treatments showed soil Mg levels below the critical Mg level of 60 mg/kg for tea.

Table 3. Effect of application of wood ash on soil available Mg and Ca

Treatments	Soil Mg (mg/kg)		Soil Ca (mg/kg)	
	0-15cm depth	15-30cm depth	0-15cm depth	15-30cm depth
Wood ash (WA) (500kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	23b	20c	118bc	103ab
Wood ash (WA) (1000kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	34a	23bc	149bc	121ab
Wood ash (WA) (500kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	38a	33ab	252ab	176a
Wood ash (WA) (1000kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	45a	37a	330a	198a
Current recommendation (VPLC880)	17b	15c	65c	59b
LSD	11.0	11.3	174.9	104.7
CV%	12.8	16.1	34.4	28.7

Similarly, Soil available Ca was also increased significantly with the application of wood ash when compared with the inorganic fertilizer recommendation ($p \leq 0.05$). Higher mineral Ca content in wood ash increased the available Ca in the soil. Highest Ca level was recorded with the application of; Wood ash (WA) (1000kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr) treatment.

Effect of application of wood ash on soil organic carbon content and CEC

The soil organic carbon content and soil CEC are shown in Table 4. There was no significant difference observed in soil organic carbon ($^{O}C\%$) as well as soil CEC among treatments at $p \leq 0.05$.

Table 4. Effect of application of wood ash on soil Organic carbon content and CEC

Treatments	Soil ^{O}C %	Soil CEC (meq/100g)
Wood ash (WA) (500kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	2.06a	20.7a
Wood ash (WA) (1000kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	1.86a	19.7a
Wood ash (WA) (500kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	1.84a	20.9a
Wood ash (WA) (1000kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	1.71a	19.4a
Current recommendation (VPLC880)	2.01a	20.3a
LSD	1.13	2.14
CV%	21.4	3.82

Effect of application of wood ash on leaf N, P and K concentration

The N, P and K, contents in mother leaves are shown in Table 5. No significant difference ($p \leq 0.05$) in N, P and K contents were observed in the mother leaves among treatments.

Table 5. Effect of application of wood ash on leaf N, P and K concentrations

Treatments	Leaf N %	Leaf P %	Leaf K %
Wood ash (WA) (500kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	3.96a	0.25a	1.18a
Wood ash (WA) (1000kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	3.99a	0.26a	1.17a
Wood ash (WA) (500kg/ha/yr) +Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	3.92a	0.24a	1.07a
Wood ash (WA) (1000kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	3.95a	0.24a	1.07a
Current recommendation (VPLC880)	4.08a	0.23a	1.17a
LSD	0.19	0.03	0.29
CV%	1.72	4.34	9.23

Effect of application of wood ash on leaf Mg, Ca and S concentration

The Mg, Ca and S contents in mother leaves are shown in Table 6. There were no significant differences among the applied treatments observed on leaf Mg, Ca and S at $p \leq 0.05$

Table 6. Effect of application of wood ash on leaf Mg and Ca concentrations

Treatments	Leaf Mg %	Leaf Ca %	Leaf S%
Wood ash (WA) (500kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	0.27a	1.47a	0.27a
Wood ash (WA) (1000kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	0.29a	1.40a	0.24a
Wood ash (WA) (500kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	0.31a	1.50a	0.22a
Wood ash (WA) (1000kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	0.30a	1.38a	0.24a
Current recommendation (VPLC880)	0.26a	1.47a	0.22a
LSD	0.09	0.17	0.10
CV%	11.69	4.45	15.5

Effect of application of wood ash on made tea yield

The variations of tea yield in relation to different treatments are shown in Table 7. There was no significant difference observed on made tea yield among treatments at $p \leq 0.05$. All wood ash treatments showed comparable made tea yield with the current inorganic fertilizer recommendation. This implies that there is a possibility to reduce inorganic fertilizer with the application of wood ash with compost/refuse tea for mature tea fields.

Table 7. Effect of application of wood ash on made tea yield

Treatments	Made Tea Yield (kg/ha)
Wood ash (WA) (500kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	2800a
Wood ash (WA) (1000kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	2827a
Wood ash (WA) (500kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	2887a
Wood ash (WA) (1000kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	2789a
Current recommendation (VPLC880)	2838a
LSD	103
CV%	1.31

JRY Abeywardana, SK Weeratunga, WMS Wijayatunga, LRMC Liyanage

b) Tea factory firewood ash as a potential plant nutrient source and liming material for rehabilitation grass (Adaptive trial)

Based on results of research trials, wood ash at the rate of 1000kg ha^{-1} $year^{-1}$and present TRI Dolomitic limestone recommendation and present TRI inorganic fertilizer recommendation (U625) at different combinations were selected as treatments for adaptive trials to validate under farmers' condition.

All research and adaptive trials were completed, and the final report is being prepared to submit to the Technology Release Committee (TRC) for recommendation

LRMC Liyanage, WMS Wijayatunga, JRY Abeywardana and WTBD Priyantha

Project A 15.3. Development of methods for formulation of bio-organic and mineral compound fertilizers suitable for tea

a) Identification and Evaluation of Plant Growth Promoting Rhizobacteria associated with Tea

Based on Scientific Advisory Committee recommendation, experiment was commenced at Nayapana Estate, Nayapana with increased number of treatments to evaluate the effects of N_2 fixers and P solubilizes as single inoculants in January 2020 with following treatments.

T1: Recommended rate of fertilizer
T2: 2/3N + 100% P + 100% K
T3: 100% N + 50% P + 100% K
T4: 2/3 N + 50% P + 100% K
T5: N fixer + 2/3N + 100% P +100% K
T6: PSB + 100% N + 50% P + 100% K
T7: N fixer + PSB + 2/3N + 50% P + 100% K
T8: N fixer alone
T9: PSB alone
T10: Absolute control

Experiment was conducted for a period of one year. Plots were laid out as RCBD with three replicates.

Table 8. Effect of application of PGPR as single inoculants '
on made tea yields after a period of one year.

Treatment	Made Tea Yield (kg/ha/year)
T1	3320 ab
T2	3144 b
T3	3226 ab
T4	3194 b
T5	3433 ab
T6	3534 ab
T7	3618 a
T8	2717 c
T9	2554 c
T10	2671 c
LSD (p=0.05)	406.33

Significant difference in made tea yields among the treatments could be observed at the end of one year period (Table 8). Treatment T7 with both inoculants added along with reduced rates of N and P recorded the highest yield. That was comparable with yields obtained in T1, T3, T5 and T6. Single inoculants added along with reduced rates of Nor P chemical fertilizers (T5 and T6) were not significantly different with their fertilizer controls (T2 and T3 respectively). Except with T10, treatments applied only with single inoculants (T8 and T9) recorded significantly lower yields compared to rest of the treatments.

Table 9. Effect of application of PGPR as single inoculants on Soil pH, organic carbon content, leaf N and leaf P contents at the end of one year.

Treatment	Soil pH	C %	Leaf N %	Leaf P%
T1	5.09	1.78 b	4.06 ab	0.143
T2	5.16	1.87 b	3.80 cde	0.126
T3	5.33	1.86 b	3.87 cd	0.150
T4	5.19	1.91 b	3.69 ef	0.137
T5	5.31	2.26 a	3.90 bcd	0.160
T6	4.96	2.16 a	3.96 abc	0.160
T7	5.55	2.21 a	4.08 a	0.146
T8	5.01	2.16 a	3.69 ef	0.153
T9	5.33	2.14 a	3.61 f	0.120
T10	5.48	2.15 a	2.39 g	0.080
LSD (p=0.05)	NS	0.162	0.162	NS
CV%	4.32	4.63	2.55	23.49

There was no significant difference in Soil pH and leaf P contents (Table 9). But significant differences could be observed in Soil carbon contents and leaf N contents. Treatments T1 to T4 showed significantly lower soil carbon contents compared to rest of the treatments. Treatment T7 showed the highest leaf N content and that was comparable with recommended rate of fertilizer treatment (T1) and Treatment T6. However, except in T10 in rest of the treatments, leaf N contents were within the desirable range for leaf N contents.

Evaluation of PGPR mixed inoculants for mid grown tea under growers' conditions

Three new experiments were commenced to evaluate PGPR mixed inoculants at Kalabokke Estate, Madulkelle, Rathwatta Estate, Ukuwela and Hantane Estate, Kandy. Plots were demarcated with 1000 bushes per treatment. Pretreatment yield monitoring was conducted. Experiments continued.

Evaluation of PGPR microbial formulations for low grown tea

Nitrogen fixing *Azospirillum* spp and phosphate solubilizing bacteria (PSB) were isolated using specific media from rhizosphere soil samples collected from low country tea estates in Galle, Matara, Kaluthara and Ratnapura districts representing Dodangoda, Pallegoda Malaboda, Weddagala, soil series, for the development of PGPR inoculants for low grown teas. They were screened in *vitro* for nitrogen fixation, phosphate solubilization and production of growth promoting substances. Most efficient *Aozspirillum* spp and PSB from each soil series were selected to formulate dual inoculant for the respective soil series and tested in nursery based on soil series level.

Two nursery experiments were commenced with three months old nursery tea plants in Kottawa and Deniyaya TRI Advisory and Extension Centers' tea nurseries in soils representing Dodangoda and Weddagala soil series respectively.

In nursery, dual inoculants were tested along with a modified T 65 fertilizer control composed of 50% N and P source replaced with ERP in place of DAP and compared with untreated control, un inoculated modified T 65 control and recommended dose of fertilizer control.

Treatments
T1: Absolute control
T2: Modified T 65 fertilizer control
T3: Inoculated treatment with Dual inoculant of respective soil series +T2
T4: Recommended rate of T65

Dual inoculant was added at the inception and chemical fertilizers were applied at fortnight intervals. Fifty replicates were maintained for each treatment. Experiments were conducted for a period of Ten months. Growth measurements were taken five months after treatment application and at termination. Destructive dismantling was done at termination, dry weights were recorded and used for nutrient analysis.

Table 10. Effect of application of dual inoculants on growth of nursery tea plants raised in soils belonging to Dodangoda and Weddagala soil series at the termination (240 days after inoculation).

Treatments	Dodangoda soil series			Weddagala soil series		
	Plant height (cm)	No. of leaves/plant	Total leaf area/plant (cm^2)	Plant height (cm)	No. of leaves/plant	Total leaf area/plant (cm^2)
T1	16.7 c	4.20 c	66 c	10.0 c	3.90 c	58.2 c
T2	44.6 b	12.2 b	271 b	38.6 a	12.3 a	320 a
T3	56.8 a	15.9 a	384 a	35.2 a	10.9 ab	272 ab
T4	47.7 b	16.6 a	361 a	25.6 b	9.10 b	203 b
LSD (p=0.05)	5.99	2.397	62.491	7.868	2.612	74.1
CV%	15.77	21.37	25.17	31.35	31.46	37.87

Experiment conducted in TRI Advisory and Extension Center, Kottawa tea nursery in soil belonging to Dodangoda soil series, significant differences were observed among the treatments in all measured growth parameters at 240 days after inoculation (Table 10, Plate 1). Inoculated treatment with 50% reduction of N and P replaced with ERP in T65 (Treatment T3) enhanced plant height significantly over rest of the treatments, but number of leaves and leaf area were comparable with recommended rate of fertilizer treatment (T4).

Plate 1. Effect of application of series specific dual inoculant on growth of nursery tea plants raised in soil belonging to Dodangoda soil series in TRI Advisory and Extension Center nursery, Kottawa, at termination.

However, in experiment conducted in TRI Advisory and Extension Center, Deniyaya tea nursery in soil belonging to Weddagala soil series, number of leaves and leaf area of plants in inoculated treatment T3 were comparable with both un inoculated fertilizer control (T2) and recommended rate of fertilizer treatment T4 (Table 10). But in un inoculated fertilizer control (T2) plants were in *banji* stage and less vigorous compared to plants in inoculated treatment T3 that had active shoots and much healthier appearance.

PLK Tennakoon and LRMC Liyanage

Project A 15.4: Establishing dolomitic limestone requirements for better growth of mature tea, in different tea growing regions at soil series level

The objective of this study is to examine the potentials of application of soil pH buffering capacity for correction of soil acidity in tea growing soils in place of initial pH of soil which is presently recommended by Tea Research Institute of Sri Lanka.

The field experiments are being carried out in following locations.

St. Coombs Estate - Mattakelle soil series
Opalgala Estate - Ukuwella soil series
El Teb Estate - Badulla soil series
Craighead Estate - Kandy soil series
Moragolla Estate - Pallegoda soil series

Following treatments have been imposed to each location.

Absolute Control (No Dolomite Application)

Dolomite application according to the Present TRI recommendations

Dolomite application based on pH the Buffering Capacity.

The results from Craighead Estate trial were presented in the Table 11.

Effect of different statergies of application of dolomite on soil pH

Based on the results dolomite application based on the pH buffering capacity recorded the highest pH value in both depths as well as in water and $CaCl_2$ though values were not significantly different.

Table 11. Effect of different stratergies of application of dolomite on soil pH at two different soil depths

Treatments	pH (Water)		pH ($CaCl_2$)	
	0-15cm	15-30cm	0-15cm	15-30cm
Without Dolomite (Control)	4.55a	4.43b	4.23a	4.02a
Present TRI Recommendation	4.55a	4.38ab	4.17a	4.10a
Dolomite application based on buffering capacity	4.69a	4.56a	4.37a	4.25a
LSD	0.50	0.52	0.47	0.42
CV%	4.80	5.14	4.88	4.56

†Values followed by same letter within a column are not significantly different at $p \leq 0.05$

Effect of different stratergies of application of dolomite on avilable Mg and Ca in the soil

An increase in soil exchangeable Mg was observed with the application of dolomite based on pH buffering capacity in both soil depths ($p \leq 0.05$). However, soil exchangeable Ca at 15-30 cm depth was significantly increased by dolomite application based on the pH buffering capacity of the soil (Table 14).

Table 12. Effect of different stratergies of application of dolomite on avilable Mg and Ca at two soil depths

Treatments	Exch. Mg		Exch.Ca	
	0-15cm	15-30cm	0-15cm	15-30cm
Without Dolomite (Control)	159a	327a	467a	99b
PresentTRI Recommendation	141a	387a	435a	157ab
Dolomite application based on buffering capacity	174a	307a	526a	216a
LSD	153	417	264	77.3
CV%	42.6	53.9	24.4	21.5

†Values followed by same letter within a column are not significantly different at $p \leq 0.05$

Intersestingly all treatments have magnesium far above the sufficiency level (60 mg/kg) for tea plant.

LRMC Liyanage, WMS Wijayatunga, SPSK Wijesinghe, BMTTK Senarathne, RMNS Bandara, DN Kahawewithana, SK Weerathunga and JRY Abeywardana

Project A 15.5. Development of economically viable slow releasing compound fertilizer for supplying of nitrogen, phosphorous, potassium and magnesium.

a) Evaluation of effects of application of different rates of slow release fertilizer at different frequencies on soil and plant nutrient status and yield (Adaptive trial)

The main objective of this study is to study yield response of mature tea to slow-release fertilizer produced by Sri Lanka Institute of Nano Technology Institute (SLINTEC) under growers' condition and to introduce economically viable slow releasing compound fertilizer.

Research trials and adaptive trials on the use of slow releasing compound fertilizer (NANO urea hybrid) have been completed and the final report was prepared. A farmer centered trial was commenced to get smallholders perceptions on the product prior to make firm recommendation which should be included into the final report. Draft report was submitted to the Technology Release Committee (TRC).

LRMC Liyanage, WMS Wijayatunga and OGKA Gunaratne

Project A15.6 Introduction of micro-nutrient fortified foliar formulation based on micro-nutrient status in tea growing soils (Adaptive trials) nutrient status in tea growing soils

Based on results of research trials, Zn, Zn+Mn and Zn+Mn+B have been selected as treatments for adaptive trials to validate them under farmers' condition.

The objective of this study is to introduce useful and economical micro nutrient formulation based on micro nutrient status in different tea growing soils under growers' conditions.

Following adaptive trials were established.

a) Natuwakelle Estate b) Deniyaya Estate c) Aislabey Estate

Trials at Deniyaya Estate and Natuwakele Estate were terminated in December 2021 and February 2022 respectively after completion of one pruning cycle.

The results of the Aislabey Estate trial are presented below (Table 13).

LRMC Liyanage, WMS Wijayatunga and SK Weerathunga

Experiment: Effect of application of micro nutrient fortified foliar formulation on soil/ plant nutrient status and yield, Aislabey Estate.

Effect of application of micro nutrient fortified foliar formulation on plant nutrient status

Zinc concentration in mother leaves was significantly different among treatments (Table 13). The optimum Zn concentration in mother leaves should be ranged from 10-40 mg/kg. Due to the unavailability of fertilizers, only one fertilizer application followed by a treatment application was performed during the year 2022. This could be the reason for lower levels of leaf micro nutrients recorded in mother leaves.

Manganese concentration in the mother leaf was not significantly different among treatments however, control recorded the lowest content in mother leaves. The sufficiency level of Mn is 100 mg/kg which two treatments recorded below to the critical level.

Table 13. Effect of foliar application of micro nutrients on Zn, Mn and B concentration in leaves (Aislabey Estate)

Treatments	Zn (mg kg^{-1})	Mn (mg kg^{-1})	B (mg kg^{-1})
Ground NPK (Control) + Zn	17ab	124a	14.2a
Ground NPK (Control) + Zn + Mn	14bc	82a	17.1a
Ground NPK (Control) + Zn + Mn + B	18a	115a	16.4a
Ground NPK (Control)	11c	73a	15.0a
LSD	4.6	54	6.06
CV%	9.52	17.14	12.10

Boron concentrations in mother leaves were not significantly different among treatments.

Effect of application of micro nutrient fortified foliar formulation on made tea yield

Made tea yield was not significantly different among treatments (Table 14).

Table 14. Effect of foliar application of micro nutrients on tea yield

Treatments	Made tea (kg ha^{-1} yr^{-1})
Ground NPK (Control) + Zn	2403a
Ground NPK (Control) + Zn+Mn	2416a
Ground NPK (Control) +Zn+Mn + B	2381a
Ground NPK (Control)	2328b
LSD	42.3
CV%	0.55

WMS Wijayatunga, LRMC Liyanag and SK Weerathunga

Project B 78: Studying root systems and architectures, with nutrient acquisition and cycling (C and N), using the mini-rhizotron, with a view to examine below and above ground relations for the promotion of sustainable tea growing.

Experiment 1: Study on the influence of Root architecture on nutrient uptake, growth and productivity of tea (St. Coombs Estate).

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

DMS Nawaratna, SPSK Wijesinghe, SK Weerathunga, WMS Wijayatunga and LRMC Liyanage

Project B 125. The survey on possible factors of contamination of made tea with Rare Earth Elements (REEs) in made tea in Sri Lanka.
The objective of this study was to study the potential contaminations of REE in made tea. Soil, leaf made tea and tea brew were analyzed for rare earth elements and the final report is being prepared.

LRMC Liyanage, WMS Wijayatunga and SK Weerathunga

D/SPND. Activities of Soils and Plant Nutrtion Division
Objectives: Divisional activities which cover all research overheads, including capital equipment, Research publications, training of students and technology dissemination of Soils and Plant Nutrition Division

Improvement of Land Productivity through Agronomic Practices

Thrust A 10. *In-situ* evaluation of establishment and growth performances of various plant species within tea inter rows before uprooting, grass species and soil quality index as an alternative to soil rehabilitation techniques

Project A 10.2. Feasibility of planting of new grasses as alternative rehabilitation grasses
Two new 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 laxmum*) and (T4) Mana (*Cymbopogon confertiflorus*), and also with (T5) No-Rehabilitation treatment. One another new Hybrid Super Napier species (*Pennisetum Purpureum x Pennisetum americanum*) (Variety-*Pakchong 1)* was included as a treatment at the site of Up-country location.

The experiment is being conducted at three locations

1. Gonakelle Estate, TRI, Passara (2018)
2. TRI- Hantane Station, Kandy (2019)
3. St. Coombs Estate, Field No 13, TRI- Talawakelle (2019)

Following treatments were applied at sites 1-3

T1	Hybrid Napier (*Pennisetum purpureum X Pennisetum americanum*) =*Pennisetum typhodieu purpureum*-Variety CO-3
T2	Mana (*Cymbopogon confertiflorus*)
T3	Guatemala *(Tripsacum laxum)*
T4	East Indian Lemongrass (*Cymbopogon flexuosus*)
T5	No Rehabilitation (No grasses) as Control

1. Gonakelle Estate, TRI, Passara

This experiment was established in 2018 February, using above five treatments with four replicates, with a plot size of 16'x24'. Grass planting spaces are 9"x2' (T2 and T4) and 1"x2' (T1 and T3). After the rehabilitation period, cultivar TRI 4078 was planted in 2021. Plant weight of second centering cutting is shown in Table 15.

Table 15. 2nd Centering Weight (g/plant) After 1 and 6 months after planting

Treatments	FW(g/plant)	DW(g/plant)
CO3(T1)	163.5(±7.3) [a]	57.2(± 2.6) [a]
Mana(T2)	158.8(±2.0[a])	55.4(± 0.7) [a]
Guatemala(T3)	158.4(±5.7) [a]	56.3(±2.2) [a]
Lemon grass(T4)	143.9(± 13.5) [a]	50.3(±4.7) [a]
No Rehabilitation(T5)	116.0(± 6.2) [b]	40.2(± 2.1) [b]
CV%	10.47	10.38
R Square	0.70	0.72
P	0.0058	0.0041
LSD	23.891	8.299

Values followed by the same letter in a column are not significantly different at $p< 0.05$

The significantly lowest ($P<0.05$) centering weight was recorded from non-rehabilitation plots. At the end of the year, tipping of tea bushes at the height of 45cm were carried out to start plucking. This experiment in progress.

2. TRI- Hantane station, Kandy

This experiment was established in 2019 October, using five treatments with three replicates, with a plot size of 16'x24'. Tea (TRI 4042) was planted in October 2021 after soil rehabilitation with above four grasses species. Large number of plants were dead due to drought and replanted the vacancies. This experiment in progress.

3. St. Coombs Estate, Field No 13, TRI- Talawakelle

This experiment included an additional treatment of Hybrid Super Napier – Pakchong 01 (spacing: 2'x1') as a potential soil rehabilitation grass, the grasses were planted in 2020 September, using six treatments with four replicates. Plot size was 10'x32'. Following are the treatments:

- T1 "Hybrid Napier" (*Pennisetum purpureum* x *Pennisetum americanum*)-Variety CO-3
- T2 "Hybrid Super Napier" (*Pennisetum purpureum* x *Pennisetum americanum*)-Variety -Packchong 1
- T3 "Guatemala" (*Tripsacum laxum*)
- T4 "Mana" (*Cymbopogon confertiflorus*)
- T5 "East Indian Lemongrass" (*Cymbopogon flexuosus*)
- T6 No Rehabilitation (No grasses) as Control

Lopping weight of the grasses after two years of planting are shown in Table 16. Biomass production of above ground on wet and dry basis under rehabilitation treatment of Packchong was significantly higher. The second biomass production was higher in CO3 Treatment than that under other three grass species Guatemala, Mana and Lemon grass, after one two years of planting ($p< 0.05$) (Table 16).

Table 16. Total lopping weight (Mt/ha) after 2 years of planting

Treatment	Fresh weight	Dry weight
CO3(T1)	227.3(±34.5)^{b}	50.4± 7.1^{b}
Packchong 1 (T2)	354.0± 44.5^{a}	77.8 ± 9.6^{a}
Mana(T3)	126.7± 11.2^{cd}	30.3 ± 3.1^{cd}
Guatemala(T4)	199.9± 18.9^{bc}	37.4 ± 4.1^{bc}
Lemon grass(T5)	63.0 ± 5.9^{d}	19.7± 2.0^{d}
CV%	27.14	26.16
R Square	0.86	0.84
P	<0.0001	<0.0001
LSD	81.1	10.5

Values followed by the same letter in a column are not significantly different at $p<0.05$

Biomass production of below ground (Root) dry basis under rehabilitation treatment of Packchong and CO3 were significantly higher than Guatemala, Mana and Lemon after one year and six months of planting ($p< 0.05$) (Table 17).

Table 17. Root weight after 1 year and 6 months of planting (Mt/ha)

Treatments	Fresh weight	Dry weight
CO3(T1)	31.2(±0.94)^{ab}	20.8(±0.72)^{a}
Packchong 1(T2)	39.2(±1.32)^{a}	19.8(±1.67)^{a}
Mana(T3)	22.2(±2.1)^{b}	13.1(±1.4)^{b}
Guatemala(T4)	37.8(±6.4)^{a}	15.1(±2.9)^{b}
Lemon grass(T5)	23.5(±2.6)^{b}	11.0(±1.4)^{b}
CV%	22.17	17.57
R Square	0.66	0.80
P	<0.0107	<0.0018
LSD	10.5	4.3

Values followed by the same letter in a column are not significantly different at $p<0.05$

Table 18 indicates There were no significant differences among treatments in earth worm population and white grub population in this experiment but highest earthworm pupation was observed in Packchong 1 (T2) grass treatment (Table 18) (<0.05).

Table 18. Earth worm population and white grub (no/m^2) at 60cm depth, after 1 year and 6 months of planting

Treatment	Earth worms	White Grubs
CO3(T1)	16.25 (±4.94)	5.25 (±2.10)
Packchong 1 (T2)	30.25 (± 16.81)	7.50 (±4.99)
Mana(T3)	15.25 (± 3.88)	6.33 (±4.11)
Guatemala(T4)	19.50 (±10.84)	2 (±0.82)
Lemon grass(T5)	22.25 (± 9.04)	5 (±2.12)
No Rehabilitation(T6)	7.25 (± 2.43)	10.75 (±5.81)
CV%	74.70	103.76
R Square	0.62	0.53
P	NS	NS
LSD	NS	NS

Values followed by the same letter in a column are not significantly different at $p<0.05$

The soil sampling and analysis were done for pH, soil carbon, total nitrogen, potassium and phosphorus. Experiment site is due for pruning. This experiment will be terminated after pruning assessment.

Project A 10.3. Soil Quality index

1. Evaluation of Growers Fields - Pedro Estate

A trial was established in 2017 at Pedro Estate, Nuwara Eliya, with cultivation of PK-2 cultivar with following three treatments.

T 1 - Planting after rehabilitation
T 2 - Direct planting
T 3 - Direct planting, with forking the land

Each treatment consists of three replicates. Made tea yield is given in Table 19.

There were significant different among treatments and highest made tea production was obtained under rehabilitation testament (Table 19) ($p<0.05$), showing nearly 23% yield increase than direct planted field. However, forking of the land has not benefitted to increase the tea yield.

Table 19. Made tea yield (kg/ha/yr.) for 2022

Treatments	Yield
Tea planting after Rehabilitation	2390.3(±43.3) [a]
Direct planting without forking	1947.1(±142.5) [b]
Direct planting with forking	1659.4(±103.8) [b]
CV%	9.38
R Square	0.86
P	0.0217
LSD	424.96

Values followed by the same letter in a column are not significantly different at p<0.05

MGS Liyanage, NPSN Bandara, EWTP Prematunga, SN Wijesekara and EMGPB Ekanayake

2. Evaluation of farmer fields with STaRR Project

Under this project, farmer fields identified by Small Scale Tea and Rubber Revitalization (STaRR) Project were first evaluated for nematode infestation, by Entomology Division. 237 fields were assessed from four districts. If found that 36 fields were infested with nematodes.

Nematode Analysis

Table 20. Number of fields analyzed for Nematode infestation in 2022, under STaRR project

District	Infected	Non infected	Total	Infected %
Galle	6	86	92	6.5
Matara	24	81	105	22.9
Ratnapura	1	20	21	4.8
Kandy	5	14	19	26.3
Total	36	201	237	15.2

After the fields were tested negative for nematode infestation, they were assessed for Soil Quality Index (SQI). 285 fields were assessed for SQI and 188 fields were found to be suitable for direct planting (with 66% success rate). In extent wise, after scrutinizing 103.1 ha, 71.2 ha was found to be suitable for direct planting (69.5%).

Table 21. Number of fields analyzed for Nematode infestation in 2022, under STaRR project

District		Rehabilitation	Direct Planting	Total
Galle	No.	26	72	98
	Ext (ha)	9.5	32.2	41.7
Matara	No.	30	73	103
	Ext (ha)	9.3	23.5	32.8
Ratnapura	No.	10	21	31
	Ext (ha)	3.2	9.4	12.6
Kandy	No.	31	22	53
	Ext (ha)	9.9	6.1	16.0
Total	No.	97	188	285
	Ext (ha)	31.9	71.2	103.1

NPSN Bandara, EWTP Prematunga, RBL Hemakumara and PGON Gunawardena

Project A 10.5. Soil erosion and conservation in mid elevation tea lands as affected by water-induced erosion in Sri Lanka

The experiment at the Kenilworth Estate, Ginigathhena, was established in 2020 with five treatments and three replicates at two slope levels which were categorized as low slope (20% – 30%) and high slope (60% -72%). Experimental plots with sediment tanks were established to collect runoff and sediments for measurement of soil and nutrient losses. Data were collected for a period of one year from August 2020 to November 2021. Weather data were gathered by the automated weather station installed in the field. Soil sampling was carried out in August 2020 prior to imposition of treatments and thereafter in March 2021 and December 2021. Soil chemical, physical and biological parameters were assessed to determine soil condition in the field. Data on runoff and sediments were recorded to determine the nutrient losses through the runoff water and sedimented soil.

Objectives

The objective was to quantify the soil erosion as affected by soil conservation measures by field method and soil erosion model in mid elevation tea-growing region in Sri Lanka.

Treatments

- T1- Stone Terrace (T)
- T2- Stone Terrace with Vetiver hedges (TV)
- T3- Terrace Wall (TW)
- T4- Tea only land (TO)
- T5- Bare (fallow) surface (B)

Results

Runoff of different soil conservation methods in high and low slope

In this study, runoff under tea (T4) was significantly lower than that of in the bare land (pr>0.0001) and the reduction of runoff under tea was 116%. As far as all the treatments were concerned, mean runoff in high slope was about 9% higher than that of low slope.

However, when runoff data of bare land is excluded, low slope recorded, a significantly higher (p>f 0.046) runoff (42%) in comparison with that of high slope. According to the runoff reduction estimates, the highest volume of runoff was reduced by 80% in T2, 68% in T3 and 55% in T1, in high slope when compared with T4. There was no significant difference in runoff among treatments (excluding bare soil-T5) in low slope. This could be due to significantly higher soil bulk density in low slope i.e. 1.588 g/cm^3. Higher soil bulk density resulted low pore space in soil leading to low water infiltration and percolation through the soil profile.

Table 22. Runoff under different soil conservation practices in high and low slopes

Slope	Soil conservation measure	Runoff ('000 l/ha/yr)
High	T1-Terrace	753.5 c
	T2- Terrace with Vetiver grass	332.9 c
	T3- Terrace wall	535.7 c
	T4- Tea Only	1681.8 b
	T5- Bare	4178.1 a
Low	T1- Terrace	1029.9 b
	T2-Terrace with Vetiver grass	1181.7 b
	T3- Terrace wall	1238.5 b
	T4- Tea Only	1245.0 b
	T5- Bare	2160.5 a

Soil loss of as affected by different soil conservation methods in high and low slope

Soils in tea land is eroded due to kinetic energy of raindrops and is washed-off with runoff water. Details of soil loss in the experimental site are given in Table 24. Soil loss in bare land and under tea was 8.1 t ha^{-1} yr^{-1} and 0.62 t ha^{-1}yr^{-1} respectively. There were no significant differences observed on soil loss between different soil conservation methods tested with compare to T5. However, soil conservation methods in high slope have shown comparatively lower soil loss than that in the low slope. In comparison with T4 (Tea only), the significant reduction of soil loss under T2, T3 and T1 were 78%, 67% and 50% respectively in high slope.

Table 23. Soil conservation methods and their impact on soil losses in high and low slopes

Slope	Soil conservation method	Mean soil loss (t/ha/yr)
High	T1- Terrace	0.40 c
	T2- Terrace with Vetiver grass	0.17 c
	T3- Terrace wall	0.26 c
	T4- Tea Only	0.80 c
	T5- Bare	12.84 a
Low	T1- Terrace	0.56 c
	T2- Terrace with Vetiver grass	0.66 c
	T3- Terrace wall	0.57 c
	T4- Tea Only	0.45 c
	T5- Bare	3.44 b

Nutrient Loss through soil erosion in tea land

Nutrient loss with the soil sediment and runoff is a common scenario. But those losses may be drastically changed due to different land use systems. Implementation of soil conservation measures is important to reduce soil and water losses thus reducing the nutrient losses from tea land with sediments and runoff. Table 24 shows the removal of major nutrients under different soil conservation measures. Both runoff and sediment were used to analysis N and P and only runoff used for K. According to the results, tea land without soil conservation measures has removed higher nutrient content by erosion. The lowest nutrient removal was found under terrace with Vetiver grass.

Table 24. Nutrient losses under different soil conservation measures in tea land

Soil conservation measures	N (kg/ha/yr)	P (kg/ha/yr)	K (kg/ha/yr)
T1- Terrace	6.29	0.93	3.37
T2- Terrace with Vetiver grass	2.81	0.40	1.27
T3- Terrace wall	4.33	0.51	2.09
T5- Tea Only	14.19	2.34	8.39

LASP Jayasinghe and EB Ekanayake

Thrust A 19. Irrigation and Water Management

Project A 19.1. 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 being conducted on St. Joachim Estate, Ratnapura to see the efficacy of drip and sprinkler irrigation on tea growth. In **Experiment A**, two tea cultivars, *TRI 4061* and *TRI 2021* were planted with and without drip irrigation in 2013 June. **Experiment B** is evaluation of response of young tea plants to sprinkler irrigation. The experimental design is a CRD; Cultivars *TRI 2023, TRI 2027* and *TRI 4004* are used in the experiment. Early growth of young tea plants was evaluated under the drip and sprinkler irrigation at these two separate trials.

In Experiment A, significant difference was observed under irrigated and rainfed treatments in both cultivars. No significant growth differences were observed in treatment wise or cultivar wise.

Table 25. Plant girth of drip irrigated and rain-fed two cultivars

Cultivar	Rainfed	Irrigated
TRI 2021	6.10(±0.34)	6.23(±0.37)
TRI 4061	6.32(±0.30)	6.73(±0.49)

In Experiment B, highest girth in the plant growth was observed from cultivar TRI 2027, under irrigated conditions, where it showed a girth of 6.49 (±0.21) cm, as against 6.14 (±0.28) cm of rainfed treatment. Difference in growth was not so significant for cultivar TRI 2027 and TRI 4004. Following Table shows the girth of three different cultivars under rainfed and irrigation conditions.

Table 26. Plant girth of three different tea cultivars, as response to sprinkler irrigation

Cultivar	Rainfed	Irrigated
TRI 2023	6.02(±0.05)	6.24(±0.51)
TRI 2027	7.69(±0.54)	7.82(±0.66)
TRI 4004	5.76(±0.48)	5.95(±0.16)

Effect of Sprinkler Irrigation in Tea Coconut Intercropping Field

Experiment was established in 2018 December in a mature tea field of TRI 2021 (2014 planted, 5 year old) in a coconut intercropping farming system at Field No 01, St. Joachim Estate, with the assistance from Hallmark Irrigation, India and Tea Small holder Federation. Irrigation was applied at shorter droughts. Yields were recorded, in six plots (3 irrigated, 3 rainfed).

Plant girth was measured at the end 2020, selecting 10 plants each for sprinkler irrigated and rainfed 10 plants, each from cultivars TRI 2021, TRI 2026 and TRI 2027.

Table 27. Plant girth as response to sprinkler irrigation under tea x coconut intercropping field

Cultivar	Rainfed	Irrigated
TRI 2021	3.95 (±0.17)	4.35 (±0.19)
TRI 2026	4.80 (±0.11)	5.07 (±0.17)
TRI 2027	5.39 (±0.18)	5.38 (±0.19)

Weekly green leaf yield was recorded for 6 plots (3 rain-fed and 3 irrigated) of TRI 2021 cultivar. Each plot consists of 51 (±1) plants. Following Table shows the total harvested green leaf yield for 2022 as made tea kg/ha. Irrigated plots showed a increase of 7% than rainfed plots. This could be due to the fact that year 2022 was a wet year with ample monthly rainfalls. In addition, there were interruption to fertilize the plots properly. However, during first 3 months of the year, irrigated plots recorded a 18% higher yield than rainfed plots.

Table 28. Made tea yield in 2022as response to sprinkler irrigation under tea x coconut intercropping field

Rain-fed	Irrigated
3226.9(±126)	3016.2(±116)

Performance of Tea (*Camellia sinensis*) in Marginal Growing Areas of Sri Lanka

Physiological performance of tea plants grown in Rambukkana, a marginal growing area, was evaluated in 2022, for dry season and wet seasons. The mature tea plants are grown with under irrigation. During, the early three months of the year, there was a severe moisture stress, based on daily precipitation. However, leaf temperature remained higher during the wet season as well. Photosynthesis increased only by 24% during wet season. Transpiration was reduced by only 4%. However, stomatal conductance was increased by 110% during wet season.

Table 29. Physiological response of tea grown in Rambukkana Sri Lanka during dry season and wet season

Measurement	Dry season	Wet season
Leaf temperature (^{0}C)	42.2 (±0.19)	39.2 (±0.28)
Transpiration rate (mmolm^{-2}s^{-1})	7.4 (±0.15)	7.1 (±0.18)
Stomatal conductance (mmolm^{-2}s^{-1})	0.388 (±0.02)	0.829 (±0.04)
Photosynthetic rate (µmolm^{-2}s^{-1})	11.04 (±0.27)	13.73 (±0.30)
Water use efficiency	1.49	1.93

Project A 19.4. Evaluating an appropriate rain water harvesting and retention method and effectiveness of rain water use for tea

1. Construction of Sustainable Terraces with soil additives for improve rain water harvesting and other agronomic practices

An experiment was established in 2021 July, converting a rehabilitated tea field with new planting with TRI 4049 cultivar. Earlier experiment on terrace farming has shown that it improves the water holding capacity of the filed, reducing run off as well. Following treatments, were added as soil amendments, prior to planting.

1. Paddy husk biochar – 1.25 kg/plant (T1)
2. Charcoal application – 750 g/plant (T2)
3. Compost application – 2 kg/plant (T3)
4. Burning of wood debris – 0.6 m height (T4)*

Under the T4 treatment, organic litter like old leaves and twigs were burnt in the plot, prior to making the planting holes. The litter was heaped to a level of 0.6m height in each plot. Each plot consists of ten plants. Following growth parameters were measured in 2023 January. Best performance was observed from paddy husk bio-char application.

Table 30. Plant growth parameters, after 18 months of field planting

Treatment	Gith (cm)	Branch no.	Leaf no.
Paddy biochar(T1)	1.84(±0.06) [a]	10.55(±0.94)	150.8(±13.3) [a]
Charcoal (T2)	1.55(±0.08) [b]	10.20(±1.0)	102.7(±11.7) [b]
Compost (T3)	1.54(±0.08) [b]	9.05(±1.0)	105.2(±9.6) [b]
Burnt wood debris (T4)	1.66(±0.07) [ab]	9.30(±0.88)	113.7(±5.5) [b]
CV%	20.5	ns	39.53
R^2	0.112	ns	0.15
P	0.023	ns	0.0054
LSD	0.21	ns	29.39

NPSN Bandara, EWTP Prematunga, RBL Hemakumara and PGON Gunawardena

Thrust A 34. Development of shade management strategies for different regions

Project A 34.1. Evaluating identified shade-tree species and establishing cultural practices

a) High Shade + Medium Shade, Yainna Division, Houpe Estate, Kahawatta

The experiment was established in 2014 with seven treatments arranged in RCBD with 3 replicates. *Gliricidia sepium* was established as medium shade commonly in all the plots.

The treatments are as follows.

T1 -	(DM-40x40)	*Derris microphylla* (40'x40')	+	*Gliricidia* (10'x10')
T2 -	(DM-30x30)	*Derris microphylla* (30'x30')	+	*Gliricidia* (10'x10')
T3 -	(DM-20x30)	*Derris microphylla* (20'x30')	+	*Gliricidia* (10'x10')
T4 -	(CN-40x40)	*Cassia nodosa* (40'x40')	+	*Gliricidia* (10'x10')
T5 -	(CN-30x30)	*Cassia nodosa* (30'x30')	+	*Gliricidia* (10'x10')
T6 -	(CN-20x30)	*Cassia nodosa* (20'x30')	+	*Gliricidia* (10'x10')
T7 -	(AM-40x40)	*Albizzia molluccana* (40'x40')	+	*Gliricidia* (10'x10')

There were continuous disturbances in data collection and field operations during the year 2022 due to problems with fuel for travelling. However, growth performances of high shade species and tea crop were recorded and other agronomic practices were carried out as far as possible. Growth performances of high shade trees are presented in the Table 31.

Table 31. Growth performance of high shade trees

Treatment	Trunk girth (cm)	Plant height (m)
DM-40x40	79.5^{bc}	11.5^{bc}
DM-30x30	91.5^{b}	13.4^{b}
DM-20x30	73.7^{bc}	10.9^{cd}
CN-40x40	75.45^{bc}	8.8^{d}
CN-30x30	69.3^{c}	4.2^{e}
CN-20x30	68.2^{c}	5.5^{e}
AM-40x40	186.4^{a}	17.4^{a}
CV%	12.0	18.7

Values sharing the same letter in a same column are not significantly difference at *p*=0.05. Chest height = 1.25 m from the ground level. Girth was measured as the circumference

Albizia (control) plants recorded a significantly (*p*=0.05) larger trunks, measured as the girth (circumference) at chest height, compared to that of *Derris* and *Cassia*. Further, the height of *Derris* plants was significantly less than that of *Albizia* (Table 31). Canopy diameters and number of branches were not recorded as shade plants were pruned. Collar region bark damages in *Cassia* due to porcupine attacks has resulted more casualties than before. However, no pest or disease attacks were reported in *Derris,* as usual.

The Table 32 presents the details on the growth of tea under different high shade systems in the experiment.

Table 32. Growth and yield of tea

Treatment	Trunk girth at Collar region (cm)
DM-40x40	17.1^{a}
DM-30x30	12.5^{a}
DM-20x30	13.4^{a}
CN-40x40	16.6^{a}
CN-30x30	14.8^{a}
CN-20x30	15.5^{a}
AM-40x40	12.4^{a}
CV%	18.2

Values sharing the same letter are not significantly difference at *p*=0.05. Girth was measured as circumference.

Comparable (*p*=0.05) growth was observed in tea plants grown under all high shade systems. Therefore, it can be suggested that the growth (girth) of tea under different new shade trees were not significantly different from *Albizzia* (control) (Table 32).

Experiment is in progress.

SRW Pathiranage, MSG Liyanage, EWTP Premathunga, PB Ekanayake, O Gunawardhane and RBL Hemakumara

b) High shade + Medium shade – Middle Division, Thalgaswella Estate, Galle

This experiment was initially established in 2014. Treatments (high shade) were arranged in RCBD with 3 replicates in combination with *Gliricidia sepium* common in all plots, as medium shade. High shade tree species used as treatments are given below.

T1 -	(DR- 40x40)	*Derris robusta.* (40'x40')	+	*Gliricidia* (10'X10')
T2 -	(CS-40x40)	*Cassia siamea* (40'x40')	+	*Gliricidia* (10'X10')
T3 -	(AM-40x40)	*Albizzia molluccana* (40'x40')	+	*Gliricidia* (10'X10')

Due to lack of transport facilities, collection of data could not be carried out in 2022.

Experiment is in progress.

SRW Pathiranage, MSG Liyanage, EWTP Premathunga, PB Ekanayake, O Gunawardhane and RBL Hemakumara

c) High shade + Medium shade – Dottala Division, Elkaduwa Estate, Elkaduwa

This experiment was established in 2017. Treatments were arranged in RCBD with 3 replicates as presented below.

T1 -	(DM-20x20)	*Derris microphylla* (20’x20’)	+	*Erythrina* (10’x10’)
T2 -	(DR-20x20)	*Derris robusta* (20’x20’)	+	*Erythrina* (10’x10’)
T3 -	(GR-20x20)	*Grevillea robusta* (20’x20’)	+	*Erythrina* (10’x10’)
T4 -	Control	No High Shade	+	*Erythrina* (10’x10’)

Table 33. Growth of high shade trees and tea and estimated tea yield under different shade systems

Treatments	Main Stem Girth*			Made Tea Yield**
	Shade tree at Collar	Shade tree at Chest Height	Tea at Collar	
DM-20x20	58.9[a]	47.5[a]	4.1[a]	3078.5[a]
DR-20x20	45.9[b]	36.7[b]	4.4[a]	2358.5[a]
GR-20x20	47.6[b]	36.5[b]	4.1[a]	2601.9[a]
No High Shade	-	-	3.7[a]	2322.7[a]
CV%	9.6	9.1	11.1	33.5

Values sharing the same letter in a same column are not significantly difference at *p*=0.05.

* - Girth was measured circumference.

** - Made tea yield was calculated considering 12500 tea bushes per ha and 21.5% made tea outturn.

Derris microphylla recorded the highest trunk girth (circumference) both at collar region and at the chest height (1.25m above ground level) while *Derris robusta* reporting comparable trunk girth with *Grevillea robusta.* Girth (circumference) of the main stem at collar region and yield of tea did not show any significant difference among all the treatments (Table 34).

The experiment is in progress.

SRW Pathiranage, MSG Liyanage, EWTP Premathunga, PB Ekanayake and SN Wijesekara

d) High shade + Medium shade – Wewebedda Division, Batawatta Estate Madolsima

This experiment had been previously established on Pitaratmale Estate and was re-located on Batawatta Estate in 2022 due to heavy drought casualties occurred at the former location. Following treatments were arranged in RCBD with 3 replicates.

T1 -	(DM-20x20)	*Derris microphylla* (small leaflets) (20’x20’)	+ *Erythrina* (10’x10’)
T2 -	(DR-20x20)	*Derris robusta* (large leaflets) (20’x20’)	+ *Erythrina* (10’x10’)
T3 -	(GR-20x20)	*Grevillea robusta* (20’x20’)	+ *Erythrina* (10’x10’)
T4 -	Control	No high shade	+ *Erythrina* (10’x10’)

Planting of high shade trees delayed considerably due to transport difficulties during 2022. Planting of high shade trees continues and the experiment is in progress.

SRW Pathiranage, MSG Liyanage, EWTP Premathunga, PB Ekanayake and SN Wijesekara

e) High shade + Medium shade – Field No. 7, Eildon Hall Estate, Talawakelle

This experiment had been previously established on Meddacoombra Estate and was re-located on Eildon Hall Estate in 2022 due to heavy casualties. Following treatments were arranged in RCBD with 2 replicates.

T1	(DM-20x20)	*Derris microphylla* (small leaflets) (20’x20’)	+	*Erythrina*(10’x10’)
T2	(DR-20x20)	*Derris robusta* (large leaflets) (20’x20’)	+	*Erythrina*(10’x10’)
T3	(GR-20x20)	*Grevillea robusta* (20’x20’)	+	*Erythrina*(10’x10’)
T4		No high shade	+	*Erythrina*(10’x10’)

There were significant delays in planting of high shade trees and other agronomic practices due to transport problems during the year 2022.

Planting was completed and experiment is in progress.

SRW Pathiranage, MSG Liyanage, EWTP Premathunga,
PB Ekanayake and SN Wijesekara

Project A 34.3 Development of pests and diseases management strategies for shade trees different AERs

Disease management tactics have been tried out for canker and dieback of Grevillea due to infection of Botryosphaeriacea fungi. Long term field monitoring has been continued after application of wound dressing at St. Coombs Estate.

GD Sinniah and DGNP Karunajeewa

CROP PROTECTION

Identification of safe pesticides and designing IPM methods

Thrust 22. Development of cost-effective control methods for integrated management of SHB

Project A 22.2. Screening biological control agents for reducing SHB damage in immature and mature tea

Mass production of Entomopathogenic Fungus (EPF) *Beauveria bassiana* and experiment continued. Progress reported in Project B 146.

NAIM Nissanka, AMP Sammani, R Wjewardana and RDPD Senanayake

Project A 22.6. Screening of Plant Protection Products for reducing SHB damage

Experiment E 414 (II): Evaluation of tea stem bark volatiles as attractants using multifunnel traps for mass trapping of SHB at different lure heights

Objective	: To determine the effective lure height for mass trapping of SHB using tea stem bark volatiles (kairomones).
Experimental site	: Field No. 07, Attampitiya Estate
Experimental Design	: Split-plot design with 3 replicates

Treatments:

T1: Blend of tea stem bark volatiles
T2: Ethanol 70%
T3: Control

The effective lure height for attracting of SHB was determined by placing the above treatments at two different heights as H1 (3 ft) and H2 (6 ft) from the ground level. Multifunnel traps (imported from the Company of Synergy Semiochemicals) were placed in the field at a distance of 15 m apart. Trap counts of SHB were monitored at monthly intervals from May to December.

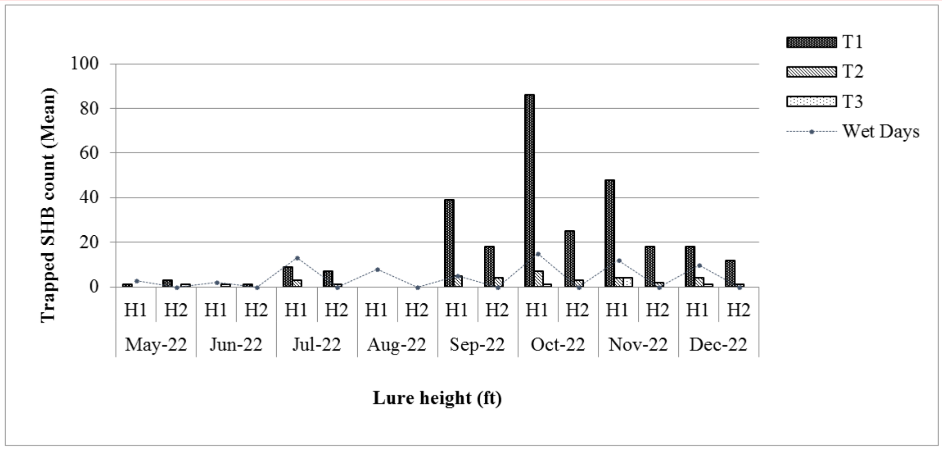


Figure 1. Trapped SHB beetle counts in different treatments at two lure heights

Results and Discussion

Trapped SHB beetle counts were gradually increased with the time from May up to October and then declined. Trapped counts of SHB beetles in T1 (blend of tea stem bark volatiles) which placed at the 3 ft hight from ground level were significantly higher than the T1- (blend of tea stem bark volatiles) placed at the 6 Ft hight from ground level. Experiment is continued with monthly assessments.

NAIM Nissanka, PADS Sumathipala, R Wijewardana, AMP Sammani and RDPD Senanayake

Thrust A 23. Development of integrated management strategies to control major tea diseases

Project A 23.4. Screening synthetic fungicides and pre-harvesting intervals (PHIs) for managing blister blight

Screening a nano copper formulation against blister blight disease in tea

The objectives of the studies were to test the efficacy of a nano-copper formulation (Copper sulphate pentahydrate 5.2% w/w) against blister blight disease in tea, to determine its effective concentration and to determine the residue levels in the made tea in declining trial/s (for effective dose). All the tests carried out to achieve the above objectives are summarized below.

Solubility of the product

Ten ml of Copper sulphate pentahydrate 5.2% w/w (ICC60) was dissolved in 100 ml water. Solubility of the solution, colour, clearness of the solution and sedimentation were observed. Each 10 g of copper hydroxide WG formulation and 10 g of copper oxide WP were dissolved separately in 100 ml water for comparison.

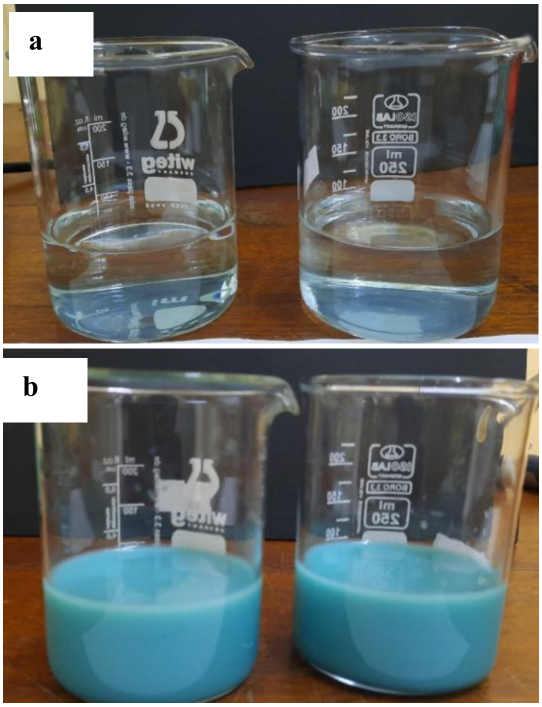


Figure 2. Solution of 0.1% Copper sulphate pentahydrate 5.2% w/w (a) 37.5% copper hydroxide WG (b) and 50% copper oxide (c). Cont.,

Figure 2. Solution of 0.1% Copper sulphate pentahydrate 5.2% w/w (a) 37.5% copper hydroxide WG (b) and 50% copper oxide (c).

Copper sulphate pentahydrate 5.2% w/w completely dissolved in water giving a clear, slightly bluish solution. Sedimentation was not observed even after leaving it for 30 minutes. Copper hydroxide and Copper oxide dissolved in water but sedimentation was observed in both products soon after stopping the stirring. Sedimentation was higher in copper oxide compared to copper hydroxide.

Efficacy trials

Trial 1**:** The experiment was carried out at the field No. 11 Lower Division, St. Coombs Estate, Talawakelle during October to November 2020. Tea cultivar grown in the field was TRI 2025 and the field was in 1st year cycle after pruning.

Trial 2: The trial was carried out at the field No. 8 in Lower Division, St. Coombs Estate, Talawakelle during July to October 2021. Tea cultivar grown in the field was TRI 2024 and the field was in 1st year cycle after pruning.

Trial 3: The confirmation trial was carried out at the field No. 8 in Lower Division, St. Coombs Estate, Talawakelle during May to July 2022. Tea cultivar grown in the field was TRI 2024 and the field was in 2nd year cycle after pruning.

Experimental design:

The experimental design was Randomized Complete Block Design (RCBD). There were 06 treatments and each replicated thrice. The basic experimental unit, a plot, had 30-35 tea bushes. The treatments imposed were as follows: T1- 0.05% Copper sulphate pentahydrate 5.2% w/w, T2-0.1% Copper sulphate pentahydrate 5.2% w/w, T3- 0.2% Copper sulphate pentahydrate 5.2% w/w, T4- 0.3% Copper sulphate pentahydrate 5.2% w/w, T5- 0.1% recommended copper hydroxide WG and T6- Control. Chemical spraying was carried out at weekly interval. Harvestable shoots with bud and three leaves were harvested at 7-8 days' interval. One hundred shoots with bud plus three leaves were selected randomly. Blister blight severity was assessed on 3rd leaf from the bud using 0-6 score blister blight assessment key

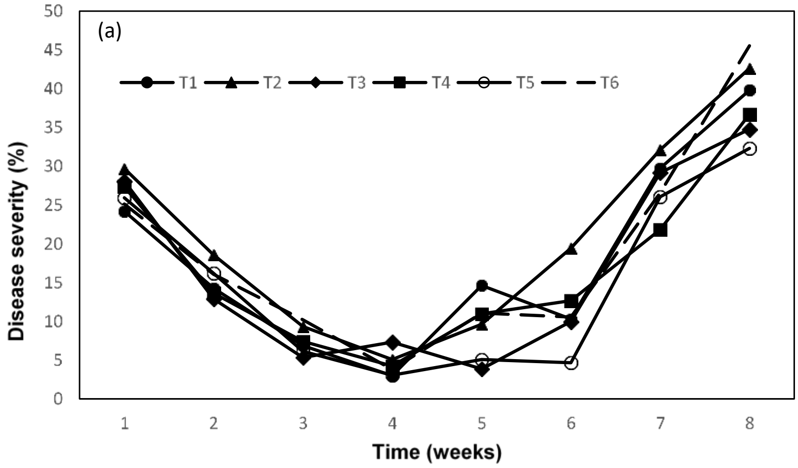
Statistical analysis:

The data were analyzed using two-way ANOVA in R software 4.2 to see the statistical differences between the treatments and blocks.

Results

Trial 1

Figure 3a illustrates the disease progression curve of blister blight during the experiment and 3b shows the Area Under the Disease Progression Curve (AUDPC). Blister blight disease severity among the treatments was significantly different ($p<0.05$) where Copper hydroxide WG treatment showed significantly lower disease severity. Blister blight disease severity in all the Copper sulphate pentahydrate treatments was comparable to disease severity in the untreated control.



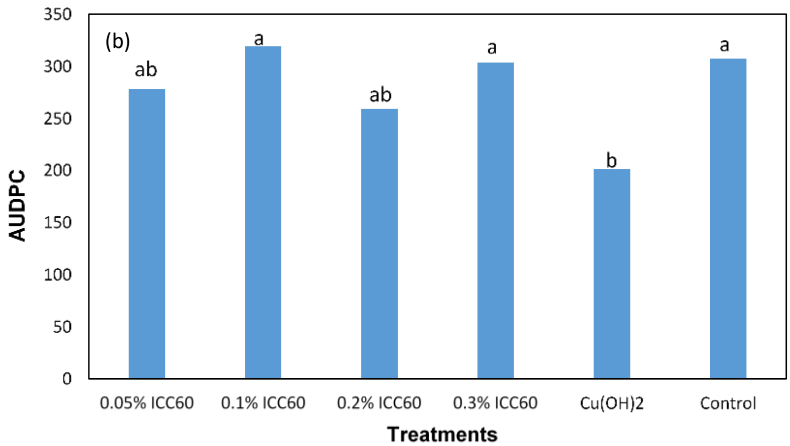
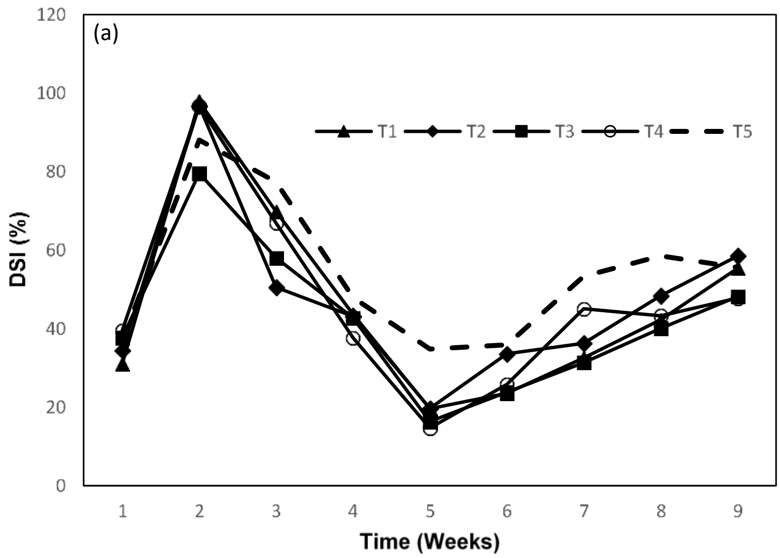


Figure 3. (a) The disease progression curve of blister blight and (b) Area Under the Disease Progression Curve (AUDPC) in the Field No 11, Lower Division, St. Coombs during October to November 2020. Bars with same letter are not significantly different at $p\leq0.05$.

Trial 2

Disease severity and AUDPC values were significantly lower in the plots treated with Copper sulphate pentahydrate and standard copper hydroxide fungicides ($p<0.05$) compared to the untreated control (Figure 3). Significantly lower disease severity in terms of AUDPC was recorded in 0.1% and 0.3% Copper sulphate pentahydrate application which was comparable to the blister blight control achieved by standard copper hydroxide treatment (Figure 3 b). Copper sulphate pentahydrate application at 0.2% did not significantly reduce the disease level when compared to the untreated control which resulted significantly higher disease severity.



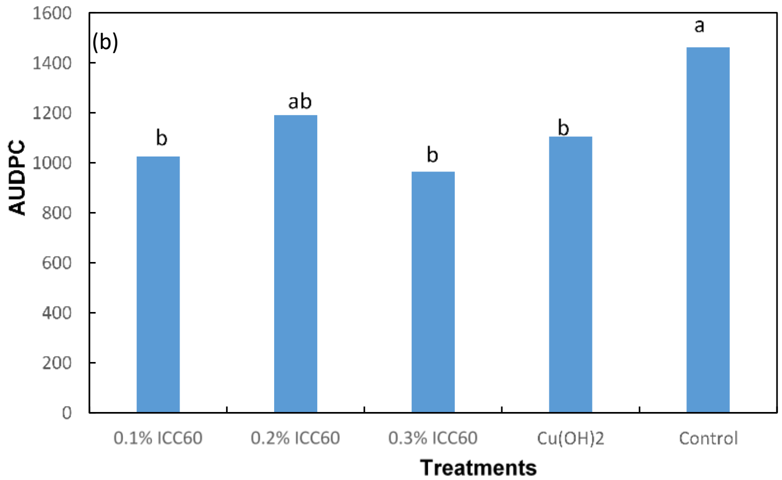
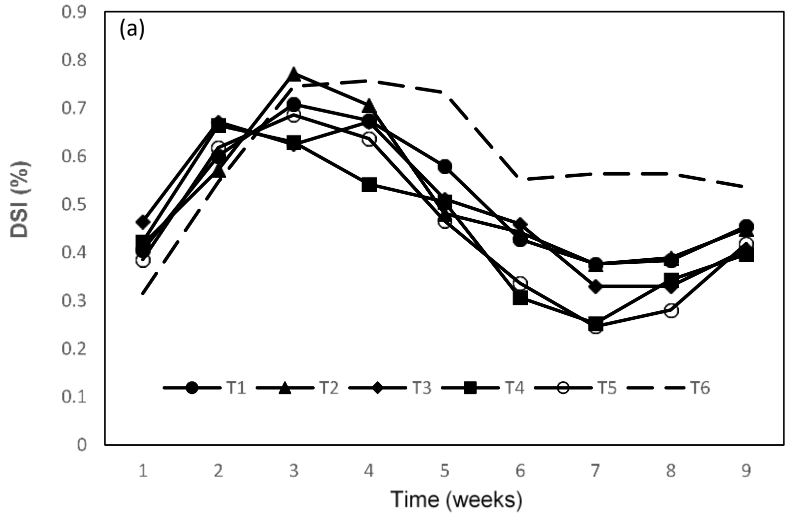


Figure 4 (a) The disease progression curve of blister blight and (b) Area Under the Disease Progression Curve (AUDPC) in the Field No 8, Lower Division, St. Coombs during July to October 2021. Bars with same letter are not significantly different at $p \leq 0.05$

Trial 3



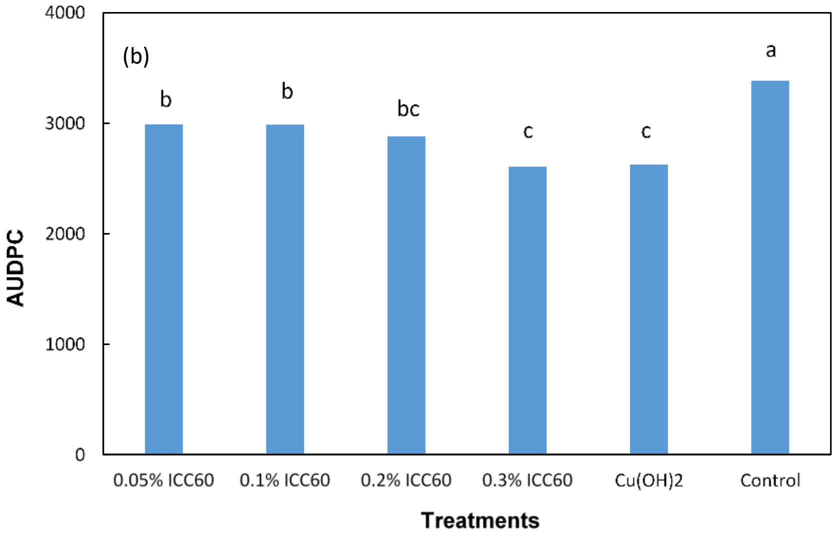


Figure 5 (a). The disease progression curve of blister blight and (b) Area Under the Disease Progression Curve (AUDPC) in the Field No 8, Lower Division, St. Coombs during May to July 2022. Bars with same letter are not significantly different at $p \leq 0.05$

Figure 5 a and b show significant variation in blister blight severity among the treatments ($p<0.05$) where untreated control showed the highest DSI and AUDPC. Among the Copper sulphate pentahydrate fungicide treatments, the lowest disease severity was recorded in 0.3% concentration, which is comparable to the disease severity in 0.1% copper hydroxide treatment. Copper sulphate pentahydrate applications at 0.05, 0.1% and 0.02% also showed significantly lower disease severity compared to the untreated control. The disease severity achieved in 0.05 and 0.1% Copper sulphate pentahydrate was significantly higher than that of 0.1% copper hydroxide treatment.

Pruned field trial

Experimental site

The trial was conducted at Field No.7, Lower Division of St. Coombs Estate, Talawakelle during September to December, 2022. Tea cultivar grown in the field was TRI 2025. The field was just after pruning.

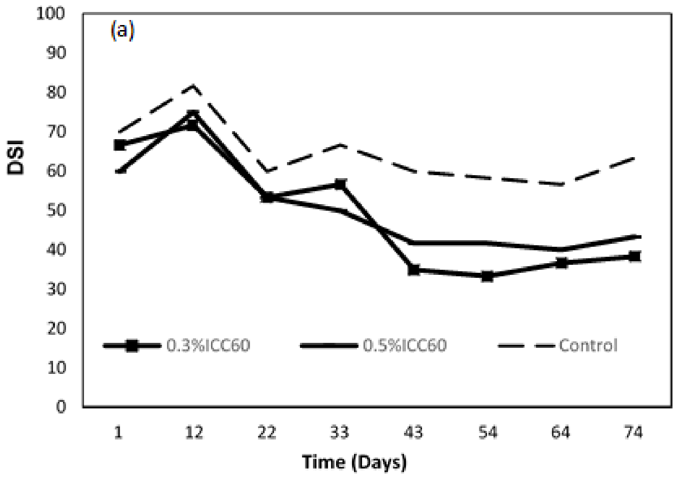
Experimental design

The experiment design was Randomized Complete Block Design (RCBD) with 3 treatments as follows;

T1-0.3% Copper sulphate pentahydrate
T2-0.5% Copper sulphate pentahydrate
T3-Unsprayed Control

Each treatment was replicated twice. The basic experimental unit, a plot, had 20-25 tea bushes. The treatments were applied at 5-7 days' interval depending on weather conditions. Disease severity of individual bushes in each plot was assesed using the disease assessment key in pruned fields at 10 days interval. AUDPC calculation and statistical analysis were carried out as described in Trial 1. Total tipping weight of each plot was measured at the time of tipping.

Results:



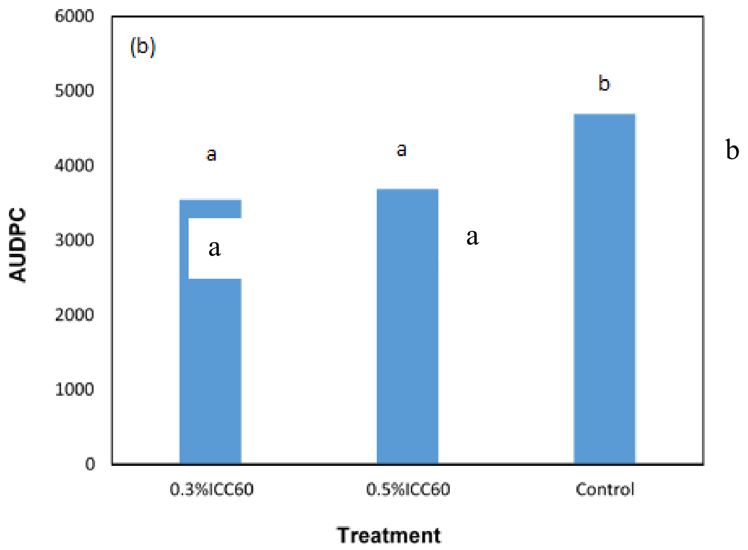
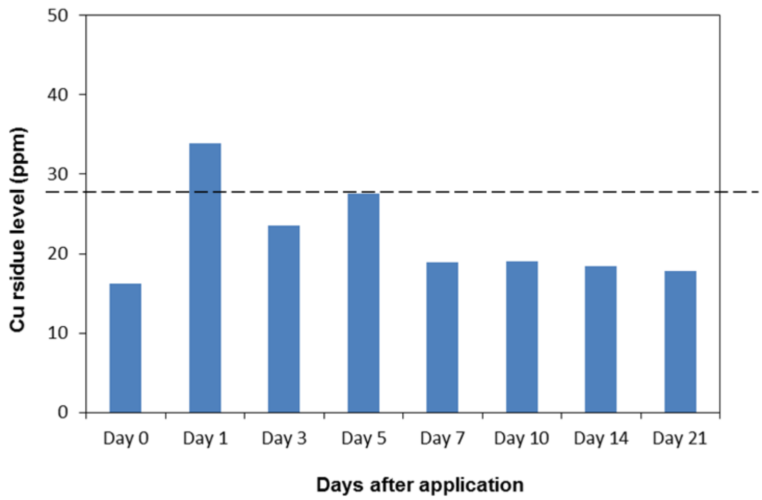


Figure 6 (a) The disease progression curve of blister blight (b) Area Under the Disease Progression Curve (AUDPC) of in the pruned field (Field No 7, Lower Division, St. Coombs) during September to November 2022. Bars with same letter are not significantly different at $p \leq 0.05$

Figure 6 shows the disease progressive curve (a) and AUDPC (b) of blister in a pruned field. The blister blight disease severity was significantly lower in Copper sulphate pentahydrate 0.3% application compared to the untreated control. Increasing concentration of Copper sulphate pentahydrate to 0.5% did not result in significant disease reduction when compared to 0.3% application.

Residue trial

A declining trial was conducted at St. Coombs, Talawakelle as per FAO and Organization for Economic Co-operation and Development (OECD) guided protocols during wet season (August to September 2022). Copper sulphate pentahydrate concentration tested was 0.3% with two replicated blocks. This concentration was selected as it resulted lower blister blight disease severity in trials conducted in plucking fields. Samples were taken at 0, 1, 3, 5, 7, 10, 14 and 21 days after the application of the chemical. Samples were subjected to miniature processing and copper residue was analyzed at the Soils and Plants Nutrition Division, TRI.



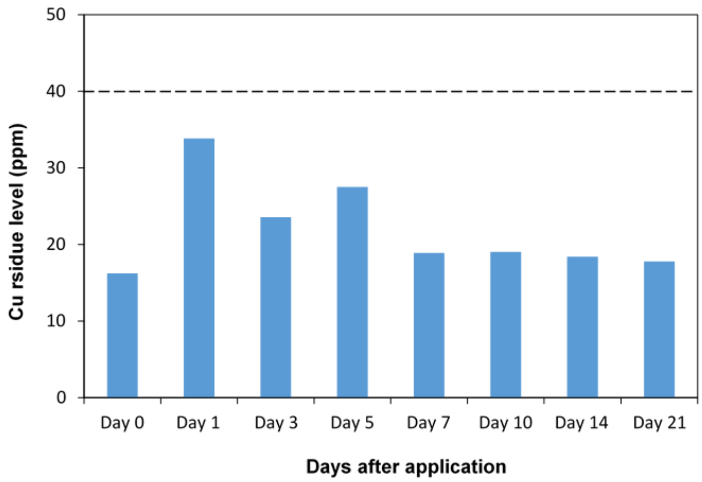


Figure 7. Levels of copper residue in the final product when Copper sulphate pentahydrate was sprayed at 0.3%. The broken line indicates the European Union's (EU) Maximum Residue Limit (MRL) for Cu 40 ppm.

Results:

Figure 7 shows the levels of Cu residue in the final product, i. e made tea processed in the miniature scale after Copper sulphate pentahydrate (ICC60) sprayed at 0.3%. Throughout the experimental period (Day 1 – Day 21), the levels of copper residue in Copper sulphate pentahydrate treated samples were lower than 40 ppm, the Maximum Residue Limit (MRL) allowed by European Union (EU) for copper.

GD Sinniah, M Niranjan, DGNP Karunajeewa, CDN Priyadarshani, SMSM Samarakoon, RPVT Chandralal, KLSC Gunawardana

Project A 23.5. Evaluating and introducing epidemiological based stem disease management strategies

Testing biocontrol agent *Trichoderma* Tric 33 against Horse Hair Blight

Laboratory bioassays

A 5 mm diameter agar disc containing Horse Hair blight pathogen, *Marasmius equirinus* isolate was taken from actively growing margin of seven days old pure cultures and placed on one side of a PDA plate separately. The same day old 5 mm agar disc of *Trichoderma* Tric 33 was placed on the opposite side of the petri dish for dual culturing. PDA plates inoculated only with the *M. equirinus* isolate were maintained as the control. The cultures were incubated at 25 ºC. For each treatment three replicates were maintained and the experiment was repeated three times. The antagonistic activity was calculated and represented as Percentage Inhibition of Radial Growth (PIRG). *Trichoderma* Tric 33 resulted an average of 89.6±1.1% inhibition of radial growth of *M. equirinus*.

Field trial

A preliminary field trial to test the efficacy of bio control agent (*Trichoderma* sp. Tric 33) against Horse Hair Blight fungus in a pruned field was established at St. Joachim Estate. Microplots were marked with five bushes per plot and a replicate plot was maintained for each treatment. Following treatments were imposed 2 months after pruning of the bushes.

T_1 – Untreated control

T_3–*Trichoderma* application

T_3 – Application of systemic fungicide Tebuconazole

The disease severity was assessed using an assessment key before and after the treatment applications. The results showed application of biopesticide *Trichoderma* Tric 33 resulted lower disease severity index when compared to the untreated control and fungicide treatment (Figure 8).

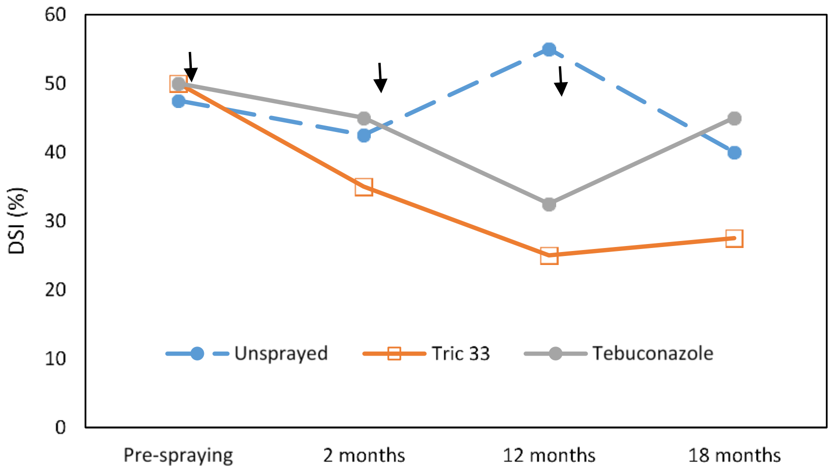


Figure 8. Average disease severity of Horse Hair blight in the experimental plots. Arrows indicate the spraying timings.

Testing of *Trichoderma* Tric 33 against stem canker pathogens

Laboratory bioassays

A 5 mm diameter agar disc of *Lasiodiplodia theobromae* isolate was taken from actively growing margin of seven days old pure cultures and placed on one side of a PDA plate separately. The same day old 5 mm agar disc of Trichoderma Tric33 was placed on the opposite side of the petri dish for dual culturing. PDA plates inoculated only with the *L. theobromae* isolate were maintained as the control. The cultures were incubated at 25 ^{o}C. For each treatment three replicates were maintained and the experiment was repeated three times. The antagonistic activity was calculated and represented as Percentage Inhibition of Radial Growth (PIRG). Complete suppression of the pathogen by *Trichoderma* Tric 33 was observed.

Experiment to establish field efficacy of *Trichoderma* Tric 33 in managing stem canker disease has been established in Galle region.

GD Sinniah, DGNP Karunajeewa, RPVT Chandralal and KLSC Gunawardana

Project A 23.7. Evaluating elicitors as plant protection products for managing tea diseases

To evaluate underlying defence mechanisms activated by defense elicitors, selected elicitors salicylic acid and silicic acid were applied to micro plots. For comparison, an unsprayed control and copper fungicide treatment were also maintained. The green leaves were harvested at two days, five days and seven days intervals from all the treatments and freeze dried. Analysis of defence related compounds is being carried out.

GD Sinniah, DGNP Karunajeewa and (A collaborative study with Biochemistry Division)

Project B 132. Establishment of potential endophytic fungi as biocontrol agents/chemical marker to control growth of fungus *Fusarium ambrosium* associated with the Shot-hole Borer beetle (2019)

As a continuation of the previous work, six potential endophytic fungal strains were identified from three tea cultivars, against Shot-Hole Borer fungus, *F. ambrosium* from dual plate culture assays. For the identification of the fungal strains, DNA was extracted and samples were prepared for gene sequencing.

KGNP Piyasena and NC Weerakoon
(A collaborative study with Plant Pathology Division and Entomology Division)

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

Project A 24.3. Integrated Weed Management

1. Screening of Avenger AG Optima Burndown Herbicide

Avenger AG Optima Burndown was evaluated, comparing with available standard chemical herbicides. Three locations were selected from Low country, Mid-country and Up country for conducting the experiment namely the Field no 01, St. Joachim Estate, Ratnapura, ($6^0$43'N, $80^0$21'E, 29m amsl), Nayapana Estate, Pussellawa ($7^0$5'N, $80^0$36'E, 986m amsl), and St. Coomb's Estate, Talawakelle ($6^0$54'N, $80^0$42'E, 1394m amsl), respectively. Following treatments were applied in a Randomized Complete Block Design, with 03 replicates for each treatment. The experiments in all locations were conducted during 2021 November to 2022 February period. Best weed control was observed from Glyphosate application. However, Avenger application too has shown a similar performance in up to 12 weeks in Mid-country.

T 1 – Avenger 20 L/ha
T 2 – Avenger 30 L/ha
T 3 – Avenger 40 L/ha
T 4 – Avenger 50 L/ha
T 5 – Glufosinate ammonium (28%) 0.7 L/ha
T 6 – Glyphosate (36%) 1.4 L/ha
T 7 – Untreated control

Table 01. Dry weight of weed (g/0.09m^2), prior to herbicide spraying and there after every four weeks interval

Treatment	Pre-sample			4 WAA			8 WAA		12 WAA	
	Low	Mid	Up	Low	Mid	Up	Low	Mid	Low	Mid
T1	41.3^{a}	22.9^{ab}	16.3^{a}	33.3^{a}	21.9^{b}	18.0^{bc}	30.3^{b}	8.9^{b}	30.7^{b}	14.8^{a}
T2	32.7^{b}	37.1^{ab}	9.3^{a}	34.0^{a}	13.9^{c}	19.3^{bc}	31.3^{ab}	5.8^{b}	31.3^{b}	16.3^{a}
T3	36.3^{ab}	20.1^{b}	16.7^{a}	30.3^{ab}	7.8^{d}	12.7^{bcd}	30.3^{b}	4.8^{b}	29.7^{b}	4.1^{b}
T4	35.0^{ab}	31.0^{ab}	16.7^{a}	30.0^{ab}	5.1^{d}	12.0^{bcd}	27.7^{b}	6.9^{b}	28.7^{b}	4.5^{b}
T5	31.3^{b}	32.1^{ab}	12.5a	24.0^{b}	18.8^{b}	5.3^{d}	17.0^{c}	5.1^{b}	17.7^{c}	2.3^{b}
T6	31.7^{b}	53.6^{a}	16.3^{a}	14.3^{c}	5.0^{d}	8.0^{cd}	12.7^{c}	5.6^{b}	8.0^{d}	3.1^{b}
T7	31.3^{b}	17.3^{b}	12.3^{a}	35.0^{a}	40.4^{a}	34.0^{a}	37.3^{ab}	15.9^{a}	42.3^{a}	20.5^{a}
LSD (0.05)	8.32	32.6	12.81	7.58	4.6	10.41	6.29	4.58	5.16	6.41

2. Screening of Glufosinate Ammonium Herbicide

Three locations were selected from Low country, Mid-country and Up-country for conducting the experiment. They are Field no 01, St. Joachim Estate, Ratnapura (6^{0}43’N, 80^{0}21’E, 29 m amsl), Upper Division, Nayapana Estate, Pussellawa (7^{0}5’N, 80^{0}36’E, 986 m amsl) and Field No. 08, St. Coomb’s Estate, Talawakelle (6^{0}54’N, 80^{0}42’E, 1394 m amsl). Following treatments are applied in a Randomized Complete Block Design, with 03 replicates for each treatment. The experiments in all locations were conducted during 2020 June to October period. Best weed control application was shown by Glyphosate application. However, Glufosinate ammonium 1.4 L/ha application too has similar performance till 8th week.

T 1 – Glufosinate ammonium 0.9L/ha
T 2 – Glufosinate ammonium 1.0L/ha
T 3 – Glufosinate ammonium 1.2L/ha
T 4 – Glufosinate ammonium 1.3L/ha
T 5 – Glufosinate ammonium 1.4L/ha
T 6 – Glyphosate (36%) 1.4L/ha
T 7 – Untreated control

Table 2. Dry weight of weed (g/0.09 m^2) of weeds, prior to herbicide spraying and after four weeks interval, up to 12 weeks

Treatment	Pre-sample			4 WAA			8 WAA			12 WAA	
	Low	Mid	Up	Low	Mid	Up	Low	Mid	Up	Low	Up
T1	35.6^{ab}	21.0^{a}	8.0^{a}	29.6^{a}	30.5^{b}	20.5^{ab}	14.3^{b}	51.5^{b}	8.7^{b}	23.9^{ab}	6.7^{b}
T2	38.2^{a}	16.4^{a}	10.0^{a}	31.7^{a}	21.4^{bc}	14.1^{bc}	11.5^{bc}	29.5^{bc}	4.0^{bc}	20.3^{ab}	12.0^{ab}
T3	34.2^{ab}	26.0^{a}	6.7^{a}	23.6^{ab}	19.3^{bc}	12.6^{cd}	8.2^{cd}	26.3^{bc}	8.6^{b}	14.8^{ab}	9.0^{b}
T4	31.5^{b}	21.3^{a}	14.7^{a}	19.9^{bc}	15.8^{bc}	16.9^{abc}	8.0^{cd}	9.0^{c}	5.0^{bc}	12.0^{bd}	14.7^{ab}
T5	34.4^{ab}	19.9^{a}	14.0^{a}	23.5^{bc}	8.2^{c}	6.1^{d}	2.9^{ed}	17.7^{c}	1.0^{c}	2.4^{cd}	15.3^{ab}
T6	32.7^{b}	22.8^{a}	11.3^{a}	15.1^{c}	6.2^{c}	17.7^{abc}	2.2^{e}	17.7^{c}	7.3^{b}	0.5^{d}	24.7^{a}
T7	33.2^{b}	24.2^{a}	13.5^{a}	29.2^{a}	57.1^{a}	25.5^{a}	26.0^{a}	85.2^{a}	27.0^{a}	42.3^{a}	18.0^{ab}
LSD (0.05)	4.5	ns	ns	8.34	16.1	7.6	5.53	25.9	5.5	12.63	13.9

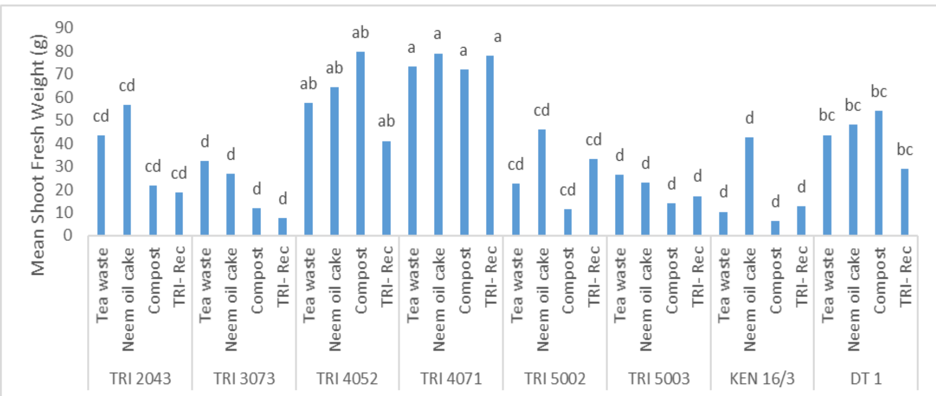
Thrust A 32. Evaluation of sustainable, organic and low-input farming systems for tea

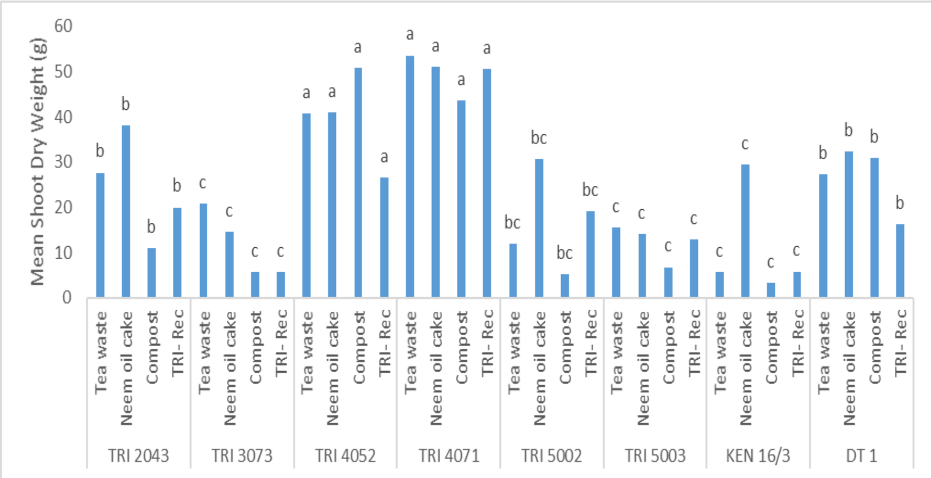
Project A 32. Evaluation of sustainable, organic and low input farming systems for tea generation of new information on sustenance of soil and crop productivity and level of natural biological control mechanisms and pest, disease and weed incidences under organic and low input tea cultivation is ascertained.

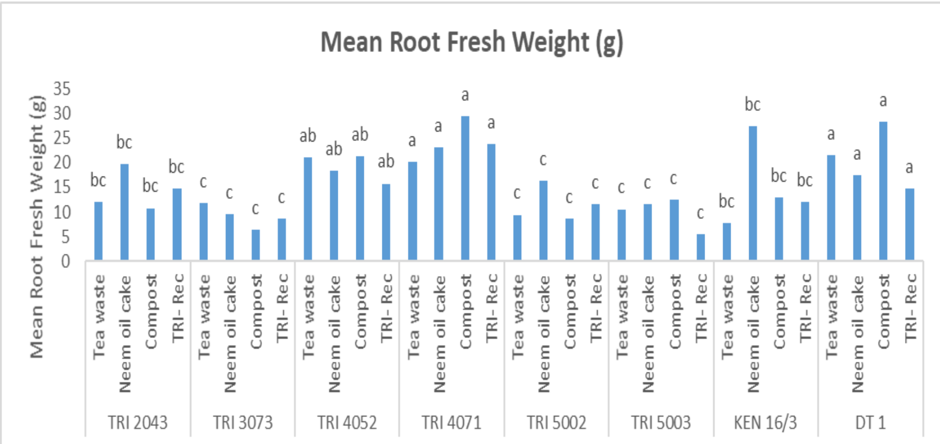
Location: Tea Research Institute, Talawakelle
Objectives: Evaluation of pest, disease and weed management under sustainable, organic and low input farming systems, scientific validation to biological and natural pest, disease and weed management practices, Development of user friendly sustainable biological and natural pest, disease and weed management methods.

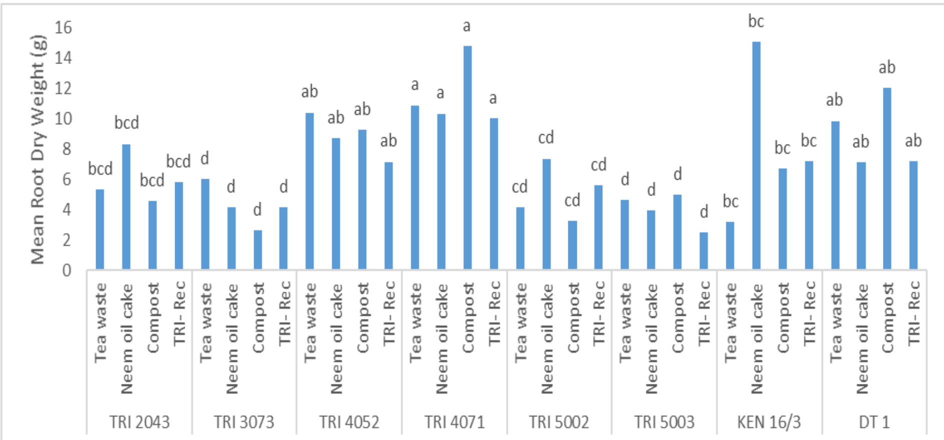
During the period under review, monitoring of data on soil and crop productivity, level of natural biological control mechanisms, pest, disease and weed incidences under organic and low input tea cultivation systems were continued in the long-term trials of TRIORCON and BIDORCON established in Talawakele for validation purpose. Field operations and yield and pest and disease ratings in TRIORCON and BIDORCON trials were monitored during the period.

Nursery plants from seven cultivars (TRI 5002, TRI 5003, TRI 4052, TRI 4071, TRI 3073, TRI 2043, DT1, KEN 16/3) were introduced to the in three replicates each to assess the response to nitrogen inputs. After one-year exposure, plants were uprooted and growth parameters *i.e.*, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight and root depths were taken (Figure 5). leaf nitrogen analysis is in progress.




Mean Shoot Dry Weight (g)
Tea waste
Neem oil cake
Compost
TRI- Rec
TRI 2043
TRI 3073
TRI 4052
TRI 4071
TRI 5002
TRI 5003
KEN 16/3
DT 1


Mean Root Fresh Weight (g)
Mean Root Fresh Weight (g)
Tea waste
Neem oil cake
Compost
TRI- Rec
TRI 2043
TRI 3073
TRI 4052
TRI 4071
TRI 5002
TRI 5003
KEN 16/3
DT 1


Mean Root Dry Weight (g)
Tea waste
Neem oil cake
Compost
TRI- Rec
TRI 2043
TRI 3073
TRI 4052
TRI 4071
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TRI 5003
KEN 16/3
DT 1

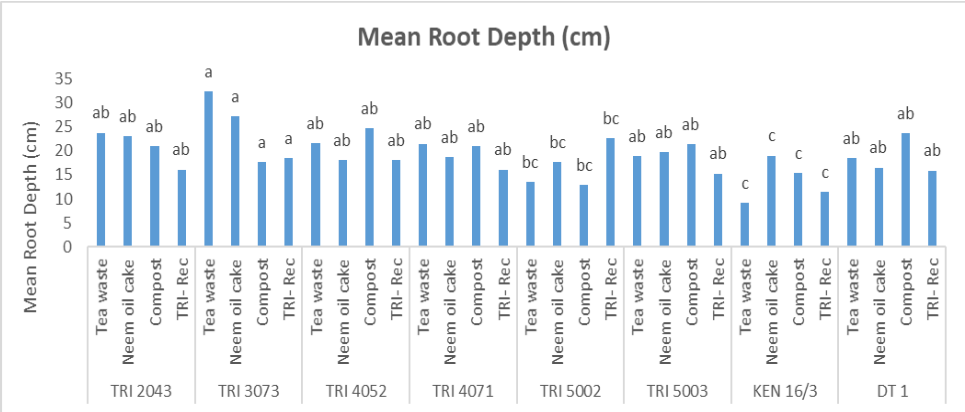


Figure 9. Growth parameters of tea plants 6 months after exposure to treatments

Figure 9 indicated the significant variations in shoot fresh weight, shoot dry weight, root fresh weight, root dry weight and root depths of tested tea cultivars with the treatments. Leaf Nitrogen analysis is in progress and data to be correlated to conclude the results.

Comparative assessments of Nitrogen dynamics in small holder lands and TRIORCON trial under foreign funded project (N Tea Project)

Soil sampling for detailed/ in-depth studies at ETH Zurich, Switzerland was continued. The studies with soil profile pits and bulk density measurements were continued.

Field Selection and Tree Survey, Estimating Biomass in Tea and Shade Trees to Quantify Plant N Stocks are in progress; field selection of 22 plots in Uva and Up-country region were completed, Tree survey, and development of boundary maps and elevation maps are completed. Tea bush uprooting and partitioning for N analysis was completed in TRIOCON trial and five out of 22 in Uva region is completed.

KM Mohotti, PGDS Amarasena, B Jananey, GKWH Dharmadasa, LRUL Senevirathna and PhD Student (N Tea Project)

Comparative Evaluation of Aqueous Leaf-Extracts of *Artemisia vulgaris* as Against Contact and Systemic Herbicides for Control of *Erigeron sumatrensis* and *Panicum repens* in Tea Plantations

Absence of effective herbicides with least threats on herbicidal residues in made tea warranted alternatives. Weed control potential of aqueous leaf-extracts of *Artemisia vulgaris* (Marikolondu) has been reported with no proper validation on its efficacy. Present investigation aimed to evaluate aqueous leaf-extracts of *A. vulgaris* at 50, 100, 150, 300 g/l doses with synthetic chemicals; Glyphosate, Glufosinate ammonium, Oxyfluorofen, Diuron, Triasulfuron, MCPA and natural extracts; Pelargonic acid, Eucalyptol and Pine oil with untreated control. A series of bio efficacy trials were performed with *Erigeron sumatrensis* (Alavangu pillu) and *Panicum repens* (Couch grass) in glass house condition and in pruned tea fields. Histological studies on weed roots were done to validate the mode of actions of the tested herbicides. Non-target effect of *A. vulgaris* on tea plants were also performed *in vivo*. All treatmets showed mortality of *E. sumatrensis* in field except untreated control. Tray culture studies revealed 100% mortality of *E. sumatrensis* with Eucalyptol at eight days after application, and with Triasulfuron and MCPA in 24 days. *Artemisia* 150g / l treatment showed mortality in 16 days after application. Eucalyptol had significantly greater bioefficacy against *E. sumatrensis*. Knock down effect of *A. vulgaris* 150g/l treatment on *P. repens* was similar to that of Glyphosate. However, re-emergence of grasses was observed 60 days after the application of *Artemisia* while Glyphosate had not recorded any re-emergence. Systemic mode of action of *Artemisia* was proved through root histology changes, necrotic / discolored cells and wilting of tea shoots. Aqueous leaf-extracts of *A. vulgaris* have shown progressive herbicidal effects for consideration as alternatives to chemical weedicides in tea. Further experimentation is proposed to evaluate non-target effects on beneficial organisms and on tea and formulations to increase the efficacy and application methods.

Thrust A 45. Development of integrated nematode management strategies

Project A 45.1. Introducing user friendly alternate tea propagation and soil sterilizing techniques, protected tea nursery concepts to minimize contamination and prevent dissemination of tea nematodes through planting materials

Experiment N 470: Screening of Fluensulfone (Nimitz) as an alternative nematicide as prophylactic measure at planting and post prune treatments

Location/ s **:** Nematology Laboratory, Tea Research Institute, Talawakelle
Objectives **:** Evaluating prophylactic methods for managing nematodes in young and mature tea

Results and Conclusions:
Nimitz (Fluensulfone 20g /kg GR), a new nematicide was tested as a prophylactic nematicide. The active ingredient in Nimitz, Fluensulfone, has a novel mode of action with favorable toxicological and eco toxicological profile. According to the literature, as a true nematicide, Nimitz cause irreversible nematicidal activity resulting in pest mortality rather than temporary nematostatic (immobilizing) activity as seen with organophosphates and carbomates.

Selected doses of Nimitz (Fluensulfone 20g /kg GR), 3g, 5g and 7 g per plant, were tested against *P. loosi* nematode populations using laboratory bioassays and incubation trials for bio-efficacy in comparison with untreated control. Preliminary studies showed that Nimitz (Fluensulfone 20g/kg GR) at 7 g per plant basis was effective in controlling parasitic nematode populations in soil.

Micro plot experiments were carried out with four treatments, Nimitz at the rate of 7 g per plant, Velum at the rate of 800 g a.i per ha basis (Recommended nematicide), biofumigant and untreated control and data confirmed that Nimitz 7 g per plant basis is effective in controlling *P. loosi* populations in soil compared to that of untreated control (Figure 10).

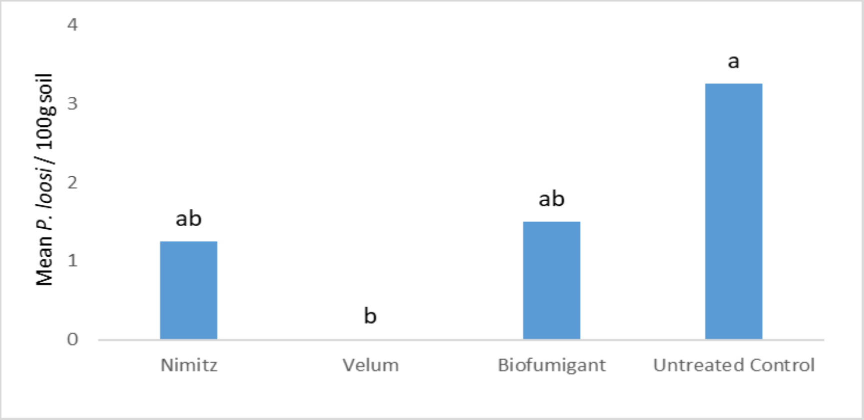


Figure 10. Mean number of *P. loosi* per 100g soil six months after treatment

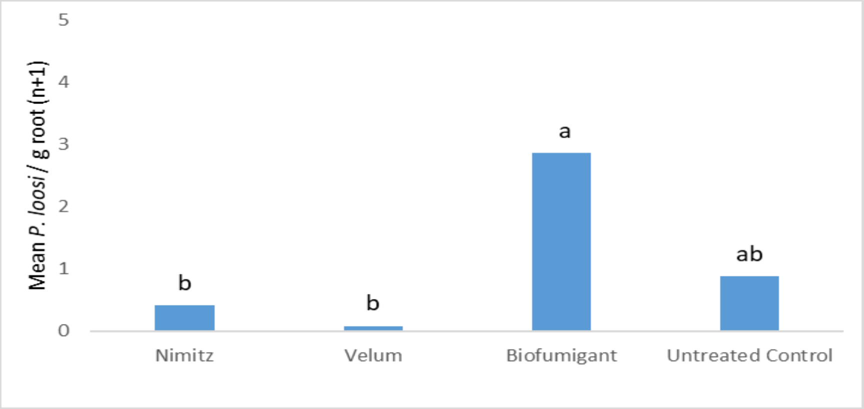


Figure 11. Mean number of *P. loosi* invaded to the tea root system six months after treatment

Results revealed that the Nimitz at 7 g per plant significantly reduced the root invasion by *P. loosi* (Figure 11).

Further field experiments in different regions yet to be carried out.

Project A 45.2. Management of nematodes in young and mature tea

1. Smallholder Tea and Rubber Revitalization Project

Assessment of nematode infestations in lands proposed for Soil Quality Index (SQI) testing for replanting

In order to identify the lands suitable for replanting using SQI determination, roots and soil samples were collected from small holder lands in Ratnapura, Matara, Galle, Kandy Districts which are proposed for testing SQI. Nematology staff attended the field sampling and the nematode estimation.

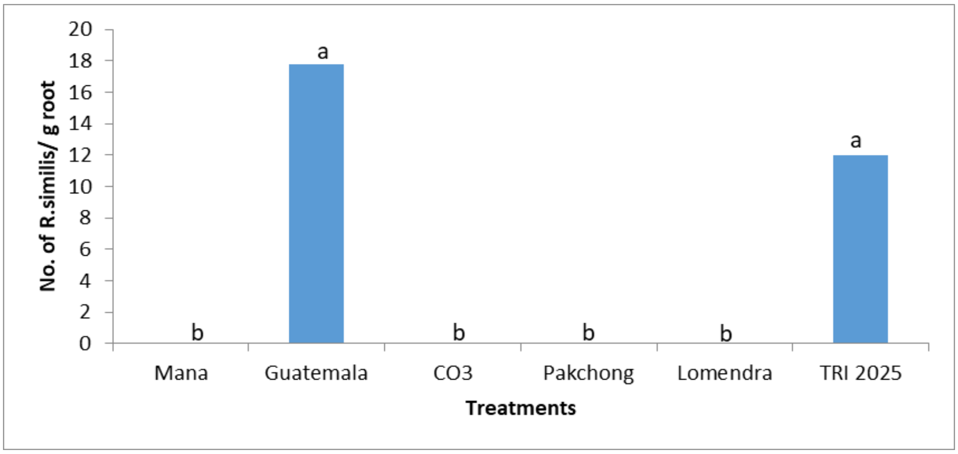


Figure 12. *P. loosi* population in roots

Over 120 of smallholder lands were sampled during the period and appropriate recommendations have been given. Sampling covered in following TI ranges in Ratnapura, Galle and Matara, Kandy Districts.

2. Screening of alternative grass species for soil rehabilitation purposes

Pot experiments were conducted under glasshouse conditions in evaluating grass species (Mana, Guatemala, CO3, Pakchong, Lomendra spp. for rehabilitation purposes. Final assessments were completed in screening of grass species against *P. loosi* and *R. similis* nematode species. screening grasses for *P. loosi* and *R. similis* were conducted at Talawakelle and Hantane respectively. Results revealed that none of the tested grass species were not hosts for *P. loosi* and *R. similis*. Nematode data and growth parameters were analyzed and data were significantly different.

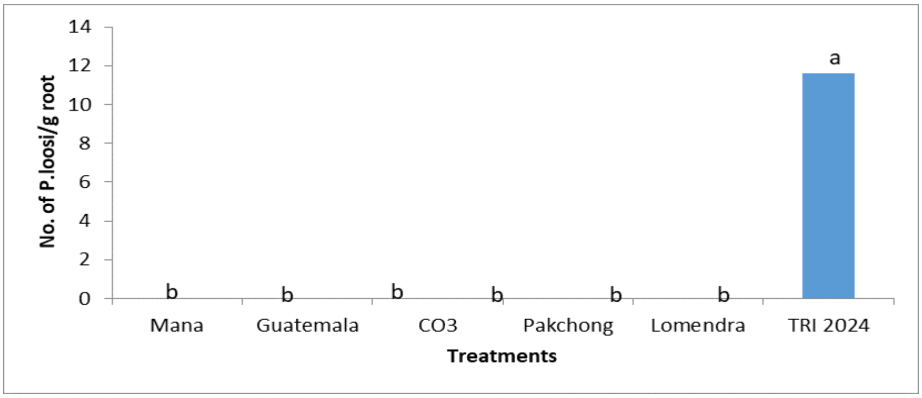


Figure 13. *R. similis* population in roots
The bars with the same letters are not significantly different at p=0.05

As shown in Figures 3, tested grass species are non-hosts for plant parasitic nematodes, *P. loosi*.

As shown in Figure 13, data confirmed that Mana, CO3, Pachong and Lomendra grass species are non-host to *R. similis* nematodes.

PGDS Amarasena, UB Herath, BMGK Godavita, B Jananey, GKWH Dharmadasa and LRUL Senevirathna

Thrust A 54. Development of IPM Strategies for managing Low-Country Live Wood Termite (LCLWT)

Project A 54.2. Screening of wound dressings to protect prune cut surfaces from wood rot and LCLWT

Based on the preliminary results of observational trial an experiment was initiated to evaluate Skim coat as wound dressing.
Experiment LE 151. Screening of wound dressing for preventing wood rot and LCLWT

Objective	: To find out an effective wound dressing
Experimental site	: Field No. 01, TRI Low-country Regional Centre, Ratnapura
Cultivar	: TRI 4042
Experimental Design	: RCBD
Treatments	T1: Skim coat T3: Brunolium 15%, T4: Control

Above treatments were applied on prune cut surfaces. Infestation of LCLWT will be assessed at next prune time.

BS Vitana, AMP Sammani and RDPD Senanayake

Project B 29. Refining techniques for sampling, laboratory and field evaluation

Experiment E 421: Screening of seed cultivars against SHB

Objective	:	To evaluate the resistance/susceptibility of tea cultivars against SHB in the enclosed environment
Experimental site	:	Experimental area, Entomology and Nematology Division, TRI, Talawakelle

Stem cuttings of new accessions from Glenanore Estate selections are being raised in the polytunnel to evaluate the resistance/susceptibility against SHB. Experiment is continued.

AMP Sammani, NAIM Nissanka, PADS Sumathipala and RDPD Senanayake

Experiment LE 145. Screening of new accessions against SHB

Objective	:	To evaluate the resistance/susceptibility of tea cultivars against SHB damage
Experimental site	:	Field No. 03, TRI Advisory and Extension Centre, Deniyaya
Experimental Design	:	CRD with ten replicates

The tea plants in jumbo bags were arranged in-between SHB susceptible cultivar (TRI 2026) under the natural infestation of SHB to assess the susceptibility/tolerance level of new accessions against SHB damage. Experiment is continued.

BS Vitana, AMP Sammani and RDPD Senanayake

Project B 69. Identification and use of semio-chemicals for reducing insect, nematode and mite pest damages

Experiment E 422: Determination the response of Shot-hole borer for Alpha pinene

Objective	:	To evaluate the attraction effect of Alpha pinene for SHB
Experimental site	:	Entomology Laboratory, TRI, Talawakelle
Experimental Design	:	CRD with four replicates
Treatments	:	Alpha pinene 20 µl, 30 µl, 40 µl, 50 µl and control

Olfactometer bioassay was conducted using 4 arm olfactometer to evaluate the response of SHB for Alpha pinene along with control treatment. The different doses of Alpha pinene mentioned above were tested. Aadult female beetles (10 number per replicate) were introduced. observations were recorded at 20minutes intervals.

Table 3. Response of SHB for treatment

Treatment	% Response of SHB (after 20 minutes)		% Non-responsive
	Alpha pinene	Control	
T1 (20 µl)	60^{a}	27.5^{c}	12.5
T2 (30 µl)	50^{ab}	37.5^{bc}	12.5
T3 (40 µl)	42.5^{abc}	27.5^{c}	30.0
T4 (50 µl)	55^{ab}	37.5^{bc}	7.5

Means with the similar letters in columns are not significantly different at P=0.05, (LSD).

Results and Discussion

There was a significant difference among treatments (P value < 0.05) when compared with untreated control. The higher response of SHB for Alpha pinene was showed by the 20 µl dose and it was not significantly different from other doses but significantly different from its control.

D Damayanthi, NAIM Nissanka, AMP Sammani and RDPD Senanayake

Experiment E 423: Extraction and quantification secondary metabolites of tea stems against Low country live wood termite (LCLWT)

Objective	:	To determine the secondary metabolites in different tea cultivars
Experimental site	:	St. Joachim Estate, TRI Low-country Regional Centre, Ratnapura

The known resistant/susceptible cultivars against LCLWT are being raised in Plant Breeding nursery to estimate the catechin, polyphenol and caffeine content in the wood. The experiment is continued until tea stems get appropriate diameter for the extraction of secondary metabolites.

BS Vitana, AMP Sammani, NAIM Nissanka and RDPD Senanayake
(Collaborative research with Bio-chemistry Division)

Project B 134. Development, validation and application of remote sensing techniques for blister blight disease management

This study aimed at identifying a suitable remote sensing technique for detection and quantification of blister blight disease under field conditions. This study was designed with the aim of developing a quantitative approach to assessing the blister blight which were captured under varying natural light conditions while attached to the tree at a consistent distance from the leaf to the smartphone. Red, Green, and Blue (RGB) colour channels were then extracted after normalizing the images to compute RGB-based colour indices. The data was analyzed to identify the best-fit colour index with blister blight disease severity stages. According to the results, image-derived average in H/H+S+V (HSV= Hue, Saturation, Value) had a strong linear relationship (R^2 = 86 %) with BB severity stages.

GD Sinniah, DGNP Karunajeewa and
Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka

Project B 100. Establishment of anatomical, biochemical, molecular and physiological basis of different tea cultivars for SHB, LCLWT and Nematodes

Objective	:	To determine the effect of SHB damage on plant photosynthesis
Experimental site	:	Experimental area, Entomology and Nematology Division, TRI, Talawakelle

Tea plants are being raised in the polytunnel until get the proper growth to take parameters. The experiment is continued.

AMP Sammani, NAIM Nissanka, D Sumathipala and RDPD Senanayake
(Collaborative research with Plant Physiology Division)

Project B 133. Development of Nano pesticides for managing pests and diseases

I. Micro encapsulated *Beauveria bassiana* and nano hexaconazole were developed by the SLINTEC for the experiments at TRI.

II. Laboratory bioassay commenced to evaluate bio efficacy of micro encapsulated *B. bassiana* against SHB has been completed.

III Bio efficacy of Nano hexaconazole against fungal symbiont (*Fusarium ambrosium*) of Shot -hole borer was commenced using four concentrations (1%, 2%,4%, 8%) and untreated control to find out the minimum concentration that inhibit the fungal growth. Colony diameter of the Ambrosia fungus is measured at four days intervals in the presence and absence of the fungicide to calculate the percentage of mycelial inhibition by the chemical. Experiment is continued.

RDPD Senanayake, NAIM Nissanka
and SPR Wijewardana (Collaborative research with SLINTEC)

Screening nano-Hexaconazole (5 SC) against blister blight disease

The objective of this study was to test the efficacy of a nano-Hexaconazole formulation against blister blight disease in tea and to determine its effective concentration.

A preliminary trial was carried out at the field No 8 in Lower Division, St. Coombs Estate, Talawakelle. The experiment design was Randomized Complete Block Design (RCBD) with 5 treatments namely T1-0.05% Hexaconazole EC (TRI Recommended), T2-0.05% nano-Hexaconazole, T3-0.025% nano-Hexaconazole, T4-0.0125% nano- Hexaconazole and T5-unsprayed control. Each treatment was replicated 3 times. Experimental plots had about 30-35 tea bushes of cultivar TRI 2024. Harvestable shoots with bud and three leaves were harvested at ten days' interval and assessment of blister blight severity was carried out using standard methods. The experiment is being continued.

GD Sinniah, M Niranjan and DGNP Karunajeewa
(A collaborative project with Entomology and Nematology Division and SLINTEC)

Project B 146. Development and applications of bio-pesticides to manage major disease and insect pests of tea

Development and promotion of use of biopesticides in integrated pest and disease management has been targeted to address the issues related to overuse of synthetic pesticides and to align with policy on transforming Sri Lanka's economy into a green socio-economy with sustainable solutions to climate change. With the objective of commercializing biopesticides for tea, three *Trichoderma* and *Pseudomonas* based biocontrol agents and *Beauveria* and *Metarhizium* based entomopathogens were developed and mass multiplied to manage diseases and insect pests, respectively.

A Microbial Processing Plant equipped with a bioreactor was established with the Treasury funded special project GL391 and functioning of the facility has been commenced. Fine tuning of mass multiplication in bioreactor is being carried out for *Trichoderma* biopesticide.

Trichoderma and *Pseudomonas* biopesticides:
A micro plot experiment was established to evaluate the biopesticide treatment to planting hole on Poria root infection. Treatment application to planting holes was completed at the time of planting. The 2nd and 3rd treatment application after planting was carried out. The experiment is being continued.
A pot trial was established to test the dose response of *Trichoderma* biopesticide against Poria root disease. The experiment is being continued.

Trials established in 2020 for testing field efficacy of *Trichoderma* and *Pseudomonas* biopesticides against brown root disease were completed.

Preliminary screening of *Trichoderma* and *Pseudomonas* biopesticides against blister blight revealed that there is no satisfactory disease management with those biopesticides at the tested concentrations.

Beauveria biopesticide:
A pot trial to evaluate bio efficacy of *Beauveria brongniartii* against white grubs was completed. The bioefficay achieved was not satisfactory.

A field trial has been established to evaluate the efficacy of *Beauveria bassiana* against Shot Hole Borer. The experiment is being continued.

Metarhizium biopesticides:
After successful completion of laboratory bioassays, pot trials were carried out to test *Metarhizium* isolate 1 and isolate 2 against up country Live wood termite separately. An average of 90% mortality of the termites was resulted in both *Metarhizium* isolates.

Efficacy of *Metarhizium* isolate 2 against white grub (1st instar larval stage) was tested in laboratory bioassays and in a pot trial. An average of 67% and 60% mortality of the larvae was observed in the bioassays and pot trial, respectively.

GD Sinniah, DGNP Karunajeewa, KLSC Gunawardana and RPVT Chandralal
(Plant Pathology Division)
AMP Sammani, NAIM Nissanka, BS Vitana, BMGK Godavita, D Sumathipala,
R Wijewardana and RDPD Senanayake
(Entomology and Nematology Division)

Project D/ENTO: Screening insecticides, acaricides and termiticides for strengthening IPM and Divisional activities

Experiment LE 143. Investigating the tolerance of Pakchong grass against white grubs in pot trial

Objective	:	To evaluate the tolerance of Pakchong grass against White Grub
Experimental site	:	TRI Low-Country Regional Centre, Ratnapura
Experimental design	:	Pot trial, CRD with 8 replicates
Treatments	:	T1- Pakchong grass + white grubs T2- Pakchong grass without white grubs

Pakchong grass sp. was planted in 16 pots. White grubs were introduced to 8 pots and survival of white grubs, growth performance and root weights of Pakchong grass are being assessed. Experiment is continued.

BS Vitana and RDPD Senanayake

Experiment E 418 (I). Evaluation the efficacy of Neem oil cake against white grubs

Objective	:	To determine the efficacy of Neem oil cake to control white grubs
Experimental site	:	Experimental area**,** Entomology and Nematology Division, TRI, Talawakelle
Experimental Design	:	CRD with 04 replicates
Treatments	:	T1: Neem oil cake 100 g/pot (Contained 4 kg of soil) T2: Neem oil cake 200 g/pot T3: Neem oil cake 250 g/pot T4: Coragen (Chlorantraniliprole 200g/L SC) 250 ml/pot T5: Control (Water 250 ml/pot)

Above treatments were mixed with soil separately in pots with tea plants and ithe mixture of different larval stages (4 no. of 1st instars, 4 no. of 2nd instars and 4 no. of 3rd instars) from *Holotrichia disparilis, Microtrichia costata* and *Anomala walkeri* were introduced into each pot (total 12 white grubs per pot). The pots were maintained at 22±2 °C of average daily temperature and 89±5% of RH. Dead count of white grubs was taken at seven days interval upto one month. The data were analyzed using SAS software. The percentage mortality of white grubs was converted to arcsine values prior to analysis.

Results and Discussion

There was a significant difference in mortality of white grubs among treatments ($P< 0.05$) when compared with untreated control (Table #). T1, T2 and T3 were not significantly different from each other when compared with T4 and T5. Neem oil cake showed the significantly higher Efficacy against white grubs when compare with control while efficacy is lower than the T4. The 1st and 2nd instars were more susceprtible to Neem oil cake than 3rd instars.

AMP Sammani, PADS Sumathipala, NAIM Nissanka, MKD Damayanthi and RDPD Senanayake

Experiment E 419 (I). Evaluation the efficacy of Flipper (botanical extract) against Red spider mites (*Oligonychus coffeae*)

Objective	:	To determine the effective concentration of Flipper against Red spider mites under laboratory conditions
Experimental site	:	Entomology laboratory, TRI, Talawakelle
Experimental Design	:	CRD

The experiment commenced to test the different concentrations with 4 replicates of Flipper against Red spider mites. Experiment is continued.

SPR Wijewardana, PADS Sumathipala and RDPD Senanayake

Project D/Pl/Pa/1. Activities of Plant Pathology Division

Disease diagnosis and recommendation of remedial measures

Dying of tea bushes at an Estate in Ratnapura region was observed /diagnosed and identified that the problem is associated with a root infection. Three of the six root samples of mature tea which were submitted from various locations were examined and confirmed to have root infections. Botyosphaeriaceae canker was identified as the cause of dieback in samples drawn from Grevillea trees. *Pestalotia* infections were found in a leaf sample submitted from a nursery. Leaf spot infection was identified in a leaf sample received from a mature tea field.

Quantifying effect of plucking intervals on blister blight severity

Shorter plucking rounds are generally recommended during blister blight season to manage the disease by removing infected shoots frequantly from the fields. Following statistically designed trials, non-replicated, large blocks (150 bushes) experiments were conducted to study the effect of extended plucking intervals on blister blight disease severity and green leaf yield.

Two adjecent blocks of 150 bushes each were marked in Field No 8, Lamilier Division. The cultivar selected for the blocks was TRI 2025 and the field was in first year of pruning cycle. One block was subjected to seven day plucking round and the other block was subjected to ten day plucking round during June to Septermber 2022. Green leaf yield of the blocks and blister blight severity of the blocks were determined using standard practices. Briefly, one hundred shoots with bud and two leaves were selected randomly from harvested green leaves from a block. Blister blight severity was assessed on 2^{nd} leaf from the bud using 0-6 score blister blight assessment key The experiment was replicated in the Field No 3, Upper Division, St. Coombs Estate.

Table 4 shows the total green leaf yield and the blister blight severity in terms of AUDP during the experimental period in plots subjected to 7-day and 10-day plucking rounds, respectively. In both locations, higher green leaf yield and less blister blight disease severity were recorded in the plots subjected to the 7-day plucking round, and the reverse was true for the 10-day plucking round.

Table 4. The total green leaf yield (GL) and the blister blight severity in terms of AUDPC during the experimental period in plots subjected to seven-day and ten-day plucking rounds in Field No 3, Upper Division, and Field No 8, Lamilier Division, St. Coombs Estate

	UD		Lamilier	
	7 Days	10 Days	7 Days	10 Days
GL (kg)	13.1	8.9	15.6	10.3
AUPDC	2686.3	2858.9	2836.6	3292.7

GD Sinniah, DGNP Karunajeewa, KLSC Gunawardana RPVT Chandralal

CLIMATE CHANGE ADAPTATION AND MITIGATION STRATEGIES

Thrust A 50. Assessment of the impact of global climate change on productivity and profitability of the tea industry

Project A 50.4. Investigation on pest and disease response of tea to global climatic change

Experiment: Determination the variation of life cycle of Shot hole borer (*Xyleborus fornicatus*) at different temperature ranges

Objective	:	To study the life cycle of Shot hole borer at different temperatures under the laboratory conditions
Experimental site	:	Entomology and Nematology laboratory, TRI, Talawakelle

A preliminary study was conducted to study the duration which require to complete the different life stages of Shot hole borer at 25 ºC. The different life cycle stages (eggs and pupae) were collected from SHB fresh galleries which were included in branch samples of TRI 2025 having pencil thickness with the use of sterilized (with 70% Ethanol) fine needle. The eggs were introduced to sterilized glass petri dishes (5.5 cm diameter) which contained the artificial diet medium of SHB. The pupae were placed on tea stem pieces (3 cm length) which included in sterilized petri dish which contained a moist dark paper and covered by using a perforated lid for aeration. All petri dishes were maintained in the incubator at 25 °C of temperature and 80% of relative humidity.

The dark papers in petri dishes were moistened daily. The numbers of days were recorded from eggs to emergence of first larval instar of SHB and from pupae to immature adult of SHB. The experiment will be conducted as a replicated trial based on the results generated from the preliminary study.

PGDS Amarasena, AMP Sammani, GKWH Dharmadasa, NAIM Nissanka and LRUL Senevirathna

Project A 50.5. Analysis of climate change, identifying vulnerable tea growing regions and seasonal weather forecasting for different tea growing regions in Sri Lanka

Seasonal weather forecasting reports issued by the Department of Meteorology, Sri Lanka was shared among the TRI advisory and Extension staff for use in outreach activities and training programmes. Rainfall and temperature data recorded at TRI Talawakelle (Up country), Kandy (Mid-country) and Ratnapura (Low-country) were analyzed and their trends established for comparison with decennial means and Confidence Intervals (CI, p=0.05). Results are given below.

Rainfall:

In the year 2022, Low country Center, Ratnapura has received more rainfall (850.7 mm) than that of the year 2021. However, July and September months were found to be with less rainfall than their respective decennial means (Figure. 1). In contrary, May, August and the last quarter (October-December) received significantly higher rainfall than the respective decennial means. Mid- country Center, Kandy has received less rainfall during the first quarter and in the month of June (Figure 2). However, July-September period recorded significantly higher rainfalls at Mid country Center. As shown in Figure 3, rainfall during 5 months at Talawakelle were significantly less than their respective decennial means, whereas three months recorded higher rainfalls.

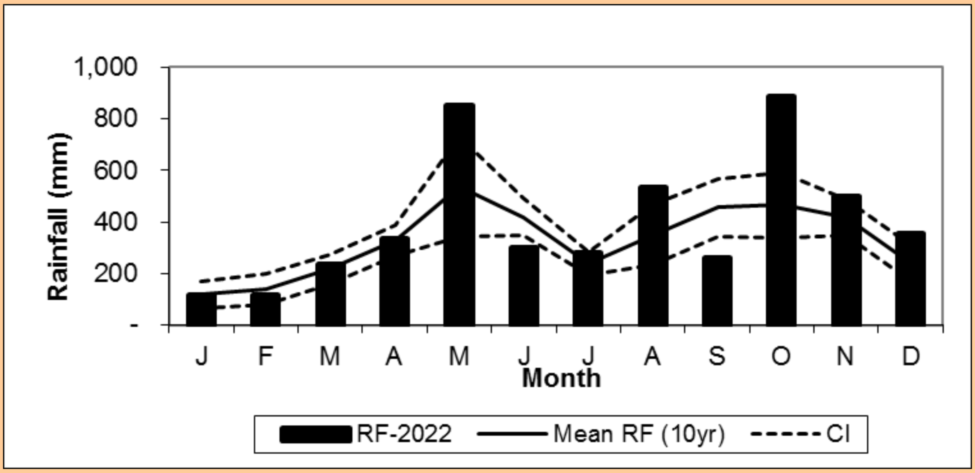


Figure 1. Monthly rainfall at TRI, Low country Center, Ratnapura (CI-Confidence Interval p=0.05)

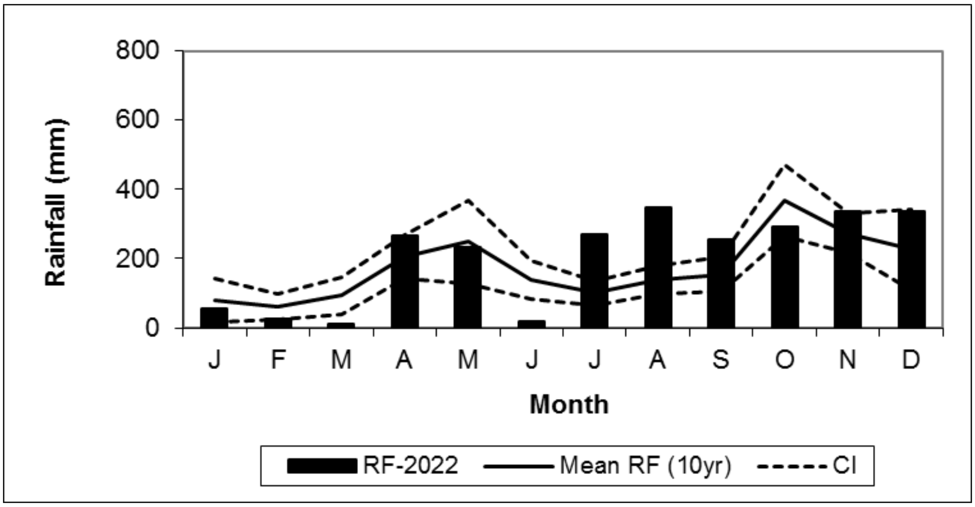


Figure 2. Monthly rainfall at TRI, Mid-country Center, Kandy (CI-Confidence Interval p=0.05)

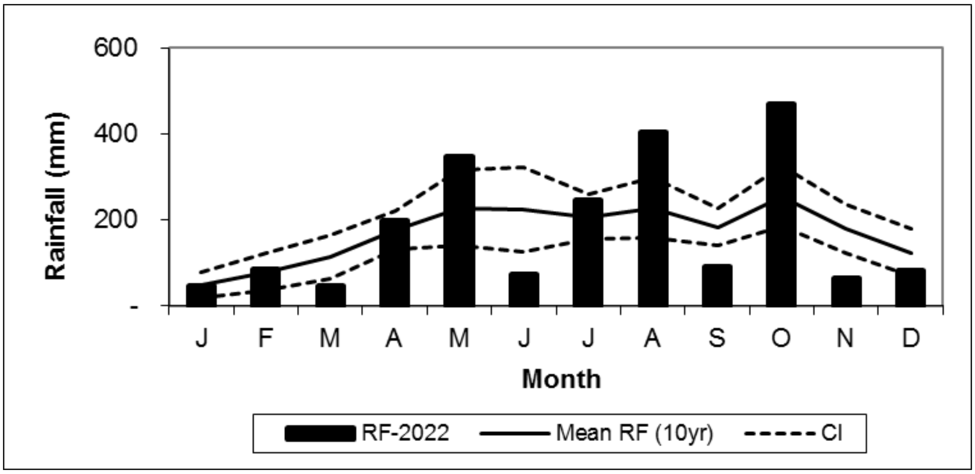


Figure 3. Monthly rainfall at TRI, Talawakelle (CI-Confidence Interval p=0.05)

Temperature:

Although there was no marked variation in the pattern - in mean temperature in the Low country, months of January and February were found to be warmer than the respective decennial means (Figure 4). Temperature in the Mid-country (Kandy) was significantly low during August to December (Figure 5). First two months in this region were found to be warmer than the decennial mean as observed in the low country. The first quarter of the year was found to be warmer than the decennial means in the Up country, Talawakelle (Figure 6).

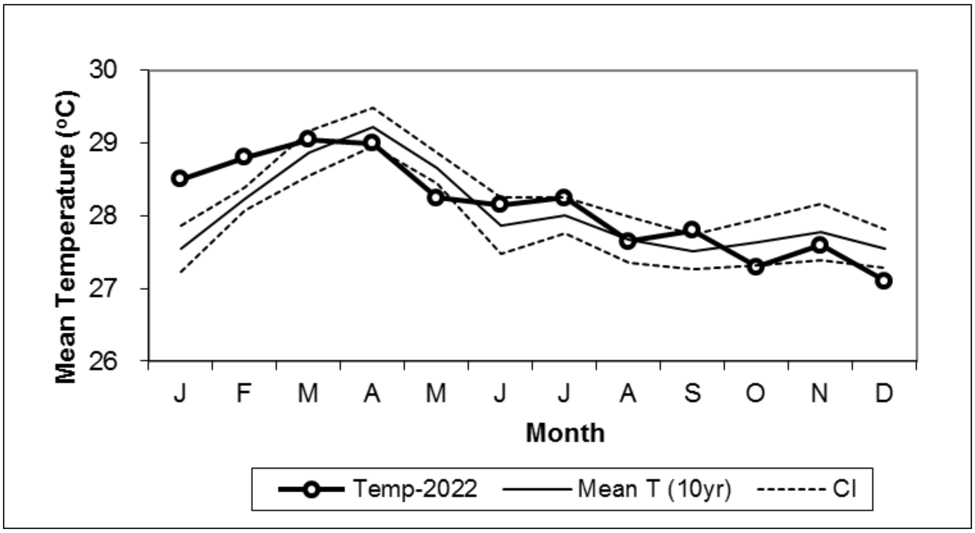


Figure 4. Mean monthly temperature at TRI, Low country Center, Ratnapura. (CI-Confidence Interval p=0.05)

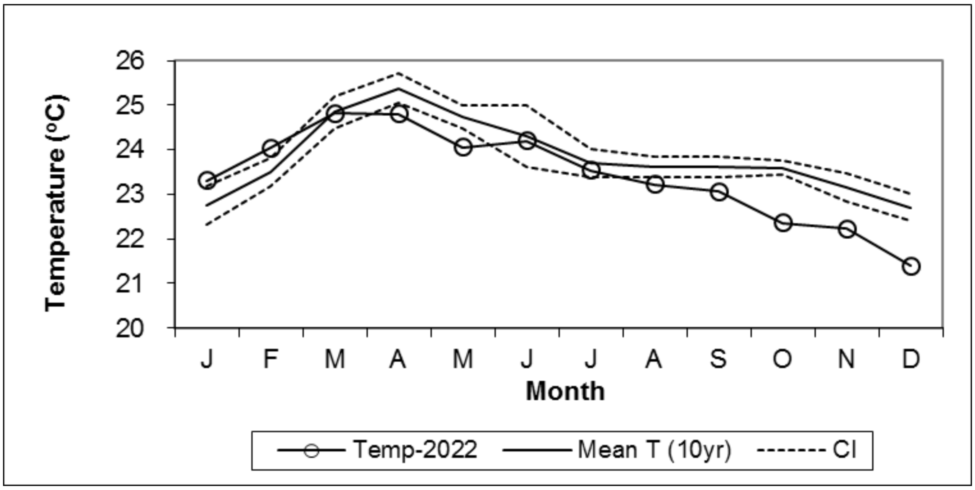


Figure 5. Mean monthly temperature at TRI, Mid-country Center, Kandy. (CI-Confidence Interval p=0.05)

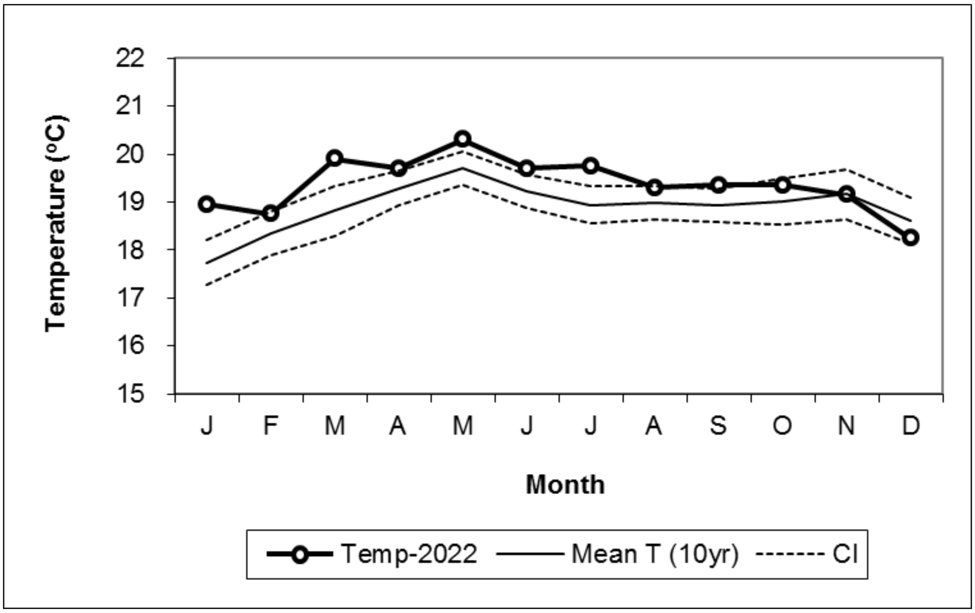


Figure 6. Mean monthly temperature at TRI, Talawakelle (CI-Confidence Interval p=0.05)

MA Wijeratne

Project B 131. Investigation of rapid interventions to minimize the adverse effects of climate change on tea

The climate change is imposing serious threats to all living beings and all the sectors. Therefore, this study was initiated to identify the potential interventions such as exogenous application of chemicals to improve the survival under short-term drought conditions and to determine their economic feasibility to minimize the adverse effects of climate change on tea. This broad objective will be achieved *via* understanding the relationships between the exogenous application of chemicals with physiological and biochemical responses in different cultivars of tea plants under drought stress condition. A series of experiments as mentioned below were conducted under glasshouse/rain shelter conditions at the Talawakelle (1382 m amsl) and field conditions at the Bearwell Estate and St. Coombs Estate, Talawakelle.

Experiment 1: Plant hormonal regulation on physiological changes in tea (*Camellia sinensis*) during drought stress.

The objective of this experiment was to; (1) understand the relationship between exogenous application of plant growth regulators such as Salicylic Acid (SA), Abscisic Acid (ABA) and Gibberellic Acid (GA) with physiological and biochemical responses in different cultivars of immature and mature tea plants under drought stress condition; and (2) evaluate the potential of plant growth regulator applications on improving survival under short term drought conditions.

Field evaluation – Experiment 1

This experiment was conducted at Field No. 08NC (elevation: 1440 m amsl, latitude: 6° 53' 6.84" N, longitude: 80° 40' 17.95" E), Fairfield Division, Bearwell Estate, Talawakelle (WU2) using three-year-old TRI 4078 cultivar (drought tolerant). The experiment was arranged according to Randomized Complete Block Design (RCBD) with 3 blocks. When plants reached a moderate moisture stress (gravimetric water content -28.93%), they were foliar sprayed with different plant hormones (Abscisic acid, ABA; Gibberellic acid, GA and Salicylic acid, SA) in selected concentrations based on the results of glasshouse studies along with no hormone i.e. water-spray (WS), and no-spray (NS) treatments. Data were collected from five randomly selected plants at 7, 14, 21 days after spraying (DAS) and recovery after rain (i.e. 75 DAS). Physiological parameters (gas exchange parameters and relative water content (RWC)) and biochemical parameters (total soluble sugar content, proline content, polyphenol content, antioxidant activity and pigment concentrations) were measured from 9 a.m. to 12.30 p.m. using recently matured fully expanded leaves along with the soil moisture content. A portable photosynthesis meter (model: LI- 6400XT, Li-Cor Inc., USA) was used to determine the net photosynthetic rate, stomatal conductance and transpiration rate. The dark respiration was also measured in another set of leaves by covering the leaves with aluminium foil for 30 minutes prior to the gas exchange measurements.

Leaf RWC was measured using the method described by Lafitte (2002). Antioxidant activity of leaves was measured using DPPH radical scavenging method (Prieto, 2012), ABTS assay and FRAP assay (Benzie and Strain, 1996). Leaf total soluble sugar content was measured according to Dubois *et al*. (1956) and leaf proline content was measured according to Bates *et al*. (1973) using oven dried, powdered leaf samples. Leaf polyphenol content was measured according to ISO14502-1 (2005). Chlorophyll a, b and total carotenoid concentrations were also measured according to Lichtenthaler and Welburn (1983).

In this field experiment, soil moisture content averaged across all treatments were 27.6%, 24.99%, 19.63% and 30.2% at 7 DAS, 14 DAS, 21 DAS and recovery after rain, respectively. RWC declined with the progression of drought. ABA and SA treated plants showed significantly higher RWC whereas GA, WS and NS treated plants showed significantly low ($p<0.05$) RWC at 14 DAS, 21 DAS and recovery after rain.

Varied responses were identified in different gas exchange parameters with the progression of drought.

Field evaluation- Experiment 2

This experiment was conducted at the Field No. 10, Lower Division, St. Coombs Estate, Talawakelle using mature tea (23 years old). The experiment was arranged according to Randomized Complete Block Design (RCBD) with 3 blocks. When plants achieved a moderate moisture stress, they were foliar sprayed with different plant hormones (Abscisic acid (ABA), Gibberellic acid (GA) and Salicylic acid (SA)) in selected concentrations based on the results of the glasshouse studies along with no hormone or water-spray (WS), and no-spray (NS) treatments. As explained previously, same measurements were taken at same frequencies.

The interesting results generated throught these two experiments along with the previously reported details were compiled to a thesis and its correction is in progress.

MMN Damayanthi, TL Wijeratne and J Damunupola (From PGIS, University of Peradeniya, Sri Lanka)

Experiment 2: Evaluation of long chain fatty alcohols on improving the physiological and biochemical responses in tea (*Camellia sinensis*) during drought stress.

The objectives of this experiment were to understand the relationship of exogenous application of long chain fatty alcohols with physiological and biochemical responses in different cultivars of immature tea plants under drought stress condition and to evaluate the potential of a commercial product of long chain fatty alcohol (GM) application on improving survival of tea plants under short term drought conditions.

This investigation was carried out in two steps: (1) Inside the glasshouse/rainshelter to test the impact on nursery tea plants and (2) in field conditions to test the impact on immature tea plants.

2.1 Testing the impact of long chain fatty alcohol on nursery tea plants under glasshouse/ rainshelter conditions

This study was conducted as a series of experiments under glasshouse and rainshelter conditions at the TRI using potted nursery tea plants of two cultivars with known drought tolerances namely TRI 2025 (drought tolerant) and TRI 2023 (drought susceptible). The experiment was arranged according to Randomized Complete Block Design (RCBD) with two blocks under the glasshouse and Complete Randomized Design (CRD) with ten replicates under the rainshelter. The plants were brought up to the field capacity and watering was withheld before applying the following treatments:

1. GM660: Plants were exposed to a drying cycle while they were foliar sprayed with GM 660 mL / 200 L water / ha
2. GM1000: Plants were exposed to a drying cycle while they were foliar sprayed with GM 1000 mL / 200 L water / ha
3. WS: Plants were exposed to a drying cycle while they were foliar sprayed with water 200 L / ha
4. K_2SO4: Plants were exposed to a drying cycle while they were foliar sprayed with 2 % Sulphate of Potash,
5. KCl: Plants were exposed to a drying cycle while they were foliar sprayed with 2 % Murate of Potash
6. WW: well-watered (positive control)
7. NS: Plants were exposed to a drying cycle while they were not sprayed with anything, i.e. no spray (negative control) treatments.

Data were collected at 3, 7, 14 and 21 days after applying treatments from five randomly selected plants along with the gravimetric soil moisture content (SMC) with the progression of drought. Following physiological parameters were measured along with the soil moisture content throughout the experiment at each measurement frequency described above. Gas exchange parameters (net photosynthetic rate (A), stomatal conductance (Gs), rate of transpiration (E), water use efficiency (WUE) and leaf temperature (Tleaf)) were measured using a portable infrared gas analyser (Model: CIRAS3, PP Systems, USA). Leaf relative water content (RWC) was measured using destructive sampling and standard protocol. Leaf total soluble sugar (TSS) content and leaf proline content were also determined using standard methods only at 21 days after spraying (DAS) due to the limitation of the resources. In addition, the plants were visually assessed at 14 and 21 days after spraying (DAS) for their appearance and thereby the percentage of plants with normal appearance was calculated.

Drought Tolerance Index (DTI) was calculated for each and every parameter measured by taking the relative values of corresponding measurements of the well-watered treatments and an example is given below for easy reference.

DTI for A = $(A\_trt / A\_WW) \times 100$

Where, DTI for A is the Drought Tolerance Index for photosynthetic rate, A_trt is the photosynthetic rate of a particular treatment at a particular measurement interval and A_WW is the corresponding photosynthetic rate under WW treatment at the same measurement interval.

The data were statistically analysed for analysis of variance (ANOVA) for each measurement interval separately and mean comparison was carried out by Duncan Multiple Range Test (DMRT) using SAS v9 package. The final decision was taken based on the rank summation index (RSI) which is a multi-criteria selection method. Accordingly, the parameters where the increasing responses were considered to be beneficial were arranged from the largest to the smallest and the ranks were given from 1-6 where, 1 being the best and 6 being the worst. In contrast, for the parameters where the decreasing responses were considered to be beneficial were arranged from the smallest to the largest and ranks were given from 1-6 where, 1 being the best and 6 being the worst. Finally, all the ranks given for each and every parameter were summed to calculate the RSI for different treatments for different days after applying the treatments.

Although the experiment was repeated several times under the glasshouse and rainshelter conditions, no additional benefit was identified due to application of different treatments such as applying GM1000 or GM660, Murate or Sulphate of Potash in many occasions as the results were not significantly different to that of either WS or NS treatments or both (Table 1). This may be due to absence of well-developed root systems in nursery plants and limited root volumes under potted conditions regardless of application of treatments.

Table 1. Mean values of Drought Tolerance Index (DTI) for different physiological traits identified as drought tolerant indicators, Ranks (R) and Rank Summation Index (RSI) of nursery plants under glasshouse conditions.

Cul	DAS	Treatment	DTI_A	R	DTI_Gs	R	DTI_E	R	DTI_WUE	R	DTI_Tleaf	R	DTI_RWC	R	RSI
TRI 2023	3	GM1000	0.76^{a}	1	0.53^{a}	1	0.75^{a}	6	1.09^{ba}	2	1.03^{cb}	3	1.05^{a}	1	14
		GM660	0.69^{ba}	4	0.48^{ba}	2	0.65^{ba}	2	1.00^{bc}	4	1.01^{d}	1	1.00^{ba}	3	16
		K_2SO_4	0.68^{ba}	4	0.37^{c}	5	0.66^{ba}	2	0.97^{c}	5	1.05^{a}	5	0.98^{b}	5	26
		KCl	0.75^{a}	1	0.47^{ba}	2	0.67^{ba}	2	1.12^{ba}	2	1.02^{c}	2	1.05^{a}	1	10
		WS	0.74^{a}	1	0.42^{bc}	4	0.61^{b}	1	1.16^{a}	1	1.03^{b}	4	1.00^{ba}	3	14
		NS	0.57^{b}	6	0.37^{c}	5	0.67^{ba}	2	0.74^{d}	6	1.06^{a}	5	0.97^{b}	5	29
	7	GM1000	0.46^{ba}	2	0.56^{a}	1	0.62^{a}	5	1.12^{a}	1	1.00^{ba}	3	0.95^{a}	1	13
		GM660	0.37^{bc}	3	0.35^{bc}	4	0.42^{bc}	2	0.76^{bc}	4	1.00^{ba}	3	0.93^{a}	1	17
		K_2SO_4	0.43^{b}	5	0.35^{bc}	4	0.43^{bc}	2	1.03^{ba}	2	1.00^{ba}	3	0.98^{a}	1	17
		KCl	0.39^{bc}	3	0.48^{ba}	3	0.53^{ba}	4	0.65^{c}	5	0.99^{b}	2	1.00^{a}	1	18
		WS	0.58^{a}	1	0.60^{a}	1	0.61^{a}	5	0.88^{ba}	2	0.96^{c}	1	0.94^{a}	1	11
		NS	0.29^{c}	6	0.22^{c}	6	0.28^{c}	1	0.60^{c}	5	1.01^{a}	6	0.94^{a}	1	25
	14	GM1000	0.16^{ba}	2	0.30^{a}	1	0.38^{a}	6	0.38^{b}	5	1.00^{b}	2	0.81^{a}	1	17
		GM660	0.08^{bc}	3	0.12^{cb}	4	0.16^{dc}	2	0.92^{ba}	4	0.99^{b}	2	0.93^{a}	1	16
		K_2SO_4	0.11^{bc}	3	0.17^{b}	3	0.22^{c}	4	1.54^{a}	1	1.00^{b}	2	0.95^{a}	1	14
		KCl	0.06^{c}	6	0.12^{cb}	4	0.16^{dc}	2	0.54^{b}	5	1.02^{a}	6	0.94^{a}	1	24
		WS	0.12^{bc}	3	0.26^{a}	1	0.28^{b}	5	1.38^{a}	1	0.97^{c}	1	0.82^{a}	1	12
		NS	0.22^{a}	1	0.10^{c}	6	0.13^{d}	1	1.67^{a}	1	1.00^{b}	2	0.87^{a}	1	12
TRI 2025	3	GM1000	0.55^{bc}	5	0.36^{bc}	4	0.58^{bc}	2	0.97^{a}	1	1.03^{c}	3	1.07^{a}	1	16
		GM660	0.64^{bac}	4	0.53^{ba}	2	0.72^{ba}	4	1.03^{a}	1	0.99^{e}	1	1.02^{a}	1	13
		K_2SO_4	0.47^{c}	6	0.34^{c}	6	0.51^{c}	1	0.93^{a}	1	1.02^{d}	2	0.87^{b}	6	22
		KCl	0.68^{ba}	3	0.39^{bc}	4	0.62^{bc}	2	1.11^{a}	1	1.03^{cb}	4	1.05^{a}	1	15
		WS	0.79^{a}	1	0.62^{a}	1	0.88^{a}	6	0.96^{a}	1	1.04^{b}	5	1.05^{a}	1	15
		NS	0.78^{a}	1	0.46^{bac}	3	0.72^{ba}	4	1.01^{a}	1	1.06^{a}	6	0.98^{ba}	5	20
	7	GM1000	0.34^{b}	3	0.23^{bc}	5	0.31^{ba}	2	1.08^{cb}	5	1.00^{b}	2	0.97^{a}	1	18
		GM660	0.37^{b}	3	0.27^{ba}	2	0.37^{a}	3	1.41^{b}	2	1.01^{ba}	5	0.90^{a}	1	16
		K_2SO_4	0.65^{a}	1	0.31^{a}	1	0.40^{a}	3	1.41^{b}	2	1.00^{b}	2	0.97^{a}	1	10
		KCl	0.34^{b}	3	0.26^{ba}	2	0.33^{a}	3	0.88^{c}	6	1.00^{b}	2	1.02^{a}	1	17
		WS	0.59^{a}	1	0.28^{ba}	2	0.34^{a}	3	1.96^{a}	1	0.97^{c}	1	1.00^{a}	1	9
		NS	0.28^{b}	3	0.16^{c}	6	0.22^{b}	1	1.44^{b}	2	1.02^{a}	6	0.94^{a}	1	19
	14	GM1000	0.12^{c}	4	0.09^{c}	5	0.13^{b}	1	1.01^{bc}	3	1.01^{b}	2	0.85^{a}	1	16
		GM660	0.10^{c}	4	0.09^{c}	5	0.13^{b}	1	0.77^{c}	5	1.01^{b}	2	0.92^{a}	1	18
		K_2SO_4	0.19^{b}	3	0.12^{ba}	3	0.17^{b}	1	0.96^{bc}	3	1.01^{b}	2	0.78^{a}	1	13
		KCl	0.23^{ba}	2	0.09^{bc}	4	0.14^{b}	1	1.67^{a}	1	1.01^{b}	2	0.83^{a}	1	11
		WS	0.11^{c}	4	0.13^{a}	1	0.17^{b}	1	0.86^{c}	5	0.98^{c}	1	0.76^{a}	1	13
		NS	0.27^{a}	1	0.15^{a}	1	0.22^{a}	6	1.37^{ba}	2	1.03^{a}	6	0.85^{a}	1	17

Cul: Cultivar, DAS: Days After Spraying, A: Net Photosynthetic Rate (µmol m-2 s-1), Gs: Stomatal Conductance (mmol m-2 s-1), E: Transpiration Rate (mmol m-2 s-1), WUE: Water Use Efficiency (A/E), Tleaf: Leaf Temperature (°C), RWC: Relative Water Content (%), TSS: Total Soluble Sugar content (mg g-1 dry weight), PRO: Proline content (µg g-1 dry weight), R: Rank and RSI: Rank Summation Index. WS: water spray, NS: no spray, K_2SO_4: 2 % Sulphate of Potash, KCl: 2 % Murate of Potash, GM1000 and GM660: long chain fatty alcohol 1000 and 660 mL / 200 L water / ha respectively

The DTI for stomatal conductance was significantly the highest in GM1000 throughout the experiment in drought susceptible cultivar, TRI 2023. In TRI 2025, the drought tolerant cultivar, at latter stages of drought especially at 14 DAS, both concentrations of GM treatments resulted the lowest DTI for Gs. This implies that application of GM1000 would enhnace the drought tolerance and thereby excert the stress alleviator action, but with no significant differnce to that of WS in susceptible cultivar (TRI 2023). However, this was not observed in drought tolerant cultivar (TRI 2025). In TRI 2025, at 7 DAS, application of K_2SO_4 resulted significantly the highest DTI for stomatal conductance with no significant differnce to that of KCl, WS or GM660. However, with the progression of drought in TRI 2025, the inherant ability of drought tolerance has become significantly higher than the impacts of application of GM1000, GM660 or KCl, with no significant difference to that of K_2SO_4 or WS treatments at latter part of the drought *i.e.* at 14 DAS (Figure 7).

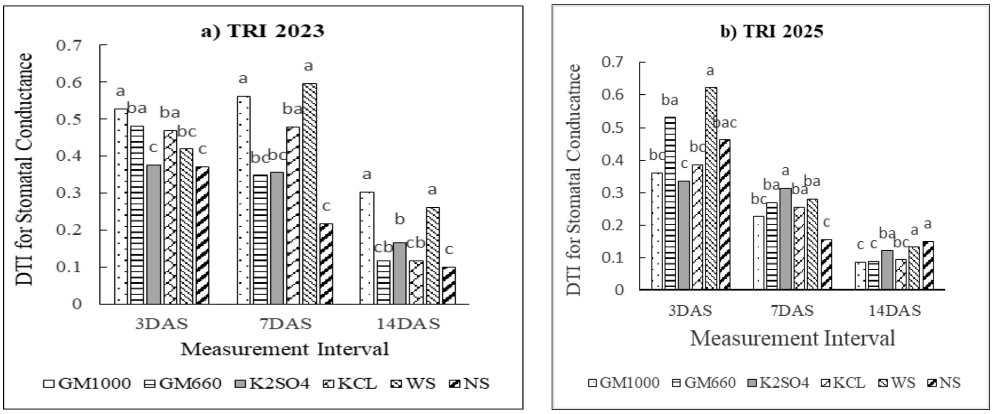


Figure 7. Drought Tolerance Index (DTI) for stomatal conductance over the experimental period in a) TRI 2023 and b) TRI 2025 after applying treatments while the plants were exposed to a progressive drought stress. GM1000 and GM660: long chain fatty alcohol 1000 mL and 660 mL / 200 L water / ha respectively, WS: water 200 L/ha, K_2SO_4: 2 % Sulphate of Potash, KCl: 2 % Murate of Potash, NS: no spray and 3DAS, 7DAS and 14DAS are 3, 7 and 14 days after spraying respectively (similar patterened bars with different lower case letters are significantly different at alpha < 0.05)

It revealed that the application of GM1000 for TRI 2025 leads to decreased rate of transpiration but with no additional benefit compared to NS or WS treatments at any of the measurement intervals (Figure 8).

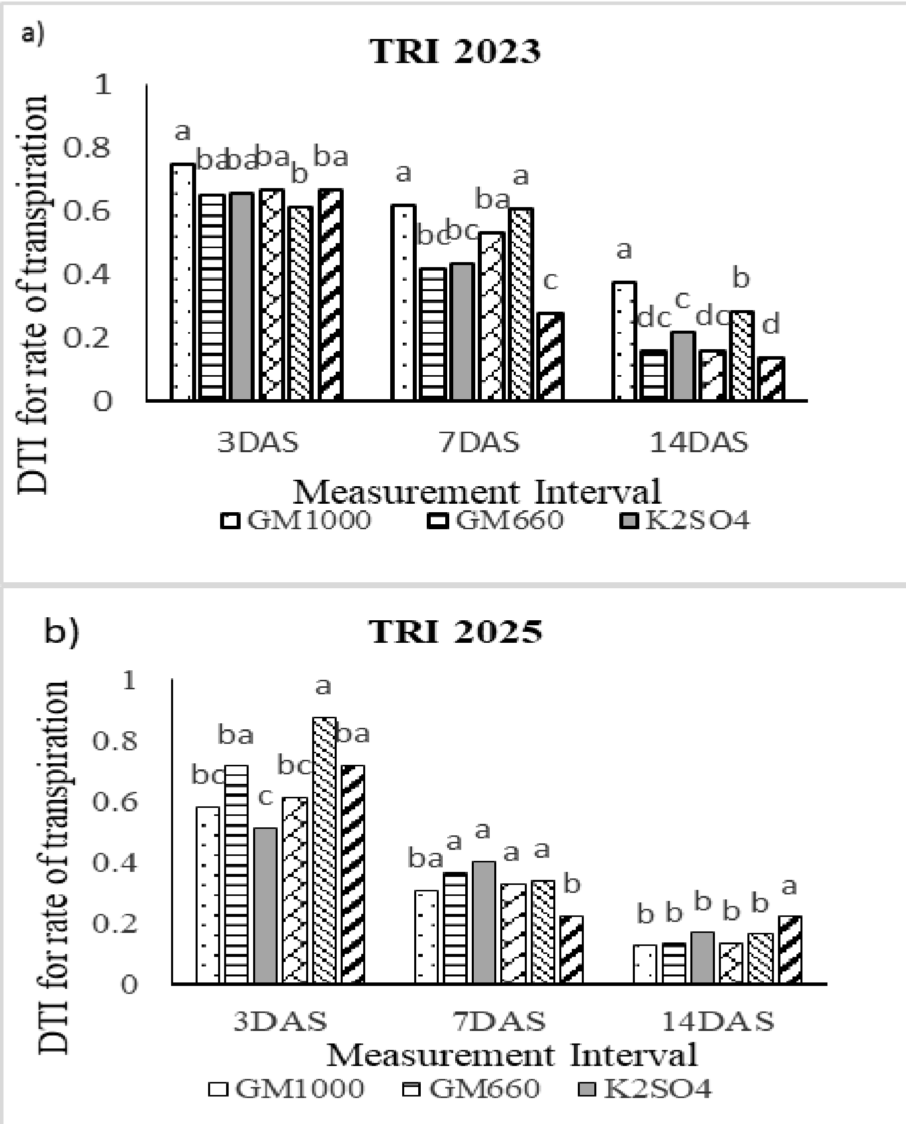


Figure 8. Drought Tolerance Index (DTI) for transpiration rate over the experimental period in a) TRI 2023 and b) TRI 2025 after applying treatments while the plants were exposed to a progressive drought stress. GM1000 and GM660: long chain fatty alcohol 1000 mL and 660 mL / 200 L water / ha respectively, WS: water 200 L/ha, K_2SO_4: 2 % Sulphate of Potash, KCl: 2 % Murate of Potash, NS: no spray and 3DAS, 7DAS and 14 DAS are 3, 7 and 14 days after spraying respectively (similar patterened bars with different lower case letters are significantly different at alpha < 0.05)

It was unable to comment on the impacts on TSS and proline due to the statistical models became insignificant. Further, there were no differences on the visual assessments conducted at 14 DAS and 21 DAS among different treatments. The calculated Rank Summation Index and the relevant statistics used for the final decision are given in the Table 2 and Table 3 for

TRI 2023 and TRI 2025 respectively. The treatments with RSI less than or equal to the mean values for different days after applying the treatments were selected as the effective interventions for enhancing drought tolerance in nursery plants.

Table 2. The Rank Summation Index (RSI) and relevant statistics for TRI 2023.

DAS	Treatment	RSI	Min	Max	Median	Mean
3	KCl	10	10	29	15	18
	GM1000	14				
	WS	14				
	GM660	16				
	K_2SO_4	26				
	NS	29				
7	WS	11	11	25	17	17
	GM1000	13				
	GM660	17				
	K_2SO_4	17				
	KCl	18				
	NS	25				
14	WS	12	12	24	15	16
	NS	12				
	K_2SO_4	14				
	GM660	16				
	GM1000	17				
	KCl	24				

Accordingly, the application of GM 660 for TRI 2023 increased its drought tolerance ability at all the measurement intervals but with no additional benefit over the WS treatment. Further, none of the tratments provided any additonal benefit for drought tolerance enhancement in TRI 2025 compared to WS treatment in all the measurement intervals (Table 3).

Table 3. The Rank Summation Index (RSI) and relevant statistics for TRI 2025.

DAS	Treatment	RSI	Min	Max	Median	Mean
3	GM660	13	13	22	16	17
	KCl	15				
	WS	15				
	GM1000	16				
	NS	20				
	K_2SO_4	22				
7	WS	9	9	19	17	15
	K_2SO_4	10				
	GM660	16				
	KCl	17				
	GM1000	18				
	NS	19				
14	KCl	11	11	18	15	15
	K_2SO_4	13				
	WS	13				
	GM1000	16				
	NS	17				
	GM660	18				

In clonclusion there are no any additional benefits of antitranspirant cum stress alleviator action with the application of long chain fatty alcohol compared to spraying of water into the nursery tea plants.

2.2 Testing the impact of long chain fatty alcohol on immature tea plants under field conditions

In the absence of any additional benefits of enhancement of drought tolerance in nursery tea plants for the treatments under glasshouse and rainshelter conditions, the same treatments (except WW) were tested under field conditions at the Field No 08NC, Fairfield Division, Bearwell Estate, Talawakelle (WU2) using three-year-old TRI 4078 cultivar (drought tolerant). The average annual rainfall in this region is 2,250 mm and maximum and minimum temperatures are 22.5 °C and 14 °C respectively. The experiment was arranged according to Randomized Complete Block Design (RCBD) with 2 blocks. When the gravimetric soil moisture content reached around 28.93%, *i.e.* plants were at moderate water stress condition, the treatments were applied as foliar spray: GM 660 mL / 200 L water / ha (GM660); GM 1000 mL / 200 L water / ha (GM1000); water 200 L/ha (WS); 2 % Sulphate of Potash (K_2SO_4); 2 % Murate of Potash (KCl) along with no spray (negative control - NS) treatment. Data pertaining to physiological and biochemical parameters mentioned above in experiment 2.1 were collected at 7, 14 and 21 days after applying the treatments (DAS) from randomly selected plants along with the soil moisture content and yield components with the progression of drought. The recovery was also assessed using the same parameters after a rainfall event at 75 DAS from randomly selected plants.

ANOVA was performed separately using data collected from different measurement intervals and the means were separated using Duncan's Multiple Range Test (DMRT) using SAS v9 package. Finally, the decision was made using Rank Summation Index (RSI) which is a multi-criteria selection method as described earlier by giving ranks for each and every parameter which are responsible for drought tolerance.

The mean gravimetric SMC was not significantly different between 7 DAS and 14 DAS and it was approximately 22% - 23%, whereas, at 21 DAS it was the lowest and reported as 19.9%. The mean gravimetric SMC of 27.04% at 75 DAS i.e. at recovery was recorded as the highest among the measurement intervals. The effect of applying different treatments on improving plant physiological and biochemical parameters along with the ranks are given in the Table 4. Accordingly, the responses of different itreatments were different at different measurement interval.

At 7 DAS, no clear patterns of variation were observed among different treatments for different parameters tested. However, with time, along with the progression of drought, the impacts of drought as well as the impacts of different treatments were clearly visible.

A significant reduction of transpiration rate was observed in field grown immature tea plants especially at 14 DAS in GM1000 and K_2SO_4 applied treatments. This must have mainly attributed to the lowest stomatal conductance to water vapour observed in these treatments. Further, GM1000, K_2SO_4 and KCl treatments showed significantly the highest water use efficiency at 14 DAS too. Although, it was not possible to continue the measurements of transpiration rate along with the progression of drought beyond 14 DAS due to unexpected breakdown of the instruments, it clearly showed that the application of GM1000 significantly decreased the stomatal conductance to water vapour throughout the experiment. Therefore, a clear reduction of transpiration rate also can be expected under the GM1000 treatment as there is a significant positive correlation between the stomatal conductance and rate of transpiration (data were not shown). Although spraying of GM1000 resulted significantly the highest TSS (with no significant difference to that of KCl and K_2SO_4) and proline (with no significant difference to that of GM660 and K_2SO_4) at 14 DAS, which were considered as positive effects, it resulted significantly the lowest RWC (with no significant difference to that of NS, K_2SO_4 and WS). In contrast, application of GM660 showed significantly the highest transpiration rate and net photosynthetic rate which may be attributed to significantly higher stomatal conductance exhibited in GM660 treated plants at 14 DAS. Further, it resulted significantly the lowest WUE with no significant difference to that of WS and NS treatments at the same measurement interval. These contrasting impacts of the two concentrations of GM highlight the need of selecting the correct concentration to get its antitranspirant cum stress alleviator actions.

Table 4. Mean, Rank (R) and Rank Summation Index (RSI) of physiological and biochemical traits identified as drought tolerant indicators of field grown immature tea plants.

DAS	Treatment	A	R	Gs	R	E	R	WUE	R	Tleaf	R	RWC	R	TSS	R	Proline	R	RSI
7	GM1000	6.1^{a}	1	95.9^{a}	1	3.1^{b}	1	2.0^{a}	1	31.8^{ba}	5	81.65^{ba}	2	57.09^{c}	5	51.57^{ba}	2	19
	GM660	6.5^{a}	1	113.4^{a}	1	3.3^{ba}	5	2.0^{a}	1	31.5^{bc}	2	77.20^{b}	5	59.24^{c}	5	73.55^{ba}	2	22
	K_2SO_4	6.1^{a}	1	115.2^{a}	1	3.4^{a}	6	1.8^{ba}	5	31.5^{bc}	2	83.54^{a}	1	78.21^{b}	2	92.05^{a}	1	19
	KCl	5.9^{a}	1	99.7^{a}	1	3.1^{b}	1	1.9^{a}	1	31.2^{c}	1	80.74^{ba}	2	62.53^{cb}	3	35.88^{b}	4	14
	WS	5.8^{a}	1	94.3^{a}	1	3.0^{b}	1	1.9^{a}	1	31.6^{b}	4	76.79^{b}	5	60.59^{cb}	3	45.05^{b}	4	20
	NS	4.8^{b}	6	118.1^{a}	1	3.1^{b}	1	1.7^{b}	6	32.1^{a}	6	80.94^{ba}	2	96.81^{a}	1	31.40^{b}	4	27
14	GM1000	4.3^{c}	3	67.7^{c}	5	2.3^{c}	1	2.0^{a}	1	32.0^{a}	5	81.20^{c}	5	94.53^{a}	1	45.05^{a}	1	22
	GM660	5.4^{a}	1	164.2^{a}	1	3.5^{a}	6	1.6^{b}	4	30.6^{c}	1	83.75^{ba}	2	71.26^{b}	4	34.97^{a}	1	20
	K_2SO_4	4.4^{c}	3	66.6^{c}	5	2.3^{c}	1	2.0^{a}	1	32.2^{a}	5	81.99^{bc}	4	83.92^{ba}	3	35.60^{a}	1	23
	KCl	4.9^{b}	2	101.0^{b}	2	2.7^{b}	3	1.8^{a}	1	30.9^{cb}	3	85.18^{a}	1	95.53^{a}	1	23.90^{b}	5	18
	WS	4.0^{c}	3	102.6^{b}	2	2.8^{b}	3	1.4^{b}	4	30.8^{c}	1	82.95^{bac}	3	73.44^{b}	4	37.97^{a}	1	21
	NS	4.0^{c}	3	96.4^{b}	2	2.8^{b}	3	1.5^{b}	4	31.3^{b}	4	80.86^{c}	5	45.29^{c}	6	23.83^{b}	5	32
21	GM1000	-	-	361.1^{b}	6	-	-	-	-	31.6^{a}	6	82.82^{ba}	2	141.04^{a}	1	134.58^{a}	1	17
	GM660	-	-	505.0^{a}	1	-	-	-	-	29.0^{c}	1	78.03^{c}	6	63.91^{c}	5	86.08^{dc}	4	18
	K_2SO_4	-	-	474.7^{ba}	5	-	-	-	-	31.1^{ba}	3	80.02^{bc}	3	86.43^{bc}	4	101.42^{bc}	3	19
	KCl	-	-	570.7^{a}	1	-	-	-	-	30.7^{ba}	3	85.66^{a}	1	127.96^{ba}	2	70.18^{d}	6	14
	WS	-	-	524.7^{a}	1	-	-	-	-	30.3^{b}	2	79.86^{bc}	3	62.99^{c}	5	79.67^{dc}	4	16
	NS	-	-	506.1^{a}	1	-	-	-	-	30.9^{ba}	3	80.12^{bc}	3	138.56^{ba}	2	121.00^{ba}	2	12
75	GM1000	-	-	855.3^{b}	6	-	-	-	-	31.0^{bc}	2	83.13^{cb}	3	57.86^{c}	4	25.83^{b}	2	17
	GM660	-	-	1241.5^{a}	1	-	-	-	-	30.6^{bc}	2	82.55^{c}	4	44.25^{d}	6	52.18^{b}	2	15
	K_2SO_4	-	-	1027.8^{ba}	3	-	-	-	-	30.2^{bc}	2	91.06^{a}	1	83.50^{a}	1	33.35^{b}	2	9
	KCl	-	-	1347.0^{a}	1	-	-	-	-	29.6^{c}	1	86.67^{b}	2	76.75^{ba}	2	41.31^{b}	2	8
	WS	-	-	1087.3^{ba}	3	-	-	-	-	32.9^{a}	6	81.88^{c}	4	61.43^{c}	4	110.16^{a}	1	18
	NS	-	-	1015.1^{ba}	3	-	-	-	-	31.5^{ba}	5	79.50^{c}	4	70.03^{bc}	3	17.93^{b}	2	17

DAS: Days After Spraying, A: Net Photosynthetic Rate ($\mu mol\ m^{-2}\ s^{-1}$), Gs: Stomatal Conductance ($mmol\ m^{-2}\ s^{-1}$), E: Transpiration Rate ($mmol\ m^{-2}\ s^{-1}$), WUE: Water Use Efficiency (A/E), Tleaf: Leaf Temperature (^{o}C), RWC: Relative Water Content (%), TSS: Total Soluble Sugar content (mg g-1 dry weight), PRO: Proline content (µg g-1 dry weight), R: Rank and RSI: Rank Summation Index. WS: water spray, NS: no spray, K2SO4: 2 % Sulphate of Potash, KCl: 2 % Murate of Potash, GM1000 and GM660: long chain fatty alcohol 1000 and 660 mL / 200 L water / ha respectively

The calculated Rank Summation Index and the relevant statistics are given in the Table 5.

Table 5. The Rank Summation Index (RSI) and relevant statistics

DAS	Treatment	RSI	min	max	median	Mean
7	KCl	14	14	27	20	20
	GM1000	19				
	K_2SO_4	19				
	WS	20				
	GM660	22				
	NS	27				
14	KCl	18	18	32	22	23
	GM660	20				
	WS	21				
	GM1000	22				
	K_2SO_4	23				
	NS	32				
21	NS	12	12	19	17	16
	KCl	14				
	WS	16				
	GM1000	17				
	GM660	18				
	K_2SO_4	19				
75	KCl	8	8	18	16	14
	K_2SO_4	9				
	GM660	15				
	GM1000	17				
	NS	17				
	WS	21				

In this study, eight parameters namely, RWC, A, Gs, WUE, E, Tleaf, TSS and Proline were used as the parameters attributed to stress alleviator action on immature tea and used for this evaluation. The treatments with RSI less than or equal to the mean values for different days after applying the treatments were selected as the effective interventions for enhancing drought tolerance in field grown immature tea plants. Accordingly, for 7 DAS, *i.e.* for a moderate moisture stress, KCl, K_2SO_4, GM1000 as well as WS treatments would be advantageous for the enhancement of drought tolerance and thereby to alleviate the stress. However, with the time passed by, even the application of GM660 would provide benefits in terms of improving the drought tolerance at 14 DAS, *i.e.* also under moderate soil moisture stress in addition to the above treatments. With further progression of drought stress, *i.e.* at 21 DAS, only the NS, KCl and WS treatments became beneficial whereas K_2SO_4 became inferior exhibiting the need of repeated application of treatments at 14 DAS as per the current recommendation of the TRI. Similarly, repeated application of GM1000 in every 14 days might also be beneficial under such circumstances. However, only the KCl and K_2SO_4 became beneficial when checked the responses of recovery after a rainfall event. Unlike for an annual crop, it should be noted that not only the survival during drought, but also the recovery would be equally important for a perennial crop like tea as it is unavoidable to experience several dry spells as well as several rainfall events during its life time. Therefore, it can be conluded that only KCl and K_2SO_4 became beneficial for enhancing drought tolerance and thereby alleviating stress in field grown immature tea plants.

When considering the yield variation, interestingly, at 7 DAS, the GM660 treatment resulted significantly the highest yield with no significant difference to that of KCl, WS and K_2SO_4 (data were not shown). However, this highest yield in GM660 was exhibited at the expense of most of the desirable traits considered favourable for enhancing drought tolerance as explained earlier. Further, the spraying of K_2SO_4, KCl and WS also resulted higher yield which do not significantly different to that of the GM660 giving an indication that these interventions would result beneficial impacts for obtaining better productivity of immature tea plants.

Application of long chain fatty alcohol (GM) at correct concentration *i.e.* 1000 mL / 200 L water / ha (GM1000) significantly decreased the stomatal conductance for water vapour throughout the experiment where a reduction of transpiration rate could also be expected. If only the survival during drought is considered, spraying 2% Murate or Sulphate of Potash, long chain fatty alcohol 1000 mL / 200 L water / ha or even spraying water 200 L water / ha would be beneficial in reducing the impacts of drought on immature tea plants. However, in addition to enhancing survival, as it is equally important to have better recovery for a perennial crop like tea which is likely to expose to several dry spells during its life time, no treatment other than the current recommended 2% Murate or Sulphate of Potash would be ideal for enhancing drought tolerance and thereby alleviating stress in immature tea.

Therefore, in conclusion the current recommendation of spraying 2% Murate or Sulphate of Potash for immature tea plants (i.e commencement of spraying before the onset of drought) can be modified accommodating the commencement of spraying these chemicals during dry weather for plants under moderate-stress conditions if spraying could not be commenced before the onset of drought for some reason or the onset of drought not precisely predicted/identified.

This experiment was successfully completed.

TL Wijeratne, DMS Navaratne, V Sidhakaran, ADIU Jayawardhana and NM Vithanage

Experiment 3: Evaluation of Trichoderma formulation on improving the physiological and biochemical responses in tea (*Camellia sinensis*) during drought stress.

This study was conducted under rainshelter at the Tea Research Institute of Sri Lanka using potted nursery tea plants of two cultivars with known drought tolerances namely TRI 2025 (drought tolerant) and TRI 2023 (drought susceptible). The experiment was arranged according to Complete Randomized Design (CRD). The Trichoderma formulations prepared by Plant Pathology Division of the TRI were used in this study. Trichoderma formulations were inoculated with compost at a ratio of 1 Trichoderma formulation: 100 Compost (one dose) and kept for incubation for one week before applying the treatments. Meanwhile the plants were brought up to the field capacity, watering was withheld and the plants were allowed to under go a natural drying cycle. When the plants were at a moderate moisture stress, the following treatments were applied.

T1: One dose of Trichoderma formulation
T2: No Trichoderma formulation
T3: Two doses of Trichoderma formulation

Physiological and biochemical data were collected at 7 and 14 days after applying the treatments from randomly selected plants along with the gravimetric soil moisture content (SMC) with the progression of drought. Following physiological parameters were measured along with the soil moisture content throughout the experiment. Gas exchange parameters (stomatal conductance (gsw), rate of transpiration (E), efficiency of photosystem II (phips2), electron transport rate (ETR) and leaf temperature (Tleaf)) were measured using a portable porometer cum fluorometer (Model: LI600, LiCor, USA). Leaf relative water content (RWC) was measured using destructive sampling and standard protocol. Leaf total soluble sugar (TSS) content and leaf proline content were also determined using standard methods. In addition, the plants were visually assessed at 14 days after applying the treatments for their appearance and thereby the percentage of plants with normal appearance was calculated.

It was not possible to comment on the changes in accumulation of total soluble sugar content (TSS) in tea leaves in TRI 2023 and the results of the 14 days after applying the treatments in TRI 2025 as the statistical models were not significant. However, it clearly showed that the application of Trichoderma formulations have decreased the TSS in TRI 2025 at 7 days after applying the treatments (Figure 9).

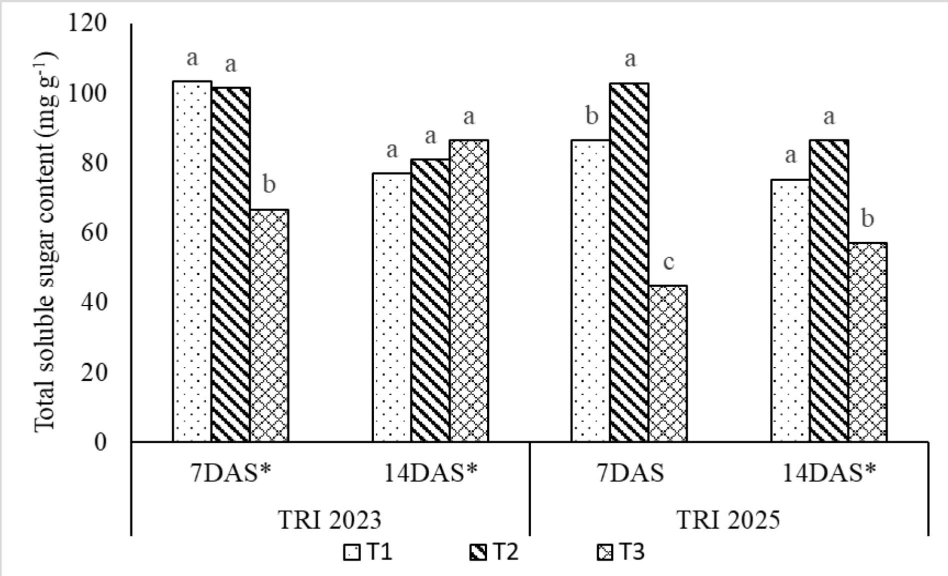


Figure 9. Total soluble sugar content of tea leaves in cultivar TRI 2023 and TRI 2025 during the experimental period under a progressive drought, where 7 DAS and 14 DAS denote the 7 and 14 days after applying the treatments respectively. T1: One dose of richoderma formulation, T2: No Trichoderma formulation and T3: Two doses of Trichoderma formulation. Different lower case letters under each cultivar under each measurement interval denote the significant variation ($p<0.05$) among different treatments. * indicates that the statistical model is not significant).

In contrast to that of TSS accumulation, application of one dose of Trichoderma formulation (T1) significantly increased the proline accumulation in both cultivars whereas application of two doses of Trichoderma formulation (T3) did not show significant variation to that of no Trichoderma formulation (T2) in TRI 2023, but it significantly increased in TRI 2025 at 14 days after applying the treatments (Figure 10).

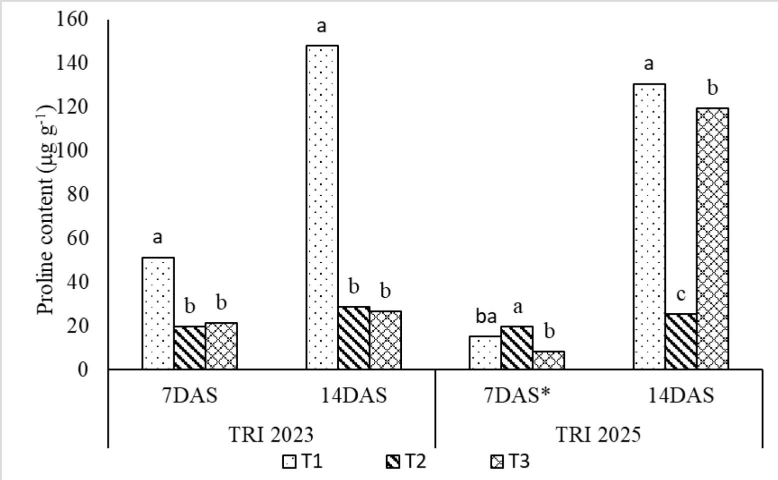


Figure 10. Proline content of tea leaves in cultivar TRI 2023 and TRI 2025 during the experimental period under a progressive drought, where 7 DAS and 14 DAS denote the 7 and 14 days after applying the treatments respectively. T1: One dose of richoderma formulation, T2: No Trichoderma formulation and T3: Two doses of Trichoderma formulation denote the (Different lower case letters under each cultivar under each measurement interval denote the significant variation ($p<0.05$) among different treatments. * indicates that the statistical model is not significant).

The chemical analysis and statistical analysis of the rest of the data are in progress.

TL Wijeratne, ADIU Jayawardhana and NM Vithanage

Repeated evaluation of Abscisic acid (ABA) hormone at glasshouse

Project C/MET. Meteorological data

Project C/MET involves data collection, analysis as well as maintenance of agro meteorological stations in TRI Regional centers of Deniyaya, Hantane (Kandy), Kottawa (Galle), Passara, Ratnapura and Talawakelle. TRI Staff Participated at the Monsoon Forum organized by RIMES and Department of Meteorology and made presentations, representing tea sector.

NPSN Bandara

D/PHYS. Activities of Physiology Division

Experiment 1: Evaluation of Trichoderma formulation on growth parameters in tea (*Camellia sinensis*)

This study was also conducted under rainshelter at the Tea Research Institute of Sri Lanka using potted nursery tea plants of two cultivars with known drought tolerances namely TRI 2025 (drought tolerant) and TRI 2023 (drought susceptible). The experiment was arranged according to Complete Randomized Design (CRD). There were ten replicate plants per cultivar per treatment. The Trichoderma formulations prepared by Plant Pathology Division of the TRI were used in this study. Trichoderma formulations were inoculated with compost at a ratio of 1: 100 and kept for incubation for one week before applying the treatments. The following two treatments were applied after one-week inoculation and the plants were maintained under well watered condition.

T1: Trichoderma formulation was inoculated
T2: Without Trichoderma formulation

Physiological and biochemical data were collected at 7 and 14 days after applying the treatments from randomly selected plants. The height and girth (measured at 1 inch above the ground level) were also measured starting from the date of applying treatments and continued for eight months. Following physiological parameters were measured along with the soil moisture content throughout the experiment. Gas exchange parameters [stomatal conductance (gsw), rate of transpiration (E), efficiency of photosystem II (phips2), electron transport rate (ETR) and leaf temperature (Tleaf)] were measured using a portable porometer cum fluorometer (Model: LI600, LiCor, USA). Leaf relative water content (RWC) was measured using destructive sampling and standard protocol. Leaf total soluble sugar (TSS) content and leaf proline content were also determined using standard methods. In addition, the plants were visually assessed at 14 days after applying treatments for their appearance and percentage of plants with normal appearance was calculated.

Increase of plant girth with the application of T1 was significantly lower than that of T2 (Figure 11).

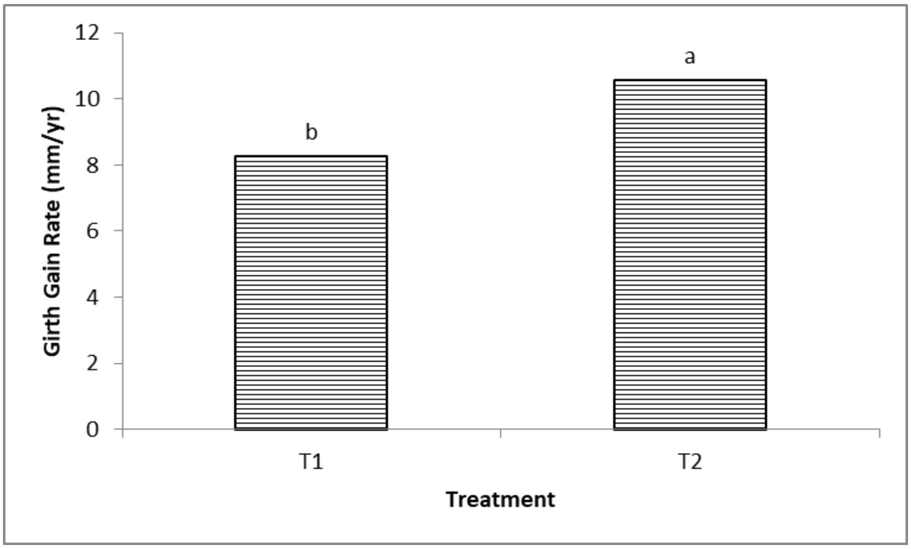


Figure 11. Girth increment rate (mm/yr) of tea plants after innoculation of T1: Trichoderma formulation and T2: Without Trichoderma formulation (bars with the same letters are not significantly different at p=0.05)

However, there was no significant difference in relative growth rate of girth of tea plants between the two treatments (Figure 12).

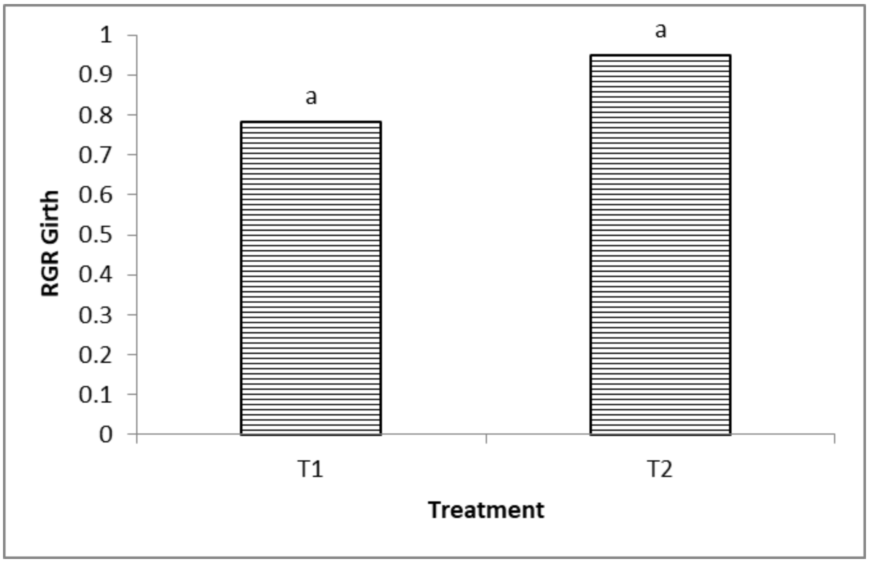


Figure 12. Variation of relative growth rate (RGR) of girth (mm of gain of girth per mm of existing bush girth per year) of tea plants after innoculation of T1: Trichoderma formulation and T2: Without Trichoderma formulation (bars with the same letters are not significantly different at p=0.05)

The statistical data analysis is in progress.

TL Wijeratne, ADIU Jayawardhana and NM Vithanage

Experiment 2: Screening of Organic Fertilizers to incorporate in Integrated Nutrient Management in Tea

Chemical fertilizers act as beneficial inputs to get higher crop productivity. However, irregular or use of high doses of chemical fertilizers are associated with many negative impacts such as reduction of soil inhabited beneficial microbes, degradation of soil properties and reducing crop yields over time *etc*. leading to economic as well as environmental problems.

In order to minimize such problems, this study was carried out as a collective effort by the Tea Research Institute of Sri Lanka (TRI) with the aim of promoting the use of integrated nutrient management for the sustainability of tea cultivation.

Details of 62 organic fertilizer products were submitted to the TRIvia the ministryunder this program. However, only 36 organic products were delivered to the TRI, among which 15 were solid and 21 were liquid fertilizers. After analyzing the chemical composition of each fertilizer received at the TRI laboratory and also considering the data obtained from production firms related to Nitrogen (N) content (2% and above) of each fertilizer, only 19 fertilizer products were selected to test at the TRI. Specific attention was given to N nutrient content in organic fertilizers as N is the most demanding nutrient for tea. Based on the above criteria, 8 solid fertilizers and 11 liquid fertilizers were tested at the TRI.

This experiment was conducted in a glasshouse of the TRI, Talawakelle Sri Lanka using one year old potted tea plants with three replicates for approximately 200 days. Nine solid fertilizers treatments (S1-S9) and seventeen liquid fertilizers treatments (L1-L17) were tested under this experiment. TRI's recommended chemical fertilizer mixture of T200 (S8) were used as the control. In order to represent all tea growing soils in Sri Lanka, following six soil series were used as the potting media when the 8 months old nursery plants were transplanted in the pots.

M1: Low-Country (Pallegoda soil series- Moragolla Estate, Galle)
M2: Low-Country (Pallegoda soil series- St. Joachim Estate, Ratnapura)
M3: Mid-Country (Kandy soil series- Rostchild Estate, Pussellawa)
M4: Up-Country (Mattakele soil series- Mattakelle Estate, Talawakelle)
M5: Up-Country (Maskeliya soil series– Strathphy Estate, Maskeliya)
M6: Uva (Mahawalatenna soil series- Gonakelle Estate, Passara)

The experiment was arranged according to a two-factor factorial experiment with the fertilizer type as the main factor and the soil series as the sub factor. The data on growth (plant height, girth, number of leaves, number of flower buds/fruits, active buds and *banji* buds), leaf pigments and soil pH were obtained in a number of different occasions during the experimental period. Their physiological behavior (efficiency of photosystem II (PhiPS2) and electron transport rate (ETR)) was also studied at different times, to check whether the tea plants were under any stress due to nutrient deficiency or imbalance. Finally, the plants were uprooted to obtain the biomass partitioning variation in response to different fertilizer treatments. Uprooted plants were separated into leaves, stems, collars and roots and their biomass were measured. Leaf area, soil pH and leaf nitrogen content were also determined.

Data were statistically analyzed using SAS software package using general linear model and the mean separation was performed using Dunnett's t test compared to the control. The solid and liquid fertilizers were analyzed separately for increased clarity.

1. **Response of solid fertilizers**

Significant differences were observed in most of the parameters tested when compared to the S8, i.e. the control. However, as there were no clear patterns of variations of different parameters tested in response to different fertilizers tested, it was decided to use only the most important parameters for the successful growth and development of the tea plants in an index to select the best fertilizers to be used in integrated nutrient management packages for tea. Therefore, those fertilizers which were not significantly lower in response to S8 in each and every parameter were given "+1" or else "0" as tabulated in Table 6.

Table 6. The score received by different solid fertilizer types tested for their suitability for use in integrated nutrient management packages for tea plants

Solid Fertilizer	Leaf Biomass (g)	Chlorophyll pigment concentration (μg g^{-1})	Carotenoid pigment concentration (μg g^{-1})	PhiPS2	ETR (μmol m^{-2} s^{-1})	Total Score
S1	1	1	0	1	1	4
S2	0	1	0	1	1	3
S3	1	1	0	1	1	4
S4	0	1	0	0	1	2
S5	0	1	0	0	1	2
S6	0	1	0	0	1	2
S7	0	1	1	0	1	3
S9	0	1	1	0	0	2

Based on the preliminary results (Table 6), four solid fertilizer products (i.e S1, S2, S3 and S7) which scored more than 2 were selected as potential products for further testing to identify the best products to be used in integrated nutrient management package.Any data gatherd in relation to response of plants to soil series used in combination with soild fertliser product tested.

2. Response of liquid fertilizers

Similar to that of solid fertilizers, significant differences were observed in the responses of liquid fertilizers in most of the parameters tested when compared to the S8 (data were not shown). Similar to that of solid fertilizers, those liquid fertilizers which were not significantly lower in response to S8 in each and every parameter were given "+1" or else "0" as tabulated in Table 7.

Table 7. The score received by different liquid fertilizer types tested for their suitability for use in integrated nutrient management packages for tea plants

Liquid Fertilizer	Leaf Biomass (g)	Chlorophyll pigment concentration (μg g^{-1})	Carotenoid pigment concentration (μg g^{-1})	PhiPS2	ETR (μmol m^{-2} s^{-1})	Total Score
L1	0	1	1	0	1	3
L2	0	1	1	0	0	2
L3	1	1	1	0	1	4
L4	1	1	1	0	1	4
L5	0	1	1	1	1	4
L6	0	1	0	0	1	2
L7	0	1	1	0	1	3

Cont.,

Liquid Fertilizer	Leaf Biomass (g)	Chlorophyll pigment concentration (µg g^{-1})	Carotenoid pigment concentration (µg g^{-1})	PhiPS2	ETR (µmol $m^{-2} s^{-1}$)	Total Score
L8	0	1	0	0	1	2
L9	1	1		0	1	3
L10	1	1	0	0	1	3
L11	1	1	0	0	1	3
L12	0	1	0	0	1	2
L13	0	1	1	1	1	4
L14	0	1	0	0	1	2
L15	0	1	1	0	1	3
L16	1	1	0	0	1	3
L17	0	1	1	0	1	3

Those fertilizers which scored more than 2 were selected for their suitability for use in integrated nutrient management packages for tea plants. Accordingly, L1, L3, L4, L5, L7, L9, L10, L11, L13, L15, L16 and L17 were selected to be further tested in developing integrated nutrient management packages for tea plants.

This special experiment was completed and the results were submitted to the Ministry of Plantation for further actions.

TL Wijeratne, DMS Navaratne, V Sidhakaran, ADIU Jayawardhana and NM Vithanage

Experiment 3: Determination of the benefits of burying of pruned litter using physiological responses

This study was conducted with the objective of validating the benefits of burying pruned litter as a climate change mitigation measure. The experiment was carried out in Field No 10, Lower Division, St. Coombs Estate, Talawakelle using the demonstration area maintained by the Advisory and Extension Division of the TRI. The experimental design was Randomized Complete Block design with two treatments namely buried (B) and non-burried (NB) with three blocks and having approximately 25 bushes per plot. The data were collected after about 1 year of applying the treatments. A portable photosynthesis system (model: LI-6400XT, Li-Cor Inc., USA) was used to determine the net photosynthetic rate, stomatal conductance, transpiration rate and leaf temperature. The dark respiration was also measured in another set of leaves by covering the leaves with a Aluminium foil for 30 minutes prior to taking the gas exchange measurements. The gravimetric soil moisture content was also measured along with the gas exchange mesurements. The root biomass data and root length were measured using destructive sampling from 0.30 m and 0.60 m away from the base of the plants and following standard protocols. Yield components were also taken using 0.30 x 0.30 m^2 quadrat and the number of active and *banji* buds and their respective dry weights were measured subsequently. The data were statistically analyzed using t-test.

The gas exchange parameters such as net photosynthetic rate, stomatal conductance and transpiration rate were significantly higher in the treatment compared to non treatment. However, no significant difference was observed in the leaf temperature between the two treatments (Figure 13).

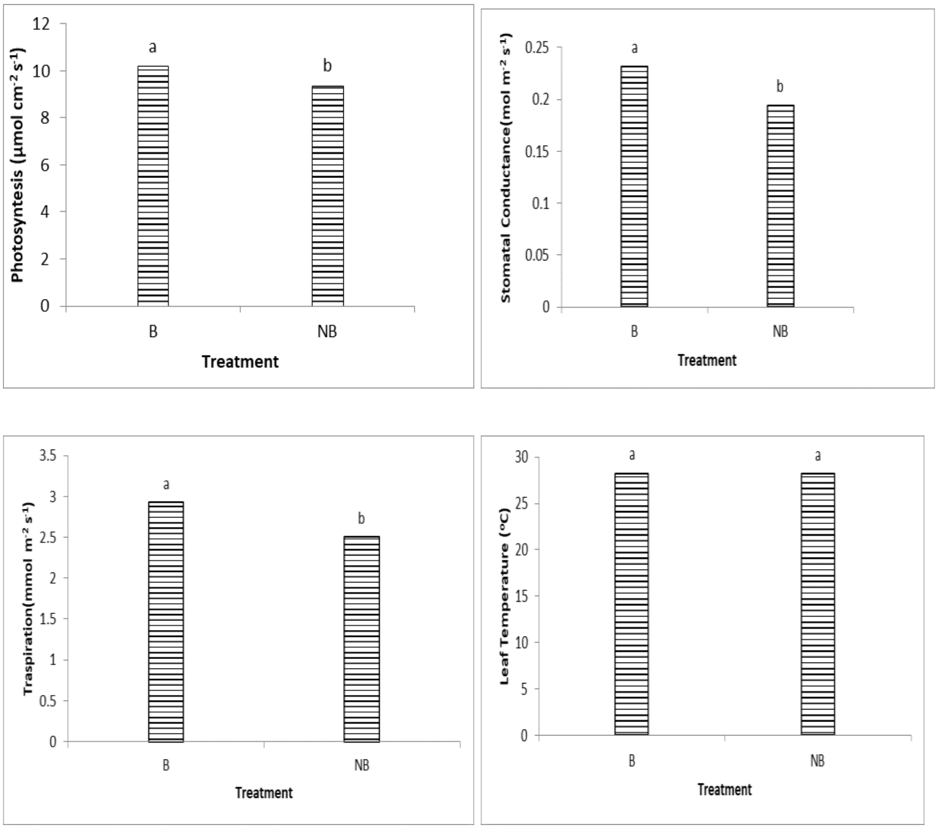


Figure 13. Variation of net photosynthetic rate (top left), stomatal conductance (top right), rate of transpiration (bottom left) and leaf temperature (bottom right) of tea leaves in response to the burial of pruned litter treatment, where B: Prunned litter was buried, NB: Prunned litter was not buried (bars with the same letters are not significantly different at p=0.05).

No significant difference was observed in the dark respiration measurements as well (data were not shown). The statistical analysis of the data is in progress.

TL Wijeratne, DMS Navaratne, MMN Damayanthi and NM Vithanage

Experiment 4: Studying the Water Use Efficiency in mature tea plants (Camellia sinensis)

This study was conducted with the objective of identifying the factors responsible for water use efficiency of tea plants. The study was conducted at the Field No. 12, St. Coombs Estate, Talawakelle and Field No. 04, Uva Extension Centre of TRI, Passara to compare the drought tolerance abilities of different tea cultivars as a collaborative study with the University of Peradeniya, Sri Lanka, Kew Garden and University of Bristol, United Kingdom. TRI 2043, DN, TRI 2025, accessions 5, 21, 88, 208 and 210 were selected to test the water use efficiencies of tea plants in Talawakelle. In addition to the above cultivars and accessions, TRI 2023, accession 89, seedlings of Salawa, St. Coombs and Rucastle were selected for the experiment in Passara. Gas exchange parameters (stomatal conductance (gsw), rate of transpiration (E), efficiency of photosystem II (PhiPS2), electron transport rate (ETR) and leaf temperature (Tleaf)) were measured using a portable porometer cum fluorometer (Model: LI600, LiCor, USA). Leaf relative water content (RWC) was measured using destructive sampling and the gravimetric moisture content (dry weight basis) was measured using standard protocol. Leaf chlorophyll content was measured using SPAD meter (Konica Minolta, USA). Additionally, leaf water potential and stomatal density were also measured and leaf samples were collected for the carbon isotope discrimination (data not shown). These data were collected in both locations. In addition, the gas exchange parameters were also measured using portable photosynthesis system (model: LI- 6400XT, Li-Cor Inc., USA) only in Talawakelle experimental site.

The gravimetric soil moisture content was varied from 36 – 40% in Talawakelle during the measurements indicating that the plants were not under a moisture stress at the time of the measurements. As a result, no clear patterns of variations were identified in most of the parameters tested.

Although due to the resource limitation the SPAD meter reading was taken as the non destructive chlorophyll measurement, almost all the data were higher than 50 except the SPAD reading of the tea leaves of accession 210 (Figure 14). The SPAD readings have a linear relationship to that of the Chlorophyll content of the tea leaves only upto 50 and beyond that the relationship becomes nonlinear.

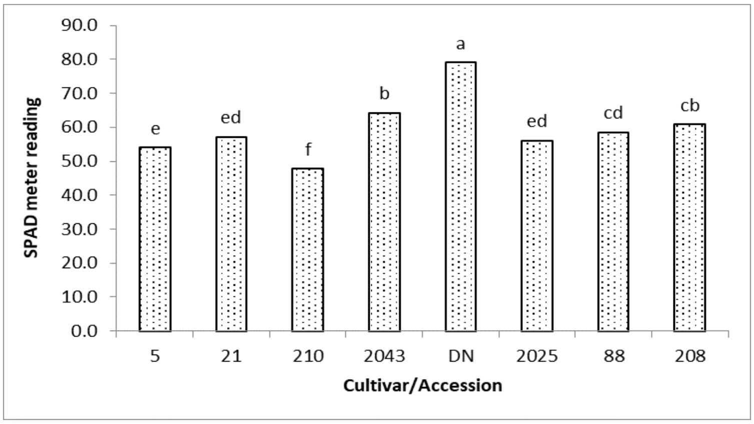


Figure 14. Variation of SPAD meter reading to compare the leaf chlorophyll content among different cultivars/accessions tested in Talawakelle (The bars with the same letters are not significantly different at p=0.05).

In Passara, the gravimetric soil moisture content was varied from 16.9% – 28.5% during day 1 and it was increased due to the unexpected rainfall event up to 20.1% – 29.4% during day 2 with the mean soil moisture content of 24.3% and 24.8% in day 1 and day 2 respectively. Due to the unexpected rainfall as well as the huge variation of soil moisture contents observed within the field, it was decided to repeat the measurements after a prolonged drought in time to come. As reported earlier, although due to the resource limitation the SPAD meter reading was taken as the non destructive chlorophyll measurement, almost all the data were higher than 50 except the SPAD reading of the tea leaves of Salawa seedlings (Figure 15).

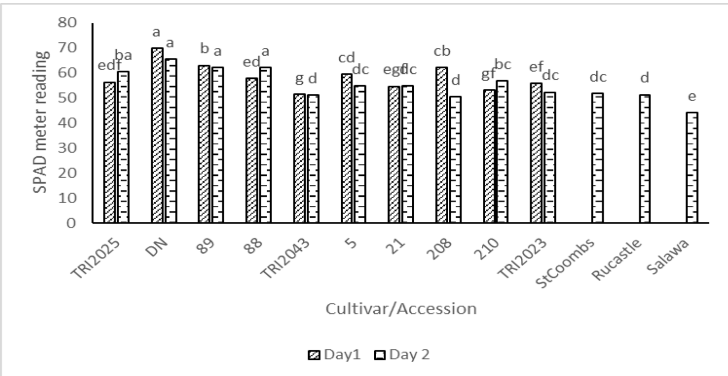


Figure 15. Variation of SPAD meter reading to compare the leaf chlorophyll content among different cultivars/accessions tested during two days in Passara (The similar patterened bars with the same letters are not significantly different at p=0.05). The experiment is in progress.

TL Wijeratne, DMS Navaratne, MMN Damayanthi, ADIU Jayawardhane, MAB Ranathunga, KM Mohotti (TRI), AJ Mohotti (University of Peradeniya) and H Alistair (University of Bristol)

MECHANIZATION OF FIELD PRACTICES

Thrust A 20. Development of Appropriate Mechanical Devices and Agronomic Practices to Overcome Labour Shortage

Project A 20.9. Testing of foliar micro nutrient mixtures for improving yield of mechanically harvested tea bushes (2019)

A new foliar micro-nutrient fertilizer mixture (Zn, Mn and B) formulated by Soils and Plant Nutrition Division was tested for its ability to minimize adverse impacts caused by non-selective motorized mechanical harvesting. The experiment was established on the St. Coombs Estate, Talawakele. The treatments were arranged as split-plot in RCBD with 3 replicates considering method of harvesting as the main plot treatment. Listed below are the treatments.

Method of harvesting

1. Manual (control)
2. Motorized harvester (Kawasaki NV 60H)

Method of fertilizer application

1. Ground fertilizer only (control)
2. Ground fertilizer + Foliar Zn (standard)
3. Ground fertilizer + New foliar formulation (Zn, B and Mn)

Tea yields were recorded in the first 3 months of 2022 and bushes were rested before pruning.

Tea Yield

The Table 01 shows the yield obtained from each fertilizer application method during the first 3 months of the year.

Table 01. Made tea yield *vs.* method of fertilizer application

Method of fertilizer application	Yield (kg/ha)
Ground fertilizer only	470.67[a]
Ground fertilizer + Foliar Zn	509.50[a]
Ground fertilizer + Foliar Zn, B and Mn	470.88[a]
CV%	13.09

Values with the same letter are not significantly different at p=0.05.

The Table 02 shows the comparison of made tea yields between methods of harvesting during the first 3 months of the year.

Table 02. Made tea yield *vs.* method of harvesting

Method of harvesting	Yield (kg/ha/3 month)	Coarse leaves (kg/ha)
Manual harvesting	573.78[a]	11.14[a]
Motorized mechanical harvesting	393.59[b]	0.00[b]
CV%	13.09	

Values with the same letter are not significantly different at p=0.05.

Method of fertilizer application showed no significant (p=0.05) difference in made tea yields during the first quarter of 2022 (Table 01). However, non-selective motorized mechanical harvesting (14-21-day intervals) recorded about 30% yield loss (Table 02) with an average of 11% coarse leaf content in the fresh yield, in comparison with selective manual harvesting (7-day intervals).

Pruning weights and leaf area of 50 g (fresh weight) of maintenance foliage were recorded and fresh weight basis Specific Leaf Area (SLA) was then calculated by dividing the leaf areas by their respective weights (50 g). Table 03 depicts the pruning weights and SLA affected by method of harvesting.

Table 03. Pruning weights and SLA at pruning as affected by method of harvesting

Method of harvesting	Pruning weights (g/bush)			SLA
	Total WT	Stem WT	Leaf WT	(cm^2/g)
Manual harvesting	3501.5[a]	2577.3[a]	883.2[a]	34.1[a]
Motorized mechanical harvesting	3000.8[a]	2107.3[a]	869.9[a]	37.0[a]
CV%	10.55	11.09	14.82	23.56

Values with the same letter are not significantly different at p=0.05.

Pruning weights and SLA were not significantly (p=0.05) affected by the method of harvesting (Table 03).

Table 04 shows the effect of different fertilizer application methods on pruning weights and SLA.

Table 04. Pruning weights and SLA at pruning as affected by fertilizer application

Methods of harvesting	Pruning weights (g/bush)			SLA
	Total WT	Stem WT	Leaf WT	(cm^2/g)
Ground fertilizer only	3099.1[a]	2245.4[a]	840.7 [a]	33.9[a]
Ground fertilizer + Foliar Zn	3454.2[a]	2489.1[a]	950.1[a]	36.6[a]
Ground fertilizer + Foliar Zn, B and Mn	3200.2[a]	2292.4[a]	838.8[a]	36.2[a]
CV%	10.55	11.09	14.82	23.56

Values with the same letter are not significantly different at p=0.05.

Pruning weights and SLA did not show any significant (p=0.05) variation among different methods of fertilizer application (Table 04).

The pandemic situation and scarcity of fuel considerably affected data collection and other field practices.

Experiment is in progress.

MA Wijeratne, SRW Pathiranage, PB Ekanayake and Soils and Plant Nutrition Division

Project A 20.10. Evaluation of cultivar characteristics of tea amenable for mechanical harvesting (2019)

Past TRI experiments reported different tea cultivars to be responding differently to non-selective mechanical harvesting with significant yield reductions compared to manual (selective) harvesting. This study further tests amenability of different tea cultivars to mechanical harvesting at TRI Low-country Center where TRI 5000 series tea accessions were already established and maintained by the Plant Breeding Division.

Method of harvesting	:	Manual (control) and Motorized harvester (Battery-operated Kawasaki plucking machine)
TRI 5000 series tea accessions tested	:	62, 107, 139, 174, 12/11, 23/5,
Control cultivar	:	TRI 4042

The Table 05 shows the tea yield and % yield reduction of each cultivar as affected by method of harvesting.

Table 05. Estimated made tea yield and yield reduction

Accession/cultivar	Made tea yield (kg/ha/yr)		Yield
	Manual	Mechanical	Reduction (%)
62	5100[a]	2497[a]	49.1[a]
107	4144[ab]	2729[a]	31.1[a]
139	2132[d]	1131[c]	45.1[a]
174	3838[bc]	2262[a]	37.5[a]
12/11	2906[bcd]	2168[ab]	25.4[a]
23/5	2060[d]	1324[bc]	33.1[a]
TRI 4042 (control)	2858[cd]	1150[c]	59.8[a]
CV%	19.2	24.6	30.2

Values with the same letter in a same column are not significantly different at p=0.05. Yield reduction is the percentage difference in yield in a same accession/cultivar between manual and mechanical harvesting. Made tea yield was calculated considering 12500 tea bushes per ha and 21.5% made tea outturn.

The percentage reduction in tea yield showed no significant (p=0.05) difference among the tea cultivars tested and all the tea cultivars reported comparable reductions in tea yield under mechanical harvesting. The average annual tea yield reduction as affected by non-selective motorized harvesting was approximately 40% compared to manual harvesting (Table 05).

Accession numbers 107, 62, 174 recorded the highest yields under mechanical harvesting while 139 being the lowest, which was comparable to control (TRI 4042) and accession 23/5. In manual harvesting, accessions 62 and 107 recorded the highest tea yields followed by 174, 12/11 and control. Both 139 and 23/5 recorded the lowest yields (Table 05).

Mechanical harvesting was done by battery-operated Kawasaki harvester with hair-clipper-type (30 cm) blade. It was used in 14-day intervals depending on the shoot growth mainly determined by rainfall. Manual harvesting was practiced selectively in 7-day intervals as recommended by TRI.

Shoot composition *i.e.,* different shoot categories in plucking table just before harvesting with respect to the method of harvesting is presented in the Table 06.

Table 06. Shoot composition in the plucking table (count/feet^2) as affected by method of harvesting

Method of harvest	*Arimbu*	*Banji*	Pluckable*	Total
Manual	12.3^{b}	5.9^{a}	9.7^{b}	22.1^{b}
Machine	15.4^{a}	7.3^{a}	12.3^{a}	27.8^{a}
CV%	11.2	18.1	14.8	8.7

Values with the same letter in the same column are not significantly different at p=0.05.
* Includes actively growing shoots with 3 or more leaves + *Banji* shoots.

Total shoot count, count of *Arimbu* and pluckable shoots were significantly low in mechanically harvested plots when compared with that of manually harvested plots. However, counts of *Banjies* did not vary between methods of harvesting (Table 06).

The experiment is in progress.

MA Wijeratne, SRW Pathiranage, EWTP Premathunga

Project A 20.12. Testing of new machines

A new model of harvesting machine was tested for its performance and effect on shoot growth. This single-man-operated and battery-powered (12V) tea harvester weighs 3.2kg and its knapsack-type battery (3.5kg) is held on the shoulder of the operator in a nylon bag. The motor rotates four rods supported with shock-absorbers in a horizontal and cylindrical path and the shoots are caught between rotating bars and blade (length 18.5 cm) and pulled upward. Further movement of the blade hit the base of tea shoot in the pulling tension and detach them from tea bush after which they were air-blown into a collecting sac (nylon) attached behind the machine. Due to this horizontal rotating action of rods and blade, the machine should be operated in a vertical up-and-down movement while proceeding forward to direct tea shoots into the cutter section of the machine.

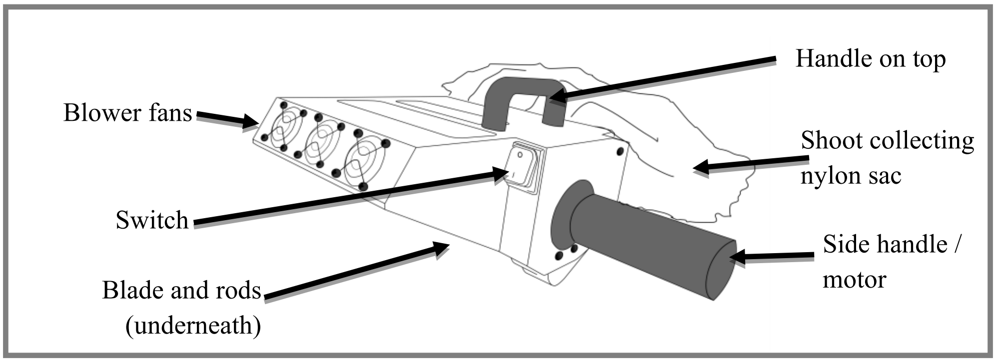


Figure 01. Sketch of the new battery-operated tea harvesting machine

During the four month period of testing, the machine reported an average of 25 kg of daily fresh yield output, out of which about 15% was thrown out from the machine without going into the nylon sac. Further, it recorded about 33% good (undamaged) leaf, 48% damaged leaf and 3% coarse leaf (maintenance foliage) contents in the fresh harvest. The machine could cover approximately 0.2 ha/day *viz*., about 6 machines/ha/day.

The count of each category of tea shoots were recorded just before harvesting at the beginning and at the end (4 months) of experiment and the change in shoot composition in the plucking table is graphically presented in Figure 02.

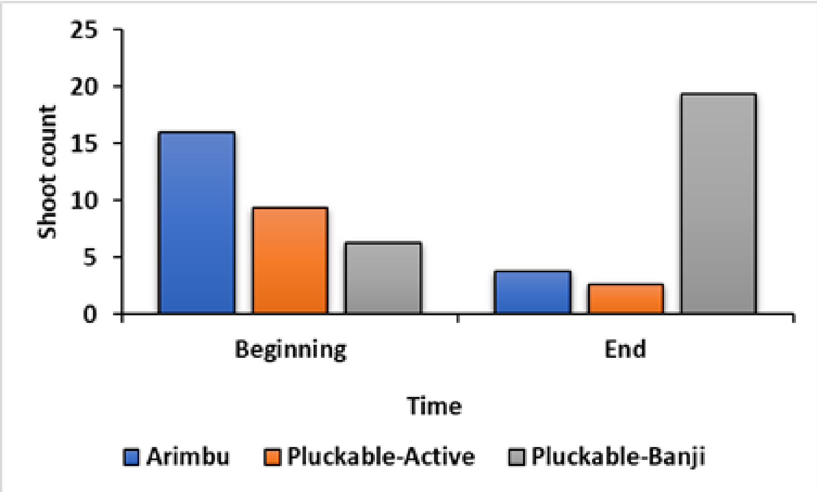


Figure 02. Shoot composition (just before harvesting) in the plucking table at the beginning and at the end of the experiment.

According to the Figure 02 it is clear that this harvester has decreased the density of *arimbu* and pluckable shoots while increasing the formation of *banji* shoots.

The machine could not pick *banji* shoots successfully and as a result accumulation of *banji* shoots in the plucking table was observed. Furter, tea shoots got entangled and rolled around the axels of rotating bars/blade and disturbed the plucking operations frequently. The up-ward pulling of tea shoots by shoot direction/cutting mechanism frequently made the machine stuck in the plucking table which brought down the efficiency of harvesting. Therefore, the output of the machine was not found to be satisfactory.

According to the results this machine has less potential to be considered as a good alternative for manual harvesting especially under the tea shoot growth pattern in Sri Lanka even in a worker-scarce situation.

MA Wijeratne, SRW Pathiranage and EWTP Premathunga

Project GL 389. Development and Introduction of a Motorized Selective Tea Harvester Suitable for Tea Lands in Sri Lanka

This special project on the Development and Introduction of a Motorized Selective Tea Harvester Suitable for Tea Lands in Sri Lanka was commenced in 2021 with Rs 35 Mn allocated by the Treasury. During the year under reference two partners selected for the project (Arthur C. Clerk Center Institute for Modern Technologies and B and N Optiums (Pvt) Ltd) continued with designing and fabrication of prototypes of motorized selective-tea harvesters. The activities of the project were monitored by the Project Advisory and Monitoring Committee and the technologies being developed by the two partners were primarily tested at TRI Low-country Center and at TRI, Talawakelle. Refining and further development of the technologies were in progress.

MA Wijeratne and SRW Pathiranage

NURSERY MANAGEMENT TECHNIQUES

Thrust A 53. Development of Nursery Management Techniques

Project A 53.0 Nursery Management

Evaluation of a suitable bed type for nursery plants
An experiment was commenced in low country station, Ratnapura to evaluate a suitable nursery bed type to facilitate better drainage in nursery sites. The following treatments were applied, using cultivar TRI 2026.

1. Normal raised (15cm) nursery bed (control) – T1
2. Plants staked in a wooden rack – T2
3. Sloppy nursery bed, covered with a polythene – T3
4. Plants staked in a gravel stone (15cm height) bed – T4

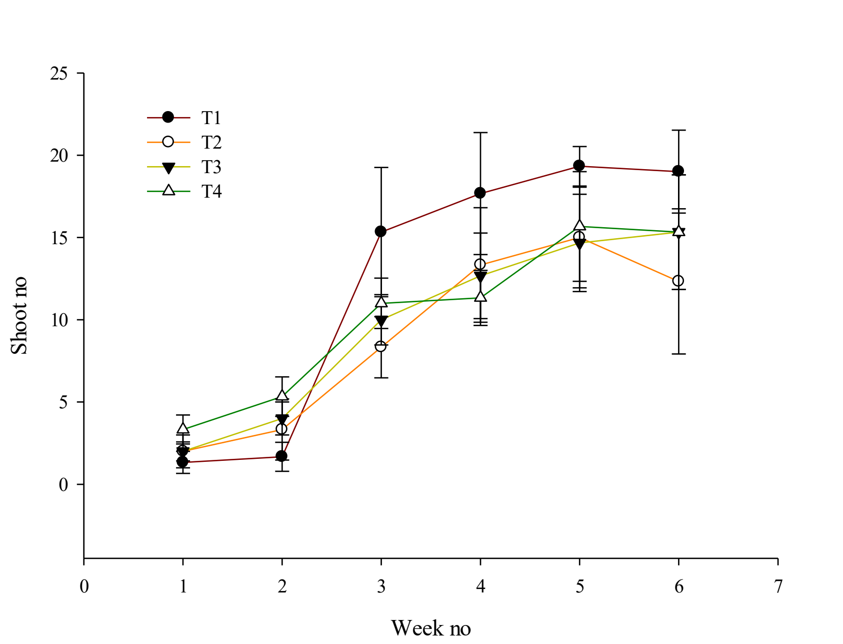


Figure 1. Shoot count up to six weeks

Table 16. Plant growth parameters after 4 months

Treatment	Height (cm)	Girth (cm)	Leaf area (cm2)
Soil bed (T1)	5.49(±0.38)	0.23(±0.02)[ab]	8.1(±0.95)[a]
Wood plank (T2)	6.02(±0.15)	0.26(±0.01)[a]	7.0(±0.38)[ab]
Slopped bed (T3)	6.98(±1.64)	0.21(±0.06)[ab]	6.8(±0.74)[ab]
Stone bed (T4)	5.03(±0.72)	0.14(±0.03)[b]	5.5(±0.88)[b]
CV%	ns	27.1	19.47
R^2	ns	0.47	0.4
P	ns	0.14	0.2
LSD	ns	0.108	2.5

Seven hundred and fifty (750) Derris plants were sold on cash, at each valued at Rs. 100.00. Another 60 plants were supplied for experimental work.

NPSN Bandara, EWTP Prematunga, RBL Hemakumara and PGON Gunawardena

TEA PROCESSING TECHNOLOGY AND PRODUCT DEVELOPMENT

Development and Improvement of Tea Machinery and Factory Conditions

Thrust A 48. Development of strategies to facilitate automation of tea manufacturing and to reduce cost of production

Project A 48.10. Development of dust removing system for fluid bed dryer

A cyclone type dust removing unit with control system was designed for fluid bed dryer (TRI-CCC FBD) at St. Coombs Tea Factory in 2021. The budget allocated in 2022 was not enough to install the system. It is intended to collaborate with an interested engineering firm with a view to obtain funds and complete the installation.

K Raveendran, WMS Weerawardena, L Jayasinghe, UGDP Ranathunga and EPDNM Wijewardhana

Project A 48.12. Development of monitoring and controlling method for rolling parameters for orthodox roller

A PLC based control system has been installed to orthodox rollers at St. Joachim tea factory by an engineering firm at the end of December 2021 using Estate account. It is intended to develop control programme for varying process parameters and study improvement on grade mix and Net Sale Average of tea commencing experiments in 2023.

MA Chamindra, K Raveendran, L Jayasinghe, KACL Kodithuwakku and WMI Sathsarani

Project A 48.15. Development of an efficient hot air supply system through radiating steam and hot water circulation

Project D/TECH. Activities of the Technology Division

Establishment of experimental process technology development factory at St. Joachim Estate

Improvement to machinery and infrastructure of the factory continued. Conveyorizing/ automating rolling room operation with modified rollers and roll breakers suitably re-cited with necessary power supply arrangement was completed. Repairs of six withering trough units were completed. Materials required to repair two withering troughs were purchased. Repairs to stand-by tea drier were attended. Repairs to 1st loft timber floor were completed. Attending to leaks in concrete slabs over worker rest room and furnace room was completed. Construction of new roof gutters and down pipes at ground floor was completed. Materials required for construction of new roof, gutter and down pipes at first floor was purchased.

K Raveendran and MA Chamindra

Verification survey on Net Out-Turn of made tea in tea factories

Survey was commenced in 37 tea factories and commercial-scale experiments were continued to verify Net Out-trun achievable in tea manufacture. Two newly purchased laboratory ovens were transferred to Wlahanduwa station and Matugama regional centre after adding more racks to increase the capacity and with required number of trays to facilitate determining moisture content of green leaf samples collected from the survey. Further, a digital balance was transferred to Matugama regional centre in this regard. Twenty one newly purchased digital laboratory balances were handed over to officials of Sri Lanka Tea Board to use in the survey.

Staff involved in coordinating the survey made few inspection visits to tea factories. 2,662 green leaf samples collected during the survey were tested for moisture content. Two commercial-scale experiments were conducted at St. Joachim factory to establish a protocol for Net Out-Turn (NOT) experiments. A progress report of the survey was submitted to MPI on 11 July. An internal meeting was held to evaluate the progress of the survey and commercial-scale experiment on 18 July. A virtual meeting was held on 26th July to review the NOT survey in the presence of SLTB and TSHDA officials. A special CCR meeting was held on Protocol for the NOT experiments. An Action Plan for the NOT survey was prepared and sent to Tea Commissioner of SLTB. A meeting on the progress of the survey was held on 2nd September with Asst. Tea Commissioner and Tea Inspectors of Ratnapura region. Four more commercial-scale NOT experiments were conducted during the year.

K Raveendran, MA Chamindra and WMS Weerawardena

Divisional activities including miniature manufacture of green leaf samples

- 234 Green leaf samples collected from different experiments of Entomology and Nematology, Plant Pathology and Plant Physiology Divisions were manufactured using miniature tea manufacturing facility and the made tea samples were graded, cleaned, packed and sent to the respective divisions.
- Prepared project proposal on "Establishment of experimental process technology development factory at TRI Head Office and "Establishment of experimental process technology development factory – Phase II (at St. Joachim Estate)" and submitted to MPI for approval.
- Prepared quarterly reports on energy consumption at TRI Head office at Talawakelle and other six Regional Centres.
- Staff participated in the Regional Technical and Extension Forum for Kegalle and Ratnapura District, Experiments and Extension Forum and Consultative Committee on TRI Estates budget preparatory Meeting.
- Staff demonstrated tea processing to 250 Students from Kadawatha Central College.
- Staff involved in testing 19 paper sack samples for grammage and dimensions.

K Raveendran, MA Chamindra, WMS Weerawardena, L Jayasinghe, UGDP Ranathunga, EPDNM Wijewardhana, KACL Kodithuwakku and WMI Sathsarani

Development / evaluation of alternative energy sources in tea processing

Thrust A 25. Development of technologies to reduce the cost of energy used in tea processing

Project A 25.3. System modification to the existing furnaces used in tea industry (2017)

An Far Infrared experimental dryer with control system was designedand a prototype unit was fabricated. A control system was developed to operate the unit.

K Raveendran, L Jayasinghe, WMS Weerawardena, UGDP Ranathunga and EPDNM Wijewardhana

Project A 25.10. Development of combustion control system to air heaters

A combustion control system that was designed and developed to control combustion of firewood in the Hot Water Generator at St. Coombs Factory in 2021 was successfully tested and validated.

K Raveendran, L Jayasinghe, WMS Weerawardena, UGDP Ranathunga and EPDNM Wijewardhana

Improvement of made tea quality

Thrust A 46. Development of technologies to enhance made-tea quality and keeping quality of made-tea

Project B 58. Identifying factors affecting blackness and curliness of Low-Country teas
An experiment was designed to identify factors affecting blackness and curliness of made teas. Purchase order was placed to procure five chemicals required for the experiment and only two chemicals have been received. Arrangement was made to obtain rest of the chemicals.

K Raveendran, MA Chamindra, KACL Kodithuwakku and WMI Sathsarani

Project B 106. Factors influencing polyphenol content and other bio-chemicals and identifying geographical indications for Sri Lanka black tea (2014)
Pilot Project on Geochemical Approach for verification of Origin of 'Ceylon Tea'
As a continuation of the previous study, sample collections were completed in all regions during wet and dry season, except in the Kandy region where sampling collection was done only during the dry season. Pre-processed black tea samples (1342 Nos.) were prepared as per the Standard Operating Procedures (SOPs) for isotope analysis.

The important chemical constituents, which influence the flavor of black tea, are polyphenols, caffeine, sugars, organic acids, volatile flavor compounds, and amino acids. Adequate information on the chemical characteristics of black tea representing all tea-growing regions in Sri Lanka is limited. Therefore, keeping in view of the complexity of black tea quality approaches, this study will be carried out to evaluate the chemical characteristics of Ceylon regional teas. Therefore, along with geochemical approaches, chemical parameters such as total polyphenol and amino acid, TF/TR, and theanine concentrations of collected tea samples have been suggested to analyze representing all tea growing regions. Accordingly, analysis of total polyphenol content (Nos. 209), TF/TF (Nos. 317), total amino acid content (Nos. 177), and theanine content (Nos. 59) in black tea samples was completed.

KGNP Piyasena, MAB Ranathunga, ENU Edirisinghe and CJ Ratiyalage
(A collaborative study with Plant Pathology Division and Soil and Plant Nutrition Division)

Project B 107. Simple techniques to identify adulterated black tea in the market (2014)

Experiment 1: Development of the HPLC method for identification of black tea adulterated with maltodextrin
In order to ensure the quality of made tea, International Standards Organization (ISO) has established standards for black tea (ISO 3720). These standards clearly specify that tea should be produced by an acceptable process. Therefore, the addition of any substance during processing is not allowed. However, there are allegations that certain tea producers

use various substances/chemicals during the manufacturing process for the purpose of altering the appearance and heaviness of black tea, its liquor quality, and infusions. Maltodextrin is one of the substances allegedly used for this purpose in black tea processing.

Maltodextrin is a white powder made from corn, rice, potato starch or wheat. It is defined as a hydrolyzed starch product with a dextrose equivalent (DE) and it is available as a dried powder or in concentrated liquid form. Maltodextrin is the name given to those hydrolysates with DE values in the range of 3–20. Maltodextrin is more soluble in water than native starches, is cheaper than other major edible hydrocolloids and its solution have a bland flavor and smooth mouthfeel.

Incidences of black tea adulterated with maltodextrin have frequently been reported. In order to prevent maltodextrin adulteration in black tea, TRI was requested to come up with a method to detect maltodextrin in black tea. The objective of this study was to develop a methodology to identify black tea adulterated with maltodextrin. High Performance of Liquid Chromatography (HPLC) coupled with ELSD (Evaporative Light Scattering Detector) methodology was developed to identify the black tea adulterated with maltodextrin qualitatively.

HPLC instrumentation consisted of Agilent Technologies 1260 HPLC (Agilent Technologies, Germany). Separation module coupled to Evaperative Light Scattering Detector (ELSD) system. Zorbax NH2 column (150 x 4.6 mm (5 μm)) was used for the analysis. Injection volume and flow rate were 10 μL and 1.5 mL min^{-1} for all the standards and the samples. Mobile phase; solvent gradient: from 70 % acetonitrile in water to 83 % of acetonitrile in water. This method could be successfully used for the identification of black tea adulterated with maltodextrin

KGNP Piyasena and ENU Edirisinghe

Experiment 2: Quantification of dynamic changes of sugars during the aeration / oxidation period of black tea processing

This work is the continuation of the study on the establishment of baseline information on fructose, glucose, and sucrose concentrations in black tea in high elevation. In the current study, it was revealed that some factories in the high elevation in Sri Lanka have adopted different approaches to manufacturing black tea, especially light liquoring tea. These factories have bypassed the normally adapted aeration step and the firing process was straightaway carried out after maceration. It was also noted that black tea samples produced in these tea factories contained a higher concentration of sucrose compared to the sucrose content in the black tea produced by randomly selected other factories in the high elevation. Therefore, this study was undertaken to investigate extensively the dynamic changes in the concentration of these three sugar components during the aeration/oxidation period. Therefore, this study was aimed at quantification of sugars in black tea throughout the aeration period.

Sampling method
Harvestable shoots (bud and the first two leaves) were collected on five different days from Talawakelle, Sri Lanka in February 2022. In the miniature manufacturing process, after maceration, dhool was collected at 15 minutes intervals and dried using Fluid Bed Drying technique. The grounded samples (0.5 mm) including freeze-dried (Freeze Dryer-Labconco, -40 oC for 24 hrs) fresh tea leaves, withered leaves, and fluid bed-dried samples have been packed and sealed in triple-laminated bags. All the samples were kept in the cold room.

HPLC instrumentation consisted of Agilent Technologies 1260 HPLC (Agilent Technologies, Germany). Separation module coupled to Refractive Index Detector (RID) system. Zorbax NH2 column [150 x 4.6 mm (5 µm)] was used for the analysis. Column oven temperature was 33 ºC in RID. Injection volume and flow rate were 10 µL and 1.5 mL min^{-1} for all the standards and the samples. The method utilized an isocratic system with a mobile phase comprised of 83% Acetonitrile: 17 % water. The column was re-equilibrated with 100 % acetonitrile for 10 min before the next injection. Total run time was 25min.

Statistical analysis was carried out using the SAS program (version 9.1). Significant differences were considered as p-values of less than 0.05 at a 95 % confidence level. The mean separation was done using Duncan's multiple-range test.

Quantification of major sugars was done at different stages of the black tea processing. According to the results (Table 1), sugar components have varied significantly ($P \leq 0.05$) throughout the black tea processing as well as during the aeration period. Fermented dhools collected at 75 min and 90 min, and final product of black tea contained the highest fructose content. Furthermore, the highest glucose content was observed in the fresh leaves. However, the lowest fructose content was observed in withered tea leaves while lowest glucose content was recorded in the withered and rolled leaves.

Table 1. Sugar content in black tea made from samples taken at different manufacturing stages after firing

Black tea manufacturing stages	Concentration (mg/g)		
	Fructose±SD	Glucose±SD	Sucrose±SD
Fresh tea leaves	6.03 ± 1.41 [b,c]	10.93 ± 0.97 [a]	16.32 ± 2.73 [d]
Withered leaves	3.16 ± 0.69 [e]	3.40 ± 1.42 [d]	32.03 ± 3.29 [a]
Rolled leaves	4.05 ± 0.81 [d,e]	3.16 ± 1.04 [d]	28.56 ± 2.37 [a,b]
Fermented Dhool (15 min)	5.78 ± 1.20 [c,d]	5.87 ± 1.25 [c,d]	25.26 ± 2.17 [a,b,c]
Fermented Dhool (30 min)	6.31 ± 1.43 [b,c]	6.65 ± 1.25 [b,c]	23.18 ± 2.32 [b,c,d]
Fermented Dhool (45 min)	7.26 ± 0.65 [a,b,c]	7.74 ± 0.88 [a,b,c]	22.52 ± 2.89 [b,c,d]
Fermented Dhool (60 min)	7.98 ± 1.08 [b,a]	8.55 ± 1.10 [a,b,c]	20.88 ± 2.11 [b,c,d]
Fermented Dhool (75 min)	8.30 ± 0.25 [a]	8.54 ± 1.36 [a,b,c]	19.24 ± 2.82 [c,d]
Fermented Dhool (90 min)	8.78 ± 1.14 [a]	9.49 ± 0.63 [a,b]	17.59 ± 2.04 [c,d]
Black Tea	9.22 ± 1.43 [a]	9.63 ± 1.87 [a,b]	16.29 ± 1.02 [d]

* Means with different letters within colomns are significantly different, SD=Standard Deviation

There was a significant change in sucrose concentration in tea samples throughout the black tea processing. The maximum sucrose content was observed in withered leaves while the lowest sucrose content was seen in the fresh leaves and the black tea (Table 1).

According to the results sucrose content increases whereas fructose and glucose contents decrease throughout the withering period. Thereafter, sucrose content decreases throughout the aeration period and it was further decreased in the fired tea. It is observed that the contents of fructose in the fresh tea flush were significantly lower than that of the black tea while glucose and sucrose contents in the fresh tea flush and the black tea were not changed significantly. In this study, it is clearly shown that sucrose concentration increased during the withering and fluctuated throughout the black tea processing. Significantly higher sucrose content was observed in black tea processed using rolled leaves, bypassing the aeration operation. According to the results obtained, throughout the black tea processing, sucrose content was remarkably varied compared to that of glucose and fructose, and also the content of sucrose in tea samples at different processing stages was higher than that of fructose and glucose.

KGNP Piyasena, ENU Edirisinghe, AAB Abayarathne and WS Jayasinghe

Experiment 3: Prediction of glucose and sucrose contentsf black tea samples using NIR spectroscopy and chemometrics

Preliminary studies carried out by the TRI on the detection of the fructose, glucose, and sucrose concentrations in black tea suggested that it is a pre-requisite to establish baseline information on naturally occurring sugar content in black tea for the detection of sugar adulteration in black tea. TRI has successfully established maximum permissible fructose, glucose, and sucrose concentration for up, mid and low elevations. The need for a robust/reliable analytical method to analyze sugar in tea was also highlighted. High-Performance Liquid Chromatography (HPLC) is the most reliable and widely used method for determining sugar levels in food. However, HPLC analysis is a destructive, time-consuming, and expensive method and not suitable for analyzing large numbers of samples within a short time. Hence, an alternative Near Infrared (NIR) technology need to be used for detection of sugar levels in black tea.

In this study, the development of a calibration models using FT-NIR technology for the quantification of major sugars found in back tea including glucose, sucrose, and fructose, was investigated using values of wet chemical method, High-Performance Liquid Chromatography (HPLC) with Refractive Index Detector (RID). Standard Normal Variation (SNV), the first and second derivative of Savitskey-Golay smoothing (SG1D, SG2D), and auto-scaling (AS) were used as spectral preprocessing methods to develop robust calibration models. These calibration models could be used for the quantification of inherent glucose and sucrose concentrations in black tea. Therefore, the findings from this study would provide useful information on the robust detection method for black tea adulterated with sugars in the tea industry.

Near-Infrared spectroscopy (FT-NIR) and chemometrics proved to be one of the most important analytical tools for the quality control of tea. A rapid quantification method was developed and validated for the quantification of sugar *viz* sucrose and glucose in black tea using FT-NIR spectroscopy. Calibration models were established by the partial least squares (PLS) regression analysis. Fructose, glucose, and sucrose concentrations in black tea were analyzed using high-performance liquid chromatography. The spectral range and the number of PLS factors were optimized for the Residual Predictive Deviation (RPD) and correlation coefficient of determination (r). The NIR spectral region between 5878-3595 cm-1 (1701-2782 nm) was selected as the best range for predicting glucose, sucrose, and fructose concentration in black tea. The calibration model developed for sucrose has high RPD (4.29) and r^2 (0.95) indicating the potential for predicting inherent sucrose content in black tea with high accuracy. The calibration model developed for glucose has RPD of 2.73 and r^2 of 0.87 showing the potential for predicting glucose content in black tea with reasonable accuracy. Both calibration models could be useful in quality assurance purposes of black tea and are easier and faster than using the wet chemistry, HPLC method. It has been demonstrated for the first time that the inherent glucose and sucrose concentrations in black tea to be quantified using FT-NIR spectroscopy coupled with chemometrics. Calibration models could be used for the rapid determination of black tea adulterated with sucrose and glucose to facilitate quality assurance of tea to maintain global reputation of Ceylon tea.

KGNP Piyasena, ENU Edirisinghe, AAB Abayarathne and WS Jayasinghe
A collaborative study with MAB Ranathunga, Plant Breeding Division

Project B 140. Refinement of critical points in tea manufacturing to minimize microbial, contamination to meet food standards

The objective was studying the potential of black tea matrix to favor the growth of aflatoxigenic molds and to determine the effect of relative humidity (RH) and temperature on their growth, proliferation and ability of releasing aflatoxins on black tea matrix. HPLC methodology for the identification of aflatoxin in made tea was optimized using aflatoxin standards B1, B2, G1, and G2. Validation of ELISA method with HPLC is in progress.

GD Sinniah, M Niranjan and Biochemistry Division

Health benefits of Tea

Thrust A 55. Investigation of health benefits of tea

Project A 55.5. Investigation of health promoting effects of Sri Lankan tea cultivars

Project D/Bioch 1. Divisional activities of Biochemistry Division

Experiment 1: Investigation of health promoting effects of Sri Lankan tea cultivars (2019) - CARP funded project

This study was a continuation of the earlier work focusing on the investigation of health-promoting effects of Sri Lankan tea Cultivars. In this study, harvestable tea shoots were collected from 15 tea cultivars during the wet and dry seasons. Altogether 60 tea extracts including freeze-dried black tea brew and methanol extract of freeze-dried fresh tea shoots were used in this study. Elastase, xanthine oxidase, nitrous oxide, and ORAC bioassays were carried out using freeze-dried tea brew and methanol extracts. Data analysis is in progress.

Experiment 2: Biological characteristics of white tea

Although the biological characteristics of Sri Lankan black tea have been undertaken, the biological investigations regarding Sri Lankan white tea are limited. Therefore, this study was undertaken to investigate the potential health benefits of Sri Lankan white tea/silver tips.

Fifteen "white tea" samples of Sri Lankan origin were collected independently from low (0-600 m), mid (600-1,200 m), and up (>1200 m) elevations from Sri Lanka in August 2019. Black tea (2 g) was brewed with boiling water for 10 minutes. The infusion was freeze-dried until it reaches a constant weight. The freeze-dried powder was used for chemical analysis and for biological activity studies. This study aimed at performing in *vitro* enzyme bioassays including α-amylase, lipase, α-glucosidase, acetylcholine esterase, and xanthine oxidase inhibition assays and antioxidant assays such as DPPH (1,1-diphenyl-2-picrylhydrazyl) radicle scavenging assay), ABTS(2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid), and FRAP(Ferric Reducing Antioxidant Power) assays. In addition, the study investigated the skin whitening potential of white tea using tyrosinase inhibition activity.

In this study, white tea recorded a mean IC_{50} values of 24.54±1.02 ppm and positive control ascorbic acid showed DPPH radicle scavenging activity IC_{50} 22.27±1.23 ppm. Similarly, white tea exhibited a mean value of IC_{50} 32.72±0.69 ppm for ABTS assay while the positive control showed an IC_{50} value of 22.72±1.52 ppm. FRAP value is a valuble indicator of the antioxidant potential regarding reducing power of ferric ions to ferrous ions. Results of all antioxidant activity assays employed in this study have exhibited an extremely potent antioxidant activity and they are comparable with the positive control, ascorbic acid, and the literature values. Results revealed that white tea exhibited much hich α-glucosidase inhibitory activity ranging from IC_{50} value of 16.19-33.64 ppm. The inhibition of the enzyme by the positive control, acarbose was 12.95±032 ppm. However, white tea showed weak activity towards α-amylase inhibition bioassay. The percentage inhibition of α-amylase ranges from 25.82-40.15 % compared to the positive control, acarbose. IC_{50} value of acarbose was 22.56±1.11 ppm for α-amylase inhibition. Furthermore, our findings revealed that white tea exhibited IC_{50} value ranging from 447.2-521.5 ppm for lipase inhibitory enzyme assay. IC_{50} of positive control, orlistat was 54.07±2.36 ppm. Further, tyrosinase inhibition activity, which is successfully associated with the suppression of melanin synthesis in the skin, is favorable for the development of natural skin whitening products. White tea also exhibited moderate tyrosinase inhibition activity with an IC_{50} value in the range of 254.03–366.80 ppm while an IC_{50} value of kojic acid, positive control was 2.18±0.02 ppm. Sri Lankan white tea also exhibited strong xanthine oxidase activity with an IC_{50} value in the range of 2.51–13.33 ppm. This potency is comparable with the positive control allopurinol which exhibited an IC_{50} value of 1.51±0.32 ppm. The present studies revealed that Sri Lankan white tea also exhibit moderate acetylcholine esterase inhibition activity ranging from IC_{50} value of 26.19-31.94 ppm while the positive control donepezil hydrochloride exhibited IC_{50} value of 0.1 ppm. There were no significant differences observed among the results generated using bioassays employed in this study for white tea samples collected from different elevational levels.

In conclusion, Sri Lankan white tea possess antioxidant activity; acetylcholine esterase, α-glucosidase, and xanthine oxidase inhibitory activities. Further, white tea exhibited moderate lipase and tyrosinase inhibitory activities. Therefore, white tea could be a useful complement to natural dietary antioxidants and could be utilized to develop nutraceuticals and cosmetics. Therefore, there is a potential to use Sri Lankan white tea as a neutraceutical and may eventually be of use in drug research leading to the development of new therapeutic products.

KGNP Piyasena, AAB Abayarathne, G. Sinniah and RDPD Senanayake
(A collaborative study with Plant Breeding Division, National Institute of fundamental Studies and University of Peradeniya)

Experiment 1: Development of a process for encapsulation of tea aroma and evaluation of potential applications of encapsulated tea aroma

Tea aroma in diluted form was collected from Martin Bauer Hayleys (Pvt) Ltd, Hatton, Sri Lanka. First, the tea aroma was dried using spray drying and freeze-drying method to identify the most suitable technique for aroma encapsulation. The aroma profile of the encapsulated tea aroma powder using the above-mentioned drying techniques was analyzed by Headspace Solid-phase Microextraction Gas Chromatography Flame Ionization Detector (HS-SPME-GC-FID). HS-SPME-GC-FID procedure was especially optimized to quantify volatile compounds in tea. The organoleptic properties of the collected powder were evaluated through a sensory evaluation.

Before drying the tea aroma, it was concentrated by a membrane filtration pilot plant (Model-L, GEA Filtration, USA) to remove the excess water. And then, the concentrated tea aroma was encapsulated by the selected drying technique using maltodextrin and gum Arabic as the carrier materials. Pre-concentration of tea aroma and drying and Simultaneous Membrane Concentration of tea aroma and drying (The concentration of tea aroma mixed with carriers by reverse osmosis and encapsulation by freeze drying technique) were the concentration methods compared under in this study. The tea aroma from the two processes was analyzed for their physiochemical and organoleptic properties. The shelf life of the encapsulated aroma powder received from the selected process was tested by measuring its aroma profile using HS-SPME-GC-FID for six months. Further, the potential applications of encapsulated tea aroma powder to improve the aroma profile of both instant tea and tea concentrate were investigated.

Spray-drying and freeze-drying techniques were examined to select the most efficient encapsulation method for tea aroma and found that the freeze-drying method encapsulates a range of tea aroma compounds in high concentrations compared to the spray-drying technique. Simultaneous Membrane Concentration of tea aroma and drying was selected as the suitable process for the concentration of tea aroma compared to the pre-concentration of tea aroma/ freeze-drying process due to its rich aroma profile and organoleptic properties. 0.01 % of encapsulated tea aroma powder in 100 ml tea concentrate (diluted) and 1.0 % of aroma powder in 100 g of instant tea were selected as the best incorporation levels to enhance aroma profiles in both instant tea and in tea concentrate. A slight decrease in the concentrations of aroma compounds under different storage conditions was observed during their storage. The developed procedure for tea aroma encapsulation is now under the application process for the patent.

KGNP Piyasena, Biochemistry Division, TRI
(A collaborative study with Department of Export Agriculture,
Faculty of Animal Science and Export Agriculture, Uva Wellassa University)

Experiment 2: Analysis of biochemical compounds during fermentation of black tea to develop correlation with the digi-nose aroma detecting system and e-vision system.

In a continuation of the previous study, the biochemical compounds were identified by solid-phase Micro-Extraction (SPME) followed by Gas Chromatography-Mass Spectrometry (GC-MS) analysis. For this study, the tea samples were collected from St. Coombs Estate tea factory, Talawakelle, Sri Lanka. The "first dhool" tea samples were collected from a selected fermentation bed every 15 minutes during the fermentation. These samples were immediately oven-dried at 120 °C for 20 minutes. The dried tea samples were used for (SPME) followed by (GC-MS) analysis. The analysis was conducted for seven fermentation cycles (49 samples). The peaks related to volatile compounds were identified using the commercial NIST08 library.

Seventy-two tea volatile compounds were identified and classified into chemical groups of aldehydes, ketones, esters, alcohols, and hydrocarbons while quantity of each compound was calculated as a percentage (%) using their total peak area of GC chromatograms. Variation of content of those groups during fermentation was determined. Results exhibited that the composition of hydrocarbons was progressively reduced from 29.02 ± 0.18 % to 22.89 ± 0.16 %, while the content of alcohols and esters fluctuated around 26 % and 4 %, respectively. Content of aldehydes increased (from 5.25 ± 0.05% to 8.88 ± 0.12 %) while content of ketones decreased (from 3.01 ± 0.03% to 1.80 ± 0.02 %) with the fermentation time. *E*-2-hexanal and *cis*-3-hexenol are classified as volatile flavour compounds (VFC) Group I that produce a grassy odor, and linalool, linalool oxides, methyl salicylate, phenyl acetaldehyde, geraniol, benzyl alcohol, 2-phenylethanol, and ionone as VFC Group II, that generate a sweet flowery aroma. These two groups were used to calculate the flavour index and it demonstrated an increasing trend with the fermentation time reaching the value of 5.23 at the end of the fermentation process, which was initially 2.94. These findings will be extended in research to develop an instrument to determine the optimum fermentation time for black tea.

KGNP Piyasena, Biochemistry Division, TRI
(A collaborative study with University of Sri Jayewardhenepura)

Experiment 3: Development of tea extract incorporated avocado butter

Suitability of using fresh tea leaves extracted to olive oil, avocado puree, salt and cinnamon in making butter was examined in the present study. Heat application to both fresh tea leaves and avocado puree were done in order to deactivate polyphenol oxidase enzymes. 50%, 60% and 70% fresh tea leaves extracts were prepared and 5ml, 7.5ml, 10ml and 12.5ml of each extract was used. Among them 10ml of 60% fresh tea leaves extract incorporated Hass avocado puree showed the best sensory profile. Ten ml of 60% fresh tea leaves extracted to olive oil applied 100g of the avocado puree, 0.3% Cinnamon and 2% salt was selected to formulate the butter. Butter was kept at -18 ^{o}C for four weeks and natural green color was remained consistent through out the time period. Formulated butter was analyzed according to Analysis of Foods I.S 3507 1966. On wet basis, butter contained 72% moisture (), 18% fat, 7% fat free solids and 2% salt content. Developed butter had 6.9 pH and titratable acidity was 0.062 g Oleic acid / g of sample. Yeast and mold count was 10 cfu/ml. 5 point hedonic scale mean sensory scores for flavor, body and texture, color and overall acceptability was 3.73±0.57, 4.06±0.77, 4.06±0.67 and 3.73±0.67 respectively (n=30). Production cost was 263.21 LKR per 100g of the butter. Developed butter was compared with dairy butter and preference to use the butter as a spread was investigated. Duo-Trio sensory test was conducted by serving butter applied bread slices and all the panelists identified the odd sample (n=30). Developed butter was served to 30 panelists at two different times. 28 out of 30 panelists (93.3%) preferred the butter to use as a spread when the product is served to them without giving information about the type of the butter. All the panelists preferred the butter to use as a spread when they were given information about the butter type.

KGNP Piyasena and AAB Abayarathne

SOCIO ECONOMICS AND RESOURCE PLANNING

Thrust 31. Identification of socio-economic measures to overcome a shortage of workers in different regions in the tea sector

Project A 31.8. Identification of typology and trajectories of tea-based farming systems by modeling land use and land cover dynamic changes in low-country region (Ratnapura District), Sri Lanka

Tea Small Holders (TSH) sector is a key subsector of tea industry and they cultivate tea as a supplementary source of income with other income avenues. There is a potential of having alternative land use approaches to make their land use economically profitable and environmentally sustainable. Also, a tendency of divergence from mono crop to multiple cultivation system can be observed in TSHs. Since, no information is available on current condition of the TSHs' land use, understanding the prevailing condition of TSHs and identifying socio-economic and environmental consequences of existing tea-based land use systems is important.

Therefore, this study was conducted to identify tea based farming systems in Low-Country Region (Ratnapura), Sri Lanka and to evaluate the performance of present farming systems.

Three hundred twenty farmer households in 44 Grama Niladhari Divisions under five District Secretariat Divisions (DSD), namely Ratnapura, Kuruwita, Imbulpe, Kalawana, and Opanayake in Ratnapura district were selected for the study.

Two Step Cluster Analyses was employed in classification process, in order to handle categorical and continuous variables. To evaluate the performance of these systems, socio-demographic factors were analysed using descriptive statistics, including percentages, minimum and maximum values, means, range and standard deviation. Main economic indicators calculated in the present study were total costs per unit area, net returns per measure of production.

According to the descriptive statistics, the sample consists of 74% male respondents and 26 % female respondents. The mean age of the respondents was 54 years, with a minimum of 23 years and a maximum of 87 years. Male to female ratio of the families was 1:1 and for the working category that ratio was 4:3. With regards to the mean level of experience in smallholder farming, the respondents had 25 years' experience. The average land size was 1.92 acres, with a minimum of 0.1 acres and a maximum of 13.5 acres

Although all farms were similar in growing tea on their farms, the presence of other crops and the varying sizes of the farms created differences among farmers. Hence, cropping system classification approach was used to classify TSHs. Aavailable crop categories such as tea mono cultivation, tea with mixed crops, coconut cultivation, rubber cultivation, paddy and cinnamon as well cultivated area, availability of off farm income sources and percentage of family labour were considered for the classification. For the classification, Two Step Cluster Analysis (TSCA) was employed using SPSS statistical software. The results of the classification procedure provided five clusters with meaning full separation such as tea mono crop (T), tea with mixed crops (T+M), coconut cultivation (CC), paddy (P) and rubber (R) cultivation (Figure 1).

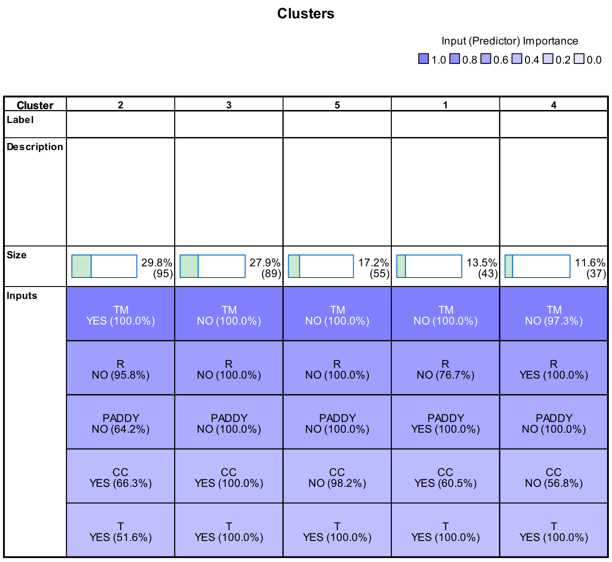


Figure 1. Results output, Description of Clusters

Details on selected clusters (farming systems) were given in the Table 1.

Table 1. Description of Different Farming Systems

Farming System	Crop combination	Representation	Average farm Size (ac)
Cluster 1	T+CC+P	43%	2.85
Cluster 2	T+T M+ CC	30%	2.06
Cluster 3	T+CC	28%	1.44
Cluster 4	T+R	12%	2.72
Cluster 5	T	17%	1.21

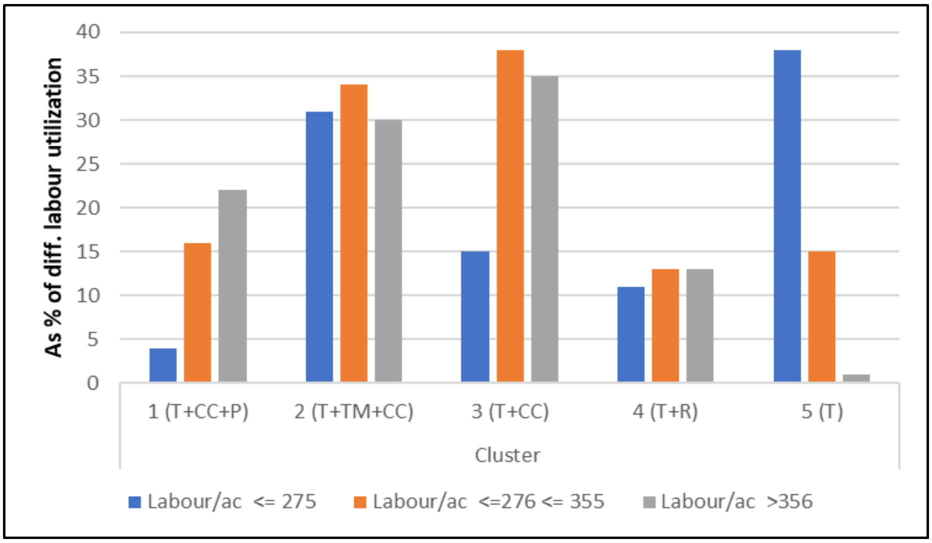


Figure 2. Labour utilization in different farming systems

Figure 2 shows the labour utilization of different farming systems and the majority respondents in cluster 5, was used more labour as compared to other farming systems.

Higher portion of the respondents in cluster 1 and 4 belonged to the lowest level of investment category (Rs. 0.15 million/acre), whilst majority in cluster 5 grouped into Rs. 0.15 -2.0 million/acre investment category (Figure 3).

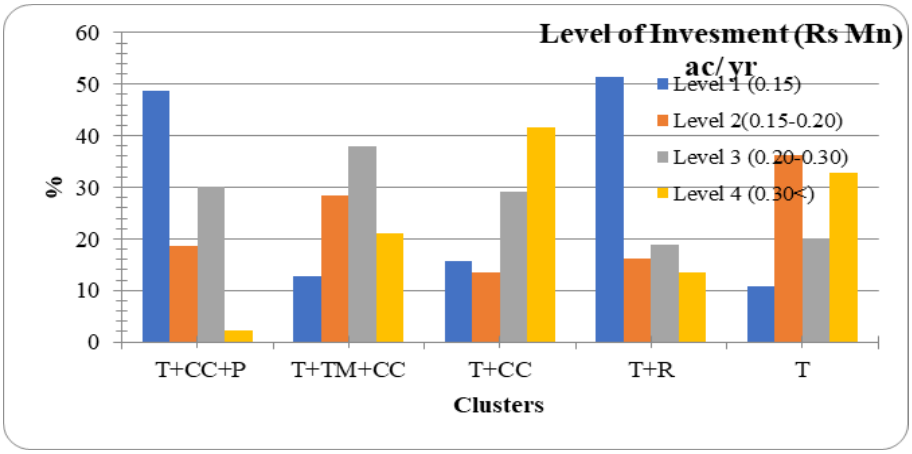


Figure 3. Level of investment as a percentage

With regards to revenue generation, tea mono crop farming system showed higher revenue compared to other farming systems (Figure 4). This may be due to adopting Good Agricultural Practices and proper management practices.

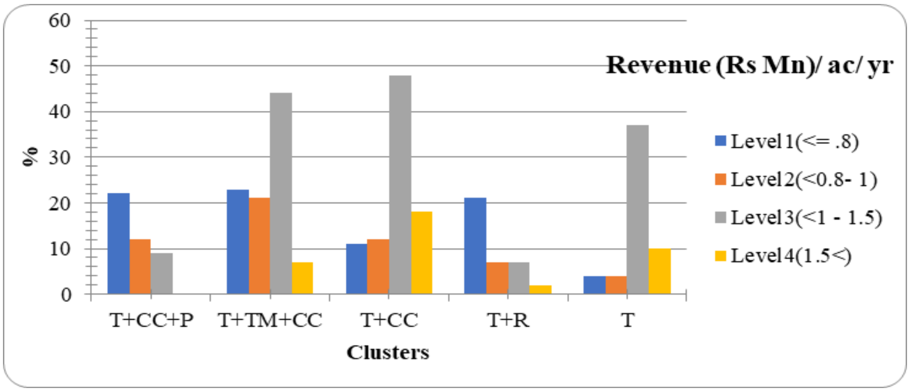


Figure 4. Distribution of income levels in different clusters

The main cash income generator in the crop enterprises is principally the tea crop. However, it was revealed that the considerable proportion of smallholders are employed in off-farm activities (Table 2).

Table 2. Income from secondary sources other than tea

Sources	T+CC+P	T+TM+CC	T+CC	T+R	T
Not having off farm income	30	55	57	68	64
Having off farm income	70	45	43	32	36

The results revealed the necessity for strong intervention on revitalization of existing tea-based farming policies and move towards the need-based target-oriented approach. Further, this study emphasize the importance of considering the diverse structure of socio-economic settings of farm households in implementing farming technologies. Also, it could be suggested to make policy implications for the development of tea intercropping considering the heterogeneity of tea-based farming practices in non-traditional areas.

Project B 127. Impact of Product Innovation towards Firm Performance in the Sri Lankan Tea Industry: Insights from Japan

Although Japan produced only about 25% of the amount of tea green leaves as compared to the produced in Sri Lanka, Japan processes its produced green leaves nearly into 25 different innovative tea beverages and hundreds of non-beverage products (*e.g.* cosmetics, food supplements and confectionaries, *etc*.).Saga prefecture is famous in Japanese tea history as the place where tea cultivation originated in 1191 (Brekell, 2018). Similar to Sri Lanka, Japan also has large-scale plantations as well as small-scale farmer families cultivating tea. However, unlike in Sri Lanka, most of the small tea growers involve in tea processing in Japan produce different types of innovative beverage teas and tea-based non-beverage products. It is obvious that most of these innovations are not only the results of long-term efforts and investments but also are results of lots of thinking of the entrepreneurs, under the correct institutional support. For example, recently Ministry of Agriculture, Forestry and Fisheries in Japan implemented a special project named “Sixth industrialization” in order to promote regional innovations in agriculture, including tea. In this, primary agricultural production (primary industry) is integrated with processing (secondary industry) and services (tertiary industry). With this background, objective of the study was to understand the practical approaches of Japanese sixth industrialization strategy in promoting innovations in small scale in order to learn lessons to design our own strategy to promote tea innovations in Sri Lanka.

Fifteen specific features were identified through an extensive literature on cases conducted under sixth industrialization. Considering the convenience in elaboration, these fifteen features were categorized into four themes as: 1. Structure, 2. Strategy, 3. Skills and 4. Supportive institutions. “Structure” consists of the features related to basic factors of production that the firm owns (1. Intense use of land/labor and capital and 2. Application of advanced technology). Series of decisions and actions that match firm’s tangible and intangible resources to acquire organizational goals were categorized under “Strategy” (1. Horizontal diversification, 2. Vertical diversification, 3. Connecting different types of industries-economies of linkage, 4. Value addition from the field throughout processing, 5.

Local branding, 6. Establish direct contacts with the end user and 7. Market orientation). "Skills" consists of features related to entrepreneurial traits and knowledge accumulation observed (1. Self-efficacy, 2. Passion for innovation and 3. Accumulation and sharing knowledge) while "Supportive institution" includes the key features related to external environment such as policy framework and related organizations (1. Education, 2. Research and 3. Financial Institutes).

The study was based on an ethnographic case study of a tea farm (X farm) run by a family (A couple with their son) in Saga Prefecture, Japan. According to (Yin, 2018), case studies suit best when the research questions are exploratory type in nature (*i.e*. "how" and "why").The data collection is composed of two methods: 1) in-depth discussions and 2) ethnographic study that lasted one month at farm X (in January and April 2021). All the discussions were audio recorded and analyzed the responses with respect to the key features identified in the sixth industry framework.

Accordingly, father of the family owns the farm X (71 years, 2ndgeneration),coming from a traditional tea growing family joined with his parents to cultivate at his early 20s in 1970s. At that time, the farm had 0.4 ha of tea land and a 1.5 ha of paddy field and 1 ha of Manderin (*Citrus unshiu*). In 1980, father bought a used greenhouse (0.1 ha in extent) and started cultivating vegetables. Son joined the farm full-time in 2000. Later, part of the vegetables in the greenhouse was replaced by traditional mandarin cultivar, and then in 2010, it was replaced by a hybrid mandarin cultivar.

Since year 2000, son of the family involved full-time with the farm and bought another 2.5ha of land and planted new tea cultivar. Since the farm had already started producing different crops (*i.e*. tea, rice, garlic, vegetables and mandarin) by that time, the Prefectural Industrial Center suggested idea of establishing a food processing unit. In 2010/2011, the farm started a food processing unit where the mother started involving full-time in the business. Further, as per their suggestion, the farm replaced 2/3rdof the paddy land with wheat and black rice.

a) Structure

By 2021, X farm occupied in 5 ha of land for tea as the main crop (2.9 ha), rice/wheat (1.5 ha), mandarin (0.1 ha), vegetables and cut flowers (0.5 ha). Tea, the main crop out of the six, covers more than half of the total cultivated land (63%). The farm basically depended on family labor and completely mechanized all the agricultural practices in the farm.

b) Strategy

Producing different types of raw material is horizontal diversification. Using raw materials produced, farm X processed 15 different types of products. This is vertical diversification. For example, tea green leaves are converted into two types of made teas: *Tamaryo kucha* and *Sencha*. Further, the farm uses tea leave powder mixed with own wheat flour to process into confectionaries such as tea-cake, tea-bread and *karinto*. The sub-features of strategy observed in farm X is summarized in Table 7.

Table 7. Product list by X farm

Horizontal Diversification	Vertical Diversification	Other sub-features under strategy
Tea	*Tamaryokucha, Sencha,* Tea-Jelly	- Adding value along the value-chain - Products are sold at famer’s market (Road-side-stations), supermarkets and JA (Japanese Agriculture Cooperative) under Brand X. - Connections with customers at road-side-stations to come up with customer-oriented products. - Forward linkages (*e.g.* Saga Japanese Agriculture cooperative green tea factory, beef cattle farm) and backward linkages (*e.g.* egg producer)
Tea and Wheat	Tea-cake, tea-bread, *Karinto*	
Wheat and mandarin	Mandarin-cake	
Wheat and black rice	Black rice bread	
Mandarin	Packaged Mandarin, Candied peel, Jam	
Black rice	Packaged black rice,	
Black rice and vegetables	Lunch parcels	
Vegetables	Packaged vegetables	
Garlic	Processed black garlic	
Cut flowers	Cut flower arrangements	
Rice	Silage for beef cattle farm	

Source: Authors’ observations in the case study

c) Skills

Features observed in-relation to accumulation and sharing knowledge, self-efficacy and passion for innovation were categorized under “skills”. Initially mother of the farmer family gained explicit knowledge on bakery products (cakes and cookies) from a resource person introduced by the Prefectural Industrial Center (accumulation of knowledge). Gradually X farm started producing different products adding different flavors using her tacit knowledge (self-efficacy).

According to food innovation literature, knowledge shared through interactions play a significant role particularly in food and beverage innovations. Accordingly, a shared experience of another member of the farmers’ society motivated the X farm to process Mandarin with imperfect shape into jam to be sold at road side station (knowledge sharing).

d) Supportive Institutes

The Ministry of Agriculture, Forestry and Fisheries in Japan (MAFF) established the sixth industrialization act in March 2011.The act consisted of four main activities as: 1) formulation of strategies regarding agriculture/forestry or fisheries innovations (municipal strategy), 2) provide subsidies for networking, 3) provide subsidies for personal training and development, and 4) Provide interest free loans to purchase capital requirements.

Under the act, first the Prefectural Industrial Center suggested the farm X to establish a food processing unit attached to the farm. Next, they linked the farm with expertise regarding implementation (*e.g.* a university Professor on food processing technology). Thirdly, one employee (in this case mother) received a free intensive course on food processing under training and development. The government completely paid the venue fee, text preparation fee, lectures' fee, lecturer's travel expenses *etc*. Fourthly, the farm X received interest free loans to purchase capital goods (*i.e.* agricultural machinery, tea leave grinding machine, cookers, *etc*.).

The case study revealed that sixth industrialization helped increase the product innovations using local resources. Under the sixth industrialization project, first the government (Prefectural Industrial Centers) identified potential farmers and helped them with formulating strategies that suits best for their businesses. Next, they developed the required human capital by providing training and development for farmers. At the same time, the roadside stations (farmers' markets) were established by Japanese Agricultural Cooperative and other organizations to bring more benefits to the farmers. Therefore, success of this case, farm X is arising from a correct collaboration of structure (resources), strategy (actions and decisions), skills of the entrepreneur under the strong government support (supportive institutes) could be a virtuous example specially for potential and interested tea growers in Sri Lanka to put a step forward to elevate themselves as tea-entrepreneurs.

Thrust A 41. Analysing the impact of macro-economic policies in the tea sector

Project B 143. Investigating the social and economic impacts of alternative worker deployment models in large scale tea plantations in Sri Lanka

The data collection is being continued and the list of the Estates which completed data collection is given in the Table 3.

Table 3. List of the Estates that completed data collection

Survey/Interview	Estate names
Mangers' surveys	Desford, Annifield, Kenilworth, Deniyaya, Aninkanda, Eltab, Nahavila, Woodside, Kalabokka Estate
A survey to measure the knowledge level of workers on key Good Agricultural Practices	Elkaduwa Estate
Socio- economic survey related to workers	Rathwatte, Gallola, Deniyaya, Aninkanda, Nahavila Estate

Level of success and failures of Alternative Worker Deployment Models (AWDM)

Tea industry absorbs more than 10% of the active work force in the country and plays an important role in the social and financial upliftment of the poor. However, one of the problems in tea plantation is unavailability of adequate labour to carry out routine activities as per the scheduled work plan. This adversely affects land and labour productivity of tea Estates and sometimes tea lands have to be abandoned. Hence, tea plantations in Sri Lanka requires a system to develop and maintain its productivity and profitability in the current labour shortage situation. Introduction of AWDMs to tea plantations would be an appropriate concept to minimize negative impacts of labour shortage, improve the abandoned tea lands and to earn an additional income to workers.

A survey was conducted by the TRI to identify the level of implementation and performance of the AWDMs in plantation sector. It is clearly shown that the most commonly adopted AWDM by the tea Estates was cash plucking (70% of the Estates adopted AWDMs). The other prominent AWDMs practiced by the tea plantations were contract farming (36%) and offering contract work (33%). About 18% of the Estates adopted block plucking, however only four Estates (2%) have practiced out grower system in their tea fields (Table 4).

Tables 4. Number of Estates practiced different AWDMs

	Up	Mid	Low	Uva	Total
Contract faming	23	19	20	12	74 (36)
Out Grower system	2	1	1	0	4 (2)
Block plucking	22	5	5	5	37 (18)
Cash Plucking	66	21	23	36	145 (70)
Contract work	43	5	13	7	69 (33)

Figures within brackets are the percentage of Estates adopted different AWDMs.
Source: Survey 2019.

Contract farming system and out grower system may be the first management system change in tea Estates in Sri Lanka. Changing management system in Estates should be well planned and well organized. In order to achieve the desired outcomes, stakeholders in the system should be clearly aware, understood and convinced to accept the system to get their commitment during the change for the successful implementation of the concept. Also all the activities done by the workers should be monitored adequately and nature of adaption them to the new system should be studied.

Further when evaluating the performance, behaviour and the operation of different AWDMs, following information was congregated. Although most of the Estates have implemented different kinds of AWDMs, status of these systems is not in a satisfactory level. The present study implies that number of success stories is less than 15% of the total sample investigated so far (Data collection completed only for50 Estates). Most of the Estates (42%) have restructured the AWDMs adopted due to failure of the initial method. This is a crucial situation because introducing another system to these workers are challenging with the negative experience they have gained while engaging in AWDMs. According to the study, it was observed that more than 16% of the Estates are underperforming and this leads to underutilization of resources like land and labour in the Estate. Therefore, proper management and close monitoring is extremely important for the success of any kind of AWDMs. Moreover, 28% discontinued maintaining AWDMs and this had led to abandoning most of the tea fields. Reasons for the failures were identified as follows (Table 5).

Table 5. Reasons for failure of AWDMs

Reason	(%)
Labour Scarcity (Level of Estate labour scarcity / Family labour availability)	52
Estate Productivity (Low yielding tea lands)	40
Managerial policies	32
Labour demotivation	72

Failures due to labour scarcity

One of the reasons for the failure of AWDMs is not considering degree of labour scarcity in the Estate in implementing the system. It is necessary to increase labour availability of the Estates by means of reducing absenteeism, increasing working hours/days and utilizing non registered work force. Therefore, degree of labor scarcity/availability would be a main criterion to choose an appropriate AWDM. In addition, there should be an adequate understanding on affected activities and tea extent due to labor shortage. It is important having sufficient tea extent to employ all the workers regularly as per the collective wage agreement. Moreover, it is also necessary to select potential workforce with adequate family labour component in order to implement AWDM, especially contract farming or out grower system.

Failures due to low land productivity

Yield level of tea field is another fact to be considered in the allocation of blocks to the workers, since land productivity is highly influenced by the availability and the productivity of labour. It is required to allocate manageable size of tea lands to get the reasonable income in order to compensate cost of their family labour. Under this circumstances, yield level of the field is a crucial factor when consider sustainability of AWDMs. On the other hand, decision making should be smart enough to implement a suitable AWDM at the correct time. That means AWDM should be implemented before land productivity drops significantly.

Failures due to managerial policies

It was observed that some Estates have implemented AWDMs for whole Estate as a company policy without prior analysis on the criteria to be considered for selection of workers, tea lands, payment, *etc*. And therefore, they have no chance to identify appropriate AWDMs for their Estate or a particular field. Ultimately, this may lead to increase incidences of failures. Even though, there is fixed Company or managerial policies, the managers and the field staff should be given flexibilities in making decisions.

Failures due to low income for the labour family

Out migration is a major factor for the labour shortage in the Estate sector. Past studies have proven that income is a critical factor for labour out migration. Therefore, emphases have to be given to provide decent income for the labour family in order to retain human resource in the Estate. Block size and the payment for the green leaf should be decided in order to get the reasonable income to the family. Most of the failures have occurred due to de motivation of contract farmers/out growers as a result of insufficient income earning from the allocated block. Some Estates have tended to provide more than one block or large extent to get more income. But, it was observed that larger block size has led to more failures due to insufficient family labour for carrying out agricultural practices. As such, they have to use hired labour for field activities. Sometimes, this makes the AWDM unprofitable for block owners. Also some labours are facing difficulty in managing large block sizes. Therefore, it is necessary to provide manageable and sufficient block size for the labour families.

SERVICES TO STAKEHOLDERS

Thrust D/ADV. Activities of the Advisory and Extension Division

The Advisory and Extension Division is mainly responsible for providing and disseminating the TRI recommended technical know-how on tea cultivation aspects to stakeholders, and thereby contributing towards adoption of technologies and good agricultural practices at field level. The division is also engaged in identification of technology needs of the industry and accordingly, various services are made available to the industry by its' main center at Talawakelle and six Regional Extension Centers located in Ratnapura, Kandy, Passara, Deniyaya, Kottawa and Matugama. The details of services offered during the year by the main center at Talawakelle and the two regional centers at Ratnapura and Kandy are given in this chapter. The services offered by the other regional extension centers are detailed in respective Regional Extension Centers in chapter under the Regional Centers.

Project D/ADV 1. Routine Advisory and Extension Activities

Activities of the D/ADV project were confined to the main center at Talawakelle that includes maintaining of TRI auditorium to provide facilities to conduct seminars, meetings, training programmes *etc.*, and maintaining Tea Information Centre at the TRI Talawakelle. During the period under review, facilities were provided to conduct 29 seminars /workshop /meetings at the auditorium. Demonstration facilities were provided at the Information Center and at the field demonstration block when necessary for 1528 visitors including students of schools and higher educational institutions.

Project C/ADV 1: Design and Production of Extension Materials

The main objective of this project is to provide advisory services to tea plantations and to train the employees in plantations (Executives, Field Staff and Workers) and Officers of Tea Small Holdings Development Authority (TSHDA). The division conducted various extension activities and fulfilled the requests of RPC plantations, medium scale proprietary Estates and small holdings. Requests received from smallholdings were dealt with the participation of officers of TSHDA. Advisory and extension activities provided during the year are given in Table 1.

Table 1. Summary of Advisory and Extension activities region-wise

Major Activities	Talawakelle	Ratnapura	Kandy	Total
Advisory visits	83	81	33	197
Advisory correspondence	180	135	60	375
Training programmes for stakeholders	49	20	33	102
Training programmes for students of higher educational institutions	7	6	7	20
Distribution of printed extension materials	804	340	149	1293
Soil samples tested for pH	-	-	515	515
Inspection of commercial tea nurseries	-	-	47	47
Meetings attended	22	12	15	49
Field visits for survey studies	-	10	2	12

Subjects covered by the advisory visits on the request of plantations during the year were; inspection of land suitability for re-planting, removal of shade trees, bush debilitation, pest and diseases, tea nurseries, yield decline, nutrient efficiency, poor growth and establishment of tea plants in new clearings and other aspects.

Residential training programmes organized by the NIPM

TRI has conducted residential training programmes organized by the NIPM and details are given in Table 2. The programs were coordinated by the staff of Advisory and Extension Division.

Table 2. Residential training programmes of NIPM

Programme	Duration / Venue
National Diploma in Plantation Crop Technology - NVQ 5	27th January to 1st February 2022, *via* Zoom platform at TRI, Talawakelle
National Diploma in Plantation Crop Technology - NVQ 6	18th and 25th February and 18th and 25th March 2022, *via* Zoom platform at TRI, Talawakelle and Passara
International Advance Certificate Course	17th and 18th November 2022, at TRI, Ratnapura

Resource persons from Advisory and Extension, Agronomy, Soil and Plant Nutrition, Entomology and Nematology, Process Technology and Pathology Divisions in Talawakelle and Ratnapura.

The programme coordinated by ARMAM Rathnayake and SPAKP Jayarathne

Educational Programmes for Students of Higher Educational Institutions

The Advisory and Extension Division in collaboration with research divisions have conductededucational programmes for students on the request of higher educational institutions. In addition, several educational programmes were conducted for officers of various government and private organizations on their request and details are given below;

Table 3. Educational Programmes conducted by Advisory and Extension Division

Programme	Duration / Venue
Practical Training Program - Activities and Process of Meteorology Station	25th March 2022, Agriculture School - Karapincha, Ratnapura
Practical Training Program on Tea Nursery Management	3rd June 2022, Undergraduate Students of Faculty of Agriculture, University of Sabaragamuwa
Practical Training Program on Tea Nursery Management	20th June 2022, 2nd Year Undergraduate Students of Faculty of Agriculture, University of Peradeniya
Practical Training Program on Tea Nursery Management	1st August 2022, 1st Year Undergraduate Students of Faculty of Agriculture, University of Peradeniya
Training Program on Tea Cultivation in Mid-country	22nd September 2022, Tea Technology Diploma Students of Faculty of Agriculture, University of Ruhuna
Practical Training Program on Tea Nursery Management	29th September 2022, Undergraduate Students of Faculty of Agriculture, University of Sabaragamuwa
Exposure Visit to TRI, Talawakelle	21st October 2022, 4th Year Undergraduate Students, University of Sabaragamuwa
Practical Training Program on Tea Nursery Management	25th October 2022, Undergraduate Students of Faculty of Agriculture, University of Peradeniya
Practical Training Program on Tea Cultivation	4th November 2022, Students of University of Colombo - Institute for Argo Technology and Rural Science
Practical Training Program on Tea Nursery Management	5th November 2022, 1st Year Undergraduate Students of Faculty of Agriculture, University of Peradeniya

Practical Training Program on Tea Cultivation	9th November 2022, Undergraduate Students of Faculty of Agriculture, University of Jaffna
Practical Training Program on Tea Cultivation	17th November 2022, Students of HARDY Advanced Technology Institute, Ampara
Practical Trining Program on Agronomy Practices	29th and 30th November 2022, Open University of Sri Lanka Undergraduates of Faculty of Engineering Technology
Practical Training Program on Tea Cultivation	30th November 2022, Students of Technical College, Hasalaka

Conducted by Advisory and Extension Staff of Talawakelle, Ratnapura and Hantane TRI Regional Centers

Regional Technical and Extension Forum (RTEF)

The RTEF programmes are particularly designed for officials of Tea Small Holdings Development Authority (TSHDA) and Tea Small Holder Societies in collaboration with TSHDA covering 8 regions under the purview of THSDA Regional Managers. Special issues and problems raised at the forum were further discussed and follow up actions were initiated. Details of the programmes conducted are as follows (Table 4);

Table 4. Details of RTEF programmes conducted physically and via Zoom platform.

Region	Subject Covered	Resource Person	Participants
Uva and Nuwara Eliya	Program 1 (04.03.2022) Impact of climate change in tea production in Sri Lanka and measures to minimize its impact	M A Wijeratne Principal Research Officer	Regional Managers, Assistant Regional Managers, Senior Tea Inspectors and tea inspectors of TSHDA Nuwara Eliya and Uva regions
	Application of micro irrigation in tea cultivation	N P S N Bandara Senior Research Officer	
	Program 2 (13.12.2022) Scientific basis of application of inorganic fertilizers for tea cultivation	L R M C Liyanage Senior Research Officer	
	Manual and mechanical harvesting and handling to maintain the leaf standards	V S Sidhakaran Head, Advisory and Extension Division	

Region	Subject Covered	Resource Person	Participants
Ratnapura	Program 1 (04.03.2022)		Regional Managers, Assistant Regional Managers, Senior Tea Inspectors and tea inspectors of TSHDA Ratnapura and Kegalle regions
	Analysis of profit and cost factors for smallholder tea lands	H W Shamalee Head, Agricultural Economics Division	
	Establishment of tea fields for mechanical harvesting	S R W Pathiranage Senior Research Officer	
	Rational use of plant nutrients and recommended new fertilizer mixture T-1240	W M S Wijethunga Research Officer	
	Introduction to "Tea Advisory mobile application (Tea Advisor)"	G S Pradeep, Extension Officer	
	Program 2 (13.12.2022)		
	Effects of the composition of chemical compounds contained in tea on quality	N Piyasena Senior Research Officer	
	Scientific background in tea harvesting for higher yield	S R W Pathiranage Senior Research Officer	
Kandy	Program 1 (01.04.2022)		Regional Managers, Assistant Regional Managers, Senior Tea Inspectors and tea inspectors of TSHDA Kandy region, Representatives of Tea Socities and Tea Smallholders
	Soil Quality Index and its usage	N P S N Bandara Senior Research Officer	
	Nutrient management in tea cultivation	W M S Wijethunga Research Officer	
	Program 2 (23.12.2022)		
	How leaf quality affects net selling price and bought leaf price	M A Chamindra Research Officer	
	Foliar application in tea cultivation	W M S Wijethunga Research Officer	

Region	Subject Covered	Resource Person	Participants
Deniyaya	Program 1 (03.03.2022) Drought mitigation practices and irrigation for tea smallholder lands	N P S N Bandara Senior Research Officer	Regional Managers, Assistant Regional Managers, Senior Tea Inspectors and tea inspectors of TSHDA Matara region
	Importance of soil conservation in smallholding tea lands	V S Sidhakaran Head, Advisory and Extension Division	
	Soil fertility, soil nutrients and the use of T 1240 in tea smallholder lands	W M S Wijethunga Research Officer	
	Program 2 (14.12.2022) Soil fertility, soil nutrients and latest TRI recommendations on fertilizer use in tea smallholder lands	W M S Wijethunga Research Officer	
	Use of social media for effective communication in tea smallholder sector	C J Liyanaarachchi Advisory Officer	
Matugama	Program 1 (28.04.2022) Practical application of Irrigation systems in smallholder's tea lands	N P S N Bandara Senior Research Officer	Regional Manager, Senior Tea Inspectors and Tea Inspectors of TSHDA, Matugama, Assistant tea
	Cultivar Related to value added tea	M A B Ranathunga Head, Plant Breeding Division and J H N Piyasundara Senior Research Officer	commissioner of SLTB, Baduraliy Regional Manager,
Matugama	Soil Fertility Management	W M S Wijethunga Research Officer	Senior Tea Inspectors and Tea Inspectors of TSHDA, Matugama

Region	Subject Covered	Resource Person	Participants
Matugama	Program 2 (22.12.2022)		
	Application of social media to improve awareness of tea leaf yield and quality through conversational communication	C J Liyanaarachchi Advisory Officer	Assistant tea commissioner of SLTB, Baduraliya, office bearers of tea small holder societies of Matugama Region, Progressive Farmers
	The effect of chemical composition of tea on quality of made tea	N Piyasena Senior Research Officer	
Galle	Program 1 (30.03.2022)		
	Integrated nutrient management with new fertilizer recommendation of T-1240	W M S Wjethunge Research Officer and L R M C Liyanage Senior Research Officer	Regional Manager, Senior Tea Inspectors and Tea Inspectors of TSHDA, Galle
	Mitigation of the climate change with the establishment of sprinkler irrigation	N P S N Bandara Senior Research Officer	

Regional Scientific Committee (RSC) Meeting (online)

One seminar was organized by the TRI Ratnapura and Kalutara Extension Centers for Ratnapura, Kegalle and Kalutara districts.

Table 5. Regional Scientific Committee (RSC) activites

Region	Subject Covered	Resource Person	Participants
Ratnapura, Kegalle and Kalutara regions	12.07.2022 Integrated soil fertility management practices and their Economic Benefits	V S Sidhakaran, Head, Advisory and Extension Division	Estates Managers and Assistant Superintendents from RPC Estates (Kalutara, Kegalle and Ratnapura)
	Mechanization of tea field operations and their Economic benefits	H W Shyamalee, Head, Agric. Economics Division S Pathiranage, Senior Research Officer	

Experiment and Extension (E&E) Forum for the Smallholding Sector

The 42nd E and E forum for the smallholder sector was conducted for the officials of TSHDA, SLTB and SLPTOA including officials of Tea Development Societies. The program was conducted at TRI Ratnapura. S P A K P Jayarathne, Extension Officer coordinated the forum.

The following subject areas were covered;

- **“**An integrated management approach to enhancing nutrient use” - M A H Nishanthi, Advisory Officer TRI
- “Economic importance of using integrated plant nutrient management practices” - H W Shyamalee, Head, Agric. Economics Division, TRI

Exhibitions

TRI took part in one exhibition during the year in Kandy region where preparation of exhibits, displaying arrangements including making the stall was undertaken by the Advisory staff and research staff of Hantane Centre.

Table 6. Details of the exhibitions participated by Advisory and Extension Division.

Month	Dates	Exhibition Theme	Place
November	11-12	"Aharata Ulelak"	Sahas Uyana, Kandy

Project C/ADV 1: Design and Production of Extension Materials

The main objective of this project is to produce printed, audio-visual, extension and educational materials for the use of technology dissemination and publicity purposes.

Table 7. Extension and Educational Materials

Type of material	Description	Prepared By	Status
Pamphlet	“තේ වගාවේ කොම්පෝස්ට් නිෂ්පාදනයට අත්වැලක්”	A Abeysooriya G S Pradeep S Piyaruwan V S Sidhakaran	Issued
Guidelines / Circulars	Interim guideline on “Strategic cost component management in tea cultivation with special reference to rational use of plant nutrients and tea manufacture”. (Sinhala and English)	M A H Nishanthi M A Wijeratne H W Shyamalee	Issued
	TRI Advisory Circular - “තේ වගාවේ තිරසාර ඵලදායිතාවය, ශාක පෝෂණය හා පාංශු සාරවත් බව සුරක්ෂිත කිරීම උදෙසා ඒකාබද්ධ කළමනාකරණ ක්‍රමවේදයන්”	M A H Nishanthi	Issued

Type of material	Description	Prepared By	Status
	Contributed as the second author for developing the draft for FFS Guide for Tea Smmalholdings (under FAO/RDAL projects)	K R W B Kahandawa, Advisory Officer	
Books	Revised version “Field Guidebook”	M A H Nishanthi (coordination and editing)	Issued
Articles	Production Usage of Nano Urea to minimize the harmful effects of Urea fertilizer	K A Maheshika, Extension Officer	Published
	“තිරසාර තේ වගාවක් සඳහා පොහොර භාවිතය”	M A H Nishanthi Advisory Officer	Published
Video Programmes	Mechanization of cultural practices in tea in “Sengawunu Kahawanu”	K R W B Kahandawa, Advisory Officer	Telecasted on Rupavahini
Coutionery Notes	Fertilizer use in tea	M A H Nishanthi Advisory Officer	Issued

Project C/ADV 2. Supply of TRI 3000 and TRI 4000 series clonal cuttings- ADB mother bush program

Establishment of TRI 3000 and 4000 mother bush sites under the Mother Bush Project was completed in 2015 and the project continued to be coordinated for the benefit of tea growers. Dr. C. J. Liyanaarachchi, Advisory Officer was appointed as the coordinator of the project with effect from 03rd June 2022.

A total of 3.21 million cuttings of TRI 3000 and TRI 4000 series cultivars have been issued to both smallholdings and Estate sectors from mother bush sites during the year against the estimated 5.96 million cuttings (Figure 1).

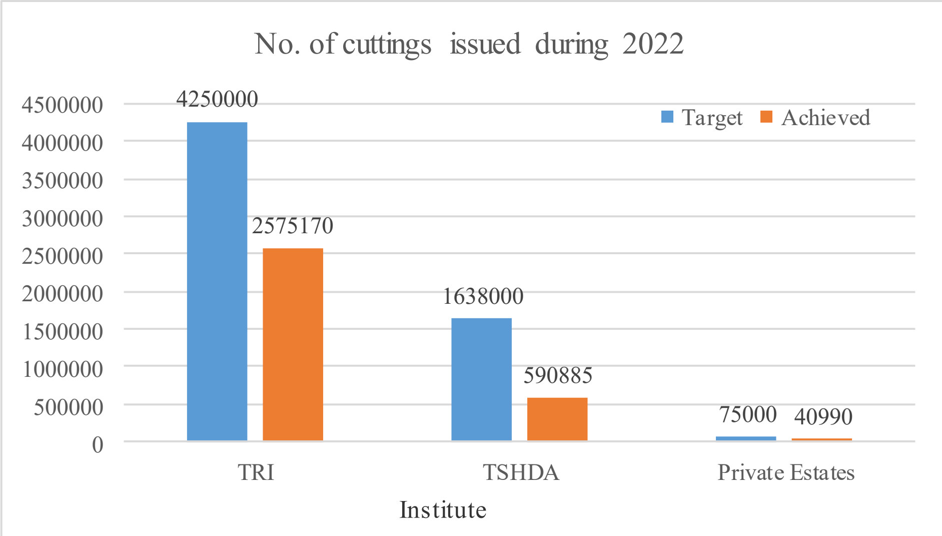


Figure 1. Number of cuttings issued during 2022

As a result of decreased demand due to the prevailed economic constrains (especially fuel shortage) and blister blight disease due to unfavorable weather conditions (misty) prevailed during the critical periods, some of the mother bush sites have been converted to plucking fields. Short supply of inorganic fertilizer, debilitation of mother bushes in some locations, less demand for certain cultivars, and management issues were the main contributory factors for not achieving of the set target.

Mother Bush Programme TRI 5000 series (G.L.340)

TRI 5000 Series mother bush project aims to facilitate the proper establishment of mother bush sites and dissemination of TRI 5000 series cultivars including few other popular cultivars among tea growers. Dr. C J Liyanaarachchi, Advisory Officer was appointed as the coordinator of the project with effect from 03rd June 2022.

The coordinator involved in providing necessary technical guidance and monitoring the progress by visiting the sites periodically.

Fourteen visits were made to selected sites to monitor the activities and to provide guidance.

Cultivated total extent of mother bush in 26 lands covering all the tea growing areas that are maintained by the respective site managers was 20.86 ha. during the project period ended on 31st December.

Project D/ADV 3: Monitoring, Evaluation and Extension Research
Papers published / presented

- Presented an abstract in PGIA congress titled Has collective action improved the efficacy of Tea Smallholding Development Societies (Mahindapala K G J P)

- Presented a research paper on An Exploratory Multiple Case Study on Mechanical Harvesting Adoption in The Corporate Sector Tea Plantation in Sri Lanka at the 12^{th} Annual Research Session, the Sabaragamuwa University of Sri Lanka held on 6^{th} December 2022. (Mahinda T G N, Esham M, and Rosairo H S R.)

- Presented the Research outcome on the title "Effectiveness of the use of "WhatsApp" Messenger Mobile Application for an Extension Campaign and Advisory Forum for Tea Smallholders in Ratnapura District" in PGIA congress - 2022 (Jayarathna S P A P K, Dissanayake U I)

- National Tea Production Decline Since 2013: Evidence Based Analysis, presented at the 240^{th} E and E forum on 16^{th} December 2022 by VS Sidhakaran, Head, Advisory and Extension Division. (Authors: Sidhakaran V S, Wijeratne M A, Shyamalie S W, Pradeep G S, Lakmali K G, Muralithasan R)

- A paper was submitted to Tea Bulletine -2020 on "Evaluation of maessages sent by the TRI SMS Gateway" (Kahandawa K R W B, Gunapala J W, Ekanayake H E M U C S)

- Prepared the survey report on "ප්‍රමිති ගත තේ පැළ තවාන් 138 ක් ස්ථාපිත කිරීමේ ව්‍යාපෘතිය" as per the request made by Sri Lanka Tea Board and " තේ වගාවන් සඳහා T 1240 පොහොර මිශ්‍රණය භාවිතය " (Nishathi M A H)

- Extension survey on adoption of GAPs by tea smallholders recommended at the time of firld inspections by the TRI Deniyaya Regional Center. (Munasinghe C E, Tharangika H B)

Project D/ADV 5: Public - Private Partnership Extension Approach

Extension approach of public - private partnership model wherein partner/collaborative organizations work together on a project having mutually benefited interests and objectives. Responsibilities in terms of time, resources, knowledge and expertise were shared among collaborating organizations (TRI and private organizations).

Tailor-made Training Programme:

Tailor-made Training Programme is a collaborative initiative by the TRI and Regional Plantation Companies with the objective of improving the technical competency of executives, field staff and plantation workers. Training programmes were selected based on timely relevant subjects/ issues appropriate to each tea growing region and also on the interest of individual plantation companies. Sixteen tailor-made training programmes have been organized and conducted for seven Regional Plantation Companies such as Hatton, Namunukula, Balangoda, Madulsima, Pussellawa, Hapugasthenna and Elkaduwa for executives, field staff and workers during the year. The subjects covered were, tea harvesting, pruning, foliar application, uprooting, replanting and aftercare, soil and leaf sampling, tea nursery management, soil concervation and soil fertility management, strategic cost management, good agricultural practices and tea manufacturing.

Advisory staff of TRI Talawakelle, Ratnapura, Hantane, Passara and Deniyaya with Process Technology Division

Para Extension Approach:

Para Extension Approach (PEA) is a grass root level extension approach implemented as a collaborative project of TRI and RPC Estates. The innovative field staff groups in plantations are trained as Para-Trainers (PT) and to function as change objective is to improve the accessibility of TRI recommendation to the supervisory employee level and to create an effective grass root level technology dissemination system within Estate. It is expected to improve knowledge, attitude and adoption of Good Agricultural Practices (GAP) at the grass root level which would contribute towards the performance of plantations. The training programmes were conducted for three RPCs namely Maturata Plantaions PLC (7 programmes for 130 workers including field staff of Revenue Share Model), Balangoda Plantaions PLC and Madulsima Plantaions PLC (6 programmes for field staff and workers). Tea harvesting, green leaf standards, fertilizer applications and other key agricultural practices were covered in the programmes.

VS Sidhakaran, G S Pradeep, R Muralithasan, K G Lakmali, A Abeysooriya and K G Nirosha Gamage

Project D/ADV 7: Cyber Extension

Cyber extension covers various extension activities using information and communication technologies. Main objective is to ensure cost effective and efficient dissemination of TRI recommendations and information to tea growers including other relevant stakeholders and thereby improving awareness and adoption. The following activities were undertaken;

SMS Gateway - Technical text messages

During the year, twenty-four (24) timely SMS (Mobitel) and 24 voice messages (Dialog) on timely important issues were developed and disseminated. This included dissemination of digital extension material as well.

The TRI Call Centre was established in the TRI Mid-Country Centre in the first quarter of the year and it was in operation for public from June 2021. 110 calls have been attended from January to December 2022. A special meeting was conducted with dialog to update the Govimitthuru app. in August 2022

Project D/AR. Adaptive trials to evaluate the adaptability of new technologies approved by the Technology Release Committee (TRC)

The main purpose of conducting adaptive trials is to test the suitability and acceptability of technologies developed by the research on real farm conditions. In order to achieve this objective, most of the adaptive trial activities were conducted on-farm and usually farmer managed with minimum involvement of the research and extension officers apart from providing the required technical support. Socio-economic aspects and practical issues encountered when implementing the technologies in the field conditions were explored. The following activities were undertaken;

- Adaptive Trial was conducted on Urea-Hydroxyapatite Nonhybrid at Pothupitiya Tea Inspector Region in Ratnapura district. (The trial started on 21st November 2022 and will be continued for 6 months period)
- Two Adaptive trials on TRI 5000 series cultivars were established and is being monitored in Smallholder lands in Morawaka and Akuressa of Matara District in collaboration with the Plant Breeding Division and TSHDA.
- One adaptive trial was conducted on the use of wood ash for tea at Kiruwanaganga Estate in collaboration with SPND.
- Two model tea lands demonstrating the TRI recommendations on management of tea bush debilitation problem were established in Pallegama and Beverley areas of Deniyaya region and are being monitored successfully.
- TRI 5000 series trials were continued at Soyza Estate, Pelawatta and Horana.
- A trial on Effect of burying was continued of prunings in Field No 10, Lower Division St. Coombs Estate.

VS Sidhakaran, GS Pradeep, R Muralithasan, KG Lakmali, TGN Mahinda, SPAKP Jayarathne, P Weththasinghe, CE Munasighe, HB Tharangika, H Jayaweera and JKAD Kalhari

Other Research Trials in Progress

Entomology and Nematology Division

- Two trials on screening of TRI 5000 series cultivars for Nematodes and Shot Hole Borer are in progress at the TRI Deniyaya premises in collaboration with the Entomology and Nematology division.

Plant Breeding Division

- TRI 5000 Series: Four LVP phase iii trials are being monitored at TRI Deniyaya premises and Indola, Kiruwanaganga and Deniyaya Estates.
- Two improved seed gardens are being monitored at Kiruwanaganga Estate

- One seedling evaluation trial is being monitored at a small holder land in Warapitiya.

CE Munasighe and HB Tharangika

Improved Seedling Project

- Three isolated seed gardens were established at Kiruwanaganga, Lankaberiya and Wilpita Estates and are being monitored in collaboration with Plant Breeding division.
- Two seed gardens at Vogan and Rayigam Estates have been monitored

Project C/AVU: Audio Visual Services

The objective of this project is to produce and or multiply videos (CD / DVDs) on technical subjects and to provide Audio Visual services for technology dissemination at seminars and prepare AV materials for TRI website. In addition, preparation and issue of videos and maintainance audio/video library for extension and research purposes have also been undertaken.

N Ekanayake

Special Project GL 386. Improvement of soil organic matter in tea lands by burying of tea prunings, planting shade and green manure crops, incorporation of compost and soil conservation measures as a strategy for mitigating climate change effects.

Project was initiated with the financial assistance of the Ministry of Plantation Industries as a special project in 2021. The Advisory and Extension Division with the assistance of Agronomy Division implemented the project.

Burying of tea prunings could provide a sustainable solution by loosening the soil and increasing the soil organic matter which in turn would improve fertilizer use efficiency including other soil chemical and physical properties leading to an overall soil health improvement in order to successfully withstand climate change impact and sustain tea yields. The project was formulated with the following objectives;

- Monitoring of the demonstration sites established in 2021 in TRI lands, RPC Estates, proprietary Estates and demonstrations on burying of pruning practices continued.
- Conducted awareness programs on climate change mitigation, essential agronomic and cultural practices for small holders, medium scale planters, RPC and state sector planters.

Special Project GL 387. Provision of an Efficient On-site Analytical and Extension Service through a Mobile Laboratory

A project titled *Provision of an Efficient Onsite Analytical and Extension Services through Mobile Laboratories* has been initiated as a special project to establish one mobile laboratory and extension unit in the year 2021 as a pilot project with financial assistance of the Ministry of Plantations Industries. The main objective of TRI analytical and extension service is to make TRI analytical and extension service easily accessible to tea growers and deliver the services onsite.

This project has been implemented by the Advisory and Extension Division in collaboration with relevant research divisions (Soils and Plant Nutrition, Plant Pathology, Entomology and Process Technology).

The mobile laboratory with modern analytical facilities developed was launched for the benefit of tea growing community, on 9th the September 2022 at the TRI Low Country Research, Advisory and Extension Center. Honorable Dr. Ramesh Pathirana, Minister of Plantation Industries declared open the launching event held in conjunction with the 42nd Experimental and Extension (E&E) Forum for Extension Officers of the TSHDA and tea smallholders.

The following field level crop clinics were conducted in collaboration with SLTB, TSHDA, Private Tea Factories and Tea Smallholder societies using the lab;

Location	No. of farmers	Conducted by
TRI, Kottawa Regional Center	60	Regional Extension Centers Kottawa and Deniyaya
Shihara Tea Factory, Thawalama	120	
Halvitigala	100	
Thawalama	100	
Gurubevilla and Balangoda	70	Regional Extension Center Ratnapura
TRI, Kottawa Regional Center and Dewagiri Tea Factory	32	Regional Extension Centers Kottawa and Deniyaya
Meepalawa Maha Vidyalaya	57	
Nandana Tea Factory, Akuressa	80	
Akuressa	200	
Ullinduwawa	75	
Kiriweldola	85	
Morawaka	125	
Ketanvila	130	
Pallegama	110	

Advisory and Extension staff (Head office and regional centers), staff from research divisions (SPND, Agronomy, Pathology, Entomology and Plant Breeding)

OTHER SERVICES TO STAKEHOLDERS

Inspection of Commercial Tea Nurseries

Inspection of commercial tea nurseries of small holders are undertaken by the staff of Advisory and Extension Division on the request of TSHDA. Reports on the suitability of nursery plants for field planting were submitted to the TSHDA in order to maintain and ensure that the standard of plants sold to the growers are of good quality. A total of 89 commercial tea nurseries were inspected during the year (Table 7).

Table 8. Commercial Nursery Inspection - 2022

Regional station	No. of Nurseries inspected
Talawakelle	-
Hantane	47
Ratnapura	-
Deniyaya	-
Kottawa	10
Matugama	5
Passara	27
Total	89

Analysis of Soil pH and Carbon

The Advisory and Extension Division has undertaken soil analysis for pH and Carbon on the request of growers (Table 8).

Table 9. Number of Soil samples analyzed for pH and Carbon - 2022

Regional station	pH	Carbon
Talawakelle	-	-
Hantane	515	-
Ratnapura	-	-
Deniyaya	587	-
Kottawa	326	-
Matugama	58	-
Passara	1162	699

Special Extension Progremmes

National programme to improve the quality of tea green leaf named *"Sahakampana"* was launched by Sri Lanka Tea Board in collaboration with TSHDA and TRI. Awareness and training programs were conducted to relevant stakeholders such as Tea Smallholders, RPC Estates, Proprietary and State Plantations, green leaf transporters, tea factory owners and their staffs. TRI Advisory and Extension Division conducted 70 training programs jointly with SLTB and TSHDA.

Project C/SPN. Services of Soil and Plant Nutrition Division

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

The objectives were:

a) To provide analytical facilities to stakeholders for soil, foliar, organic manure and fertilizer analysis and assist tea growers in site specific fertilizer application.
b) To carryout analysis of research samples of regional based field trials.

Total number of analyses performed on soil, leaf, fertilizer and organic manure at Talawakelle, Walahanduwa and Ratnapura during period under review were 10,835, 2,009, 704, and 334 respectively. Of these analyses, highest number of analyses were performed for soil pH (10,331) followed by soil organic carbon (6,099). Total number of analyses performed was 40,508.

BVR Sanali, BMTTK Senarathne, RMNS Bandara, DN Kahawewithana, MGK.Madhushani DR Gamage, SK Weeratunga, SPSK Wijesinghe, OGKA Gunaratna, JRY Abeywardana, WTBD Priyantha and WMS Wijayatunga

Project C/PATH. Services of Plant Pathology Division

Thirty-three made tea samples were analyzed for microbial parameters. Hygienic condition of processing environment and workers were assessed in a speciality tea processing factory.

GD Sinniah, DGNP Karunajeewa, KLSC Gunawardana and RPVT Chandralal

Project C/ENTO. Services of Entomalogy Divison

1. Inspection visit was made to Nuwara Eliya Estate to investigate mite infestation and recommendations were given.
2. Inspection visit was made to small holder land to investigate ant infestation and recommendations were given.
3. An advisory visit was made to Gouravilla Estate and Glenugie Estate to inspect the white grub problem and recommendations were given.

AMP Sammani, BS Vitana and RDPD Senanayake

Project C/NEM. Services of Nematology Division

Nematode diagnostic service from Talawakelle, Hantane and Ratnapura and Walahanduwa laboratories were continued to serve smallholder and corporate sectors in Up-Country, Mid-Country, Uva and Low-Country in nematode diagnosis. During the period under review, more emphasis was given to establish nematode related factors to yield declines observed in low grown tea areas.

Field sampling for nematode assessments in SQI proposed lands were continued.

PGDS Amarasena, UB Herath, BMGK Godavita, B Jananey, GKWH Dharmadasa and LRUL Senevirathna

Project C/PHYS. Services of Plant Physiology Division

Fifteen root starch analysis reports were submitted. Thirty millilitres of Iodine solution was provided to Bramley Estate, 60 ml of Iodine solution was provided to the Advisory and Extension Division of TRI head office and 300 ml of Iodine solution was handed over for the use in the mobile laboratory. The method of performing root starch test was explained to the representatives of the Mattakelle Estate and Summerset Estate. The sampling guideline was prepared in both English and Sinhala languages and submitted for the approval of the Director, TRI, while it's Tamil translation being done.

TL Wijeratne, DMS Navaratne, V Sidhakaran, ADIU Jayawardhana and NM Vithanage

Project C/TECH. Services of Technology Division

- Staff extended advisory services on various aspects of tea manufacture to 58 tea factories.
- Staff calibrated 28 moisture meters received from tea factories and submitted reports.
- Staff calibrated 17 thermometers received from tea factories and submitted reports.
- Staff determined moisture content in 1,173 made tea samples received from tea factories and submitted reports.
- Staff tested eight made tea sample received from a tea factory for chemical parameters and submitted report.
- A drop test and a moisture barrier test were conducted on 2-Ply paper sack samples received from a supplier. A drop test was conducted and a moisture barrier test was commenced on 3-ply paper sack samples received from a supplier.
- Staff participated in three discussions with Department Chairman and Manager, of Special Projects of JEDB on factory development.
- Staff contributed to the workshop on Handmade tea processing at Indola Estate.
- Staff contributed to the Seminar on “Small Holders Responsibilities for Quality Manufacture” at Sanasa Tea Factory.
- Staff conducted lectures on grading, bulking and packing processes to Higher National Diploma in Plantation Crop Technology Students, lectures on Tea Manufacture to Factory Officers and Training on Tea Manufacture to 20 students organized by NIPM.
- Staff provided details on small-scale tea processing to entrepreneurs of Kalutara district.
- Staff participated in two discussions with DGM Engineering and Manager of Houpe Estate on implementing value addition to tea manufacture, miniature manufacture of tea and withering process.
- Staff conducted training on “Tea Tasting and Grading” to tea-related entrepreneurs of Nuwara Eliya district organized by Industrial Development Board, Nuwara Eliya.
- Staff conducted training/ workshop on tea manufacture to staff and workers of Rajjuruwatta Tea Factory, factory staff of New Vithanakanda Tea Factory, 180 undergraduates of University of Colombo and 2nd year Undergraduates of University of Sabaragamuwa.

- Staff conducted a lecture on Green Leaf Quality to factory owners, Balangoda Leaf Collectors and KDU Leaf collecting staff in the prgrammes organized by SLTB.
- Staff conducted three lectures on Green Leaf Quality to tea small holders organized by Devagiri Tea Factory, New Hopewell Tea Factory, Wikiliya Tea Factory, Karawita Tea Factory and Karandana Tea Factory.
- Staff participated in the Crop Clinic held on 09th November organized by TRI.
- Staff facilitated exposure programme on tea manufacture to Trainee Assistant Manager of Wanaraja Estate.
- Staff enlightened CECB Engineers potential energy saving measures and practices in tea factories who made an exposure visit to institute at the tea factory at St. Coombs Estate.
- Staff participated in the meeting on "Formulation of Standards for the packaging products" organized by Ministry of Industries.

K Raveendran, MA Chamindra, WMS Weerawardena, L Jayasinghe, UGDP Ranathunga, EPDNM Wijewardhana, KACL Kodithuwakku and WMI Sathsarani

Project C/MECH. Service by Mechanical Workshop

General Mechanics completed 24 jobs on vehicle repair, 25 jobs on machinery repairs for institute factories and 66 jobs on fabrication and maintenance work for research and Advisory and Extension divisions and service units.

NA Bowie and V Sivakumar

INFORMATION AND COMMUNICATION TECHNOLOGY UNIT

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/uploaded to meet the requirement and mentioned in table below.

Content	Updated/uploaded Location
News items of TRI Call Centre – 0812244777, Releasing 1st Ed Field Guide Book (English version), තේ වගාවේ පොහොර භාවිතය පිළිබඳ අවවාදාත්මක සටහන (Sinhala version of Cautionary note on the use of fertilizers in tea cultivation), Revision of Levy for Analytical Services at TRI – 2022, TRI Launches Mobile Laboratory facilities and Vacancy Advertisement of Preschool Teacher for TRISTAN Preschool	What's New" area of the Homepage

Graphical banners of Deadline extension of Call for EOI on “Commercialization of Process of Manufacturing Tea Wine” Mobile Laboratory and Extension Service (Sinhala Notice regarding bus)	Slide Show area of Homepage
Photograph and details of new Chairman, Mr. C S Lokuhetti	Board of Directors, Tea Research Board under About TRI
2022.11.09 දින පැවැත්වුණු ජංගම වගා සායනය (Notice on upcoming events of Mobile Crop Clinic on 09.11.2022 in Galle) Notice on upcoming events of 240th Meeting of E and E Forum (Cooperate sector) with Presentation Abstracts and Agenda held on 16.12.2022 Photos and Presentations of 240th Meeting of E and E Forum with downloading facility	Extension Events under Technology Dissemination
Sinhala version of Advisory Circular SP 11 - 01/2022 (තේ වගාවේ තිරසාර ඵලදායීතාවය උදෙසා ශාක පෝෂණය පාංශු සාරවත් බව සුරක්ෂිත ඒකාබද්ධ කළමණාකරණ ක්‍රමවේදයන්) with downloading facility Guidelines No. 04/2021 regarding “Interim Guidelines on Strategic Cost Component Management in Tea Cultivation with Special Reference to Rational Use of Plant Nutrients and Tea Manufacture” English, Sinhala and Tamil versions with downloading facility	Recommendations under Technology Dissemination
Vacancy advertisements for recruitment of following positions of Estate Medical Practitioner, Superintendent (Contract Basis) of St, Joachim, Principal Research Officer (Internal), Senior Research Officer, Senior Advisory Officer, Preschool Teacher for TRISTAN Preschool and Superintendent (Contract Basis) of St. Joachim	Vacancies under Notices
Call for EOIs of Commercialization of Process of Manufacturing Tea Wine in English and Sinhala versions	Call for Expression of Interest under Notices

Tender Invitations of Supply of Motor Coach suitable for Mobile Laboratory and Extension Unit, Supply of Two Double Cabs under Monthly Rental Basis, Provision of Security Service for the Tea Research Institute for 2022/23 and Calling bids for unused Mitsubishi Rosa Bus Sheets Tender Documents of Insurance Coverage for Year 2023 with downloading facility Notice on Registration of Suppliers for 2023	Procurement Notices under Notices

Development of Management Information System (MIS)

The proposed MIS is a fully integrated system interconnecting divisions/ units/ offices and also regional and extension centers. M/s Sri Lanka Telecom (Servicers) Limited already started developments adhering to the finalized Software Requirement Specification (SRS) document which detailed functional requirements of proposed system. So far, master data entering facility for Human Resource, Payroll, Procurement, Finance and Accounting, Inventory, Staff Transport, Fault and Service and Expenses Reimbursement modules were completed by the developer and relevant insertions are done by responsible officers divisions. Also, arrangements were also made to commence some functionalities of the MIS System i.e. Update personal file details, apply leave, make vehicle requisition, seat booking of schedule trips etc as trial with effect from 01.01.2023.

Infrastructure Development and Maintenance

- Seven laptop computers, two desktop computers, three 2000VA UPS systems, four 1200VA UPS system and seven 650VA UPS systems were checked with set specifications under new purchases and distributed among the head office and other regional/extension centers according to procurement plan.
- Kaspersky® Anti-Virus software was also purchased and installed in 130 servers, desktop and notebook computers at head office with automatic update and virus scanning facility.
- User activity monitoring and threat management software (Sophos®) annual subscription was renewed in order to manage and control internet bandwidth, internet usage and also to protect TRI intranet from outside threats coming over the internet.
- Fifty one major jobs under the activity of installation and troubleshooting of computers, computer accessories and LAN completed were carried out.

Other Services

Information and Communication Technology (ICT) unit rendered following ICT related services also to other divisions, units, regional and extension centers as well as TRI Estates. These included;

- Administration and maintenance of DNS (Domain Name System), E-mail and File servers
- Providing and regular monitoring of internet access to TRI officers
- Facilitated the development and maintenance of new accounting software for St. Coombs and St. Joachim Estates
- Facilitated maintenance of software based Call Center at Mid Country Regional Center
- Successfully completed 233 on-call jobs to facilitate, managing and sharing research data and quick access to other information sources
- Facilitated to arrange/host/connect 214 Online Video conference meetings as and when required for the management and staff members using Microsoft Teams, Zoom, Google Meet, *etc* technologies
- Maintenance of CCTV Surveillance Camera System
- Ten sets of technical specifications were formulated to purchase different ICT equipment, accessories, etc and delivered them for procurement
- Maintenance of ICT Assets Register of Computers, Accessories and Software
- Assisted management and staff members to prepare various reports, presentations, documents and graphic designs, *etc;*
- Arranged Temporary Computer Lab facility for 17 participants for "E-Bar Examination" at the TRI Auditorium, Talawakelle
- Facilitated maintenance and access Tea Land Registration Database of Sri Lanka Tea Board using 2 Mbps VPN Facility obtained from M/s Sri Lanka Telecom PLC to download data for institutional requirement

Mr. U D Alagiyawadu continued his services as follows;

- Maintenance of Finger Print Scanners located at Head Office and Low and Mid country Regional Centers, St. Coombs Estate and its software
- Formulation of Technical Specifications and representing Technical Evaluation Committees (TECs) for ICT related procurement
- Translation of ICT unit section of Annual Report 2020 to Sinhala language

Staff Movements

Mr. U D Alagiyawadu successfully continued covering up duties of Network Administrator at the ICT Unit during the year.

Ms. W M M S H Paranayapa taken over duties at ICT unit as Technical Officer (Research and Development) with effect from 14th February, 2022.

Trainees

Ms. H M S N Wijayarathna at the ICT Unit has successfully completed her six months practical training commenced on 15th November 2021 on Information and Communication Technology Technician (NVQ Level 4) training programme at the National Apprentice and Industrial Training Authority (NAITA), Hatton.

LIBRARY

Main function of the library is the collection and dissemination of information on the requirements of TRI scientists for work connected to their research and publications. The library renders its service to TRI staff, undergraduate and diploma students who undertake their projects at the TRI and also official requests made from other libraries and individuals. The library involved in the following activities during the year.

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

Acquisition

Four new books were added to the current collection of 4792 books by free of charge. The Library procured 57 journals/serials through subscription, gift and exchange. Two PhD thesis were added to the thesis collection. Subscriptions renewed for the year for ITC (International Tea Committee, UK) Monthly Statistical Summary. ITC Annual Bulletin of Statistics (Annual Subscription Price £266) offered to the TRI library in this year by Mr Manuja Peiris, Chief Executive/Statistician of the International Tea Committee, UK, on complementary basis.

Services

Library circulation was 146 (books, journals and other library materials) during the year. 256 news paper articles were added to the news clippings collection. 376 papers were photocopied for TRI staff from bound periodical collection and other library materials.

PHOTOGRAPHY UNIT

Photography Unit attended to taking digital photographs relevant to all Research Divisions and functions held at the institute and captured 1189 digital photographs.

During the year ten events have been covered and provided photographs for Publications and Publicity unit for the update of TRI website and FB page. Further, around 14,000 photographs were sorted and inserted into the Photograph Repository collection.

PUBLICATIONS AND PUBLICITY UNIT

The publications and Publicity Unit of the TRI provide its support services to carry out the research dissemination process through annual publications of the Institute during the year. Further, it carries out several assignments of the Institution as a support services provider within the Institute.

Planned works for the year 2022 were carried out successfully, except the printing works due to the high cost of printing and frequent price fluctuations; which affected the printing works of Annual Reports, Sri Lanka Journal of Tea Science, Tea Bulletin, and Newsletters of 2021 and 2022. However, the unit provided assistance in carrying out the operations related to information dissemination to the stakeholders by electronic means.

In house Printing/ Duplicating works

The unit has provided printing facilities for research divisions/ units on request. The Publication Unit has completed digital printing works worth Rs. 15,725.00 within the year. Advisory Circulars, Guidelines, E and E Handouts, Budget of TRI, Handouts for Regional Technical and Extention Forum, and research publications related to fertilizer, pesticides, *etc*. for the year 2022 were the printing assignment completed.

Further, the Publication unit has served other divisions/units, and staff members, in making photocopies at the main photocopying service of TRI. Due to the breakdown that occurred in the main photocopy machine, the photocopying service was not functioned during the year.

Sales of Publications

Sale of TRI Publications is the major operation carried out by the Unit. The sales of publications worth of Rs. 920,495.00was done during the year. A summary of the sales is given in Table 01. Compared to the year 2021, sales increased during the year 2022. Hand Book on Tea and the new edition of Field Guide book were the highly demanded publications. Further, the unit facilitates the stakeholders to purchase publications via confirming online payment facilities, with the assistance of the Finance Division successfully.

Table 01. Summary of sales 2019 - 2022

Year	English	Sinhala	Tamil	AV materials	Total
2019	572,375.00	30,090.00	6,190.00	850.00	609,505.00
2020	79,990.00	11,785.00	3,270.00	900.00	95,945.00
2021	159,465.00	6,010.00	1,800.00	250.00	167,525.00
2022	895,190.00	8,825.00	15,580.00	900.00	920,495.00

Table 02. Sales of 2022 (English, Sinhala, Tamil publications and AV materials)

English Publications

No.	Description	Price (Rs.)	Quantity	Amount (Rs.)
1	Advisory Circular Folders (English)	600	48	28,800
2	Chemical Control of Tea Pests	150	17	2,550
3	Correction of nutrient deficiency symptoms in tea Poster	15	2	30
4	Proceedings of Regional Scientific Committee - 1988	250	2	500
5	Field Guidebook (English) (Issued to TRI Officers with Discount)	1000	1	1000
6	Field Guidebook (English)	1500	444	666,000
7	Nuwara Eliya District Tea Development Plan	150	2	300
8	Shoot growth and harvesting of tea	100	24	2,400
9	Monograph No.4 - Tea Manufacture in Ceylon, EL Keegal	750	22	16,500
10	Monograph No.5 - One day course in tea manufacture, EL Keegal	350	13	4,550
11	Monograph No.6 - Insect and mite pests of tea in Ceylon, JE Cranham	100	6	600
12	Monograph No.7 - Facets of the tea research in practice, RL Wickremasinghe	100	42	4,200
13	Cost of tea Cultivation from nursery to the field	400	4	1,600
14	Tea and Health	750	7	5,250
15	Tea for Health	100	9	900
16	Weeds of Tea lands in Sri Lanka	200	8	1,600
17	Twentieth Century tea research in Sri Lanka	2,000	1	2,000
18	Poster on Soil conservation with vetiver grass	30	2	60
19	Wall chart on Major pests of tea in Sri Lanka	100	5	500
20	Handbook on Tea-1st Edition (Issued to TRI Officers with Discount)	1,500	3	4,500
21	Handbook on Tea (Reprint 2019)	2,000	26	52,000
22	Handbook on Tea - Reprinted 2019 Price Revised (Issued to TRI Officers with Discount)	2000	1	2,000
23	Handbook on Tea- Reprinted 2019 (Price Revised)	2,500	35	87,500
24	Integrated Soil Fertility Management	500	18	9,000
25	Soil Conservation in Tea Lands	20	9	180
26	Common Diseases on Tea Cultivation Poster (English)	100	1	100
27	Sri Lanka Journal of Tea Science	100	2	200
28	Tea Bulletin	50	1	50
29	TRI Update	20	1	20
30	Annual Reports	100	3	300
			Sub-total	895,190

Sinhala Publications

No.	Description	Price (Rs.)	Quantity	Amount (Rs.)
1	උපදෙස් චක්‍රලේඛ ගොනුව	500	13	6,500
2	සැවැන්දරා වගා කර පස සුරකිමු (පෝස්ටරය)	30	1	30
3	සුව රැකුමට තේ	125	5	625
4	ශ්‍රී ලංකාවේ තේ කර්මාන්තය සහ තේ පර්යේෂණ ආයතනය	10	7	70
5	තේ වගාවට සරු පසක්	50	14	700
6	තේ ඉඩම්වල පස සංරක්ෂණය	20	15	300
7	තේ වගාවේ ප්‍රධාන රෝග හඳුනා ගනිමු (පෝස්ටරය)	100	1	100
8	තේ තවාන් පාලනය (පෝස්ටරය)	100	5	500
			Sub-total	8,825

Tamil Publications

No.	Description	Price (Rs.)	Quantity	Amount (Rs.)
1	Advisory Circular Folders	500	28	14,000
2	Correction of nutrient deficiency symptoms in tea Poster (Tamil)	15	3	45
3	Field Guide Book (Tamil)	125	11	1,375
4	Poster on Soil conservation with vetiver grass (Tamil)	30	3	90
5	Tea Industry and TRI of Sri Lanka (Tamil)	10	7	70
			Sub-total	15,580.00

Audio-visual materials

No.	Description	Price (Rs.)	Quantity	Amount (Rs.)
1	Plucking and Pruning CD	100	7	700
2	Soil Conservation CD	50	4	200
			Sub-total	900
			Total	920,495

Distribution of the Publications to stakeholders through Regional Research, Advisory and Extension Centers

Publications unit engaged in distributing the institutional publications to the stakeholders through six regional Research, Advisory and Extension Centers (Table 3).

Table 03. Summary of the publication distribution to regional centers

No	Regional Center	Annual Publications*	Circular Folders	Books	Posters	AV Materials
1	Low-country	03	10	429	60	-
2	Mid-country	02	10	85	-	-
3	Kalutara	02	-	25	-	-
4	Galle	02	20	75	-	-
5	Deniyaya	02	-	50	-	-
6	Uva	02	20	140	-	-
	Total (Qty)	13	60	804	60	-
	Value (Rs.)	-	32,000.00	1,117,500.00	600.00	-

*free issues

Rs. 1,150,100.00 worth Publications distributed among the six regional centers for sales purpose except the free issues of the Annual Publications.

In addition, TRI recommendations (Advisory Circulars and Guidelines / Cautionary notes) were issued to the stakeholders, researchers, Institutes/ organizations on request via electronic means. Encouraging the use of e-mail, FB and webpage for sharing information, addressing the queries received from RPC, THSDA and tea growers, Universities, foreign Institutes, personals via e-mail continued.

1. Annual Reports (English, Sinhala, and Tamil)

The printing of the Annual Report of the Institute was a challenging task due to the high market price fluctuations. However, completed the printing of the Annual Report 2019 in tri-language during the year. Following the Guideline issued dated 30 March 2022 by the "Office of the leader of the house of parliament",quantity of the printed copies was reduced and increased the number of CDs (Softcopies) for submission to the parliament and for In-house and among stakeholders.

Ministry of Plantation Industries (MPI) approval was received for the Annual Report 2020 during the third quarter of the year and Annual Report 2021 was compiled and submitted to the MPI with the approval of the Tea Research Board. After reviewing the Annual Report 2021 MPI suggested amendments to the report and corrected them accordingly.

Translation of the Tamil Annual Report was carried out by the Coordinator, Mr. G S Pradeep, Extension Officer of the Advisory and Extension Division with the support of the Tamil Officers of TRI. English and Sinhala reports were compiled and formatting completed by the unit, with the supervision of the Chairman of the Publications and Presentation Panel.

2. Sri Lanka Journal of Tea Science Review

The Sri Lanka Journal of Tea Science (SLJTS) has been publishing the current research in tea covering all aspects of Tea Science. The content of the journal is peer-reviewed. The journal is published in print form and distributed as a free issue to the stakeholders of the tea industry.

Volume 83, Volume 84, and Volume 85 printing processes were initiated during the year with the completion of the reviewing process of the articles. Of the nine articles reviewed by fourteen external subject specialists, five articles were accepted for publishing in Volume 83 (Part I and II).

The selected articles for the 7th Plantations Crop Research Symposium with the permission of the Symposium secretariat were included in Volume 84 (Part 1 and II) and Volume 85 (Part I and II).

Eleven articles were received for Volume 86 and Volume 87 of the SLJTS and peer reviewing process was carried out during the year. Out of the 11 articles nine articles were accepted for the two volumes.

3. TRI Update (English) and *Thea Thathu (Sinhala)* News Letters

TRI update and *Thea Thathu* are the publications published twice a year in June and December. Those were the two newsletter-type magazines in English and Sinhala that provide updated information on the tea industry, TRI research, innovations and knowledge dissemination, *etc.* Dr. Noel Piyasundara, Senior Research Officer of the Plant Breeding Division continued as Coordinator of TRI Update. Mrs. M A H Nishanthi, Senior Advisory Officer of the Advisory and Extension Division continued as Coordinator for *Thea Thathu* (Sinhala) Newsletter.

"TRI update" Volume 19 (Issues 1 and 2) has been published and articles for the newsletter Volume 20 (Issues 1 and 2) were reviewed and edited by the coordinator.

Further, *Thea Thathu* Volume 17 (Issue 2) and Volume 18 (Issues 1 and 2) were reviewed and edited by the coordinator, and printing was initiated.

The Coordinators of both newsletters have continued their work on publishing upcoming volumes.

4. Tea Bulletin

Tea Bulletin is an annual publication of TRI that provides current updates on tea in short and simple language which is helpful for planters and smallholders of the tea sector. Volume 29 (Part I and II) of the Tea Bulletin was in the process of printing.

The Coordinator for Tea Bulletin Mr. S P Rathnayake, Senior Advisory Officer of the Advisory and Extension Division resigned.

5. TRI Cautionary Note

One Sinhala Cautionary note issued on "තේ වගාවේ පොහොර භාවිතය පිළිබඳ අවවාදාත්මක සටහන" dated 19th July, 2022.

6. TRI Advisory Circulars

Soil Fertility Management and Plant Nutrition (SP 11 - තේ වගාවේ තිරසාර ඵලදායිතාවය උදෙසා ශාක පෝෂණය හා පාංශු සාරවත් බව සුරක්ෂිත කිරීමේ ඒකාබද්ධ කළමනාකරණ ක්‍රමවේදයන්) new Advisory Circular has been issued in August 2022.

Upcoming Publications and Promotional Materials

1. **Guide to Identification of Weeds in Tea Lands in Sri Lanka**
   The two scientists of the Agronomy Division updated the 1st edition of the book "Guide to Identification of Weeds in Tea Lands in Sri Lanka" reviewed by Prof. Siril Wijesundara, Research Professor of Plant Taxonomy and Conservation, of the National Science Foundation, as an external subject specialist and provided his inputs to improve the technical content of the book. Accordingly, authors compiled the book with amendments.

2. **Field Guide Book**
   The First Edition of the English Field Guide Book was printed and added to the TRI publications during the year. The Institute has taken initiatives to make available the book in Sinhala and Tamil.. Translation of the Sinhala Book was coordinated by Mrs. M A H Nishanthi, Senior Advisory Officer, and Tamil translation by Mr. G S Pradeep, Extension Officer of Advisory and Extension Division, Talawakelle.

3. **Tri Language Booklet on "Guideline for Compost Preparation in Tea Cultivation"**
   The Advisory and Extension Division developed the "Compost Preparation Guide" tri-language booklet and the Publications and Publicity Unit provided assistance with printing. The printing of the Sinhala booklet was completed. English and Tamil first proof reading was completed and the work was in progress.

4. **Printing of Promotional Materials**
   The Advisory and Extension Division designed tri-lingual stickers; a car sticker and a normal sticker on "Soil conservation". The publications and Publicity Unit provide assistance to the Advisory and Extension Division in the printing process and successfully completed the printing.

Obtaining ISBN Number for Institutional Publications

An initiative was taken to create an Online Login with the "National Library and Documentation Centre" website to facilitate the process of obtaining ISBN numbers for the institutional publications. Six of ISBN numbers obtained via the user login during the year.

Initiation of the MIS for Operations

With the initiation of the MIS for the TRI operations, it was proposed to automate the major operations of the Publications and Publicity Unit such as inventory management activities, stock of the publications, and sales-related operations. Publication stock of the unit updated to the MIS, expecting to go forward with the next level of operations. Clientele details were also compiled to update the system and expecting to run the trial version in the first quarter of the year 2023.

Photograph Repository of the Institute

With the Guidance of the Additional Director and with the collaboration of the Photography, ICT Unit, and all Research Divisions and Regional Centers, initiatives were taken to develop a Photograph Repository during the year 2021 and the work continued.

Photographs of R and D, Divisional research, calendar events, special meetings, special visitors gathering, and staff social events were also updated successfully into the shared folders by end of November. Approximately 3000 photographs were included into the collection with the updates of ongoing R and D works, in addition to the 16 calendar events photographs of year 2022.

Updates of the TRI Facebook Page and TRI Webpage

Events updated: With the support of Photography and ICT unit, Publications and Publicity unit updated the FB page and webpage notes of following events;

1. TRI 5000 for Uva Region
2. TRB Members for Year 2021 / 2022
3. EandE – Low-Country Research, Advisory and Extension Centre
4. Revised analytical service chargers
5. Launch of mobile laboratory
6. Expression of Interest – notification of TTO office
7. Opening of Plant Pathology Microbial Laboratory

Technical Messages of TRI Call Centre: With the guidance of Mr. W B Kahandawa, Officer-in-Charge of Mid-Country Research, Advisory and Extension Centre, Messages of SMS gateway in graphical means uploaded to the FB page update the tea growers with current problems/ issues of the industry. Twenty-two messages were uploaded to the FB page during the year to make aware the tea growers, through the social media platform.

Other assignments

Publications/ Publicity Officer developed the artworks for Annual Reports, TRI update and for FB page.

Publications/ Publicity Officer served as a member of Technical Evaluation Committees for the Selection of Supplier for printing annual publications and books / booklets and stickers, Advisory Circular Folder and stationery stores during the year.

Due to the retirement of Mr. N Ekanayeke, Audio Visual Officer with effect from 31st December,2022, Publications and Publicity Officer taken over the Inventory of the Photocopier Unit and the record books maintained by Mr. N Ekanayeke.

Study Programmes

W H T C Silva, Publications and Publicity Officer completed her postgraduate studies in Masters in Development Studies from the Faculty of Graduate Studies, University of Colombo.

W H T C Silva, Publications and Publicity Officer started a one-year Diploma in Library and Information Management (DLIM) from the National Institute of Library and Information Science, University of Colombo, and completed the studies.

TECHNOLOGY TRANSFER OFFICE (TTO)

M A B Ranatunga
Manager - TTO

The Technology Transfer Office of TRI is being continued to operate on a virtual platform.

Staff movements

Ms A R M A M Rathnayake, Advisory Officer, Advisory and Extension Division who worked as TTO Assistant resigned from the post with effect from 20th December 2022 and Dr. (Ms) H M C G Pilapitiya assumed duties as the TTO Assistant with effect from 21st December 2022.

New IPs filed

During 2022, amendments were submitted to two previously filed patent applications;

1. Mathematical model based control system for trough withering of tea
2. Method of formulating talc-based *Trichoderma asperellum* (Tric 33) wettable powder, method of preparation and method of application for tea disease management and plant growth enhancement

Commercialization of IPs

Expression of Interest (EOI) was called for commercialization of Process of Manufacturing Tea Wine (Patent No 13621) and after a series of evaluations International Distillers Ltd has been identified as the potential commercial partner. Agreement will be signed in early 2023.

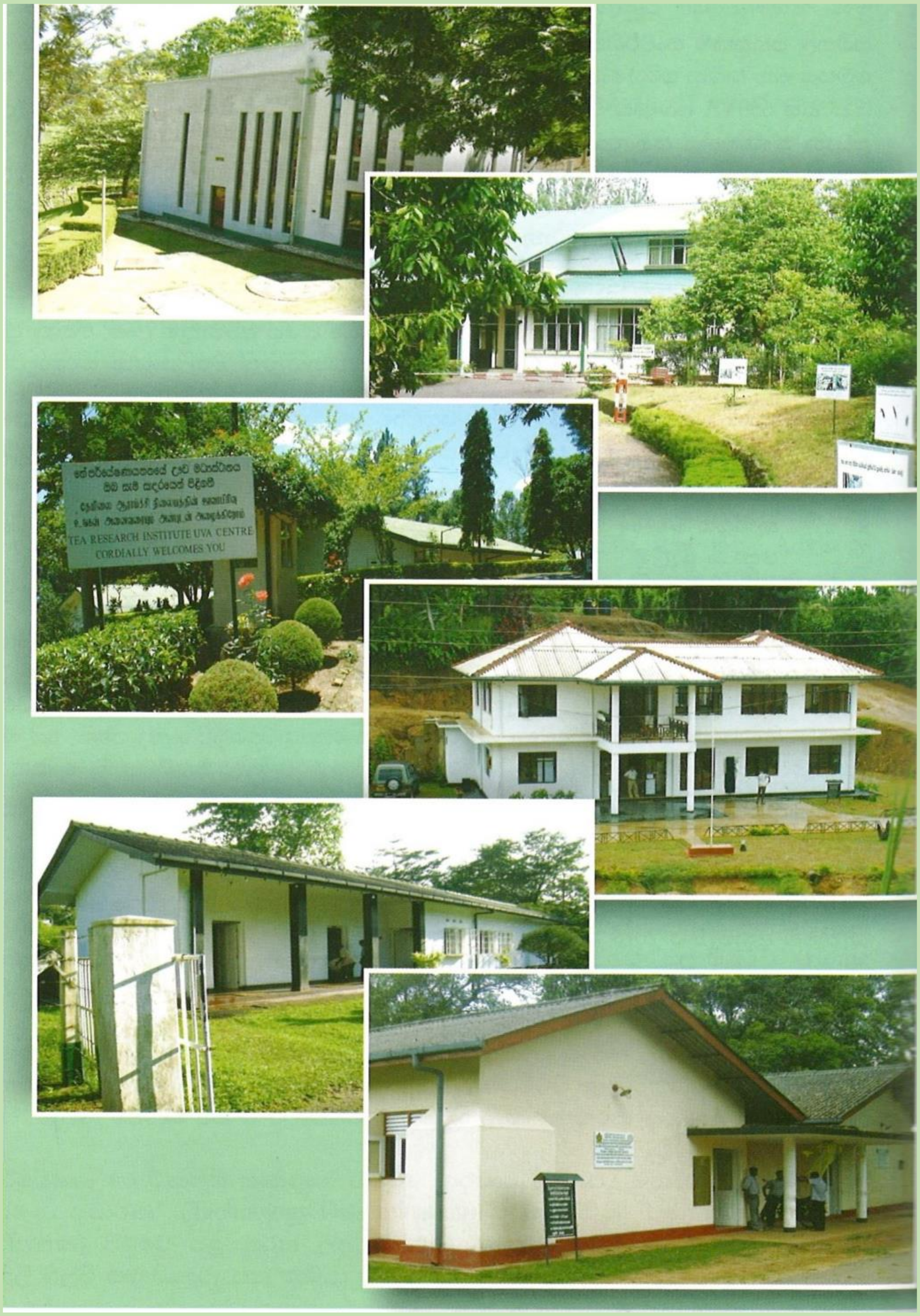
Institute IP policy

Provisionally approved institutional IP Policy and IP disclosure form by the Tea Research Board has been circulated among TRI staff before implementing.

Other activities

The fourth round of remote mentoring programme organized under the Enabling Innovation Environment Program organized by the World Intellectual Property Organization (WIPO) which commenced on the 27th October 2021 continued till 8th March 2022 with the mentorship of the Mr. Cengiz Tarhan and one technology was selected for the programme titled Spicy Tea Sauce and Method of Preparation.

TRI REGIONAL CENTRES



TRI LOW-COUNTRY RESEARCH, ADVISORY AND EXTENSION CENTRE – RATNAPURA

M A WIJERATNE
BSc. Agric (Ruhuna, Sri Lanka), PhD (London, UK)
Head

General

In line with governments food security programme, staff of the TRI Low-Country Center grew food crops including vegetables and yams in court yards of staff quarters, guest house, hostel and office and laboratory buildings. State Minister Hon. Kanka Herath paid on a brief visit to Low Country Center on 18.03.2022 with a view to discuss land availability for establishment of a tea nursery. The mobile laboratory of the TRI was launched at the TRI Low-country Center on September 9, 2022 by Hon. Ramesh Pathirana, Minister of Plantation with the participation of Mr Chinthaka S Lokuhetti, Chairman, TRB, Director TRI, Deputy Director-Research (Production) TRI and Heads of Divisions. Food crops cultivation and maintenance at guest house and office/laboratory premises were continued.

Staff movement

Mr T M G W Jayaweera, Electrician, was transferred from Head Office to Low Country Center with effect from 10.03.2022 while Mr S H P Dayaratne, Engineering Assistant (Electrical) was transferred to Head Office with effect from 10.03.2022. Mr K A C L Kodithuwakku, Technical Officer of Process Technology Division transferred from Head Office reported to work at Low-country Center with effect from 23.05.2022. Ms M K D Damayanthi, Technical Officer, Entomology and Nematology Division, Head Office was transferred to Low-country Center with effect from 12.12. 2022. Ms P Wettasinghe, Extension Officer was transferred from Low-country Center to Galle Extension Center with effect from 12.12.2022. Ms W M I Sathsarani, Technical Officer, Process Technology Division, Head Office was transferred to Low-country Center with effect from 19.12.2022. Mr P G Chandrakeerthi, General Worker retired from the service with effect from 31.12.2022.

Research, advisory and extension activities

Agronomy, Plant Breeding, Entomology/Nematology and Process Technology Divisions continued their field and laboratory experiments. The total number of field and laboratory experiments exceeded 49, Staff of Plant Breeding Division established 10 seed gardens in the low country Estates in addition to nine old seed gardens maintained by them. Details of the experiments are given under the relevant research projects. The Advisory and Extension Officers have done 82 Advisory and extension visits to tea Estates and smallholdings and organized 8 training programmes. They also visited 13 farmer centered bio-organic trials and eight farmer fields on the use of T1240 mixture. Advisory and Extension staff have inspected 27 tea nurseries established in the low country region under special project of the

Sri Lanka Tea Board. More than 160 stakeholders from plantations, private Estates and smallholdings have been entertained by the Advisory and Extension Division.

Staff of Process Technology Division has done 23 visits to tea factories and provided solutions for tea manufacture and machinery related problems and conducted 24 training programmes. Mr. M A Chamindra, RO also served in two TECs appointed for purchasing of machineries to tea factories.

The first RTEF for TSHDA officials and members of the smallholder societies representing Ratnapura and Kegalle Districts was held at the TRI LCRC on March 29, 2022 and the second RTEF was held on December 13, 2022. The RSC seminar for plantation executive of Ratnapura, Kegalle and Kalutara regions was held on virtual platform on July 12, 2022. The E and E Sinhala forum for small holder sector was held at the TRI Low-country Center on September 9, 2022. A seminar was held in collaboration with the TSHDA for improving productivity of the model farmers of Ratnapura and Kegalle regions. A seminar on tea harvesting was held on April 26, 2022 for executive and field staff of Balangoda plantations. Staff of the Low-country Center participated in the mini crop clinic held on November 9, 2023 at TRI Galle Center.

Advisory and Extension staff conducted practical sessions on tea cultivation for NIPM trainees following Advance Certificate Course in Agric Plantation and Farm management (November 17-18) and OUSL students (December 2). Staff of the Center participated in leaf quality improvement programme (*Sahakampanaya*) of TSHDA/SLTB in the low country region. Staff of Agronomy Division conducted a field session on mechanical harvesting for the executives and field staff of Maskeliya Plantations at Talawakelle on July 26, 2022. They also conducted a field session on mechanization of field operations for the executives and field staff of Kotagala Plantations at Raigama Estate on September 28, 2022. Staff of Agronomy Division conducted a field session on shear harvesting for the smallholders of Orangefield Tea Factory, Panwilathenna on December 14, 2022. They also conducted feasibility assessments and field training sessions on tea irrigation. Officials of the STaRR project had several project progress meetings with TRI staff at the Low-country Center.

TSHDA, SLTB, STaRR project and Valuation Department conducted awareness/ training sessions for their stakeholders using seminar hall facilities at the Low Country Center.

Dr M A Wijeratne continued his duties of Head, Agronomy Division, TRI in addition to those of the Head of the center. He convened four CCR meetings during the year under reference. He was also involved in revising the National Land Use Policy and served as a member of the Faculty Board of Agriculture, University of Ruhuna and Board of Study in Crop Science of the PGIA, University of Peradeniya. He also virtually joined the FAO-IGG on Tea meeting held on February 23, 2022 representing Working Group on Climate Change. Representing the TRI, he attended DCC meeting of Ratnapura District. Dr Wijeratne served as a member of the judging panel of the Young Graduates Forum - 2022 of the Faculty of Agriculture, University of Ruhuna held on December 5, 2022. He also participated in the workshop held in Colombo (19.12.2022) on Development of a Tea Policy for Sri Lanka organized by the ADB.

Analytical and other services

Staff attached to the STaRR project and Agronomy Division has analyzed more than 2820 soil samples from smallholdings in Low-country Tea Growing Districts and given Soil Quality Index (SQI) reports. Two of the Technical Officers of Agronomy Division also supported soil sampling and laboratory analysis of the STaRR project. Entomology and Nematology Division has analysed 141 samples for nematodes. The soil analytical laboratory of SPND has analyzed 1002 soil samples, 77 chemical fertilizer samples and 24 organic manure samples. The Process Technology Division has also undertaken moisture meter calibration tests in tea factories.

Human resource development /Training

Mr TGN Mahinda, Advisory Officer Senior Advisory Office commenced his postgraduate programme at Sabaragamuwa University whilst Mr K G J P Mahindapala, continued his postgraduate study programme at PGIA, Peradeniya while performing his duties at the TRI Low-country Center as the Senior Advisory Officer.

Miscellaneous activities

Senior staff of the Center served as members of TECs appointed for procuring of laboratory equipment, tea factory machineries and general goods and services to TRI and also for other tea related organizations. The St. Joachim Tea Factory development using special Treasury funds continued and was in the near completion.

In 2022, nine progress meetings and discussions were held by the project advisory and monitoring committee on Development and introduction of a motorized selective tea harvester suitable for tea lands in Sri Lanka (2021-2023). Dr M A Wijeratne and Dr Sampath Pathiranage closely associated with development partners and tested prototypes of selective tea harvesters developed by them at the Low country Center and St. Coombs Estate.

Staff of Agronomy Division maintained 2 ha block of CO3 grass on St. Joachim Estate and issued cuttings to beneficiaries of the STaRR project and other smallholders. In addition, some nursery plants of *Derris spp* grown in the Agronomy Division nursery were sold to corporate sector Estates and smallholders. Staff of Plant Breeding Division established seed gardens and mother bushes of new TRI cultivars on St. Joachim Estate and other low country Estates. They also coordinated supply of improved seeds from corporate sector Estate's seed gardens to tea growers and supported for maintenance of those seed gardens.

Infrastructure developments

Buildings and lay-out

The refurbishment of three washrooms of the circuit bungalow was completed. Cement floor of the room was also painted. Other necessary repairs in the guesthouse and its premises were also attended. Repairs to roof, ceiling, valance board and gutters of staff quarters (B2, C7), glasshouse and Field Office of Agronomy Division were attended. Section of the timber floor of main seminar hall damaged by termite attack was repaired. Ceiling of information center of TRI LCRC damaged by termites was repaired and painted. Driver's room of the guesthouse was improved by painting and fixing two glass windows. Maintenance repairs to kitchen, drains and roof of D8 quarters were attended. Nursery hut of the Advisory Division in the Techno Park was renovated by fixing a permanent roof and synthetic nettings. Layout and building premises were thoroughly cleaned during Dengue prevention week in order to prevent mosquito breeding as advised by PHIs. However, grass cutting and cleaning of the layout around the laboratories, office and roadsides were partly done due to lack of fuel for grass cutters. Sand beds and drains for Plant Breeding Nursery and pavements were repaired. Essential maintenance repairs of the Sport Club building were also attended. Other routine cleaning and maintenance work of the buildings and layout were continued.

Electrical maintenance

The electricity generator and capacitor bank of the St. Joachim Estate Tea Factory were serviced. Electricity was also supplied to relocated motors of the tea factory. Electrical repairs/rewiring of pump and sprinkler system of St. Joachim factory, drier (damaged by fire), Superintendent bungalow and TRILCRC information Center were attended. Two ACs of Administration Division was repaired and re-installed. The electric motor and fan of the fume cupboard of Agronomy Division was repaired. Electrical repairs of C1 bungalow, re-wiring of two renovated washrooms of the guesthouse and were successfully completed. Electricity consumption of the guesthouse was reduced by replacing old bulbs with LED bulbs. Electricity supply was given through a UPS to the newly fixed projector in the seminar room. Panelboard and control circuit repairs of Trough No 02 of St. Joachim Factory were done. Water leakage of the 300KVA generator of St. Joachim factory was repaired. Electric motors of Trough No 3 and 4 and control panels were repaired. Electrical repairs of St. Joachim Estate office and TRI Sport club buildings were attended. Urgent repairs of seminar hall generator *i.e.* repairs to AVR unit, battery charger replacement were successfully completed. Electrical repairs of the TRI guesthouse including those of the television and refrigerator, hostel rooms and air conditioner of Head of the Center's room were completed. Other day-to-day maintenance of layout, repairs of the electricity supply to office, laboratories, staff quarters and other buildings and street lights and repairs to telephone connections were attended as necessary.

Transport

Painting and cushion work of seats of the TRI Low-country Center staff bus were completed. During the period of the repairs, transport facilities for school children was provided using the staff bus of Mid-country Center which was temporarily transferred to the Low-country Center. The Mobile Laboratory of the institute and the St. Coombs Estate lorry were stationed at the Low-country Center. General maintenance, urgent running repairs and servicing of the vehicles of the Low-country Center were carried out using the limited funds available.

Undergraduate Trainees

One undergraduate from Faculty of Agriculture University of Ruhuna completed industrial training at the TRI Low-country Center.

Security service

The services provided by M/s J and T security and investigation services were not as per the agreement and up to the expectations of the institute. Therefore, deficiencies were reported to TRI, Talawakelle. M/s Golden Heart Security Service took over the service with effect from August 1, 2022 and their services were satisfactory.

Weather

A total rainfall of 4776.5 mm was recorded during the year under reference. Although it was comparable to the total rainfall of the last year, it was 850.3 mm more than the decennial mean. The total number of wet days was 181. Rainfall extremes were recorded during the month of May and October. They were 851.8 mm and 887.6 mm. July and September months received significantly lower rainfall than the decennial means. Rainfall during the months of May, August and October-December were higher than those of decennial means.

As observed during the month of December last year, temperature during the month of January and February 2022 continued to be higher than their respective decennial means. In contrast, the month December 2022 was cooler than its decennial mean.

TRI MID-COUNTRY RESEARCH, ADVISORY AND EXTENSION CENTRE, HANTANE

K R W B KAHANDAWA
BSc Agric (Peradeniya Sri Lanka), MSc (Peradeniya Sri Lanka)
Officer in Charge

The TRI Mid-Country Regional Centre, Hantane, Kandy is serving for mid elevation tea plantations situated in Kandy and Matale Districts and some part of Nuwara Eliya District by implementing the research, advisory and extension programme of the institute. The services of this centre are extended to 37 government sector Estates 23 regional plantation company Estates, about 200 medium scale Estates and about 33000 smallholders. Research activities of the center are executed under the disciplines of Soils and Plant Nutrition, Agronomy, Entomology and Nematology, and Plant Breeding along with the Advisory Extension Division. A unit of Agricultural Economics is also established at the center and tea field and a nursery are also maintained for issuing planting materials, conducting research experiments, demonstrations, and for training purposes. The center conducted number of various programmes and activities for its stakeholders throughout the year under review, despite of various constrains due to the situation prevailed in the country.

Land use Pattern of the Centre

Table 1. Land utilization of the center - 2022

Land Use	Extent (ha)
Seedling tea	1.50
VP tea	5.00
Uprooted for replanting	1.00
VP tea (young)	2.50
Mother bushes	2.75
Tea nursery	0.20
Under mana grass	1.50
Fruit trees	0.40
Coconut	0.81
Forestry	1.20
Marshy land	0.62
Buildings, gardens paths and roads	5.77
Total	23.25

Staff Movements

1) Mr. W M S Wijayatunga, Research Officer, was retired from the TRI service with effect from 31st December, 2022.
2) Ms. D G Gamage Technical Officer was transferred to TRI Mid Counrty Regional Center with effect from 12th December, 2022 from the head office.
3) Ms. H W M M M Jayaratne, Technical Officer was transferred to TRI Mid Counrty Regional Center with effect from 15th December, 2022 from the head office.

Advisory and Extension Programmes

Many training and awareness programmes on different themes were conducted for tea growers of corporate and smallholding sectors and higher education students in the year 2022. Among them, two Para Extension Training Programmes on harvesting were conducted for the field staff and the selected workers of Elkaduwa, Ratwatte, Hunugala and Pitakanda Estates with the participation of all the field staff of all tea growing Estates of Elkaduwa Plantations. A training programme on harvesting, pruning and replanting was conducted for the chairman and executives of all the estates of Janatha Estates Development Board in March 2022. Also, two programmes on cultural practices of tea were conducted for Asistant Managers of all the Estates in Pussellawa Plantations and three up country Estates of Agalawatte Plantations under Damro Group in the months of August and September of the year. A yield decline analysis has been continued and reported by visiting all six tea Estates of Elkaduwa Plantations and presented to the chairman and management of the company by the Advisory and Extension Staff.

The Advisory Officer involved in training and made presentations for seven programmes on Mechanization of Cultural Practices in Tea conducted at Rathnasiri Wickramanayake Training Centre of Tea Small Holdings Development Authority, Hantane. This series of programmes was organized by TSHDA for selected group of young entrepreneurs among tea smallholders and programs were conducted in first and last quarters of the year. In addition, the Advisory Officer made two presentations in two programmes on “Maintaining the Quality in Tea Production under the Present Situation of the Country” conducted by TSHDA and Sri Lanka Tea Board for factory owners and selected medium scale growers. Two meetings of Regional Technical and Extension Forum were conducted by the centre for Regional Manager and Extension Staff of TSHDA and office bearers of Tea Small Holding Development Societies in Kandy and Matale Districts. Four different topics were discussed and officers of research divisions also made presentations in those RTEF meetings. In the last quarter of the year, advisory officer participated and made presentations on maintenance of quality in black tea production in the series of programme called “Empathy for Leaf Quality” organized by SLTB and TSHDA.

The Short Message Service (SMS) Gateway of the TRI for educating the tea growers, was also continued by the staff. Technical content editing for Dialog *Govimithuru* Mobile Voice Message Service was also attended by the staff of the division. In addition, the TRI Technical Information and Advisory Service (TRI Call Centre) was successfully maintained by the staff answering the calls from the various type of clients. The advisory officer and extension officers involved in data collection of Farmer Centered Organic Fertilizer Trials initiated by the TSHDA and handed over the data to the head office for analysis. Also, they involved in collection of data on usage of T 1240 fertilizer usage by the small holders.

A demonstration plot of 0.7ac was continued in the centre for demonstrating the effect of burring of pruning under the project of GL 386. A chopping machine for production of compost was received to the centre under the same project.

All the above programmes were coordinated and conducted by the advisory and extension staff with the assistance of research staff whenever necessary, while attending to many routine services like advisory visits to Estates and small holdings of the region on cultivation issues and soil analytical work for pH. Thirty-six advisory visits had been conducted and furnished reports to RPC Estates, Government owned Estates and medium scale growers and smallholdings throughout the year amidst of various transport difficulties prevailed in the country in many months of the year.

Staff of the Advisory and Extension Division participated to *Aharata Ulelak* three day exhibition by setting up a stall which was held at Sahas Uyana Complex, Kandy in November 2023. The exhibition was organized by the Kandy Municipal Council and few Non-Governmental Organizations.

Agronomy Division

The experiment was continued for evaluation of different shade varieties under the project - A34, at Dotalawa Division at Elkaduwa Estate and necessary cultural practices were implemented in the trial plots. The experiment trial on different rehabilitation grass species (A 10.1) was continued at the center. The pH and carbon levels of the plots were measured. Also recording of metrology data at the centre under C/Met project was attended by the divisional staff.

Entomology/Nematology Division

The final assessment was carried out for 5000 series cultivars against *Radopholus similis* and results were handed over for analysis under the cultivar screening project-A45. Host range studies were also carried out for CO3, Lomendra, Packchong, Mana, Guatemala, and TRI 2025 cultivar for Mid-country nematode, *Radopholus similis.*

Twenty two soil and root samples of tea growers from Hewaheta and Wattegama Tea Inspector ranges were tested for nematodes in the year under the STaRR project. The samples which handed over by the Advisory and Extension division from 8 smallholdings were tested for nematodes. During the period under review cultivar screening beds were also prepared for testing of TRI 6000 series cultivars.

Soils and Plant Nutrition Division

Three new experiments were commenced to evaluate PGPR mixed inoculants at Kelebokke Estate, Madulkelle, Ratwatte Estate, Ukuwela and Hantane Estate, Kandy, under the Project

A 15.3, on development of methods for formulation of bio-organic and mineral or compound fertilizers suitable for tea. Plots were demarcated with 1000 bushes per treatment. Pre-treatment yield monitoring was conducted and the experiment is continued. Experiments are continued at Opalgala Estate, Panvilla and Craighead Estate, Dolosbage to measure pH buffering activity under the project A 15.4. The experimental officer participated in fertilizer review committee meetings and working group committee meetings on developing biofertilizer standards.

Plant Breeding Division

The normal functions of the division started after seven years with the new technical officer who transferred from the head office.

Infrastructure Development

The renovation work of the roof of the office building was completed. Laboratory renovation work was almost completed with some delays due to the situation prevailed in the country. Colour washing and necessary maintenance work of quarters, office buildings and repairs of vehicle fleet were also attended. Repair work of roads which damaged due to heavy rains was started. Under the G L395 project for new mother bush area expansion of TRI 5000 series cultivars, land preparation and levelling work in 0.7 ha field was completed. Part of the same area was planted with rehabilitation grass in the last monsoon.

Miscellaneous Activities

Mr. K.R.W.B. Kahandawa, Advisory Officer/ Officer in Charge continued to represent the TRI for the expert group of Farmer Field School Group Component of Rehabilitation of Degraded Agricultural Lands Project of Food and Agricultural organization and contributed as the second author for developing the draft for Farmer Fied School Guide for Tea Smallholdings.

Mr. K.R.W.B. Kahandawa Advisory Officer/ Officer in Charge participated and presented mechanization of cultural practices in tea in the *Sengawunu Kahawanu* Video Programme of the Department of Export Agriculture telecasted on 14.01.2022 on Rupavahini.

Crop

The Green leaf (kg) harvested during the year 2022 is given in the table below;

Table 2. Income from crop

Month	Crop harvested /sold (kg)	Rate (Rs) per kg	Income received (Rs)
Jan	1132	96.28	108,988.96
Feb	551	92.51	50,973.01
March	903	108.98	98,408.94
April	1865	158.05	294,763.25
May	1358	151.06	205,139.48
June	1017	137.06	139,390.02
July	607	136.32	82,746.24
August	457	170.00	77,690.00
September	1137	190.00	216,030.00
October	315	165.00	51,975.00
November	846	173.48	146,764.08
December	699	168.12	117,515.88
Total	10,887		1,590,384.86

Income

Table 3. Income of the year 2022

Income source	Value (Rs.)
Income received from sale of VP cuttings (300,900)	451,350.00
Income received from sale of VP Plants (12,798)	383,940.00
Income received from sale of Green Leaf (10,887 Kg)	1,590,384.86
Guest House accommodation charges	60,950.00
Income received from Soil pH and Fertilizer Testing Charges	71,925.00
Sale of TRI Publication	72,725.00
Miscellaneous	20,610.00
Total	2,651,884.86

Visitors to the Centre

Table 4. Visitors to the centre - 2022

Category	No. of visitors
Tea Growers	205
Students (higher education)	443
Foreign visitors	0
General visitors	21
Total	669

TRI ADVISORY AND EXTENSION CENTRE - PASSARA

A ABEYSOORIYA
BSc Agric (Peradeniya, Sri Lanka)
Officer-in-Charge

General

The Uva Advisory and Extension Center is the first regional center established by the TRI in 1931 to research the prevalence of Nettle Grub infestation in the region. At present, this center serves 62 Regional Plantation Company sector Estates, about 60 medium-scale Estates, and about 29,000 smallholders in the Uva region. The center is equipped with a small-scale laboratory for soil and carbon analysis and a field extent of 14.98 ha for field trials, mother bush area, and demonstration blocks. The land use pattern of the centre is given in Table 01

Table 1. Land utilization of the center - 2022

Land use pattern		Extent (ha)
Mature tea in plucking	-	3.80
Young tea and demonstration blocks	-	0.70
Mother Bushes	-	3.53
Seed garden	-	0.16
Buildings/Roads	-	1.24
FAO Project	-	0.30
Forest / Scrub / Rocky/Streams	-	5.23
Observatory and Nursery	-	0.02
Total Extent	-	14.98

Staff movements

Mr. M Ramasamy was appointed as a Guest House Keeper with effect from 26th April 2022.

Advisory and Extension Programs

In 2022, Uva Extension Center organized a large number of field investigations in plantations situated in the Uva region and made appropriate recommendations. The center continued its services to both corporate and smallholdings by conducting advisory and extension visits, training programs, and seminars. The important extension activities carried out in 2022 by the advisory staff of the center are mentioned below.

Two RTEF meetings were conducted during the year 2022.

- The first RTEF program was conducted at Uva Extension Center, Passara with the participation of TSHDA and TRI Officials on 4th March 2022. The topics discussed were “Impact of climate change on Tea Industry” and “Application of Micro Irrigation Techniques as a Control Measure for Mitigating Drought”.

- The second RTEF program was held at TRI Talawakelle with the participation of TSHDA, TRI officials, and office bearers of Tea Small Holder Development Societies of Uva and Nuwara Eliya regions on 13th December 2022. The subject areas covered were "Scientific Method of Application Chemical fertilizers" and "Economic Analysis of Fertilizer Application".

A series of training programs, awareness programs, and field days were conducted for the growers in the region as follows;

- A series of Plucking training programs were conducted for field staff and pluckers of the Madulsima and Balangoda Plantations with the support of the advisory staff of TRI, Talawakelle.
- Two awareness programs were conducted on Recommended tea cultivars for the Uva region and How to minimize post-harvest losses in tea, for the bought leaf collectors of the Uva Region in January and December 2022.
- Training program on Land Preparation, soil conservation, and rehabilitation was conducted for field staff of Warwick Estate in February 2022.
- Two virtual training programs on "Tea pruning" and "Infilling vacancies of Tea" were conducted for NIPM NVQ 6 students in March 2022.
- A series of Shear plucking training programs were conducted for plucking gangs of Agarapathana and Maskeliya Plantations Estates.
- Training program on "Safe use of Pesticide" was conducted for Craige Estate Spray Gang in May 2022
- Two "Soil Conservation and Soil Fertility Management" field programs were conducted for field staff and executives of Hapugasthenna Plantations PLC in August 2022
- One method demonstration on Vermicompost Preparation was conducted for field staff of Varellapatana Estate, Madulsima in October 2022.
- Two awareness programs were conducted for school children at Uva Extension Center.
- Tea Manufacturing and Post-harvest losses training program was conducted for the Factory staff of Aruna Tea Factory at Uva Extension Center in August 2022
- A Series of Plucking training programs were conducted for Smallholders of the Uva region under the "Sahakampana" program from September to December 2022 with the collaboration of Tea Small Holding Development Authority and Sri Lanka Tea Board officials of the region.
- Three awareness programs on "How to minimize post-harvest losses of Tea" were conducted for factory owners, estate managers and leaf collectors of the Uva region.

Table 2. Income of the Centre - 2022

Income source		Nos.
Advisory visits made to Estates and smallholdings in Uva	-	84
Advisory Letters issued	-	106
Seminars/ Field days/ Training programs	-	52
Regional seminars held in the area	-	02
Meetings seminars attended	-	42
Soil sample tested for pH	-	1,162
Soil sample tested for organic carbon content	-	699
VP cutting issued	-	661,400
VP plant sold	-	17,866
No. of a publication sold	-	114
Commercial nursery inspections	-	27

Research Programs/ Trials/Adaptive Trials

Following field trials were continued at the center with the supervision of relevant divisions of the head office

- Up keeping of Germplasm in field No. 03
- Up keeping of PPPB UVP 11 trail at field No. 02
- Up keeping of PPPB UVP 12 and UVP 13 trials at field No. 03
- Up keeping the root study trial in TRI 5000 series cultivars by the Physiology Division at field No. 03
- Up keeping of PPPB UVP 14 trial at field No. 02
- Up keeping the polyclonal seed garden at field No. 04
- Up keeping the rehabilitation grass trial by the Agronomy Division at field No. 05
- Initiated duplication of the core collection of germplasm in field No. 05
- Three seed gardens were established by the plant breeding division in Welimada, Haliela and Passara TSHDA sites. Nine farmer-centered organic trials were conducted in smallholder lands of the region with the collaboration of TSHDA.

Mother Bush project

Out of the targeted 400,000 number of cuttings, the Uva extension center was able to issue 661,400 cuttings from the Mother Bush site at the center.

Regional-specific issues/Miscellaneous activities

- Officer-in-Charge/EO and Extension Officer have collected leaf and soil samples for the analysis of farmer-centered organic trials in the region.
- Officer-in-Charge/EO and Extension Officer have collected leaf and soil samples for the analysis of T 1240 fertilizer mixture.
- Officer-in-Charge/EO and Extension Officer have inspected 27 commercial nurseries in the region.

- Officer-in-Charge also served as a member of the District Agricultural Committee chaired by the District Secretary and presented the activities carried out by the TRI for the Uva tea growers.
- Officer-in-Charge has participated in Planters Association (Uva) meetings.

Crop and Income

Table 3. Income from crop

Month	Green Leaf (kg)	Price	Amount (Rs.)
January	1637	86.64	141,829.68
February	1522	86.12	131,074.64
March	2602	104.43	271,726.86
April	3602	169.15	609,278.30
May	3755	157.65	591,975.75
June	2701	143.77	388,322.77
July	2754	167.92	462,451.68
August	2321	175.55	407,451.55
September	2002	185.07	370,510.14
October	1988	158.81	315,714.28
November	1484	155.68	231,029.12
December	1299	175.65	228,169.35
Total	27,667		4,149,534.12

Income

Table 4. Income of the centre - 2022

Source of Income	Value (Rs.)
Sale of the Green leaf (27,667 kg)	4,149,534.12
Sale of VP cuttings	992,100.00
Sale of VP plants	535,980.00
Soil analytical charges	624,125.00
Sale of publications	131,305.00
Guesthouse accommodation charges	91,750.00
Sale of firewood	37,660.00
Total income	6,562,454.12

Visitors to the centre

Details of visitors to the center are as follows

Table 5. Visitors to the centre

Category	No. of visitors
Foreign	5
RPC	110
Smallholders	420
Others	245
Students	40
TRI Officers	75
Total	895

TRI ADVISORY AND EXTENSION CENTRE - KOTTAWA

P D De ALWIS
BSc Agric (Sp) Hons (Ruhuna, Sri Lanka)
Officer-in-Charge

General

The TRI Galle Extension Centre was established at Kottawa in 1961, with a view to promote, enhance and facilitate regional research and extension activities. The centre is predominately an Advisory and Extension Centre equipped with a small scale laboratory for the analysis of soil pH. As per the survey plan No. GA/YKK/2012/65 and GA/YKK/2012/66, the center has 28.96 ha extent and the land use pattern is as follows (Table 1).

Table 1. Land utilization pattern of the centre - 2022

Land utilization	Extent (ha)
Mature tea in plucking	2.73
New Clearing	0.40
Mother Bushes (mature/ immature)	5.06
Tea Nursery	0.81
Under Rehabilitation (Mana)	1.00
Under Rehabilitation (CO-3)	1.00
CO- 3 (new rehabilitation grass spp.)	0.40
Tea Seed Garden	0.83
Coconut and other crops	1.52
Marshy Land	1.22
Forestry/uncultivated areas	5.08
Buildings, Gardens, Roads, Weather Station *etc.*	8.91
Total	28.96

Obtaining the deed on long term lease for the land is in progress.

In consultation with the Heads of Divisions at TRI head office, the extension centre carried out research and extension activities for the corporate and proprietary estates and small holdings in the region.

The important extension activities carried out in 2022 by the advisory staff of the centre are mentioned below:

- Regional Technical and Extension Forum (RTEF) was successfully held in March, for all the officials of TSHDA-Galle, on "Integrated Nutrient Management with New Fertilizer Recommendation of T-1240" (conducted by. Mr. W M S Wijethunge, Head, Soils and Plant Nutrition Division) and "Mitigation of the Climate Change with the Establishment of Sprinkler Irrigation" (conducted by Dr. N P S N Bandara, Principal Research Officer, Agronomy Division).

- Awareness programmes on Soil Fertility and New VP Tea Cultivars were conducted for the members of "Kottawa-West" and "Yatalamaththa" Tea Small Holding Societies.
- A TOT programme was conducted on land selection, planting, plucking, pruning and shade management for factory based extension officials of "Hingalgoda" and "Neluwa Medagama" tea factories, with the collaboration of TSHF (Tea Small Holder Factories PLC.) and CIC Agri-Businesses.
- A TOT programme was conducted on tea planting and premature flowering and fruiting, for the field staff of Devitura Estate.
- Training programme was conducted on all aspects of the cultivation of tea, for the members of "Hiniduma-West" and "Hingalgoda" Tea Small Holding Societies.
- Training programme was conducted on Pruning of Tea for TSHDA officials and workers at TSHDA Walahanduwa Centre.
- Seminar/awareness programme was conducted on green leaf quality on the "Sahakampana" programme for tea factory officials and green leaf collectors, organized by Sri Lanka Tea Board.
- Seminars/awareness programmes were conducted in the "Sahakampana" programme and the crop clinics were conducted along with the service of TRI Mobile Laboratory. The programmes were organized by Sri Lanka Tea Board-Galle and the relevant tea factories in the region.
- Training programme was conducted on double hedge-row planting for TSHDA and Tea Small Holding Society officials
- Training and awareness programme were conducted on land selection and planting of tea, soil fertility management, pest and disease management, nursery management, weed management, plucking and introduction of new VP tea cultivars, for TSHDA and Tea Small Holding Society members of "Unanwitiya" and "Walakumbura" Tea Small Holding Societies.

Advisory and Extension Activities

Table 2. Summary of Advisory and Extension Activities - 2022

Item	Number
Visitors to the centre (Estates/Small holders/Students/Foreigners/Others)	437
Advisory correspondence with Estate/Small holders	80
Advisory Visits (on call and routine) to Corporate sector and Small holding sector	47
Training programmes/ Seminars/Group discussions/Field Days/ Demonstrations	31
Educational/Familiarization and Meetings	32
Issue of Publications/Leaflets/Pamphlets (free issues were not included)	66
V.P. Cuttings sold	305,750
V.P. Plants sold	13,250
Soil Samples tested for pH	326
Visits/Involvements in Experiments/Adaptive Trials	02

Staff movements

Mr. P.S. Kulasiri, Field Supervisor retired from the service with the effect of 31st December 2022.

Research Trials

The following trials have been carried out by the respective research divisions in collaboration with the Galle Extension Centre.

(1) Plant Breeding Division:

TRI 5000 series observation/ multiplication plots in Field No. 02.

Four potential 5000 series accessions (12/11, 10/1, 107, 23/5) were planted in 2014. Shoots have been harvested from accessions 12/11 and 23/5 and the other plots have been used for plucking.

(2) Soils and Plant Nutrition Division

"Evaluation of Plant Growth Promoting Rhizobacteria based Microbial Inoculants for Tea Nurseries in Low Country". Data collection was completed and the experiment was terminated.

Mother Bush Project

A total of 305,750 cuttings of TRI 4000 series cultivars were issued from approximately 1.1 ha of mother bush area. Some plucking fields have been converted into mother bushes to cater for high demand of shoots as old mother bushes in the centre are in unproductive stage.

Moreover, 13,250 plants were sold to the tea growers and 4,270 plants were established for the infilling programme of the centre.

Visitors

The number of visitors received by the centre was 437 and its breakdown is as follows;

Table 3. Visitors to the centre - 2022

Category	Number
Corporate Sector, Private Estates and Small Holders	404
University/Diploma Students and Others	33
Total	437

Infrastructure Developments and Maintenance

- Reconstruction of the access road from the main entrance to the guest house was completed.
- Renovation of labour hut in field No. 06 was completed.
- Renovation of garage for the vehicle is in progress.

Field Development Activities

- Approximately 4,270 plants of TRI 4049 cultivar were established at field No.06 for the infilling programme.
- Construction of pump house and pipe laying for sprinkler irrigation system is in progress. Two hectare (02ha) of immature mother bush area is planned to be irrigated.
- Land preparation and planting of soil rehabilitation grass, CO-3 were completed in 01ha land at field No.02 and 04 under the special project, "Expansion of Mother Bushes" of Plant Breeding Division.
- Land preparation was completed at field No.03 for the establishment of another 02ha mother bushes under the special project, "Expansion of Mother Bushes" of Plant Breeding Division.

Special Events

- Service of the TRI Mobile Laboratory was inaugurated for the stake holders in the region, specially along with the "Sahakampana" programmes organized by the Tea Board and relevant tea factories. Meanwhile several Crop Clinics were also conducted during these programmes.
- The Director, Deputy Director Research (Production), Heads of the Agronomy, Nematology and Entomology, Plant Pathology and other relevant officials of the TRI, officials of STaRR project, visited tea lands of STaRR project beneficiaries at Panangala area.
- The Officer in Charge attended to a special DCC meeting on food security, chaired by Hon. Prime Minister. Hon. Minister of Plantation was also participated in the meeting.

Crop:

Monthly harvested crop, price offered by the factory, monthly income and income generated from other sources are given in table 4 and table 5 respectively.

Table 4. Crop and Income - 2022

Month	Green Leaf (kg)	Price (Rs.)	Amount (Rs.)
January	1866	123.00	229,518.00
February	972.5	130.00	126,425.00
March	1639	155.00	254,045.00
April	2150	245.00	526,750.00
May	2062.5	260.00	536,250.00
June	2009.5	260.00	522,470.00
July	2165	294.00	636,510.00
August	1914.5	291.00	557,119.50
September	1738.5	292.00	507,642.00
October	1322	264.00	349,008.00
November	2177.5	245.00	533,487.50
December	2102.5	257.00	540,342.50
Total	22119.5		5,319,567.50

Income

The income of the centre with its activities and the income breakdown shown in the Table 5.

Table 5. Income earned during the year 2022

Activity	Income (Rs.)
Sale of Green leaf	5,319,567.50
Sale of VP Cuttings	458,625.00
Sale of VP Plants	397,500.00
Soil Analytical Charges	11,597.90
Sale of Publications	15,665.00
Guest House accommodation charges	6,090.00
Miscellaneous income	9,540.00
Total income	6,218,585.40

Annual Weather

The annual precipitation was 3148.8 mm and it was significantly low when compared with the last year (3648.4 mm). But the monthly rainfall distribution was uneven. The mean minimum temperature was 23.1 ^{0}C and the mean maximum temperature was 30.9 ^{0}C. Mean Sunshine hours were 6.0 per day.

There were no clear changes in all meterology data compared with the averages of last ten years.

TRI ADVISORY AND EXTENSION CENTRE - DENIYAYA

C E MUNASINGHE
BSc Agric (Wayamba University) MPhill (University of Peradeniya)
Head

Introduction

The TRI Deniyaya Extension Centre, Deniyaya is primarily an Advisory and Extension center equipped with a small-scale laboratory for soil pH and Carbon analysis. The land use pattern of the Centre is given in Table 01.

Table 1. Land use pattern of the center - 2022

Land use pattern	Extent (ha)
Mature tea	0.32
Experimental trials	0.16
New clearing (TRI 3000/4000 series)	0.20
New clearing (TRI 5000 series mother bushes)	0.40
Buildings, Gardens, Roads, Nursery, *etc.*,	0.92
Total	2.00

TRI Deniyaya Center, in consultation with the Heads of Divisions at the Head office, conducted field investigations in the Low Grown plantations situated in Matara and Hambantota districts and rendered its services by conducting Advisory and Extension visits, training programs in the form of field days, workshops and seminars, *etc.,* for the stakeholders of both corporate and small holding sectors. Depending on the requirement, these programs were conducted in and outside the TRI premises. Extension programs were aimed at Tea Nursery Management, Soil and Shade Management, Plucking and Pruning (manual and machine) and Pest and Disease management of tea plantations. Tea productivity improvement through Good Agricultural Practices and management of bush debilitation problem in Deniyaya region were given the top priority.

Staff Movements

- Mr. R G Shiran was appointed as the Guest House keeper with effect from 26th April 2022.
- Mr. U W G Kumara was transfered to TRI Deniyaya with effect from 19th July 2022.
- Ms. W S T Wijesingha was temporary transferred to TRI Kottawa with effect from 8th August 2022.

Advisory and Extension programs - 2022

1. Advisory and Extension Activities

Amidst the COVID 19 pandemic and economic crisis situation, The Centre conducted following advisory / extension and stake holder interactive activities in the year 2022 (Table 02).

Table 2. Advisory and Extension Activities 2022

Item		Number
Visitors to the station (*from Estate/Students/Foreigners/ Smallholders/Others)*		891
All correspondence (Advisory, Extension and Administrative)		501
Advisory visits (on call and routine) to corporate sector and small holder sector and Extension visits		78
Training programs/ Seminars/ Group Discussions /Field days/ Demonstrations/ Educational/ Familiarizations and Meetings		26
Issue of Publications /Leaflets/Pamphlets	Free issue	130
	On cash	24
Soil Samples tested for pH		587
Soil Samples tested for C%		-
Soil Samples handed over for testing for Nematodes		49
VP Cuttings sold/issued for own nursery		12,854
Green Leaf sold (kg)		3,327
Commercial Nursery Inspections		-
Exhibitions / Mobile Services		10
Visits/Involvements in experiments (Adaptive/Research Trials and Mother Bush sites)		39
VP Plants sold/issued		12,615

2. Technology Dissemination/ Stakeholder Service/ Public Relation Activities

- TRI Deniyaya Centre conducted awareness / field day programs on managing tea bush debilitation for the TSHD Society members of Deniyaya and Kolawenigama tea inspector regions of Matara district where the bush debilitation problem is prominent at the moment.
- TRI Deniyaya Centre in collaboration with SPND, TRI and TSHDA, Matara concluded seven Farmer Centered Bio Fertilizer Trials (trial designing, sampling, treatment application and monitoring) of Matara district.
- The Head delivered a lecture on “TRI recommended strategic management practices for enhancing productivity and reducing COP in tea nurseries and plantations” for the General Managers, Managers and Factory Officers of tea factory owned cooperative societies of Matara district on 18th May 2022.
- TRI Deniyaya Centre conducted a Tailor-Made Training Program on “Replanting of Tea” for the superintendents, assistant superintendents and field staff of Namunukula Plantations Limited in Matara on 23rd June 2022.

- TRI Deniyaya Centre conducted a field survey on smallholder response on newly introduced T 1240 interim fertilizer mixture in Matara district, as per the guidelines given by the Head / Advisory and Extension division.
- The Head and EO actively participated in SAHAKAMPANA programs organized by the Sri Lanka Tea Bord, Matara intended for improving leaf quality in Matara district during October to December 2022.
- TRI Deniyaya Centre organized six crop clinics with mobile laboratory service during November and December in collaboration with Sri Lanka Tea Bord, Tea Small Holdings Development Authority and some of the tea factories in Matara district.
- TRI Deniyaya Centre organized a public – private partnership (PPP) program for the representatives of tea fertilizer suppling companies in Galle and Matara districts for uplifting their knowledge and awareness on latest TRI recommendations on 15th December 2022.

Research Programmes

1. **Research trials**

Following trials are being carried out in the region in collaboration with the respective Research Divisions.

- Entomology and Nematology Division
  Two trials on screening of TRI 5000 series cultivars for Nematodes and Shot Hole Borer are in progress at the TRI Deniyaya Centre premises in collaboration with the Entomology and Nematology division.

- Plant Breeding Division
  i) TRI 5000 Series: four LVP phase iii trials were being monitored at TRI Deniyaya Centre premises and Indola, Kiruwanaganga and Deniyaya Estates.
  ii) Two improved seed gardens were being monitored at Kiruwanaganga Estate
  iii) One seedling evaluation trial was being monitored at a small holder land in Warapitiya region.

2. **Adaptive / Observation Trials**
   - Two adaptive trials on TRI 5000 series cultivars were established and being monitored in smallholder lands in Morawaka and Akuressa of Matara District in collaboration with the Plant Breeding Division and TSHDA.
   - One Adaptive trial on use of wood ash for tea at Kiruwanaganga Estate was conducted in collaboration with SPND.
   - Two model tea lands demonstrating the TRI recommendations on management of tea bush debilitation problem were established in Pallegama and Beverley areas of Deniyaya region are being monitored successfully.

3. **TRI 5000 Series Mother Bush Project**
   - 3682 plants of Accession No. 84 and 23/5 of TRI 5000 series were being maintained successfully at TRI Deniyaya premises in collaboration with Mother Bush Coordinator and Plant Breeding Division, TRI.
   - 3815 plants of TRI 5000 series raised at TRI Deniyaya nursery were delivered to establish TRI 5000 series mother bush sites in Alapaladeniya and Rakwana (owned by Tea Smallholdings Development Authority) and few selected smallholders of Matara district for establishing demonstration sites under TRI supervision.

4. **Improved Seedling Project**
   - Three Isolated seed gardens were established at Kiruwanaganga, Lankaberiya and Wilpita Estates and were being monitored in collaboration with Plant Breeding division.

Constructions/ Cultivations /Infrastructure Developments and Maintenance

- Wall painting of the circuit bungalow at TRI Deniyaya was initiated under the supervision of Engineering division, TRI.
- Repairing of sprinkler irrigation system in nursery and tea fields are in progress.
- Uprooting of old tea bushes in the Field No 01 block in front of the office was initiated for replanting

Special issues encountered in the region

Bush debilitation incidences were reported in few tea smallholder lands in Deniyaya, Kolawenigama and Beralapanathara tea inspector regions of Matara. Officers of TRI Deniyaya inspected all the reported tea lands and identified the major causes behind the bush debilitation problem such as pest attacks, aging of tea bushes and poor adoption of Good Agricultural Practices. Followed by the field inspections, relevant smallholders were made aware on this and necessary advices were provided in order to manage the situation. Simultaneously, awareness programs on bush debilitation were conducted in these regions with the assistance of Tea Smallholdings Development Authority.

Crop and Income

Total income of the center with its activities and the income breakdown is given in Table 03.

Table 3. Annual Income of TRI Deniyaya Center - 2022

No	Item	Quantity	Income (Rs.)
1	Sales of Green Leaf	3327 kg	828,367.11
2	Sales of Publications	24	13,580.00
3	Sales of cuttings	5,575	8,362.50
4	Sales of plants	8,565	256,950.00
5	Soil Analysis	587	48,045.00
6	Visitors / Guests	79	38,450.00
7	Miscellaneous	-	1,582.00
	Total Income		1,195,336.61

Visitors to the station

Table 4. Visitors to the center – 2022

Category	No. of visitors
Planters from RPC sector	10
Proprietary sector	38
Smallholders	276
Officers from other institutes	138
University / Diploma Students	05
School Children	264
Others	160
Total	891

Weather data 2022

The annual rainfall of year 2022 was recorded as 4026.8 mm which is approximately a 9% decline when compared to that of the previous year (4452.2 mm). The highest rainfall was observed in May (671.7 mm) and the lowest was recorded in June (141.4 mm). The number of annual wet days was 170, which is nearly a 7% decline when compared to that of previous year (182 days). Accordingly, rainfall and its distribution throughout the year 2022 was favorable for tea in Deniyaya region, as similar to the previous year. The average temperature of year 2022 was recorded around 26 ^{0}C in the region.

Miscellaneous Activities

Special Presentations

The Head and EO participated in two (02) regional mobile services held in Deniyaya and Ketanvila regions organized by the Southern Governor's office on 19th / 20th March and 11th December 2022. Exhibition stalls were set up and the participants (particularly tea smallholders) were educated on tea cultivation.

TRI ADVISORY AND EXTENSION CENTRE
MATUGAMA

H JAYAWEERA
MBA (Malaysia) CMI (UK) CIPM (SL)
Officer-in-Charge

General

The TRI Kalutara Advisory and Extension Centre, Niwithigalakelle, Matugama is located in the 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 carried out a large number of field investigations in the low grown plantations situated in Kalutara, Gampaha, and Colombo Districts. 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 Regional Plantation Companies, Proprietary Estates and for Tea Smallholding Sector of the region. Tea productivity improvement through Good Agriculture Practices (GAPs) with special attention for Soil Rehabilitation and Conservation, Shade Management, Pest and Disease Management, Mechanization and Weed Management, and proper harvesting of tea were the themes that received high priority.

Advisory and Extension Programs

Regional Technical and Extension Forum (RTEF)

Two Regional Technical and Extension Forums (RTEF) were successfully held at the Kalutara Advisory and Extension Centre for the Smallholder sector with the participation of TRI, TSHDA, SLTB officials, Progressive farmers and the members of Tea Development Societies. Two Lectures in first RTEF seminar was conducted via online. The subjects areas discussed were,

- Practical application of Irrigation systems in smallholder’s tea lands in Low Country
- Cultivar Related to value added tea in Sri Lanka
- Soil Fertility Management in Low country Region
- Application of social media to improve awareness of tea leaf yield and quality through conversational communication
- Increase green leaf yield, minimize post-harvest losses and improve quality of yield by proper harvesting practices
- The effect of chemical composition of tea in to the quality of made tea

Regional Scientific Committee Meeting (RSC)

Kalutara, Ratnapura and Kegalle Regional Scientific Committee Meeting (RSC) were successfully held on July 12, 2022 as an online seminar under theme of "Integrated soil fertility management for higher productivity and mechanization of field practices to lower the cost of production". Presented topics were "Integrated Soil Fertility Management practices and its Economic Benefits" and "Mechanization of Tea Field operations and its Economic Benefits".General Managers, Deputy General Managers, Managers and Assistant Managers of tea Plantations of Ratnapura, Kegalle and Kalutara Districts participated in the seminar.

Training Programs /Field days

- The staff of the Extension Centre successfully conducted Field Day for all the Field Staff and Executives of Low Country Estates in Kotagala Plantations PLC with the help of TRI Ratnapura Officials. Mechanization of the field activities (Harvesting, Pruning, Holing), Planting and Re-supplying, Soil Conservation methods (SALT Tecnique/Contour Terraces, Drains), Burying of pruning and Forking of Tea fields were discussed.
- Officer-in-Charge and Extension Officer actively participated in more than 20 "Sahakampana" training programs with Tea Board and Tea Small Holding Authority. These programs were organized for the Tea Factory owners, Managers, Line Managers and Green Tea leaf dealers/bought leaf suppliers as well as for tea smallholders to improve the quality standard of made tea under B Leaf 60 project.
- The staff of the Extension Centre successfully conducted Plucking training programs for the corporate sector Estates, proprietary Estates as well as for tea smallholders to improve the quality standard of made tea.
- The staff of the Extension Centre successfully conducted plucking and mechanization training programs for the proprietary Estates,
- Officer-in-Charge and Extension Officer actively participated in the Commercial Nursery Inspection Survey for nurseries which registered and get subsidies from Sri Lanka Tea Board as requested by SLTB.
- The Officer-in-Charge actively participated in the awareness programs conducted by TSHDA, SLTB and District Secretariat Office.

Advisory and Extension Activities

Table 1. Advisory and Extension activities of the year 2022

Item	Number
Advisory visits made to Corporate sector, Proprietary Estates and Smallholding sector	63
Advisory correspondences	71
Training programs/Seminars/ Field days/ Group Discussions/ Crop clinics/ Demonstrations	16
Issue of publications/ leaflets/ pamphlets	11
Soil samples tested for pH	58
Commercial Nursery Inspections	05

5000 series mother bush project visits	14
Visits/Involvements in Experiments (Adaptive Trial)	37
Meetings Attended	37
Other visits	06

Adaptive Trials

Three Adaptive trials on TRI 5000 series were established in smallholdings in Pelawatta, Horana and Meegahatanna in Kalutara District in collaboration with the Plant Breeding Division and the TSHDA and the progress was periodically monitored by the TRI staff.

Field Experiments

I. Net out turn survey was successfully conducted in Three Tea Inspector ranges (Matugama, Ingiriya and Elpitiya) and survey data collected from five tea factories. The survey was carried out in collaboration with the Technology division of TRI Ratnapura and Talawakele.

II. A trial was commenced on mechanical harvesting in Soyza Estate, in collaboration with Agronomy Division.

III. Investigation on nematode attack of tea land in 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 Plant Breeding Division of Ratnapura to educate the stake holders and general public

Mother Bush Project

- Distribution of new tea cultivars among tea growers is one of the most important services offered by the Regional Center to the tea industry. Therefore with the help of the mother bush coordinator and Plant Breeding Division, Officer In-charge has established and monitored TRI 5000 series mother bush area and nursery at Vogan Estate.
- With the purpose of providing high-quality planting materials to regional stakeholders, two thousand nine hundred (2900) tea plants of accession No 12/11and 23/5 of TRI 5000 series and TRI 4049 were established in 0.58 acres land at RRI, Niwithigalakale premises and are being monitored with the help of Mother Bush project coordinator and the Plant Breeding Division.

Seed garden Project

- Two seed gardens were established and are being monitored in selected two lands in Vogan Estate and Rayigam Estate of Kalutara District in collaboration with the Plant Breeding Division.

Special Events/ Meetings

- The Officer-in-Charge actively participated in District Agriculture Committee and District Development Committee meetings held at the District Secretariat Office.

Infrastructure Developments and Maintenance

- The routine maintenance and repairing of the office building, cleaning, and maintenance of layout, and repairs and services of the office vehicle were successfully completed
- The Information Centre was developed and improved by Installing six Crystal Panel Display Boards.

Miscellaneous Activities

- The Officer-in-Charge actively participated at the meeting at Ministry of Plantation.
- Extension Officer attended a work shop on Implementing Geographical Indication (GI) System for Ceylon Tea at Hotel Uma garden on November 22, 2022 organized by the Sri Lanka Tea Board and Institute of Policy Studies of Sri Lanka.
- Familiarization programs were conducted for foreign visitor (Australia) and local visitors.
- Survey on T1240 Fertilizer mixture was successfully conducted in two Tea Inspector ranges (Meegahathenna and Horana) in Kalutara District and survey data were collected from eight tea smallholders in collaboration with the Advisory and Extension Division TRI, Talawakele and Soils and Plant Nutrition Division TRI, Ratnapura.

Income

Total income of the centre with its activities and the income component breakdown is as follows;

Table 2. Income of the year 2022

Activity	Income (Rs.)
Sale of Publication	12,440.00
Soil Analysis for pH	8,090.00
Suppliers registration fees	5,500.00
Sale of Tea Green leaf	2,710.00
Total	28,740.00

Visitors to the centre

Total of 75 personnel visited the Kalutara Advisory and Extension Centre and its breakdown was as follows;

Table 3. visitors to the centre 2022

Category	No. of Visitors
Corporate Sector Estates	09
Small holders	44
University Student	05
Agriculture School Student	06
TRI Officers	11
Total	75

Annual Weather

The average annual rainfall for the year 2022 was 304.96 mm and the highest rainfall was observed in October (923.3 mm) and the minimum was recorded in January (65.9 mm)

AWARDS, GRANTS, STUDY PROGRAMMES, PUBLICATIONS AND SPECIAL PRESENTATIONS

ADVISORY AND EXTENSION DIVISION

Study Programmes

C J Liyanaarachchi, Advisory Officer resumed duties on 5th January 2022 after three-year fulltime study leave and completed his PhD programme on "Integrating Dialogic Communication in Socail Media for Technology Dissemination among Corporate Sector Tea Plantations in Sri Lanka" with effect from January 2022.

K G J P Mahindapala, Senior Advisory Officer resumed duties on 26th June 2022 after three-year fulltime study leave and completed thesis writing on his PhD programme on "Analysis of Key Factors Contributing to the Efficacy of Tea Smallholding Development Societies" and submitted to supervisors at PGIA.

T G N Mahinda, Senior Advisory Officer continued his PhD programme on "Adoption of Mechanization Technologies in Corporate Sector Tea Plantations in Sri Lanka" at University of Sabaragamuwa.

A L R U Kumara, Advisory Officer proceed for his PhD programme on 8th May 2022 on "Community Development Agribusiness Based Extension Model for the Sustainability of Medium Scale Tea Estates in Sri Lanka" at University of Putra, Malaysia.

V S Sidhakaran, K.R.W.B. Kahandawa, Amila Jayarathne, R Muralithasan, Wathsala Gunapala attended and successfully completed the Technology Stewardship training programme conducted by the Department of Agriculture Extension, University of Peradeniya.

S P Rathnayake, Senior Advisory Officer resumed duties after three-year fulltime study leave on 25th July 2022. The Post Graduate (PhD) was not completed and resigned from the post with effect from 10th October 2022.

AGRICULTURAL ECONOMICS DIVISION

Study Programmes

Ms. H M C G Pilapitiya, Research Officer successfully completed her PhD program at Saga University, Japan and resumed duties on 29th March 2022.

Publications

Shyamalie H W, Nadeeshani K W N, Rathnayake A R M T and Wimalarathne W T R P. 2022. Investigation on worker shortage in smallholding sector in Sri Lanka. *Submitted to publish in Sri Lanka Journal of Tea Science.*

Nadeeshani K W N, Shyamalie H W and Gunathilake J. 2022. Tea Based Smallholder Farming Systems in Ratnapura District of Sri Lanka. Submitted 16th Annual Research Forum of Sri Lanka Agricultural Economics Association.

Sidhakaran V S, Wijeratne M A, Shyamalie H W, Pradeep G S, Lakmali K G, Muralithasan R. 2022. National tea production decline since 2013: Evidence based analysis. Proceedings of 240th E and E (Corporate sector) held on 16th December 2022

Chamila Pilapitiya and Saliya De Silva. 2022. Processing *Camellia Sinensis* into Innovative Teas in Japan: Lessons for Sri Lankan Tea Industry. *Submitted to publish in TRI UPDATE.*

Special presentations

H W Shyamalie made a presentation on තේ නිෂ්පාදන පිරිවැය සහ ලාභදායිතාවය on 4th January 2022 at the Ministry of Plantation

H W Shyamalie made a presentation on කුඩා තේ ඉඩමක ආදායම සහ වියදම පිළිබඳ විශ්ලේෂණයක් at the Ratnapura RTF held on 28th March 2022 at the virtual platform.

H W Shyamalie made a presentation on Economic Benefits of Soil Fertility Management Practices in Tea Lands at the RSC Ratnapura held virtual platform on 15th July 2022.

K W N Nadeeshani made a progress presentation on Typology of tea-based farming systems and modeling land use and land cover dynamic changes in Ratnapura district Low Country region, Sri Lanka to the Board of Study in Earth Sciences of the Postgraduate Institute of Science on 26th July 2022.

A presentation was made by HMCG Pilapitiya on "New Products into New Markets - Avenues to Promote Tea Innovations in Sri Lanka" 19th August 2022 at the auditorium, Sri Lanka Tea Board.

H W Shyamalie presented a paper on ඒකාබද්ධ ශාක පෝෂක කළමනාකරණ ක්‍රමවේද භාවිතයේ ආර්ථික වැදගත්කම at E and E (Smallholdings) Forum held on 9th September 2022 at the Auditorium of TRI Low country Research and Extension center.

H W Shyamalie made a presentation on Facts to be Considered in Valuation of Tea Plantations for valuation department on 29th October 2022.

H W Shyamalie presented new research areas of Agricultural Economics Division on 2nd November 2022 at the TRI Board room.

H W Shyamalie made a presentation on පොහොර භාවිතය සහ යාන්ත්‍රික දළු නෙලීම පිළිබඳ ආර්ථික විශ්ලේෂණයක් at Nuwara Eliya RTEF Forum held on 13th December 2022**.**

Miscellaneous activities

Committee members

Dr H W Shyamalie served as a Member of Review committee in Agriculture modernization project.

Dr H W Shyamalie served as a member of Board of Study Agriculture Economics and Business Management, Postgraduate Institute of Agriculture. University of Peradeniya.

Dr H W Shyamalie served as a contact person of TRI for National Research, Development and Innovation Survey -2020 conducted by the National Science Foundation.

Dr H W Shyamalie served as a contact person of TRI for National Research, Development and Innovation Survey -2020 conducted by the NASTEC.

Dr H W Shyamalie served as a chairman of the two Technical Evaluation Committees (Renovation of Hantane laboratories and Agricultural Economics Division).

Dr H W Shyamalie served as a member of Research allowance Sub- committee at Council for Agricultural Research Policy, Colombo.

Dr H W Shyamalie serves as a committee member of National Committee on Forestry Sector for the period from March 2021 to February 2024.

Reports

A report on ශ්‍රී ලංකාවේ තේ කර්මාන්ත ක්ෂේත්‍රයේ තිරසර සංවර්ධනයක් ඇති කිරීම උදෙසා, එහි පාර්ශවකරුවන්ට පවතින ගැටළු හා යෝජිත විසඳුම් සාකච්ඡා කිරීම. submitting to the Ministry of Plantation.

A proposal for Development of TRI Galle Extension Center

A proposal for Alternative Income Generating Activities in St. Coombs Estate, Talawakelle

A report on Use of Glyphosate on plantation crops in Sri Lanka

A report on Impact of Social Security Levy (SSL) on RPCs and Tea Factories

Reports on compensation calculation (Court Lodge Estate, Ekkeralle Estate, Park Estate, Ketaboola Estate, Daulagala smallholder property,

A report on Observations on the request of sublease tea lands for Gliricidia cultivation

A report including tea related data for the Preparation of Central Province Regional Physical Plan - 2035

A proposal on Energy Efficiency Improvements in Tea Processing Sector

A project proposal on "Preliminary study on Innovative Tea Producers in Sri Lanka" under the Ministry special projects.

A report on Fertilizer subsidy for tea growers in Sri Lanka.

A report on postponed and abandoned projects during 2015-2021

Meetings/Forums attended

H W Shyamalie participated to the meeting organized by National Physical Planning Department regarding the preparation of Central Province Regional Plan on 8th February 2022

H W Shyamalie participated to the Kandy RTEF held on 1st April 2022 at the Auditorium of Mid-country Research and Extension center.

H W Shyamalie and H.M.C.G. Pilapitiya attended to A Presentation on "New Products into New Markets -Avenues to Promote Tea Innovations in Sri Lanka: Insights from Japan" 19th August 2022 at the auditorium, Sri Lanka Tea Board.

H W Shyamalie and H.M.C.G. Pilapitiya attended to the workshop on econometrics modeling held on 29th October on a virtual mode.

H W Shyamalie participated to the 191st HOD meeting will be held on 02nd November 2022 commencing at 02.00 p.m. at TRI Board Room at Talawakelle.

H M C G Pilapitiya Regional Workshop on Ceylon Tea CI Registration held on 30th November at Okray Hotel, Kandy.

H W Shyamalie attended to the meeting on "ශ්‍රී ලංකාවේ තේ කර්මාන්ත ක්ෂේත්‍රයේ තිරසර සංවර්ධනයක් ඇති කිරීම උදෙසා, එහි පාර්ශවකරුවන්ට පවතින ගැටළු හා යෝජිත විසඳුම් සාකච්ඡා කිරීම" held on 12th December 2022 at Ministry of Plantation.

H W Shyamalie and H.M.C.G. Pilapitiya attended to the E and E forum held on 16th December 2022 at the Auditorium of Tea Research Institute.

H W Shyamalie attended to the RTEF held on 20th December 2022 at Rathnasiri Wickramanayake training center at Hantane.

H W Shyamalie attended to the Consultative committee on Estate held on 21st December 2022 at the Board room of Tea Research Institute.

H W Shyamalie participated to the meeting on National Energy Potential and Strategy organized by Prime Minister's office held on 25th December 2022 (virtual mode).
H W Shyamalie attended to the meeting held on 28th December with Software development team from Sri Lanka Telecom (Services) Ltd.
H W Shyamalie attended to the meeting held on 30th December 2022 at the Board room of Tea Research Institute to discuss Estate matters.

H W Shyamalie participated to the zoom meetings on Net out turn, hybrid meeting on Independent Committee to Review the existing fertilizer recommendations and make appropriate recommendations of fertilizer use in tea' organized by Sri Lanka Tea Board on development activities of tea industry

Student supervision

Ms. W M A M Weerasinha, an undergraduate student of Department of Agricultural Economics and Business Management, Faculty of Agriculture, University of Peradeniya, conducted her final year research project under the supervision of Dr.H.W. Shyamalie**.**

Ms. T W P J Gnanasiri an undergraduate student of Department of Mathematical Sciences, Faculty of Applied Sciences, South Eastern University of Sri Lanka undertook her Industrial training under the supervision of Dr. H.W. Shyamalie.

AGRONOMY DIVISION

Study Programmes

Ms L A S P Jayasinghe completed her postgraduate study programme leading to PhD at the University of Philippines, Los Banos (UPLB) and resumed duties on 4th May 2022.

Publications

Pathiranage S R W, Wijeratne M A and De Costa W A J M. 2022. Impact of Shoot Cutting and Collecting Mechanisms of Different Motorized Tea Harvesters on Tea Yield and Yield Determining Physiological Parameters. *In;* Proceedings of the 34th PGIA Annual Congress on 18th November 2022 (published online)

Reports

Report on Evaluation of Irrigation System – Badugoda Watta, Iththepana, Matugama by Dr N P S N Bandara
Report on Irrigation Feasibility on Dayagama East Estate by Dr N P S N Bandara
Report on Direct Planted Tea Fields – Panangala, Thawalaama by Dr N P S N Bandara
Report on Screening of Avenger AG Optima Burndown Herbicide by Dr N P S N Bandara
Report on Screening of Glufosinate Ammonium Herbicide by Dr N P S N Bandara

Special Presentations and training programmes

Dr M A Wijeratne addressed at RSC seminar for Ratnapura, Kegalle and Kalutara Districts (July 12) and Regional Technical Extension Forums-Uva (March 4) and Ratnapura (Match 29 and December 13).

Dr M A Wijeratne participated in the Mini-Crop Clinic conducted at TRI, Advisory and Extension Center, Galle (8th -9th November).

Dr M A Wijeratne addressed plantation executives of: JEDB (21st March), Balangoda Plantations (26th April), Maskeliya Plantation (26th July) and Horana Plantations (28th September) and smallholders of Orange Field Factory, Nawalapitiya (14th December).

Dr M A Wijeratne addressed smallholders/leaf suppliers at the Sri Lanka Tea Board's special programme on "*Sahakampanaya*" on 16th November 2022

Dr N P S N Bandara made presentations on tea irrigation and use of Soil Quality Index for smallholders and Regional Technical Extension Forums (2022-03-04 at Passara, 2022-03-08 at Deniyaya, 2022-03-30 in Galle, 2022-03-31 in Kandy, 2022-05-19 at Matugama. In addition, he made presentations for 2021/22 North East Monsoon and 2022 1st Inter Monsoon Climate – 26th Monsoon Forums and 2022 South West Monsoon – 27th Monsoon Forum

Dr N P S N Bandara also addressed officials of the STaRR Project in Galle and Matara Districts on Soil Quality Index.

Dr. S R W Pathiranage served as a resource person for three RSC forums, three RTEFs and one seminar organized by the NIPM on harvesting, pruning and use of machines in tea fields. Dr. S R W Pathiranage took part in two training programs on shear harvesting for the Estate sector, one training program on use of motorized harvesting machines and conducted three practical sessions for university students on harvesting and pruning of tea.

Dr (Ms) L A S P Jayasinghe made presentations on "Soil conservation in mid elevation tea lands affected by water induce erosion in Sri Lanka" to the Consultative Committee on Research and for the Tea Research Board. She also made similar presentation titled "Soil conservation in tea lands affected by water induce erosion " at the EandE Forum (16th December)

Mr M G S Liyanage made two presentations on "Weed Management in tea" at TRI, Talawakelle for students pursuing Higher Diploma in Plantation Crop Technology, (1st February and 22nd March).

Miscellaneous activities

Dr M A Wijeratne, served as the Convener/Secretary of the Consultative Committee on Research (CCR) and participated in the meeting of Consultative Committee on Advisory and Estates of the TRI.

Dr M A Wijeratne served as the Head of the Low country Regional Center Ratnapura in addition to his duties of the Head of Agronomy Division, TRI.

Dr M A Wijeratne appointed as a member of the Board of Crop Science, PGIA and served as a member of the Faculty Board of Agriculture, University of Ruhuna.

Dr M A Wijeratne involved in the development activities of STaRR Project.

Dr M A Wijeratne continued to share his expertise for revising the National Land Use Policy of Sri Lanka and development of tea policy for Sri Lanka (ADB funded project).

Dr M A Wijeratne participated as the country representative of the working group on climate change at the FAO/IGG session held virtually (23rd February).

Dr M A Wijeratne and Dr S R W Pathiranage engaged in a three-year special project (2021-2023) on development and introduction of a motorized selective tea harvester suitable for tea lands in Sri Lanka.

Dr M A Wijeratne served as a member of the judging panel for Young Graduate Forum- of Faculty of Agriculture, University of Ruhuna (December, 5) and attended the District Co-ordination Committee, Ratnapura representing the TRI

Dr. S R W Pathiranage served as an internal reviewer for reviewing scientific manuscript of the PGIA Annual Congress.

Presentations

Irrigation Techniques for Tea : Designing & Maintenance – Tea Small Holding Authority, Kandy, 18.02.2022

Irrigation Techniques for Tea : Designing & Maintenance – Uva Regional Extension & Experiment Forum, Passara, 04.03.2022

Irrigation Techniques for Tea : Designing & Maintenance – Deniyaya Regional Extension & Experiment Forum, Deniyaya, 08.03.2022

Irrigation Techniques for Tea : Designing & Maintenance – Galle Regional Extension & Experiment Forum, Galle, 30.03.2022

Soil Quality Index, Regional Experiment & Extension Forum, Kandy, 31.03.2022

2021/22 North East Monsoon and 2022 1st Inter Monsoon Climate – 26th Monsoon Forum

Irrigation Techniques for Tea : Designing & Maintenance - Kalutara Regional Extension & Experiment Forum, Matugama, 19.05.2022

2022 South West Monsoon – 27th Monsoon Forum

BIOCHEMISTRY DIVISION

Publications

Piyasena K G N P, Hettiarachchi L S K, Jayawardhane S, Edirisinghe E N U, and Jayasinghe W S. 2022. Evaluation of inherent fructose, glucose and sucrose concentrations in tea leaves (*Camellia sinensis* L.) and in black tea. Applied Food Research, 2(1), 100100. https://doi.org/10.1016/j.afres.2022.100100

Jayawardhane S, Edirisinghe E N U, Fernando M S C, and Tharangika H B. 2021. Development and Validation of a HPLC based analytical method, towards the determination of sugar concentration in processed black tea.Technium BioChemMed, 2(1), 1-9.

Jayawardhane P S, Edirisinghe E N U, Fernando M S C, Ghouse S A, Abayarathne A A B, Jayasinghe W S, and Piyasena K G N P. 2021. Determination of Inherent Fructose, Glucose and Sucrose concentrations in Black Tea from Low Country Region in Sri Lanka. *Sri Lanka Journal of Tea Science*, *86(1),* 12-17.

Yasaswin S T N, Piyasena K G N, Hettiarachchi L S K, de S Wanniarachchi D D C. 2022. Study on the variation of volatile flavor compounds of black tea during the fermentation process *Proceedings of the Sri Lanka Association for the Advancement of Science*, *78*, 80.

Vithusha M, Ranatunga M A B, Samarasinghe K G B A, Meegahakumbura M K and Piyasena K G N P. 2022. Development of low caffeine genotypes by backcross breeding of tea (*Camellia sinensis* (L) O. Kuntze). *Proceedings of International Research Conference of Uva Wellassa University (IRCUWU)*, 24.

ENTOMOLOGY AND NEMATOLOGY DIVISION

Publications

Gamlath R D S M, Senanayake P D, Sinniah G D and Rajapakse R G S C. 2022. *In vitro* Bio Efficacy of *Beauveria* sp. against Tea Shot-hole Borer (*Euwallacea fornicatus* Eichh.). Proceedings of the 42nd Annual Sessions of Institute of Biology, Sri Lanka, 30th September 2022, Marino Beach Hotel, Colombo, 26p.

Presentations/Awareness programmes

Dr P G D S Amarasena conducted an awareness program and demonstration on integrated nematode management and prevention of nematode infestation in tea nurseries for superintendents, assistant superintendents and field officers at Court Lodge Estate, Kandapola (31st August).

Dr P G D S Amarasena conducted an awareness program and demonstration on Integrated nematode management and sampling methods for nematode estimation for STaRR project officers at TRI Low Country Regional Centre, Ratnapura (25th February).

Dr (Mrs.) P D Senanayaka conducted a demonstraion on IPM of tea pests for the students of University of Peradeniya at TRI, Talawakelle (8th June).

The students of University of Sabaragamuwa and Ruhuna visited the Entomology laboratory, TRI Low Country Regional Centre, Ratnapura (June 2022).

Mrs B S Vitana conducted a demonstration on IPM of tea pests at TRI Low country Regional Centre, Ratnapura for the students of University of Sabaragamuwa (September 2022).

Mrs A M P Sammani conducted a demonstration on IPM of tea pests at TRI, Talawakelle for the students of Faculty of Agriculture, University of Jaffna (9th November).

A student of Eastern University was trained at Entomology Division, TRI, Talawakelle (February-May 2022).

An exposure visit to TRI was made by Trainee Assistant Manager of Wanarajah Estate to TRI, Talawakelle (16th November).

Mrs B S Vitana conducted demonstration on IPM of tea pests for the students of NIPM at TRI Low Country Regional Centre, Ratnapura (November 2022).

Mrs B S Vitana conducted a demonstration on IPM of tea pests to the students of Open University of Sri Lanka at TRI, Ratnapura (November 2022)

Dr (Mrs.) P D Senanayaka conducted a demonstration on IPM of tea pests to the students of Wayamba University at TRI, Talawakelle (15th December).

Mrs A M P Sammani conducted a demonstration on IPM of tea pests for the students of NIPM at TRI, Talawakelle (December 2022).

Mrs B S Vitana participated to the crop clinic which was held in Gurubevulagama, Wewalwatta (December 2022).

PLANT BREEDING DIVISION

Study programs/Training programmes/Workshops

J D Kottawa-Arachchi was awarded PhD degree from Chaudhary Sarwan Kumar Himachal Pradesh Agricultural University, Palampur, Himachal Pradesh, India with effect from 24th June 2022.

K K Ranaweera successfully defended his postgraduate research leading to PhD on 19th September 2022 and submitted the final thesis to PGIA, University of Peradeniya

K K Ranaweera has been continued 10 months training programme at the Plant Breeding and Genetics Laboratory, Seibersdorf, International Atomic Energy Authority, Vienna since April 2022.

H W M M Jayarathna completed a three months training programme at the Plant Breeding and Genetics Laboratory, Seibersdorf, International Atomic Energy Authority, Vienna from August to October 2022

Publications

Kottawa-Arachchi J D, Ranatunga M A B, Amarakoon A M T, Gunasekare M T K, Sharma R K, Chaudhary H K, Sood V K, Katoch R, Banyal D K, Piyasena K G N P, Edirisinghe E N U and Attanayake R N. 2022. Variation of catechin and caffeine content in exotic collection of tea [*Camellia sinensis* (L.) O.Kuntze] in Sri Lanka and potential implication in breeding cultivars with enhanced quality and medicinal properties. *Food Chemistry Advance* doi.org/10.1016/j.focha.2022.100108

Kottawa-Arachchi J D, Ranatunga M A B and Abeysiriwardena D S Z. 2022. Utilization of within location non-replicated multi-locational yield trials and GGE biplot methods for testing adaptability of Tea [(*Camellia sinensis* (L.) O.Kuntze)] over diverse environments. *Indian Journal of Genetics and Plant Breeding*

Kottawa-Arachchi, J.D., Ranatunga, M.A.B., Amarakoon, A.M.T., Gunasekare, M.T.K., Sharma, R.K., Chaudhary, H.K., Sood, V.K., Katoch, R., Banyal, D.K., Edirisinghe, E.N.U. and Attanayake, R.N. (2022). Genotypic and seasonal variations of catechin and caffeine content in exotic tea [(*Camellia sinensis* (L.) O.Kuntze)] germplasm in Sri Lanka. *Himachal Journal of Agricultural Research* 48(1): 8-16

Ranaweera K K, Ranatunga M A B, Eeswara J P, Tilakarathne S. and Kadono H. 2022. Regeneration of tea [*Camellia sinensis* (L.) Kuntze] cv. TRI 5001 plants through somatic embryogenesis in a liquid dynamic medium. *Tropical Agricultural Research* 33(4): 364-375

Amali R K A, Abeyweera N H A S, Gunaratne O G K A, Gunaratne G P and Kottawa-Arachchi J D. 2022. Performance evaluation of newly developed tea (*Camellia sinensis* L.) cultivars in response to different levels of nitrogen fertilizer. *International Journal of Agricultural Research* 17 (4): 201-209

Piyasundara J H N, Ranatunga M A B and Mudalige A K. 2022. Assessment of seed characteristics of progenies in tea (*Camellia sinensis* L.) seed gardens: Towards facilitating effective utilization of tea seeds and the productivity enhancement of the gardens. Proceedings of the 4th International Conference of Agricultural Sciences (AgInsight 2022) Sabaragamuwa University of Sri Lanka. 87-91pp

Bandara W M D M, Piyasena K G N P. Jayatilake D V, Liyanage N M N and Ranatunga M A B. 2022. Feasibility Assessment of Using CafLess-TCS1 Marker to Identify Low caffeine Tea Hybrids. Proceedings of the Faculty of Agriculture Undergraduate Research Symposium, 28th December 2022 –pp124

Presentations
M A B Ranatunga made a presentation at Sri Lanka Forum on Poverty Alleviation through Agricultural Innovation organized by Yunana Province, China

J H N Piyasundara, made a presentation at the 4th International Conference of Agricultural Sciences (AgInsight 2022) Sabaragamuwa University of Sri Lanka.

Demonstrations and Crop Clinics
J H N Piyasundara made a presentation and demonstration on Tea Breeding for a group of students from University of Sabaragamuwa

Divisional staff demonstrated New Planting materials at the lunching ceremony of the Mobile Laboratory at TRI, Ratnapura

Divisional staff demonstrated New Planting materials at 02 Crop Clinics in Galle District

Services
J H N Piyasundara continued to serve as the coordinator of TRI Update

PLANT PATHOLOGY DIVISION

Postgraduate study
M Niranjan, Research Officer, is continuing his postgraduate study program leading to PhD at Graduate School of Environmental and Life Sciences, Okayama University, Japan since October 2021 (Awarded MEXT scholarship).

Publications
Niranjan M, Sinniah G D, Priyadarshani C D N, Samarakoon S M S M and Karunajeewa D G N P. 2022. Botryosphaeriaceae fungi causing canker and die-back on Grevillea *robusta* in tea plantations of Sri Lanka. Australasian Plant Pathology. https://doi.org/10.1007/s13313-022-00875-8

Gamlath R D S M, Sinniah G D, Rajapakse R G S C, and Senanayake R D P D. 2022. Isolation, identification and development of *Trichoderma* as a biocontrol agent against tea root pathogens. *In* Proc: Plant Health 2022, The Second National Symposium of Sri Lanka Association for Mycology and Plant Pathology (SLAMPP), 25th June 2022, PGIS University of Peradeniya, Sri Lanka. pp: 27.

Gamlath R D S M, Senanayake R D P D, Sinniah G D and Rajapakse R G S C. 2022. *In vitro* Bio Efficacy of Beauveria sp. Against Tea Shot-hole Borer (*Euwallacea fornicatus* Eichh.). Proceedings of the 42nd Annual Sessions of Institute of Biology, Sri Lanka 30th September 2022, Marino Beach Hotel, Colombo.

Jayawickrama J.A.S.S., Salgadoe A.S.A., Sinniah G.D. and Ranasinghe W.M.A.M. (2022) Development of Smartphone-based Method for Quantifying Blister Blight Severity (*Exobasidium vexans* Massee) in Tea Leaves. Proceedings of 20th Agricultural Research Symposium, Wayamba University Sri Lanka. pp. 420-424

Seminars/Presentations/lectures

Dr G D Sinniah conducted a lecture on blister blight management under current situation for executives of Balangoda Plantation (26th April 2022)

Dr G D Sinniah conducted two lectures on blister blight management under current situation for executives of Mdulsima Plantations (26th -27th May 2022)

Dr G D Sinniah conducted lectures for NIPM students on tea disease management on 3rd February 2022)

Short courses/trainings

Dr G D Sinniah attended a virtual conference on Regional biosafety organized by Ministry of Environment (10th -11th March).

PLANT PHYSIOLOGY DIVISION

Publications

Damayanthi M M N, Wijeratne T L, Damunupola J W. 2022. Exogenous Salicylic Acid Induced Drought Stress Tolerance in Immature Tea (*Camellia sinensis* L.) Plants. Journal of Tropical Agricultural Research (In printing).

Vithanage N M, Gunasekera H K L K and Wijeratne T L. 2022. Effect of Foliar Application of Glycine Betaine on immature Tea (*Camellia sinensis* L.) plants during drought. Asian Journal of Plant and Soil Sciences (In printing).

Damayanthi M M N, Wijeratne T L, Damunupola J W. 2022. Effect of exogenous application of salicylic acid on alleviation of drought stress of immature tea (*Camellia sinensis* L.) plants. Israel Journal of Plant Sciences (In printing).

Damayanthi M M N, Wijeratne T L. and Damunupola J W. 2022. Alleviation of Drought Stress on Immature Tea (*Camellia sinensis*) Plants by Exogenous Application of Abscisic Acid (ABA). *In* proceedings of the International Conference on Applied and Pure Sciences (ICAPS) 2022. Faculty of Science, University of Kelaniya, Sri Lanka, p7.

Damayanthi M M N, Wijeratne T L and Damunupola J W. 2022. Exogenous Salicylic Acid Induced Drought Stress Tolerance in Immature Tea (*Camellia sinensis* L.) Plants. *In* Proceedings of the 34th Annual Congress of the Post graduate Institute of Agriculture. 18th November 2022, Peradeniya, Sri Lanka, p10.

Special presentations

Dr T L Wijeratne delivered a presentation for the stakeholder group at Melsta corp on the "Importance of Shade Managementin Tea" at the Skill Development training Program at TRI, Talawakelle for Balangoda and Mdulsima Plantations Executives on 26th and 27th May 2022.

Study Programmes

Ms M M N Damayanthi completed her postgraduate research component of her PhD degree at the Postgraduate Institute of Science, University of Peradeniya, Sri Lanka 31st July 2022.

SOILS AND PLANT NUTRITION DIVISION

Study Programmes

L R M C Liyanage completed his doctoral program and awarded the PhD degree for his thesis titled "Mineralization of organic materials and bio availability of nutrients to partially replace inorganic fertilization for tea" at the University Putra Malaysia, Malaysia (10th November).

Mr S Raguraj (RO) and Miss R K A Amali (RO) resumed duties in the SPND on 30th December 2022 after completing their postgraduate studies at the University Putra in Malaysia, Malaysia.

Publications

Liyanage L R M C, Hanafi M M, Sulaiman M F, Ismail R, Gunaratne G P, Dharmakeerthi R S, Rupasinghe M G N and Mayakaduwa A P. 2022. Consequences of nitrogen mineralization dynamics for soil health restoration of degraded tea-growing soil using organic amendments *Chilean Journal of Agricultural Research, 82 (2)* http://dx.doi.org/10.4067/S0718-5839202200020 0199

Raguraj S, Kasim S, Md Jaafar N, and Nazli M H. 2022). Growth of Tea Nursery Plants as Influenced by Different Rates of Protein Hydrolysate Derived from Chicken Feathers. *Agronomy*, *12 (2)* https://doi.org/10.3390/agronomy12020299

Raguraj S, Kasim N M, Jaafar, Nazli M H and Amali R K A. 2022. A comparative study of tea waste derived humic-like substances with lignite-derived humic substances on chemical composition, spectroscopic properties, and biological activity. *Environmental Science and Pollution Research*. https://doi.org/10.1007/s11356-022-20060-0.

Amali R K A, Abeyweera N H A S, Gunaratne O G K A, Gunaratne G P, Kottawa- Arachchi J D. 2022. Performance evaluation of newly developed tea (*Camellia sinensis* L.) cultivars in response to different levels of nitrogen fertilizer, *International Journal of Agricultural Research.* 17 201–209. https://doi.org/10.3923/IJAR.2022.201.209.

Amali R K A, Lim H N, Ibrahim I, Zainal Z, Ahmad S A A. 2022. A copper-based metal-organic framework decorated with electrodeposited Fe_2O_3 nanoparticles for electrochemical nitrite sensing, *Microchimica Acta.* 189 1–10. https://doi.org/10.1007/S00604-022-05450-Y.

Amali R K A, Lim H N, Ibrahim I, Zainal Z, Ahmad S A A. 2022. Silver nanoparticles-loaded copper (II)-terephthalate framework nanocomposite as a screen-printed carbon electrode modifier for amperometric nitrate detection, *Journal of Electroanalytical Chemistry*. 918 116440. https://doi.org/10.1016/j.jelechem.2022.116440.

Special Presentation

L R M C Liyanage made a presentation on Carbon Mineralization Dynamics of Organic Materials and Their Usage in the Restoration of Degraded Tropical Tea-Growing Soil at the 240th E and E forum held at TRI, Talawakelle (16th December).

L R M C Liyanage conducted a training program on Drawing soil and leaf samples and use of Site-specific fertilizers for Managers and Assistant managers, Hatton Plantation held at TRI, Talawakelle (21st September).

L R M C. Liyanage conducted a seminar on “Soil Organic Matter Improvement in Tea Lands and Composting with Special Reference to use of Refuse Tea” for Executives of Balangoda Plantations held at the TRI, Talawakelle (28th April).

L R M C Liyanage conducted a seminar on “Soil Organic Matter Improvement in Tea Lands and Composting with Special Reference to use of Refuse Tea” for Executives of Madulsima Plantations held at the TRI, Talawakelle (27th May).

L R M C Liyanage conducted a seminar for officials of the TSHDA and Tea smallholders at the Regional Technical and Extension Forum of Nuwaraeliya and Badulla at the TRI, Talawakelle (13th December).

W M S Wijayathunga conducted a seminar for officials of the TSHDA and Tea smallholders at Regional Technical and Extension Forum, Deniyaya at the TRI, Talawakelle (13th December).

L R M C Liyanage conducted a seminar on Soil organic matter improvement in tea lands and composting with special reference to use of refuse tea for executives of Balangoda Plantations held at the Tea Research Institute, Ratnapura (26th April).

W T B D Priyantha, J R Y Abeywardana, O G K A Gunatratne and M G K Madushani attended the Crop clinic with the mobile laboratories coupled with Sahakampana programs at Galle, Matara and Ratnapura Districts in November- December 2022.

S K Weerathunga conducted training on Fertilizer recommendation for Tea Cultivation and Soil Testing for Assistant Manager, Wanarajah Estate (16^{th} November).

S K Weerathunga conducted training on Demonstration on recommended fertilizers for tea cultivation for students from University of Jaffna (27^{th} October).

W M S Wijayatunga conducted a training program on Soil Fertility Management and Soil Sampling held at Mid-country Research, Advisory and Extension Center for managers and asst. managers of Pussallawa Plantation (31^{st} August and 2^{nd} September).

L R M C Liyanage and W.M.S. Wijayathunga attended the Regional Sceintific Committee Forum for Ratnapura, Kegalle and Kaluthara districts (12^{th} July).

W M S Wijayathunga conducted a seminar on Soil Fertility Management at Regional Technical and Extension Forum- Kaluthara helt at TRI Mathugama Regional Advisory and Extension center (19^{th} May).

W M S Wijayathunga conducted a seminar on New Fertilizer Recommendation (T1240) and soil fertility management at Regional Technical and Extension Forum- Galle held at TRI Kottawa Advisory and Extension center (30^{th} March 2022).

W M S Wijayathunga conducted a seminar on New Fertilizer Recommendation (T1240) and soil fertility management at Regional Technical and Extension Forum- Ratnapura held at TRI Low country Research Advisory and Extension center (29^{th} March).

W M S Wijayathunga conducted a seminar on Nutrient Management in Tea Under Present Day status at Regional Technical and Extension Forum- Kandy held at TRI Mid-country Research, Advisory and Extension center (1^{st} April).

O G K A Gunaratne attended Regional Technical and Extension Forum- Ratnapura held at TRI Low country Research Advisory and Extension center (13^{th} December).

ST. COOMBS ESTATE - TALAWAKELLE

Mr. M K D PRIYANTHA
Superintendent

Clerical Staff	Mr K A M Chathuranga	Administrative Officer
	Mrs M G D Dilrukshi	Senior Assistant Clerk
	Mr G P Roopasinghe	Junior Clerk
	Miss N W H A Haruni Pamalka	Junior Clerk
	Mr R Krishan Kumar	Store Keeper cum Clerk
Field Staff	Mr N Illangeswaran	Field Officer
	Mr S Suresh	Field Officer
	Mr S L Rodrigo	Field Officer
	Mr S D Perera	Assistant Field Officer
	Mr P Bakthakumar	Junior Assistant Field Officer
	Mr R Sathiyaraj	Junior Assistant Field Officer
Factory Staff	Mr K W T U S de Silva	Head Factory Officer
	Mr S M Sunil Shantha	Senior Assistant Factory Officer
	Mr P Mohotti	Assistant Factory Officer
	Mr M SarathKumar	Junior Assistant Factory Officer
	Mr G N L Kumara	Junior Assistant Factory Officer
Transport	Mr S Christpoher	Driver
	Mr R Udayakumar	Driver
	Mr D Sundareson	Driver
Medical	Mrs P I Christy	EMP
	Mr D Punniyamoorthy	Welfare Officer
	Mrs G N Sylvester	Child Development Officer
	Mrs K Jothy	Child Development Officer
	Mrs T Ponmany	Child Development Officer

General

- Messes Forbes and 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 (New Peacock Estate – Pussellawa) Visited the Estate on 28.07.2022

Hectare Statement as at 31st December 2022

Table 1. Hactare statement as at 31st December 2022

	St. Coombs	Lamiliere	Total
Seedling	1.10	1.00	2.10
V.P.	84.21	46.25	130.46
Total Estate Hectare in Tea	85.31	47.25	132.56
A.D.B. Project	11.39	2.6	13.99
New Clearing Block	0.25		0.25
T.R.I. Experiment Area	4.64		4.64
T.R.I. Experiment Area (Agronomy)	0.25		0.25
Nurseries	1.20		1.20
Total Bearing in Tea	103.04	49.85	152.89
Housing project	2.09		2.09
Buildings/Roads	34.28	14.72	49.00
Ravines and Wastelands	32.37	1.35	33.72
Total Hectare	171.78	65.92	237.70

Cultural Operations

The Following fields were pruned during the season in year 2022.

Table 2. Pruned fields - 2022

Division	Field No	Ha
Upper	4B, 5	11.40
Lower	7,13A,13G	7.67
Lamiliere	8B, 11, 13	11.15

All field works were done as per the estimate following TRI guidelines.
Fertilizer application was based on TRI recommendation.

ADB Mother Bush Project

258, 303 Nos of VP Shoots from TRI 3000 and 4000 series cultivars were issued to the Tea Small Holders and to the corporate sector.

Crop and Yield

Table 3. Crop and yield (2022 and 2021)

Crop and Yield	2022		2021	
	Crop	Yield	Crop	Yield
St. Coombs	147, 152	1751	165,180	1940
Lamiliere	67,334	1429	74,815	1581
Total	214, 486	1636	239,995	1811
Bought Leaf	55, 886		24,153	
Grand Total	270, 372		264,148	

A Yield of 1,636 kg/ha was recorded in the year 2022.

Factory and Manufacture

Gross sale average for 2022 was Rs 1133.18 which is Rs.14.57 above the Western High Grown Elevation average.

Weather Conditions

Rainfall of 3,627 mm was recorded on 150 wet days in year 2022.

Working Results

The Estate Profit of Rs. 64,882,098.92(Approx) for the season.

Factory

Mr.S.M.S.Shantha ,Senior Factory Officer retired from the service w.e.f 16th June 2022 but continued service up to June 2023 –On Contract Basic

Medical

Mrs.P.I.Christy appoint as a Estate Medical Practitioner w.e.f 2nd May 2022

ST. JOACHIM ESTATE - RATNAPURA

M K D PRIYANTHA
Acting Superintendent

Executive	Mr. D C C Jayasekera	Superintendent (Retired from Service w.e.f. 22.08.2022)
	Mr. M.K.D. Priyantha	Act. Superintendent (Assumed duties w.e.f. 22.08.2022)
Office	Mrs. N Koralage	Administrative Officer
	Mrs. K M G Lankika Dias	Senior Assistant Clerk
	Miss. W K Prasanika	Junior Assistant Clerk
	Miss. S Sudharshini	Junior Assistant Clerk (Resigned from Service on 17/05/2022)
Factory	Mr.A G D Hemantha Kumara	Head Factory Officer
	Mr. D A J Pushpakumara	Assistant Factory Officer
	Mr. P P Wickremaratna	Assistant Factory Officer
	Mr.W N Perera	Junior Assistant Factory Officer
	Mr. R Vitharana	Junior Assistant Factory Officer
Field	Mr. J Senadeera	Asst. Field Officer
	Mr. V Ariyaraj	Jnr. Asst Field Officer
Stores	Mr. M W Jayasekera	Storekeeper/Clerk
Transport	Mr. J Kumara	Lorry Driver
	Mr. A M A H Dharshana	Lorry Driver
	Mr. D V D Jagath	Lorry Driver
	Mr. C Perera	Lorry Driver
	Mr. H E G Dilan Isuru	Lorry Driver

General

M/s. Forbes and Walker Tea Brokers (Pvt) Ltd., continued to be the Brokers of St. Joachim teas.

Land Utilization

Table 1. Land use as at 31st December 2022

Land use pattern	Area
Total tea in bearing	47.54
TRI 5000 Series (Mother Bush Area)	2.20
Tea in Capital	5.02
TRI Coconut area	3.89
V.P. Nursery	1.58
Immature Rubber	4.56
Mature Rubber (Intercrop area)	3.68
Paddy fields	8.74
ADB Fields N.C. Tea	12.41
Field No 6, Gem Land	2.00
Tea Board Field No.6 (Co 3 Grass -TRI)	1.00
Tea Board Field No. 5 (Co 3 Grass -TRI)	1.00
Housing Project (Field No. 5)	1.00
TRI Buildings and Experimental Area Field No.9	12.02
Buildings Roads Jungle and Patna	35.34
Total	141.98

As per a Bush Count undertaken in October 2015, the effective hectarage is given in Table

Table 2. Actual extent as per the bush count as at October, 2015

Description	Extent (ha)
V.P. Tea in Bearing	12.47 ha
ADB Land released for Plucking	6.43 ha
TRI Fields	7.06 ha
Total effective hectarage	25.96 ha

Crop

The tea production of St. Joachim Estate in 2022, compared to the previous year is given in Table 3.

A) TEA (made tea kg)

Table 3. Tea Crop - 2022

Year	Estate Crop (kg)	Bought Leaf Crop (kg)
2022	15,730	274,981
2021	18,765	224,457
Variance	-3035	50,524

The Estate crop, -3035 kgs has decreased compared to the last year.
The Bought Leaf quantity has increased by 50,524 kgs as against last year.

Field Wise Yield Details – 2022

Table 4. Field wise yield details - 2022

Field No.	Extent (ha)	Effective (ha)	Total Made Tea (units)	Y.P.H (Based on Actual ha)	Y.P.H (Based on Effective Extent)
1	2.68	1.10	1095	409	995
Factory Block		0.08	0	0	0
1A	0.8	0.15	116	145	773
1B	0.8	0.50	590	739	1182
2A	0.93	0.58	734	789	1266
2F	4	0.87	817	204	939
3	3	0.86	856	285	995
3A	1	1	812	812	812
3B	0.5	0.5	883	1766	1766
3C	1	1	935	935	935
4	4.85	1.38	1073	221	778
5	0.6	0.12	267	445	2225
6C	2	0.23			
8A	3	0.1	9	3	90
8C	1	1	873	873	873
8E	0.5	0.5	908	1816	1816
8F	3	2.5	1486	495	594
ADB					
1	3.46	0	0	0	0
3	1.2	0.4		0	0
4	1.62	1.62	430	265	265
5	0.94	0.94	538	572	572
8	4	2.87	1185	296	413
10	0.6	0.6	226	375	375
TRI Fields					
2	3.52	3.52	383	109	192
3A	1.34	1.34			
1A	1.2	1.2	1264	1053	1053
04	1	1	250	250	250
Total	48.54	25.96	15730	324	630

B) RUBBER

Table 5. Rubber Crop - 2021

Year	Estate Crop (kg)	Yield
2022	2030	246
2021	2510	304

Cultural Operations
The normal GAPs were undertaken in the Estate.

Nursery plants
A total of 48210 nursery plants were sold to small holders and issued to TRI 5000 Series Mother Bush Project during the year.

Table 6. Nursery plants - 2022

Description	Number of plants
Plants issued form GL 340 Nursery to the TRI Agronomy and Plant Breading Divisions	1375
Plants issued to small holders from Estate nursery	19875
Plants issued to small holders from contract nursery	26960
Total number of plants	48210

Mother Bushes issue Details:
A total of 5300 shoots were issued to smallholders and Estate Nursery.
Estate Nursery - 2600 Nos.
Small Holders - 2700 Nos

Tea manufacture
NSA of Rs. 1493.22 was achieved in the year 2022 and it was Rs. 609.99 in 2021.

Total production (Made Tea)
Quantity of leaf manufactured at St. Joachim Tea Factory showed an increase of 47,489 Kg in 2022 as against the previous year.

Weather and Rainfall
Rainfall of 4,364.7 mm was recorded for 181 wet days, as against 4,553.70 mm and 184 wet days in 2021.

Trading Results
St. Joachim Estate and Factory Trading results as at 31st December 2022 are as follows (Table 7 - As per draft Accounts)

Table 7. Trading results - 2022

Description	2022 (Rs.) Actual	2021 (Rs.) Actual
Total Profit and Loss	47,996,169/=	(11,775,558/=)

Staff Movements

Mr. D.C.C. Jayasekera Superintendent of St. Joachim Estate retired from service with effect from 22/08/2022 and Mr. M.K.D. Priyantha, Superintendent, St. Coombs Estate is over-looking the property with effect from 22/08/2022

Mrs. S. Sudharshi, Junior Asst. Clerk resigned from St. Joachim Estate with effect from 17/05/2022.

ADMINISTRATION AND FINANCE

Special highlights

1. Human Resource Development and Capacity Building

a) Staff strengthening and motivation

Staff Recruitments

Name	Designation	Date
Ms G D N N Dayarathna	Technical Officer (R & D)	14.02.2022
Ms D R Gamage	Technical Officer (R & D)	14.02.2022
Ms W M I Sathsarani	Technical Officer (R & D)	14.02.2022
Ms L R U L Senavirathna	Technical Officer (R & D)	14.02.2022
Ms D N Kahawewithana	Technical Officer (R & D)	14.02.2022
Ms P G N D Gallage	Technical Officer (R & D)	14.02.2022
Ms S M J U Bandara	Technical Officer (R & D)	14.02.2022
Mr U G D P Ranathunga	Technical Officer (R & D)	14.02.2022
Ms M G K Madushani	Technical Officer (R & D)	14.02.2022
Ms R P V T Chandralal	Technical Officer (R & D)	14.02.2022
Mr K A C L Kodithuwakku	Technical Officer (R & D)	14.02.2022
Ms P A M Jayawardana	Technical Officer (R & D)	14.02.2022
Ms M T S Sewwandi Perera	Technical Officer (R & D)	14.02.2022
Mr R B L Hemakumara	Technical Officer (R & D)	14.02.2022
Ms K L S C Gunawardana	Technical Officer (R & D)	14.02.2022
Ms U K R Kumari	Technical Officer (R & D)	14.02.2022
Mr J Jeyandran	Technical Officer (R & D)	14.02.2022
Ms M K D Damayanthi	Technical Officer (R & D)	14.02.2022
Ms W M M S H Paranayapa	Technical Officer (R & D)	14.02.2022
Ms B L D S M Fernando	Technical Officer (R & D)	14.02.2022
Ms J M K Udayangani	Technical Officer (R & D)	14.02.2022
Ms G K W H Dharmadasa	Technical Officer (R & D)	14.02.2022
Ms B M T T K Seanarathne	Technical Officer (R & D)	14.02.2022
Ms B V Sanali	Technical Officer (R & D)	14.02.2022
Mr P A D S Sumathipala	Technical Officer (R & D)	21.02.2022
Ms R M N S Bandara	Technical Officer (R & D)	21.02.2022
Ms E P D N M Wijewardhana	Technical Officer (R & D)	21.02.2022
Ms S P R Wijewardhana	Technical Officer (R & D)	28.02.2022
Ms T G O N Gunawardhane	Technical Officer (R & D)	28.02.2022
Mrs S R Wickramasinghe	Senior Accountant	02.03.2022
Mr R G Shiran	Guest House Keeper	26.04.2022
Mr P Parthiban	Hostel Care Taker	26.04.2022
Mr J Naasaran	Hostel Care Taker	26.04.2022
Mr. M Ramasamy	Guest House Keeper	26.04.2022

Resignations

Name	Designation	Date
Mr H I G S Piyaruwan	Advisory Officer	21.01.2022
Mr P G N D Gallage	Technical Officer (R & D)	30.04.2022
Mr S P Ratnayake	Senior Advisory Officer	10.10.2022
Ms A R M A M Rathnayake	Advisory Officer	16.12.2022

Retirements

Name	Designation	Date
Dr L S K Hettiarachchi	Director	31.12.2022
Mr W M S Wijayathunga	Research Officer	31.12.2022
Mr W T B D Priyantha	Experimental Officer	31.12.2022
Mr P K Jayawickrama	Experimental Officer	31.12.2022
Mr N S Ekanayake	Technical Officer (AV)	31.12.2022
Mr S Muthukumar	General Worker	31.12.2022
Mr S Balakrishan	General Worker	31.12.2022
Mr P S Kulasiri	Field Supervisor	31.12.2022
Mr S Thangaraj	General Worker	31.12.2022
Mr P Weeramuttu	General Worker	31.12.2022
Mr P G Chandrakeerthi	General Worker	31.12.2022
Mr N Pushparaj	General Worker	31.12.2022
MrW M S J Weerasinghe	General Worker	31.12.2022
Mr G Selvaraj	General Worker	31.12.2022
Ms S Hettiarachchi	General Worker	31.12.2022
Mr K Jayarathnam	General Worker	31.12.2022

Promotion

Name	Designation	Date
Dr S R W Pathiranage	Senior Research Officer	01.02.2022
Dr (Ms) P G D S Amarasena	Senior Research Officer	01.02.2022
Dr (Mrs) T L Wijerathne	Principal Research Officer	12.12.2022
Dr (Mrs) KG Nelum P Piyasena	Principal Research Officer	12.12.2022
Dr J D Kottawaarachchi	Senior Research Officer	12.12.2022
Mr M Niranjan	Senior Research Officer	12.12.2022
Dr (Ms) H M C G Pilapitiya	Senior Research Officer	12.12.2022
Dr C J Liyanarachchi	Senior Advisory Officer	12.12.2022
Ms M A H Nishanthi	Senior Advisory Officer	12.12.2022

VOP

Name	Designation	Date

Demise

Name	Designation	Date
Mr A K J Athukorala	General Worker	16.11.2022

Transfers

Name of Officer	Designation	Place of Transfer	Date
Mr A H P Dayaratne	Engineering Assistant (Electrical)	Talawakelle	10.03.2022
Mr J M G W Jayaweera	Electrician	Ratnapura	10.03.2022
Ms TOGN Gunawardhene	Technical Officer (R&D)	Ratnapura	14.03.2022
Mr R B L Hemakumara	Technical Officer (R&D)	Ratnapura	14.03.2022
Mr K A C L Kodituwakku	Technical Officer (R&D)	Ratnapura	23.05.2022
Ms K V Kahawevitana	Technical Officer (R&D)	SPND	17.05.2022
Ms W S T Wijesinghe	Management Assistant (Station)	Kottawa	08.08.2022
Ms D R Gamage	Technical Officer (R&D)	Hantane	12.12.2022
Ms M K D Damayanthi	Technical Officer (R&D)	Ratnapura	12.12.2022
Ms N C Weerakoon	Technical Officer (R&D)	Walahanduwa	12.12.2022
Ms K A M Premamali	Extension Officer	Ratnapura	12.12.2022
Ms P Weththasinghe	Extension Officer	Kottawa	12.12.2022
Ms H W M M M Jayaratne	Technical Officer (R&D)	Hantane	15.12.2022
Ms W M I Sathsarani	Technical Officer (R&D)	Ratnapura	19.12.2022

Local Training/ Seminars/ Workshops

Mr P P H Wijesena Management Assistant (Clerical), Procurement Unit, Mr. K A D Sudath Management Assistant (Accounting), Finance Division participated at 24th training on “Procurement Procedure” conducted by National Institute of Plantation Management (March 2022).

Mrs. K P K A Sewwandi Senior Administrative Officer, Administration Division, Mr. R M N Nayanajith Procurement Officer, Procurement Unit participated at training on “How to build a paperless office environment conducted by National Institute of Plantation Management (3rd November).

Overseas Training/ Seminars/Conferences

Study period of the following officers were extended:
Mr. S Raguraj, Research Officer, Soils and Plant Nutrition Division, TRI from 15th Sep 2022 to 31st Dec 2022 at the University Putra, Malaysia

Ms. K A A Rathnasekera, Research Officer, Soils and Plant Nutrition Division, TRI from 15th Sep 2022 to 31st Dec 2022 at the University Putra, Malaysia

2. Infrastructure Developments and Maintenance

Infrastructure Development under the Special Project

Roof renovation works – St. Joachim Tea Factory, Ratnapura – Completed
Replacing timber floor - St. Joachim Tea Factory, Ratnapura – Completed
Balance works of replacing Gutters and Down pipe "A" type Bungalows - Completed
Sprinkler irrigations system Kottawa - work in progress

Infrastructure Development under the Capital Budget

Roof renovation works - office building Hanthana - Completed
Construction retaining wall near workers quarters at Kottawa - Completed
Bath room renovation works- Agriculture Economics unite - Completed
Balance works of renovation Bathrooms at Camilia Hostel - Completed
Laboratory up gradation - Hanthana - Work in progress
Bath room renovation works - Advisory and Extension Centre - Work in progress

Maintenance works

The following colour washing works have been completed under the annual colour washing program.
All repair works of these buildings were also carried out during internal colour washing works. (including carpentry, masonry, plumbing and roof repairs *etc.*)
"A" Type Bungalows- 03, 13
"B" Type Bungalows - 09, 07
"C" Type Bungalows - 05, 19, 21, 39, 23,11,06,09,35,44
"D" Type Quarters- 40,09,08,07

Additional painting works:

Prepared 15 Nos. of Hostel rooms in Camelia Hostel with cleaning, polishing and other maintenance works for new recruits
Internal and external painting works at Security points in the TRI premises
Repairing works at internal roads
Concreting works at Camelia hostel road
Floor painting work at Senior Accountant's office room
Internal cleaning and polishing work at Advisory Division
Garage roof painting works at "A" 03 Bungalow
Roof painting works ant "B" 01 Bungalow
Internal colour washing and floor painting works at renovated room in Plant Pathology Division
Internal painting works at Laboratory areas and other premises for the Minister's visit
Fixed wire mesh for windows and Fanlights at "A" 14 – Bungalow
Internal renovation and painting work at St. Coombs Estate quarters
To assist the installation of fume hood machine to the Biochemistry Division
Cleaning and polishing works at Camelia Hostel - Room No: 18,38,22,36,34
Cleaning works at Junior Ladies Hostel - Room No: 06

Internal painting works at Junior Ladies Hostel Room No. 04
Cleaning and waxing on the floor of Sports Club
Internal wall painting and floor painting works at renovated room in Biochemistry Division
Internal and External colour washing works at Sports Club for E and E Forum.
Internal colour washing and polishing works at Auditorium and Advisory entrance for E and E Forum.
Repair and painting work at main entrance of the Advisory Division for E and E Forum
150 Nos of Maintenance Jobs (MB) have been completed
All painting works and repair works (carpentry, masonry, roof repairing and sanitation) have been carried out under the colour washing program.

Water supply and maintenance works:
129 Nos. water supply maintenance jobs (WS) have been completed.
Cleaning works at storage tanks, sedimentation tanks and all water tanks in the premises of TRI have been completed.

Safety
Replacing fire extinguishers of TRI Head office.
Conducting a short training program to sensitize the staff on the use of fire extinguishers.

Electrical Unit
204 Nos of jobs were completed by the electrical unit during the year 2022. Maintenance works of 99 TRI staff bungalows and quarters have been completed (A type - 17, B type -13, C type -31 and D type -12)
Other Maintenance Electrical works at Hostels and Guest Houses -36 Nos jobs were completed. Offices, Laboratories and St. Coombs Estate- 95 Nos were completed. Arranged new 3 phase wiring in the newly renovated Plant Pathology Division. 186 Nos. regular Light system were replaced with energy saving LED bulbs with filament bulbs/ballast type tube bulbs at common areas of Camellia Hostel, Senior Staff Gents Hostel, Senior Staff Ladies Hostel, Junior Staff Ladies Hostel, Office wash rooms. Completed whole electrical wiring and repairs in Camelia Hostel rooms. Biochemistry Division lighting system convert into energy saving LED Panel (9 Nos.) lights. Arranged 3 phase Arial Bundle laying (1500mtrs.) for Filter Plant. Arranged wiring in newly set up Fume Cupboard at Biochemistry Division. Cu/Al overhead currant line (B and C type Bungalows power line) fixed with new electrical light poles at "Y" junctions (at the beginning of Waltrim Road). Arranged 3 phase wiring in newly set up AC Unit at Biochemistry Division Cool room. Replaced old wiring and arranged 3 phase wiring in newly set up Dryer machine at St. Coombs Estate (Due to short circulated 3 Phase line). Completed servicing of 500Kva Generator and Radiator cleaning successfully. MaintainedMaintenance work of St Coombs Estate Bungalow, Factory, All pump Houses and overhead lines. Maintained Street lights.

Telephone Exchange
Following maintenance work were completed during the year.

1. Maintenance work - 08 Nos of jobs.

2. Repair of telephone line and servicing - 263 jobs

Procurement Activities

Departmental Procurement Committee (Major and Minor) Meetings were organized for the purchase of both foreign and local items such as Machinery and Laboratory equipment, Agricultural inputs for tea cultivation, Spare Parts for machinery, Office equipment and stationeries, Fuel and Lubricants, Building materials and Accessories, hardware and electrical items, Fire wood and fertilizer *etc.* Insurance Coverage for buildings and vehicles, and provision of Security Service to head office and regional centers.

Transport and Motor Garage

Following services and repairs were also done during the year 2022

No of total services of vehicle	- 25 Nos
No of total repairs (Major)	- 08 Nos
No of total repairs (Minor)	- 125 Nos
Replacing tyres	- 38 Nos
Visit Arrangements	- 971 Nos.

TRI Legal Matters and Bond and Agreements

Appeared for four Courts Cases, nine LT Cases and sixteen Consultations.

FINANCIAL STATEMENTS

TEA RESEARCH BOARD
STATEMENT OF FINANCIAL POSITION AS AT 31ST DECEMBER 2022

	Note	SLPSAS 2022 Rs. '000	SLPSAS 2022 Rs. '000	SLPSAS 2021 Rs. '000
ASSETS				
Current Assets				
Cash and Cash Equivalents	07		98,143	85,113
Short-term Investments			108,811	81,980
Trade and Other Receivables	08	69,227		54,598
Less:- Provision for Bad Debts		1,208		189
			68,019	54,409
			274,973	221,502
Inventories/Stocks	09	111,010		86,330
Deposits and Prepayments	10	3,353		3,420
Excess & Shortages	11	8		11
			114,371	89,761
Total Current Assets			389,344	311,264
Non-Current Assets				
Capital Work-in-Progress	12		10,337	6,600
Property, Plant & Equipment	13	3,093,839		2,957,672
Less:- Accumulated Depreciation		(812,526)		(811,831)
			2,281,313	2,152,440
Intangible Assets	14		521	-
Total Non-Current Assets			2,292,171	2,152,440
Total Assets			**2,681,515**	**2,463,704**
LIABILITIES				
Current Liabilities				
Creditors and Payables	15	39,977		33,515
Accrued Expenses	16	20,085		23,761
Short-term Borrowings	17	25,499		28,448
Short-term Provisions	18	10,710		10,869
Employee Benefits	19	3,688		4,866
			99,959	101,459
Non-Current Liabilities				
On Going Projects	20	66,784		95,616.00
Provision for Gratuity	21	267,110		265,474.29
Petrol Deposit Refundable	22	11		11.00
Long Term Borrowings	23	12,276		16,947
			346,181	378,049
Total Liabilities			446,140	479,508
Total Net Assets			**2,235,375**	**1,984,196**
NET ASSETS/EQUITY				
Grants & Reserves	24	425,320		423,508
Tea Research Fund		(108,379)		(186,265)
Revaluation Reserve		1,918,434		1,746,953
Total Net Assets/Equity			**2,235,375**	**1,984,196**

The accounting policies on pages no 22 to 25 and notes on pages no 05 to 21,26,27 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 Statements were approved by the Board of Directors and signed on their behalf.

Certified by:-

Senior Accountant

Director - TRI **Chairman - TRB**

TEA RESEARCH BOARD
STATEMENT OF FINANCIAL PERFORMANCE FOR THE YEAR ENDED 31ST DECEMBER 2022

	Note	SLPSAS 2022 Rs. '000	SLPSAS 2021 Rs. '000
Revenue			
Government Funds (Recurreent)	25	419,900	383,500
Deferred Income (Capital)	25	89,332	83,898
Other Income	26	54,283	23,037
		563,515	**490,436**
Add: P/L from Two Estates	27	108,939	(52,662)
		672,454	**437,774**
Expenses	28		
Personal Emoluments		326,182	292,067
Travelling		3,236	2,450
Supplies and Consumables		24,393	12,747
Repairs & Maintenance		25,750	24,524
Contractual Services, Transport, Utility & Services		42,311	49,893
Electricity & Heating		18,718	12,862
Communications		3,419	5,665
Research and Development		41,739	32,375
Depreciation		102,320	71,449
Other Expenses		6,241	3,613
Finance Cost		341.51	335
Total Expenses		**594,651**	**507,980**
Surplus/(Deficit) before Adjustments		77,803	(70,206)
Prior Year Adjustments		83	(7,272)
Net surplus/(Deficit) for the period		**77,886**	**(77,478)**

TEA RESEARCH BOARD
CONSOLIDATED CASH FOLW STATEMENT FOR THE YEAR ENDED 31ST DECEMBER 2022

	2022 Rs. '000	2022 Rs. '000	2021 Rs. '000
Cash Inflow / (Out Flow) from Operating Activities			
Net Surplus / Deficit for the year		**77,803**	**(70,206)**
Adjustment for			
Provision for Bad Debts	1,020		(54)
Prior year Adjustment	83		(7,272)
Provision for Gratuity	17,370		54,194
Depreciation	131,517		91,755
Increase/ Decrease Accumulated Depreciation	(130,823)		(248)
Loan Interest	(2,148)		1,019
Fixed Assets Adjustment	(40,626)		(478)
Asset Revaluation Adjustment	171,481		480
Deferred Income (Recurrent & Capital)	(463,117)		(467,947)
		(315,243)	(328,551)
Operating Cash Inflow / (Out Flow) befroe Changes in Working Capital		**(237,440)**	**(398,757)**
Changes in Working Capital			
Increase / Decrease in Inventories	(24,680)		(13,456)
Increase / Decrease in Trade & Other Receivables	(14,629)		1,190
Increase / Decrease in Excess & Shortage	3		-
Increase / Decrease in Creditors & Other Payables	6,462		2,508
Increase / Decrease in Refundable Deposit	(0.25)		(2)
Increase / Decrease in Deposits & Prepayments	67		1,024
Increase / Decrease in Accrued Expenses	(3,677)		(2,669)
Increase / Decrease in Short Term Provisions	(159)		1,207
Increase / Decrease in Employee Benefits	(1,178)		393
		(37,791)	(9,804)
		(275,231)	(408,561)
Less: Gratuity Paid	15,735		19,211
Interest Received	10,155		1,019
		25,890	20,230
Net Cash Inflow / (Out Flow) from Operating Activities		**(301,121)**	**(428,791)**
Cash Inflow /(Out Flow) from Investing Activates			
Intangible Assets	(521)		2,382
Investing Activities	(26,831)		(1,302)
Interest Received	10,155		-
Purchase of Fixed Assets	(95,541)		(84,078)
Decrease in WIP	(3,738)		6,578
Increase in On-going Projects	(28,832)		57,321
Net Cash Inflow / (Out Flow) from Investing Activites		(145,308)	**(19,100)**
Net Cash Inflow / (Out Flow) from Operating & Investing Activites		**(446,429)**	**(447,891)**
Cash Inflow / (Out Flow) from Financing Activites			
Grants Received from Treasury	464,930		508,888
Loan Interest	2,148		-
Loan Obtained	42,400		40,650
Loan Repaid	(50,020)		(53,571)
Brokers Advance	-		12,000
Brokers Advance Repaid	-		(12,000)
Net Cash Inflow / (Out Flow) from Financing Activites		459,458	**495,967**
Net Increase / (Decrease) in Cash and Cash Equivalents		**13,030**	**48,076**
Cash & Cash Equivalents at beginning of the year		**85,113**	**37,037**
Cash & Cash Equivalents at end of the year		**98,143**	**85,113**

TEA RESEARCH BOARD
STATEMENT OF CHANGES IN EQUITY FOR THE YEAR ENDED 31ST DECEMBER 2022

Rs'000

	Tea Research Fund	Revaluation Reserves	Grants & Reserves	Total Equity
Balance as at 01/01/2022	(186,265)	1,746,953	423,508	1,984,196
				-
Prior year adjustment	83	-	-	83
				-
Amounts received to Grant & Reserves	-	-	464,930	464,930
				-
Amount transferred to Deffered Income	-	-	(463,118)	(463,118)
				-
Revaluation Profit /(Loss)	-	171,480	-	171,480
				-
Surplus / (Deficits) for the year	77,803	-	-	77,803
				-
Balance as at 31/12/2022	(108,379)	1,918,433	425,320	2,235,374

Schedule A

TEA RESEARCH BOARD
ST.COOMBS & LAMILIERE ESTATES WORKING ACCOUNT
FOR THE PERIOD FROM 1ST JANUARY TO 31ST DECEMBER 2022

2021 Rs. Cts	2021 Kg's		2022 Kg's	2022 Rs. Cts	2022 Rs. Cts
		REVENUE			
		Tea sales Gross Proceeds			
133,446,906.54	204,718	Tea Sales Ex. Brokers(Gross)	214,405	242,234,980.00	
34,587,955.57	61,023	Tea sales Local & Graties	50,568	46,768,185.00	
1,992,429.15	5,844	Green Leaf Sales		-	
170,027,291.26	**271,584**		**264,973**		**289,003,165.00**
		Cost of Sales			
21,525,423.70	33,601	Opening Stock 01/01/2022	26,165	17,716,734.45	
		Add			
214,444,900.73	264,149	Cost of Manufacturing *Sch A. (1)*	272,359	249,021,955.87	
235,970,324.43	**297,750**		**298,525**	**266,738,690.32**	
		Less			
17,716,734.45	26,165	Closing Stock 31/12/2022	33,552	30,570,442.29	
218,253,589.98	**271,584**	**Cost of Sales**	**264,973**	**236,168,248.03**	**236,168,248.03**
(48,226,298.72)		**Gross Profit**			**52,834,916.97**
		Add			
18,175.78		ADB Profit / Loss (Sales of VP Cuttings)		341,741.43	
1,477,001.97		Local Tea Centre Profit/Loss		390,013.58	
8,789,295.08		Miscellaneous Income		11,464,775.48	
442,876.36		Deferred Income		442,876.36	
10,727,349.19		**Total Income**			**12,639,406.85**
(37,498,949.53)					**65,474,323.82**
		Administration & Finances			
1,817,758.54		Bank Loan & Brocker Advance Interest		1,167,414.06	
1,817,758.54					**1,167,414.06**
		Sales Tax & Disribution Expenses			
1,735,506.55		Brokerage,Handling charges & Sales Expenses		3,240,154.22	
1,735,506.55					**3,240,154.22**
3,553,265.09		**Total Expenditure**			**4,407,568.28**
(41,052,214.62)		**Profit /(Loss) For the Year**			**61,066,755.54**
		Schedule A. (1)			
		Cost of Manufacturing			
77,562,333.85		General Charges			60,136,037.12
18,689,148.40		Field Work & Cultivation			25,736,148.82
93,240,228.75		Production			95,524,073.32
9,402,948.52		Depreciation			13,463,609.17
15,550,241.21		Bought Leaf			54,162,087.44
214,444,900.73					**249,021,955.87**

Schedule B

TEA RESEARCH BOARD
ST.JOACHIM ESTATE WORKING ACCOUNT
FOR THE PERIOD FROM 1ST JANUARY TO 31ST DECEMBER 2022

2021 Rs. Cts	2021 Kg's			2022 Kg's	2022 Rs. Cts	2022 Rs. Cts
		REVENUE				
		Tea sales Gross Proceeds				
139,782,935.00	222,550	Tea Sales Ex. Brokers(Gross)		270,105	369,361,270.00	
7,708,782.00	15,074	Tea sales Local & Graties		14,920	9,555,434.50	
147,491,717.00	**237,624**			**285,025**		**378,916,704.50**
		Cost of Sales				
16,879,065.25	27,047	Opening Stock 01/01/2022		32,645	19,959,260.53	
		Add				
171,509,710.35	243,222	Manufacturing	*Sch B. (1)*	290,711	378,800,593.77	
188,388,775.60	**270,269**			**323,356**	**398,759,854.30**	
		Less				
19,959,260.53	32,645	Closing Stock 31/12/2022		38,331	48,233,069.14	
168,429,515.07	**237,624**	Cost of Sales		**285,025**		350,526,785.16
(20,937,798.07)		Gross Profit				**28,389,919.34**
		Add				
1,472,156.62		Tea Center Profit			1,692,004.00	
69,299.59		Profit/Loss from Nursery			(120,858.90)	
6,836,810.05		Sale of Green Leaf			13,142,513.98	
5,339,222.40		Miscellaneous Income			11,846,394.67	
17,500.00		Income From Rubber			508,040.00	
(734,199.29)		Profit/Loss from ADB Shoots			(115,974.00)	
855,719.52		Deferred Income			855,720.00	
13,856,508.89						27,807,839.75
(7,081,289.18)		**Total Income**				**56,197,759.09**
		Administration & Finances				
2,320,261.79		Bank Loan & Broker Advance Interest			3,315,815.00	
2,320,261.79						**3,315,815.00**
		Sales Tax & Disribution Expenses				
2,207,926.36		Brokerage, Handling charges & Sales Expenses			5,009,580.91	
2,207,926.36						**5,009,580.91**
4,528,188.15		**Total Expenditure**				**8,325,395.91**
(11,609,477.33)		**Profit /(Loss) For the Year**				**47,872,363.18**

2021 Rs. Cts			2022 Rs. Cts
	Schedule B. (1)		
	Cost of Manufacturing		
1,911,320.27	General Charges		3,634,851.96
1,724,707.48	Field Work & Cultivation		2,111,222.44
4,325,619.00	Production		4,312,386.57
230,845.11	Expenditure on Rubber		2,634.00
10,903,206.34	Depriciation		15,733,030.18
152,414,012.15	Bought Leaf A/C		353,006,468.62
171,509,710.35			**378,800,593.77**

TEA RESEARCH BOARD
NOTES TO THE ACCOUNTS AS AT 31ST DECEMBER 2022

Note 01
Fundamental Accounting Concepts
The Tea Research Institute Board (TRB) commenced operation with effect from 07th March 1994, Under the Tea Research Board Act No.52 of 1993.

The accounts of the board have been prepared under the going concern concept and its financial operation mainly based on Government funds receivable from the Treasury monthly. The Internal generation of funds from the profit of plantation and other commercial activities, short term Investments and miscellaneous income are also being utilize to enable the Board to meet its revenue expenditure.

Note 02
Adaptation of New Accounting Standard
Tea Research Board has been converted to Sri Lanka Public Sector Accounting Standards (SLPSAS) from Sri Lanka Accounting Standard (SLAS), w.e.f. 2013.

Re-measurement
The first volume of SLPSAS (1-10) shall apply periods beginning on or after 01st January 2011. However, TRB fully converted to SLPSAS w.e.f 2013 according to instructions given by the Ministry of Finance and Planning and reported no material re-measurements during implementation.

Note 03
Accounting Policies
a) Accounting Convention
The Accounts are prepared under the historical cost convention.

b) Accrual Basis
All dues to the board as at 31stDecember 2022are dealt with on accruals concepts as per SLPSAS 01 Presentation of Financial Statements. (Recognition of the effects of transactions and other events when they occur without waiting for receipt or payment of cash or its equivalents)

c) I. Government Grants
Government of Sri Lanka is theprincipal possessorof the TRB and Granting funds for the recurrent and capital expenditure in each year through Treasury using CESS fund. This is covered by SLPSAS 11 under the Revenue from Non-Exchange Transaction (Taxes and Transfers) andhas been adapted by the TRB to present government grants in the financial statements. Accordingly, grants received for recurrent expenditures are directly credited to the statement

of financial position and transferred to the statement of financial performance as income under the general heading of “Government Funds”.Grant received for capital expenditure are directly identified to the statement of financial position under equity and recognizes as deferred income that is recognized in profit or lost on a systematic basis over the useful life of the assets.

II. Special Project on Mechanization

Based on the 2013 Budget proposal, Rs. 100Mn was allocated to TRI to popularize Mechanization Tea Harvesting among the Tea Small Holders to overcome the labour shortage with the collaboration of Tea Small Holders’ Authority (TSHDA) and Sri Lanka Tea Board (SLTB) and sum of Rs. 48 Mnhas been received in total for the said project during the year 2013 and 2014. However, Rs 48.11Mn has been spent incurring an over expenditure of Rs. 0.11Mn which had been transferred to a receivable account (Mechanization of Tea Harvest) since 2018.

d) Depreciation of Fixed Assets

Depreciation policy is in line with SLPSAS 07 property, plant and equipment. The assets are depreciated over the period which and asset is expected to be available for use by the institute from the year of purchased as well as the year of disposal.

Rate of depreciation are as follows.

i.	Building	2%
ii.	Motor Vehicles	20%
iii.	Factory Machinery	12.5%
iv.	Machinery and Equipment	20%
v.	Laboratory Equipment	20%
vi.	Library Books	20%
vii.	Water Supply	10%
viii.	Furniture	10%
ix.	Office Equipment	10%
x.	Electricity Installation	10%
xi.	Telephone	10%
xii.	Water Supply Equipment	10%
xiii.	Capital Replanting	3%
xiv.	Computers and Software	25%
xv.	Roads	5%

e) Produce Stock/Inventories

i. **Stocks**

Stocks are measured at the lower of cost and net realizable value accordance with SLPSAS 09 except the biological asset/produce stocks arisen from the agricultural activities which are measuredaccordance with well-established practices in the plantation industries.

ii.**Reclaimable Tea**

A new terminology was introduced under the SLTB to recognize Reclaimable Teas (RT) instead of calling Refuse Tea. The stocks are measured at net realizable value and disclosed in the note to the accounts whilst the income of selling of RT is recognized on cash basis since the institute is not allowing credit sales for particular RT sales.

Year's Transaction

Income				
Estate	**Production Including Opening Stocks(kg)**	**Quantity Sold (kg)**	**Avg @ (Rs)**	**Value (Rs)**
St. Coombs Estate	41,037.50	31,204.50	338.38	10,559,041
St. Joachim Estate	38,901.00	32,211.00	295.12	9,506,194

Stock Valuation			
Estate	**Physical Stock as at 31/12/2022 (kg)**	**Avg @ (Rs)**	**Value (Rs)**
St. Coombs Estate	6,192.00*	338.38	2,095,249
St. Joachim Estate	6,690.00	295.12	1,974,353

**Note: Denatured reclaimable tea stock for the year 2022 is 4,094 Kg*

f) Research and Development Expenditure

Research Expenditure is written off in the same year.

g) Suppliers & Services

Procurement procedure defined in Procurement Manual and Guidelines/NPA Circular No.8 issued by the National Procurement Agency (NPA) in 2006 is being followed currently.

h) Provision for Gratuity

The cost of retirement benefits is accounted for in the period during which qualifying services are rendered as gratuity liability starts accruing. The calculation of GratuityProvision isbased on Half Month Salary “x” No. of Service Years or last 14 Days Salary “x” No of Service Years.

i) Provision for Holiday Pay and Bonus

The basis of calculation is as follows.

$$\frac{\text{Total earnings for the year “x”Entitled days}}{\text{Total days worked for the year (Per Employee)}}$$

j) Green Leaf

The method of formula used in estimating Factory weight of Green Leaf is ascertained after deducting 3% of the field weight for moisture.

k) Provision for Bad Debts

5% on Debtors

l) General

Other financial information including related disclosures are being prepared in conformity with generally accepted accounting principles.

m) Comparative Information

The comparative information’s in-respect of previous year has been re-classified wherever necessary to comfort with the current year’s classification in order to provide a better presentation as per SLPSAS 01.

Note 04
Contingent Asset (SLPSAS 08)

a) Outstanding Bonds

The TRB is providing necessary foreign/local training facilities for scientific staff to upgrade their professional stratum using government funds. It is compulsory to enter in to a bond and agreement by each individual before commencing their higher studies in accordance with the provision of establishment code. However, instances were occurred where several employees were in breach of agreement and they have to pay the bond value, which is totaling to Rs. 15,054,891/- of 04 ex-officers employed by TRI as of end 2022. Please refer annexure (I).

The management has taken legal actions with the guidance of AG’s Department of Sri Lanka to recover the above outstanding bond value. The management is in opinion that these cases will be confirmed only by the occurrence or non-occurrence of one or more uncertain future events (decision of courts) which not wholly within the control of the entity.

b) Outstanding and Pending Court Cases

Two court cases, OneLT case and One pending case are in progress as at 31st December 2022 and will be confirmed only by the occurrence or non-occurrence of one or more uncertain future events (decision of courts) which not wholly within the control of the entity. These events are not taken in to accounts since the outcome of the case is not yet known and the economic value is yet to be determined. Please refer annexure (ii)

Note: Contingent assets will recognize in the accounts only on period where the change in status occurs.

b) Financial Fraud in St Coombs Estate

Domestic inquiries are completed in respect of financial fraud (Rs 10.3Mn) incurred at St Coombs Estate during 2017/2018 period. Legal action has been taken against the parties connected as at 31st December 2022.

Note 05

Biological Assets

There are 5,654 nos of valuable trees have been identified and marked in the premises of Talawakelle, Ratnapur, Hantane, Passara and Kottawa of the Board. However, the above nos of trees have not been valued and taken into the accounts.

A special committee was appointed to carry out the physical verification of biological assets and once the verification process is completed, the new values will be taken in to the accounts during the financial year ending 2023.

Note 06

Disclosures

a) Revaluation of Fixed Assets

i. All fixed assets have been revalued (except library books) as at end 2019 and relevant fixed assets registers were updated accordingly.

ii. The carrying amount of revalued vehicles of the Institute (revalued on 2015) differs significantly from its fair value as of end 2020 and is required to revalue the entire class of vehicles by 2021. A revaluation committee was appointed on 28th Jan 2022 by the TRB and entire class of vehicles have been revalued except the following items as at end December 2022. New values were taken in to the accounts during 2022 and disclosed in Note 13 and Statement of Changes in Equity respectively.

Vehicles to be Revalued (Kottawa Sub Station)

- Hand Tractor (72 Sri 7900)
- Motor Bicycle (96-5849)

iii. Carrying values of vehicles after revaluation have been taken in to the accounts w.e.f 01st January 2022 and depreciated throughout the year respectively.

b) Tea Research Fund

Tea Research Fund has been recorded negative balance since 2019. However as at end 2022, the negative balance has been reduced by Rs Million 77.88 during the year 2022 especially due to the performances of two Estates. Please refer the Statement of Changes in Equity (Page 04).

c) Presentation of Budget Information (SLPSAS 15)

i. The annual budget is approved on a cash basis whilst the consolidated financial statements are prepared on the accrual basis. The approved budget covers the fiscal period from 1st January 2022 to 31st December 2022.

Tea Research Institute					
Budget Vs Actual 2022					
CODE	**ITEM**	**ESTIMATE**	**ACTUAL**		**VARIANCE**
			TO-DATE	**%**	
1	**PERSONEL EMLUMENTS**	**263,233,875.00**	**271,419,699.84**	**103.11**	**(8,185,824.84)**
1.01	Salaries & Wages	150,525,060.00	156,286,459.04	**103.83**	(5,761,399.04)
1.03	Other Allow.	60,325,815.00	65,295,241.34	**108.24**	(4,969,426.34)
1.04	Staff Overtime	23,850,000.00	16,140,575.11	**67.68**	7,709,424.89
1.06	Medical Benefits	4,500,000.00	5,697,160.16	**126.60**	(1,197,160.16)
1.07	Daily Paid Labour	24,000,000.00	28,000,264.19	**116.67**	(4,000,264.19)
1.08	Membership & Subscriptions	33,000.00	-	**-**	33,000.00
2	**TRAVELLING**	**6,000,000.00**	**3,236,313.11**	**53.94**	**2,763,686.89**
2.01	Travelling - Local	6,000,000.00	3,236,313.11	**53.94**	2,763,686.89
3	**SUPPLIES & REQUISITES**	**24,000,000.00**	**24,393,184.56**	**101.64**	**(393,184.56)**
3.01	Stationery & Office Requisites	2,000,000.00	2,427,643.00	**121.38**	(427,643.00)
3.02	Fuel & Lubricants	15,000,000.00	15,570,941.88	**103.81**	(570,941.88)
03.03L	Mech,Elec.,Chemicals & G/Goods-Local	3,000,000.00	3,261,070.31	**108.70**	(261,070.31)
3.04	Books,Periodicals,N/Papers & P/Graphy	2,500,000.00	3,074,764.37	**122.99**	(574,764.37)
3.07	Uniforms,Boots & Raincoats	1,500,000.00	58,765.00	**3.92**	1,441,235.00
4	**REPAIRS & MAINTENANCE OF CAPITAL ASS**	**99,000,000.00**	**128,070,331.03**	**129.36**	**(29,070,331.03)**
04.01A	Machinery & Lab Equipments	2,500,000.00	1,210,038.07	**48.40**	1,289,961.93
04.01B	Vehicles	5,000,000.00	7,986,066.08	**159.72**	(2,986,066.08)
4.02	Buildings & Others capital Assets	6,000,000.00	6,618,514.05	**110.31**	(618,514.05)
4.03	Office Equipments	2,000,000.00	1,190,816.57	**59.54**	809,183.43
4.04	Furniture & Fittings	500,000.00	51,141.96	**10.23**	448,858.04
4.05	Utility Services	8,000,000.00	8,693,382.30	**108.67**	(693,382.30)
4.06	Depreciation of Fixed Assets	75,000,000.00	102,320,372.00	**136.43**	(27,320,372.00)
5	**TRANSPOTATION,COMMI,UTILITY & O/SERV**	**75,433,500.00**	**62,877,474.90**	**83.35**	**12,556,025.10**
5.01	Advertising	1,000,000.00	743,176.00	**74.32**	256,824.00
5.02	Postage & Telecommunications	6,000,000.00	3,418,698.22	**56.98**	2,581,301.78
05.03A	Elec,Heating	14,000,000.00	18,717,681.06	**133.70**	(4,717,681.06)
05.03B	Water Supply	4,000,000.00	3,229,858.72	**80.75**	770,141.28
05.03C	Roads	500,000.00	554,321.70	**110.86**	(54,321.70)
5.04	Transport & Hire Charges	500,000.00	373,423.77	**74.68**	126,576.23
5.06	Health & Sanitary Services	5,000,000.00	1,877,281.61	**37.55**	3,122,718.39
5.07	Rent for Colombo/Deniyaya Guest House	2,034,000.00	1,701,150.00	**83.64**	332,850.00
5.08	Insurance-Buildings, Vehicles etc.	2,000,000.00	1,978,594.74	**98.93**	21,405.26
5.09	Security Services	25,000,000.00	26,696,468.81	**106.79**	(1,696,468.81)
5.1	Audit Fees	700,000.00	440,700.00	**62.96**	259,300.00
5.11	Legal Fees	200,000.00	112,350.00	**56.18**	87,650.00
5.13	Bank Charges	550,000.00	341,510.06	**62.09**	208,489.94
5.14	Provision for Bad Debtors	500,000.00	223,163.61	**44.63**	276,836.39
5.15	Licence of Vehicles	1,100,000.00	352,728.60	**32.07**	747,271.40
5.16	Losses & write-offs	6,000,000.00	0	**-**	6,000,000.00
5.17	Vehicle Leasing	6,349,500.00	2,116,368.00	**33.33**	4,233,132.00

7	**CONTRIBUTIONS GRANTS & SUBSIDIES**	**10,500,000.00**	**10,419,844.88**	**99.24**	**80,155.12**
7.01	Liquid Tea Supplies to Staff	5,000,000.00	1,916,037.85	**38.32**	3,083,962.15
7.02	Packeted Tea to Staff	5,000,000.00	7,972,422.65	**159.45**	(2,972,422.65)
7.03	Staff Welfare	500,000.00	531,384.38	**106.28**	(31,384.38)
8	**PENSIONS,RETIREMENT BENEFITS & GRATU**	**46,266,125.00**	**44,341,325.73**	**95.84**	**1,924,799.27**
8.01	E.P.F. Contributions	26,810,199.00	27,986,418.30	**104.39**	(1,176,219.30)
8.02	E.T.F. Contributions	5,362,040.00	5,597,283.63	**104.39**	(235,243.63)
8.04	Gratuity Payments,Provision	14,093,886.00	10,757,623.80	**76.33**	3,336,262.20
10	**MEDIA ADVERTISING,PUBLICITY & GIFTS**	**2,450,000.00**	**1,911,525.92**	**78.02**	**538,474.08**
10.02	Entertainment	250,000.00	311,092.96	**124.44**	(61,092.96)
10.09	Gift Tea	200,000.00	268,861.11	**134.43**	(68,861.11)
10.15	Publicity,Exhibition and Symposium	2,000,000.00	1,331,571.85	**66.58**	668,428.15
12	**MISCELLANEOUS EXPENSES**	**5,616,500.00**	**6,237,097.10**	**111.05**	**(620,597.10)**
12.01	Fees & Travel for Board Members	750,000.00	774,172.03	**103.22**	(24,172.03)
12.06	Expenses on outsiders working on Pro	500,000.00	104,375.00	**20.88**	395,625.00
12.16	Other Misce.Expenses	4,366,500.00	5,358,550.07	**122.72**	(992,050.07)
	Recurrent Expenditure Total	**532,500,000.00**	**552,906,797.07**	**103.83**	**(20,406,797.07)**

01. Utilized TRI restructure budget line lease rental budget line to finance compensation for Bus accident.
02. Obtain machinery & lab equipment amount to finance SPND SPECORD A (Machinery part) replacement.
03. Salary for the new recruitments of the year 2022 is utilized from the gravity provision made for the year 2022

TEA RESEARCH BOARD
NOTES TO THE ACCOUNTS AS AT 31ST DECEMBER 2022

	2022 Rs. Cts	2021 Rs. Cts
Note 07		
Cash and Cash Equivalents		
Cash and Bank Balance		
Tea Research Institute		
Bank of Ceylon, Talawakelle	6,882,006.25	5,101,304.13
Bank of Ceylon, Corporate Branch	23,071,192.33	19,931,249.54
Bank of Ceylon, Working Account (St. Coombs)	8,600,000.00	(14,224,870.16)
Bank of Ceylon, Savings Account (St. Coombs)	9,377,949.73	147,280.03
Bank of Ceylon, Working Account (St. Joachim)	4,100,000.00	98,000.00
Bank of Ceylon, Savings Account (St. Joachim)	21,671,129.40	247,002.50
Cash - TRI Talawakelle	284,764.91	245,215.35
Cash - Imprest - TRI Ratnapura	228,464.80	198,512.65
Cash - Imprest - TRI Hantana	253,898.16	53,883.36
Cash - Imprest - TRI Kottawa	6,102.44	14,640.28
Cash - Imprest - TRI Passara	21,869.22	57,562.53
Cash - Imprest - TRI Deniyaya	18,567.72	23,328.82
Cash - Imprest - TRI Walahanduwa	-	8,147.33
Cash - Imprest - TRI Mathugama	5,000.00	2,280.00
Stamps Imprest - TRI Talawakelle	3,735.00	3,835.00
Stamps Imprest - TRI Ratnapura	20.00	1,185.00
Stamps Imprest - TRI Hantana	1,055.00	585.00
Stamps Imprest - TRI Kottawa	2,165.00	1,110.00
Stamps Imprest - TRI Passara	-	560.00
Stamps Imprest - TRI Walahanduwa	577.00	392.00
Stamps Imprest - TRI Deniyaya	350.00	-
Stamps Imprest - TRI Matugama	490.00	120.00
Postal Franker - TRI Talawakelle	107,220.90	73,975.90
Postal Franker - TRI Ratnapura	3,249.45	3,249.45
	74,639,807.31	11,988,548.71
St. Coombs Estate		
Cash in Hand	140,486.04	105,412.76
Cash at Bank	1,992,866.76	141,143.11
Stamps	298.00	480.00
	2,133,650.80	247,035.87
St. Joachim Estate		
Cash in Hand	1,248.88	5,000.00
Cash at Bank	356,306.06	61,856.55
Stamps	2,530.00	1,015.00
	360,084.94	67,871.55
Short Term Investments		
Call Deposits - BOC (Corporate Barnch)	21,009,931.70	72,809,911.44
Total Cash & Cash Equivalents	**98,143,474.75**	**85,113,367.57**

TEA RESEARCH BOARD
NOTES TO THE ACCOUNTS AS AT 31ST DECEMBER 2022

	2022 Rs. Cts.	2021 Rs. Cts.
Note 08		
Trade and Other Receivables		
Debtors and Other Debit Balances		
Tea Research Institute		
Sundry Debtors	5,095,499.94	3,437,252.80
Debtor- Income Utilization	152,950.00	152,950.00
Mechanization of Tea Harvesting	110,224.14	110,224.14
Recovery A/C (Staff Debtors)	272,486.62	240,919.18
Trade Debtors	773,067.12	472,825.97
Analytical Charges Due	3,151,345.00	346,320.00
Insurance Claim Due	324,262.94	336,239.01
Accrued Interest (BOC)	5,088,605.57	1,191,513.70
	14,968,441.33	6,288,244.80
St. Coombs Estate		
Check Roll Debtors	2,035,801.57	1,977,731.26
Sundry Debtors	514,956.55	999,406.38
Cash Not Deposited 2017/2018	3,217,245.27	3,217,245.27
Tea Center Debtors	6,070,354.62	6,078,407.12
Refuse Tea Debtors	308,346.00	308,346.00
Debtors - Mr. R.A.D.Kalum	672,630.14	672,630.14
Debtors - Mr. M M L Jayathilake	30,751.84	30,751.84
Electricity Recovery Lamillier	8,099.92	1,691.69
Sri Lanka Tea Board & TSHDA	4,236,434.47	1,930,330.77
ADB Debtors	500,975.00	553,250.00
Labour Jerking Recovery	173,779.09	267,304.09
Staff Debtors	60,752.65	113,711.17
Green Manure	284,093.83	-
TRI Advisory GL 395	292,200.00	-
	18,406,420.95	16,150,805.73
St. Joachim Estate		
Check Roll Debts	17,927.77	23,515.86
Sundry Debtors	118,669.02	406,331.06
GL 340	510,886.88	654,143.28
M.P.C.S.Ltd Ratnapura	59,229.59	16,173.42
Staff Debtors	366.01	4,322.37
Bought Leaf Debts	995,390.64	216,614.19
Kiriporuwa Estate	56,975.00	139,475.00
Prepayment Account	697,117.00	-
	2,456,561.91	1,460,575.18
Loans and Advances		
Tea Research Institute		
Staff Loans	21,759,125.89	21,136,572.50
Labour Loans - TRI Hantana	26,630.00	29,077.00
Labour Loans - TRI Kottawa	52,000.00	52,000.00
Labour Loans - TRI Passara	137,000.00	94,000.00
Labour Loans - TRI Deniyaya	4,000.00	5,000.00
Labour Loans - Walahanduwa	4,000.00	4,000.00
Labour Loans Skilled Workers	7,750.00	10,250.00
	21,990,505.89	21,330,899.50

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TEA RESEARCH BOARD
NOTES TO THE ACCOUNTS AS AT 31ST DECEMBER 2022

	2022 Rs. Cts.	2021 Rs. Cts.
St. Coombs Estate		
Festival Loan - Workers	5,493,285.00	4,112,535.00
Labour Advance	720,118.05	2,127,118.05
Cash Advance	1,882,049.97	92,200.00
Staff Loan	1,435,954.98	1,424,084.91
Special Loans	609,492.61	609,492.61
	10,140,900.61	8,365,430.57
St. Joachim Estate		
Staff Loan	97,676.50	67,509.84
Deepavali Festival Advance	993,124.94	726,624.94
X'mas Festival Advances	75,000.00	50,000.00
Sinhala New Year Festival Advance	97,850.00	157,850.00
	1,263,651.44	1,001,984.78
Total Trade & Other Receivables	**69,226,482.13**	**54,597,940.56**

TEA RESEARCH BOARD
NOTES TO THE ACCOUNTS AS AT 31ST DECEMBER 2022
Note 09
Inventories/Stocks

Tea Research Institute		
General Stocks	6,526,443.96	4,905,450.41
Electrical Stocks	722,629.75	899,934.08
Stocks at TRI Ratnapura	1,252,270.20	1,184,867.21
Stocks at TRI Hantana	301,799.03	478,893.53
Stocks at TRI Kottawa	954,801.65	99,116.35
Stocks at TRI Passara	348,116.37	137,672.32
Stocks at TRI Walahanduwa	44,820.00	44,820.00
Drugs Stocks	210,407.95	210,407.95
Motor Spare Parts Stocks	1,634,940.06	1,765,798.55
Stationery Stocks	1,260,066.30	803,391.79
Stationery Stocks-Walahanduwa	8,900.68	19,229.36
Tea Stock TRI Talawakelle	250,470.00	257,443.75
Milk & Sugar Stock Talawakelle	21,666.13	187,213.86
Tea Stock - TRI Ratnapura	565.60	-
Publication Stocks (Hand book on Tea)	1,533,362.00	1,864,258.00
Field Guide Book	1,479,668.00	4,950.00
Labour Economic on Tea	900.00	900.00
Timber Stocks A/c - TRI Kottawa	9,248.72	9,271.97
Timber Stocks A/c - TRI Hantane	5,936.67	6,016.67
	16,567,013.07	12,879,635.80

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TEA RESEARCH BOARD
NOTES TO THE ACCOUNTS AS AT 31ST DECEMBER 2022

	2022 Rs. Cts.	2021 Rs. Cts.
Goods-in-Transit A/C	50,754.90	22,486,867.15
Timber Stocks A/C - TRI Passara	3,552.94	4,873.88
V.P Plants Stocks -Hantane	1,085,483.21	1,357,410.03
V.P Plants Stocks -Kottawa	1,299,725.73	1,179,722.23
V.P Plants Stocks - Passara	439,978.94	314,911.52
V.P Plants Stocks -Deniyaya	333,576.50	471,028.15
Water Treatment Chemical Stocks	1,143,395.85	239,971.90
Stock of Fuel in Vehicles	578,626.80	251,294.90
Offset Paper Stocks	263,200.00	303,800.00
	5,198,294.87	26,609,879.76
St. Coombs Estate		
Rice & Food stuff	665,920.00	134,521.34
General Stock	5,773,411.54	6,363,025.98
Made Tea Stock	31,060,377.29	17,863,421.80
Nursery Stock 2019/2020	76,935.25	180,566.85
	37,576,644.08	24,541,535.97
St. Joachim Estate		
General Stock	1,110,077.70	1,181,018.08
Nursery Stock 2019/2020	37,711.00	40,273.00
Nursery Stock 2020/2021	637,523.77	935,150.85
Nursery Stock 2022/2023	1,495,034.64	9,100.00
Nursery Stock 395	59,800.00	-
Made Tea Stock	48,328,028.52	20,133,807.35
	51,668,175.63	22,299,349.28
Total Inventories/Stocks	**111,010,127.65**	**86,330,400.81**

TEA RESEARCH BOARD
NOTES TO THE ACCOUNTS AS AT 31ST DECEMBER 2022

Note 10
Deposits and Prepayments

Deposits **Tea Research Institute**	2022 Rs. Cts	2021 Rs. Cts
Advance A/C	20,375.00	236,988.65
Deposits A/C	1,659,600.00	1,559,600.00
Deferred Revenue Expenditure TRI Hantane	-	32,878.42
Empty Cylinder Deposits A/C	625,107.60	625,107.60
	2,305,082.60	2,454,574.67

St. Coombs Estate		
TRI Staff Co-operative Stores	400.00	400.00
Empty Gas Cylinder Deposit	30,467.00	30,467.00
	30,867.00	30,867.00
St. Joachim Estate		
Deposit on Fuel	10,000.00	10,000.00
Empty Gas Cylinder Deposits	15,250.00	15,250.00
Purchase Advance A/c	(0.31)	-
	25,249.69	25,250.00
Pre Payments		
Tea Research Institute		
Pre Payments	991,851.03	908,991.49
	991,851.03	908,991.49
Total Deposits & Prepayments	**3,353,050.32**	**3,419,683.16**

Note 11
Excess and Shortage

Opening Balance as at 01/01/22	11,209.65	11,209.65
Less: Fuel Adjustment	3,283.60	-
Closing Balance as at 31/12/2022	**7,926.05**	**11,209.65**

Note 12
Capital Work-in- Progress

TRI Work-in-Progress	8,240,457.40	2,730,109.00
St. Coombs Estate Work-in-Progress	1,652,528.47	3,235,874.47
St. Joachim Estate Work-in-Progress	444,080.19	444,080.19
ISO Certificates WIP St.Coombs	-	189,479.00
Total Capital Working Progress	**10,337,066.06**	**6,599,542.66**

Note 12
On-going Project Works

Mechanization of Tea Harvesting

Total On-going Project Works

Note 13
Fixed Assets as at 31/12/2022

Item	Cost as at 01.01.2022	Addition Adjustments 2022	Accounting Adjustments 2022	Revaluation Adjustments 2022	Balance as at 31.12.2022	Depreciation as at 01.01.2022	Depreciation for the year 2022	Disposal Adjustments 2022	Accounting Adjustment 2022	Accumulated Depreciation 31.12.2022	Net Book Value as at 31.12.2022
T.R.I											
Lands	244,656,124.31	-	-	-	244,656,124.31	-	-	-	-	-	244,656,124.31
Building	957,795,428.34	9,848,512.18	-	-	967,643,940.52	117,255,775.00	19,343,422.25	-	-	136,599,197.25	831,044,743.27
Internal Roads	7,083,398.00	8,375,118.50	-	-	15,458,516.50	1,568,030.00	984,768.46	-	-	2,552,798.46	12,905,718.04
Machinery & Equipments	410,563,413.64	56,777,896.76	(42,000.00)	-	467,299,310.40	307,521,827.00	40,120,519.56	(9,346.00)	-	347,633,000.56	119,666,309.84
Furniture	48,451,427.27	358,733.50	-	-	48,810,160.77	29,372,117.00	4,877,062.27	-	-	34,249,179.27	14,560,981.50
Utility Services	28,945,145.85	967,791.99	31,840.00	-	29,944,777.84	7,935,227.00	2,964,539.47	-	-	10,899,766.47	19,045,011.37
Vehicles	113,218,108.68	15,919,200.00	(115,007,309.00)	150,863,000.00	164,992,999.68	108,005,730.00	32,777,197.26	-	(108,005,730.00)	32,777,197.26	132,215,802.42
Other Fixed Assets	4,241,715.62	-	-	-	4,241,715.62	903,273.00	451,478.05	-	-	1,354,751.05	2,886,964.57
Library Books	59,815,828.95	83,375.25	-	-	59,899,204.20	59,066,008.00	426,948.66	-	-	59,492,956.66	406,247.54
Re- Planting Mature	11,139,387.73	-	1,341,804.00	-	12,481,191.73	7,430,753.00	374,435.76	-	-	7,805,188.76	4,676,002.97
Re- Planting Immature	1,987,429.36	-	(1,341,804.00)	-	645,625.36	-	-	-	-	-	645,625.36
Total	1,887,897,407.75	92,330,628.18	(115,017,469.00)	150,863,000.00	2,016,073,566.93	639,058,740.00	102,320,371.74	(9,346.00)	(108,005,730.00)	633,364,035.74	1,382,709,531.19
St.Coombs/St.Joachim											
Lands	543,278,378.66	-	-	-	543,278,378.66	-	-	-	-	-	543,278,378.66
Buildings	220,648,177.00	-	-	-	220,648,177.00	29,484,361.00	4,404,358.00	-	-	33,888,719.00	186,759,458.00
Machinery & Equipments	106,788,918.00	2,590,756.00	-	-	109,379,674.00	58,547,590.00	13,616,647.00	-	-	72,164,237.00	37,215,437.00
Furniture	508,198.00	-	-	-	508,198.00	270,191.00	50,820.00	-	-	321,011.00	187,187.00
Utility Services	791,326.00	-	-	-	791,326.00	-	79,133.00	-	-	79,133.00	712,193.00
Vehicles	26,097,022.82	-	(26,097,022.82)	30,877,000.00	30,877,000.00	22,807,444.00	6,175,400.00	-	(22,807,444.00)	6,175,400.00	24,701,600.00
Other Fixed Assets	1,744,917.00	-	-	-	1,744,917.00	131,552.00	190,977.00	-	-	322,529.00	1,422,388.00
Total Estates	899,856,937.48	2,590,756.00	(26,097,022.82)	30,877,000.00	907,227,670.66	111,241,138.00	24,517,335.00	-	(22,807,444.00)	112,951,029.00	794,276,641.66
Total TRI & Estates	2,787,754,345.23	94,921,384.18	(141,114,491.82)	181,740,000.00	2,923,301,237.59	750,299,878.00	126,837,706.74	(9,346.00)	(130,813,174.00)	746,315,064.74	2,176,986,172.85
Capital Re Planting Development Programme											
St.Coombs Estate Mature	64,723,768.00	-	51,038.89	-	64,774,806.89	26,145,555.00	1,750,345.21	-	-	27,895,900.21	36,878,906.68
St.Coombs Estate Immature	122,914.00	604,760.29	(51,038.89)	-	676,635.40	-	-	-	-	-	676,635.40
St.Joachim Estate Mature	104,111,508.00	-	655,370.63	-	104,766,878.63	35,385,873.00	2,928,960.42	-	-	38,314,833.42	66,452,045.21
St.Joachim Estate Immature	959,557.00	14,902.65	(655,370.63)	-	319,089.02	-	-	-	-	-	319,089.02
Total Replanting	169,917,747.00	619,662.94	-	-	170,537,409.94	61,531,428.00	4,679,305.63	-	-	66,210,733.63	104,326,676.31
Total Fixed Assets	2,957,672,092.23	95,541,047.12	(141,114,491.82)	181,740,000.00	3,093,838,647.53	811,831,306.00	131,517,012.37	(9,346.00)	(130,813,174.00)	812,525,798.37	2,281,312,849.16

TEA RESEARCH BOARD
NOTES TO THE ACCOUNTS AS AT 31ST DECEMBER 2022

	2022 Rs. Cts	2021 Rs. Cts
Note 14		
Intangible Assets		
St. Coombs ISO Certificate	521,034.00	-
	521,034.00	-
Note 15		
Creditors & Payables		
Payables		
Tea Research Institute		
Retention Money Payable	2,000,276.06	7,374,457.90
Tender Deposits Refundable	305,740.20	333,130.63
Security Deposits Refundable	367,258.58	366,605.41
	2,673,274.84	8,074,193.94
St. Coombs Estate		
Pushpa Trading Corporation	504.00	504.00
Death Donation A/C Lamiliere	19,378.00	3,028.00
Death Donation A/C St.Coombs & TRI	220,713.50	53,413.50
Estate Staff Medical Scheme	1,091,663.45	1,136,965.94
TRI Buddhist Association	2,000.00	3,100.00
Insurance Premium of Cash Transport	117,807.41	-
TRI Sports Club	110.00	2,510.00
Temple Committee - St. Coombs	220,481.95	132,657.34
Temple Committee - Lamiliere	(62,858.30)	65,445.75
One Day Wages Recovery	-	482,000.00
Check off	186,400.00	187,016.00
Check Roll Recovery	944,868.26	794,777.93
Diyanillakelle Estate (B/L Supply)	2,972,579.54	-
Sutton Estate, Hatton	1,100,685.18	77,677.32
Smart Business LTD	12,500.00	(1,000.00)
Mr.D.C.C. Jayasekara (Actg. Superintend)	97,214.25	97,214.25
Mr.Buddhi Jayathilake (Asst. Superintend)	34,440.53	34,440.53
Mr.M K D Priyantha (Superintendent)	75,882.33	72,852.56
Mr. Dayananda (B/L Supply)	441.54	441.54
Mr. Jayantha (B/L Supply)	1,448.07	1,448.07
Out Grower Payable	-	523.38
Odinton Estate (B/L Supplier)	78,662.52	-
Security Fund - Lamilier	4,700.00	4,950.00
	7,119,622.23	3,149,966.11

TEA RESEARCH BOARD
NOTES TO THE ACCOUNTS AS AT 31ST DECEMBER 2022

	2022 Rs. Cts	2021 Rs. Cts
PHDT Housing Loan Recovery	845.44	845.44
Bank of Ceylon (Recovery)	385,060.00	414,210.00
NHDA	23,148.90	23,148.90
Chapel A/C -St Anthony's Church	101,550.00	40,400.00
Staff Welfare	143,915.00	116,815.00
Iona Estate, Agarapatane	473,650.56	188,099.68
National Security A/C	750.00	750.00
Made up Cents	(1.60)	2,459.88
Inland Revenue Department	12,945.33	7,695.33
Macduf Estate (B/L Supply)	-	0.10
Lion Press A/C	2,458.00	2,458.00
Stock Suppliers A/C	4,742,543.58	6,826,218.98
Melton Estate (B/L Supply)	1,089,840.91	1,006,857.78
Tea Small Holder (B/L Supply)	439.00	43,610.26
Green Leaf Over kg 2021 Balance	-	1,110,880.00
Accured Expenditure	3,083,297.97	993,267.75
DIMO (B/L Supply)	1,070,778.45	-
Talawakale Hardware (B/L)	22,592.64	-
	11,153,814.18	**10,777,717.10**
St. Joachim Estate		
Unclaimed Bought Leaf	464,000.10	280,640.69
Check off	15,150.00	15,986.00
Fine A/C	47,624.42	47,624.42
Bought Leaf Suppliers A/C	15,536,665.17	7,199,532.54
Insurance Premium (Recovery)	205.49	205.49
Pay Card recovery	558.00	1,292.00
Bank Loan Recovery	132,050.00	99,200.00
Kovil Rcovery	-	2,928.63
Stamp Duty	9,600.00	8,400.00
Labour Welfare	12,953.32	12,953.32
Unclaimed wages	73,876.84	56,253.37
Estate Staff Medical Scheme	2,409,966.55	3,026,315.81
Staff Recovery	2,100.00	2,100.00
Cash in Transits A/C	47,102.65	105,741.43
Death Donation A/C	6,900.00	7,400.00
Harshani Water Supply Project	14,503.88	14,503.88
PHDT /EWHCSA	134,151.06	51,840.00
DCC Jayasekara WP KS 9386	-	45,160.00
Contract Nursery	122,200.00	534,976.00
TRISC Low Country	200.00	-
	19,029,807.48	11,513,053.58
Total Creditors & Payables	**39,976,518.73**	**33,514,930.73**

TEA RESEARCH BOARD
NOTES TO THE ACCOUNTS AS AT 31ST DECEMBER 2022

	2022 Rs. Cts	2021 Rs. Cts
Note 16		
Accured Expenses		
Creditors and Credit Balances		
Sundry Creditors	5,941,848.28	3,742,384.11
TSHDA Advance	480,000.00	480,000.00
Advance Receipts (Analytical Work)	24,775.00	1,543,530.00
Hantana Labour Wages	782,558.75	783,868.95
Kottawa Labour Wages	497,662.12	468,038.61
Passara Labour Wages	457,506.94	492,901.02
Deniyaya Laour Wages	76,757.01	108,454.42
Walahanduwa Labour Wages	46,300.00	53,200.00
Treasury Payable A/C	699,717.00	699,717.00
Skilled Workers Wages	31,043.01	26,609.12
Accrued Expenses	-	1,496,880.00
	9,038,168.11	9,895,583.23
St Coombs Estate		
Accrued Expenditure		
Check Roll	4,424,880.00	6,863,710.00
Sundry Creditors	473,304.60	383,491.14
ADB Payment	320,573.00	318,923.00
Outgrow Expenditure/Contract Plucking	387,450.00	-
	5,606,207.60	7,566,124.14
St Joachim Estate		
Accrued Expenditure		
Check Roll	2,262,485.76	2,610,620.00
Sundry Creditors	3,177,674.55	3,688,821.85
	5,440,160.31	6,299,441.85
Total Accrued Expenses	**20,084,536.02**	**23,761,149.22**

TEA RESEARCH BOARD
NOTES TO THE ACCOUNTS AS AT 31ST DECEMBER 2022
Note 17

Short-term Borrowings	2022 Rs. Cts	2021 Rs. Cts
Tea Research Institute		
Loan against FD - St. Coombs Estate	1,659,999.96	9,620,968.69
Loan against FD - St. Joachim Estate	23,839,054.38	18,827,192.77
	25,499,054.34	28,448,161.46
St. Coombs Estate		
Brokers Advanecs (Forbes & Walker)	-	-
		-
St. Joachim Estate		
Brokers Advanecs (Forbes & Walker)	-	-
Total Short-trem Borrowings	**25,499,054.34**	**28,448,161.46**

Note 18
Short-term Provisions

	2022 Rs. Cts	2021 Rs. Cts
Tea Research Institute		
Provision for Audit Fees	1,356,000.00	1,356,000.00
Provision Holiday Pay/Bonus	1,061,021.73	981,872.60
	2,417,021.73	2,337,872.60
St. Coombs Estate		
Provision for Holiday Pay	4,625,600.00	4,866,870.00
Provision for Attendance Bonus	289,000.00	325,500.00
Incentive Provision (2016)	382,335.63	382,335.63
Incentive Provision (2017)	906,670.16	906,670.16
Profit Share Bonus	40,500.00	-
	6,244,105.79	6,481,375.79
St. Joachim Estate		
Provision for Holiday Pay	1,943,531.39	1,973,675.92
Provision for Attendance Bonus	105,395.83	76,250.00
	2,048,927.22	2,049,925.92
Total Short-term Provisions	**10,710,054.74**	**10,869,174.31**

Note 19
Employee Benefits

	2022 Rs. Cts	2021 Rs. Cts
St.Coombs Estate		
Employees' Provident Fund	2,648,445.86	3,439,230.53
Employees' Trust Fund	361,151.86	449,745.37
	3,009,597.72	3,888,975.90
St. Joachim Estate		
Employees' Provident Fund	574,424.98	868,591.54
Employees' Trust Fund	104,030.66	108,510.00
	678,455.64	977,101.54
Total Employee Benefits	**3,688,053.36**	**4,866,077.44**

TEA RESEARCH BOARD
NOTES TO THE ACCOUNTS AS AT 31ST DECEMBER 2022

	2022 Rs. Cts.	2021 Rs. Cts.
Note 20		
On-Going Projects		
MPI Special Project Plant Breeding	(6,313,775.63)	(5,589,976.42)
MPI Special Project Physiology	3,454,049.82	3,454,049.82
MPI Special Project Engineering	1,903,091.43	3,989,301.25
CARP Special Project Entomology	1,615,141.06	1,621,651.06
MPI Special Project Engineering C Type Bungalow	13,167,288.42	10,676,236.44
ACMSC	2,595,458.89	2,783,806.08
Indo Sri Lanka Joint Research Project	294,524.50	416,339.86
FAO Passara	64,868.71	192,419.71
Synkromax Biotech Project	(285,265.97)	(285,265.97)
CARP Special Project Bio Chemistry	130,573.40	-
MPI Special Project 19 Eng 18Mn	48,906.72	48,906.72
MPI Special Project 19 Cap Equip 46	1,541,700.73	1,541,700.73
JIFF Products (Plant Breeding)	84,620.70	84,620.70
Michigen	555,834.88	688,600.00
JAT Agri	197,209.22	228,429.95
STaRR Project	(438,088.62)	(4,355,731.98)
CIC & TRI Tyara Project	838,186.40	838,186.40
Zagro Singapore Testing of Green Tea	18,327.78	110,643.75
Zagro Singapore Testing of Herbicide	185,081.12	185,081.12
Green Tea Extraction & Analysis Bio	27,800.00	27,800.00
Metabolic Profile	38,400.00	38,400.00
MPI Special Project 2020	3,376,395.59	3,078,873.34
Chopping & Trenching Machine (Advisory)	3,004,471.70	13,857,882.88
Mobile Laboratory (Advisory)	557,427.56	14,522,403.69
Experimental Tea Factory (Technology)	(66,021.74)	30,572,165.99
Automated Tea Harvester (Agronomy)	7,258,847.47	7,530,313.63
Seed Garden Establishment P/ Breeding	3,186,720.40	6,844,989.37
Promotion of Bio Petside P / Breeding	1,032,328.59	2,514,674.78
TEA Wine MOU	(187,137.20)	-
N - Tea Project	10,391,199.33	-
Mother Bush Expansion	15,677,584.00	-
WUE- University of Bristol	2,769,000.00	-
Testing Chloran- Innovative marketing	59,300.00	-
Total On-going Projects	**66,784,049.26**	**95,616,502.90**

	2022 Rs. Cts.	2021 Rs. Cts.
Note 21		
Provision for Gratuity		
Tea Research Institute		
Opening Balance as at 01/01/22	145,088,156.85	140,884,785.25
Add : Provision for the year	10,857,381.90	17,624,291.60
Under Provision	86,000.00	390,990.00
	156,031,538.75	158,900,066.85
Less : Paid During the year	4,557,424.00	13,774,785.00
Over Provision	165,200.00	37,125.00
Closing balance as at 31/12/22	**151,308,914.75**	**145,088,156.85**
St.Coombs Estate		
Opening Balance as at 01/01/22	95,827,068.75	69,330,847.75
Add : Provision for the year	5,752,422.00	5,919,000.05
Under Provision	-	24,238,454.70
	101,579,490.75	99,488,302.50
Less : Paid During the year	9,847,720.40	3,661,233.75
Over Provision	2,099,649.11	-
Closing balance as at 31/12/22	**89,632,121.24**	**95,827,068.75**
St. Joachim Estate		
Opening Balance as at 01/01/22	24,559,060.38	20,275,286.38
Add : Provision for the year	1,562,562.50	1,517,735.00
Under Provision	1,608,896.50	4,548,550.00
	27,730,519.38	26,341,571.38
Less : Paid During the year	1,330,000.00	1,775,000.00
Over Provision	231,916.00	7,511.00
Closing balance as at 31/12/22	**26,168,603.38**	**24,559,060.38**
Total Provision for Gratuity	**267,109,639.37**	**265,474,285.98**

TEA RESEARCH BOARD
NOTES TO THE ACCOUNTS AS AT 31ST DECEMBER 2022

	2022 Rs. Cts.	2021 Rs. Cts.
Note 22		
Petrol Deposit Refundable		
Opnenig Balance as at 01/01/2022	11,000.00	12,800.00
Add:- Additions during the year 2022	250.00	250.00
	11,250.00	13,050.00
Less:- Refunds during the year 2022	500.00	2,050.00
Closing Balance as at 31/12/2022	10,750.00	11,000.00
Note 23		
Long-term Borrowings		
Tea Research Institute		
Loan against FD - St. Coombs Estate	5,201,666.94	6,861,666.90
Loan against FD - St. Joachim Estate	7,074,800.00	10,085,645.44
	12,276,466.94	16,947,312.34
Note 24		
Grants and Reserves		
Tea Research Institute		
Government Grants	134,428,046.00	163,986,495.91
Treasury Grant Duke's Bungalow	24,500.00	28,000.00
Capital Reserve - National Scientific	-	566,305.09
Capital Reserve - ADB	70,562,506.25	73,516,253.25
Capital Reserve - ARP	5,345,787.17	5,602,653.79
Capital Replanting - SLTB	1,109,975.00	1,109,975.00
Special Project - 30Mn 2016	1,996,069.82	1,996,069.82
Special Project - 30Mn 2017	973,169.66	973,169.66
Capital Grants - Save the Children (St.Coombs) 2017	1,600,000.00	1,600,000.00
Capital Reserve 30Mn Special Project - 2017	1,554,714.02	6,709,620.48
Capital Reserve 30Mn Special Project - 2016	218,937.43	1,755,104.65
Capital Reserve Indo Sri Lanka Joint Reserch Project	289,023.25	625,810.75
Capital Reserve Special Project Physiology	21,235.62	44,235.62
Capital Reserve Special Project Plant Breeding	1,597,057.87	1,881,678.62
Capital Reserve Special Project ACMSC Unipower Project	18,745.21	40,745.21
Capital Reserve Special Project 2019	27,613,841.02	35,018,177.73
Capital Reserve Special Project 2018 - 99Mn	73,899,379.41	75,579,855.16
Capital Reserve Tresuary Special Project - Bio Chemistry	142,555.53	513,847.74
Capital Reserve Michigen	108,200.05	122,340.05
Capital Reserve STaRR Project	9,505,683.25	11,659,432.80
Capital Reserve MPI Special Project 2020	27,784,930.27	18,723,924.27
Capital Reserve Experiment Tea Factory	12,155,167.48	13,936,679.29
Capital Reserve Supporting Genetic Improvement of P/Breeding	4,532,884.79	5,295,798.93
Capital Reserve Automated Tea Harvester	914,697.79	-
Capital Reserve MPI Special Project Bio Pesticides	16,176,048.07	-
Capital Reserve Mobile Laboratory	20,590,315.71	-
Capital Reserve Chopping & Trenching	9,905,068.08	-
Capital Reserve Seed Garden Establishment	91,898.04	-
	423,160,436.79	**421,286,173.82**
St. Coombs Estate		
PHDT Grant	2,159,783.22	2,221,336.95
	2,159,783.22	**2,221,336.95**
Total Grants & Reserves	**425,320,220.01**	**423,507,510.77**

TEA RESEARCH BOARD
NOTES TO THE ACCOUNTS AS AT 31ST DECEMBER 2022

	2022 Rs. Cts	2021 Rs. Cts
Note 25		
Government Funds (Recurrent)		
Government Grants Received for Recurrent Expenditure	419,900,000.00	383,500,000.00
Total Government Funds (Recurrent)	**419,900,000.00**	**383,500,000.00**
Deferred Income (Capital)		
Deferred Income from Government Grants Received for R & D &Capital Asset	56,558,449.91	53,008,867.38
Deferred Income from other Grants	32,773,053.38	30,889,572.39
Total Deferred Income (Capital)	**89,331,503.29**	**83,898,439.77**

	2022	2021
Note 26		
Other Income		
Sales of Colonal Cuttings		
TRI Hantane	438,600.00	763,650.00
TRI Kottawa	468,000.00	967,127.50
TRI Passara	977,100.00	966,675.00
TRI Deniyaya	8,362.50	44,063.00
	1,892,062.50	2,741,515.50
Sales of Green Leaf		
TRI Talawakelle	451,780.25	298,920.75
TRI Hantane	1,591,598.86	1,893,202.32
TRI Kottawa	5,319,567.50	2,383,438.83
TRI Passara	4,149,594.06	2,162,091.61
TRI Deniyaya	838,265.38	583,978.65
	12,350,806.05	7,321,632.16
Net Sales of VP Plant		
TRI Hantane	(143,081.64)	(132,346.70)
TRI Kottawa	(76,083.70)	60,559.38
TRI Deniyaya	(17,516.55)	29,104.00
TRI Passara	187,235.68	22,312.75
TRI Ratnapura	-	-
	(49,446.21)	(20,370.57)

Cont'd…

TEA RESEARCH BOARD
NOTES TO THE ACCOUNTS AS AT 31ST DECEMBER 2022

	2022 Rs. Cts	2021 Rs. Cts
Miscellaneous		
Sales of Publication	1,213,496.00	148,300.00
Interest & Rental	1,076,437.11	1,018,864.48
Analytical Services	16,897,565.00	5,337,115.00
Income From Bond	4,455,000.00	-
Miscellaneous	4,199,944.53	1,777,466.34
	27,842,442.64	8,281,745.82
Interest on Investment	12,247,160.78	4,712,672.30
	12,247,160.78	4,712,672.30
Total Other Income	**54,283,025.76**	**23,037,195.21**

Note 27
P/L from Two Estates

	2022 Rs. Cts	2021 Rs. Cts
Net Profit from St. Coombs Estate ***(Schedule - A)***	61,066,755.54	(41,052,214.62)
Net Loss from St. Joachim Estate ***(Schedule - B)***	47,872,363.18	(11,609,477.33)
Net Profit / (Loss) From Estates	**108,939,118.72**	**(52,661,691.95)**

Note 28
Expenses

	EXPENDITURE	Administration Finance and Common Service	Advisory, Extensions & Publicity	Substation Ratnapura Hantane	Research	2022 Rs. Cts Total	2021 Rs. Cts Total
01	Personnel Emoluments	87,092,986.17	40,039,840.82	37,816,013.26	106,470,859.59	271,419,699.84	235,596,836.14
08	Pensions and Retirement Benefits	10,366,383.07	5,153,721.30	3,778,856.52	14,284,741.04	33,583,701.93	31,725,866.02
08	Gratuity Provision	10,757,623.80				10,757,623.80	17,980,744.10
02	Travelling	1,191,308.75	694,724.74	520,457.05	829,822.57	3,236,313.11	2,449,822.34
03	Supplies and Requisites	12,686,798.97	2,759,632.76	3,176,785.13	5,769,967.70	24,393,184.56	12,746,742.36
04	Repairs and Maintenance of Capital Assets	18,759,263.00	1,626,046.39	3,694,936.19	1,669,713.45	25,749,959.03	24,524,255.83
04	Depreciation of Fixed Assets	102,320,372.00				102,320,372.00	71,448,625.04
05	Security Services	13,455,372.51	3,577,202.63	8,072,635.27	1,591,258.40	26,696,468.81	26,660,341.39
05	Electricity	13,150,252.41	605,890.54	4,783,438.81	178,099.30	18,717,681.06	12,862,395.35
05	Communication	1,372,265.82	830,701.95	502,659.51	713,070.94	3,418,698.22	5,665,395.86
05	Transportation, Utility & Other Service	10,332,985.15	2,122,691.06	1,499,090.83	89,859.77	14,044,626.81	22,818,536.13
07	Contributions Grants & Subsidies	9,697,627.82	268,912.45	121,170.88	333,445.73	10,421,156.88	6,763,425.94
10	Media, Advertising, Publicity and Gifts	262,372.66	1,417,733.81	171,703.59	59,715.86	1,911,525.92	749,020.29
12	Miscellaneous -Other	6,065,603.90	32,554.70	398.00	138,540.50	6,237,097.10	3,604,018.28
	Research and Development					-	-
13.03	Chemical and Glasswares (Local & Foreign)	116,176.78	665,295.19	4,715.00	15,548,098.62	16,334,285.59	10,078,981.95
13.01	Cultivation and Field Trials	-	12,465,673.02	4,350,490.35	7,250,970.93	24,067,134.30	21,379,658.04
13.05	Nursery Expenditure - TRI	-	-	-	337,863.78	337,863.78	434,393.53
14.01	Training - Local	23,000.00	-	-	463,440.31	486,440.31	346,700.00
14.02	Training - Overseas	-	-	-	513,000.00	513,000.00	135,198.00
15	Special Project - TTO Project	-	-	-	4,100.00	4,100.00	9,200.00
15	Special Project - Plant Breeding	-	-	-	-	-	-
	Total Expenditure	**297,650,392.81**	**72,260,621.36**	**68,493,350.39**	**156,246,568.49**	**594,650,933.05**	**507,980,156.59**

METEOROLOGICAL OBSERVATIONS

TRI - St. Coombs, Talawakelle
(Lat. 6.54'N; Long. 80.42E; 1394 amsl)

Month	Air Temperature (^{0}C)		Soil Temp. (°C) 20 cm		Mean Relative Humidity		Mean Sunshine (hrs per Month)	Total Evaporation (mm)	Rainfall (mm/ month)	Wet days (No / Month	Velocity Mean (km/hr)
	Max	Min	8.30 am	3.30 pm	8.30 am	3.30 pm					
January	25.9	12.0	22.0	23.0	80	65	7.8	74.6	47.0	3	1.5
February	25.9	11.6	21.4	24.1	82	66	6.5	66.5	85.2	4	1.7
March	26.6	13.2	21.4	26.5	82	68	6.3	80.3	46.1	5	1.9
April	26.0	13.4	22.0	26.3	85	86	5.8	55.3	198.9	13	1.6
May	23.7	16.9	22.1	25.1	93	87	2.3	39.4	348.0	16	2.4
June	23.4	16.0	21.8	24.9	90	84	3.4	44.3	73.2	8	2.1
July	23.4	16.1	21.0	23.9	91	87	2.4	41.3	247.5	19	3.0
August	22.7	15.9	20.6	23.3	92	87	3.1	44.2	404.5	14	3.2
September	23.7	15.0	21.5	25.1	90	79	4.5	57.5	92.8	8	2.5
October	23.2	15.5	20.9	24.0	90	90	3.2	39.8	469.1	18	2.1
November	25.0	13.3	20.9	25.0	83	79	5.3	58.1	64.4	6	1.8
December	23.4	13.1	19.6	23.0	84	79	4.0	46.2	84.4	8	2.2
Total								647.6	2161.1	122.0	
Average	24.3	14.5	21.2	24.7	87.5	81.1	4.3	52.1	192.2	10.8	2.2

TRI Low-Country Research, Advisory and Extension Centre, Ratnapura

(Lat. 6° 43'N; Long. 80° 21' E; 29m amsl)

Month	Mean Temperature		Mean Relative Humidity		Mean Sunshine hrs per day	Rainfall Total (mm)	Wet days	Evaparation (mm)	Mean velocity (km/h)
	Min.	Max.	1.30am	3.30 pm					
January	22.3	34.7	87.0	66.0	6.0	115.7	6	106.3	1.0
February	22.7	34.9	87.0	64.0	5.2	115.6	7	77.4	0.8
March	23.6	34.5	87.0	73.0	4.5	237.1	12	100.7	1.5
April	23.8	34.2	87.0	77.0	4.5	336.2	13	83.5	1.1
May	24.5	32.0	88.0	80.0	1.9	851.8	26	52.6	1.4
June	24.2	32.1	88.0	78.0	2.8	300.9	22	104.8	1.7
July	24.4	32.1	87.0	76.0	3.9	280.5	12	99.4	2.6
August	23.9	31.4	86.0	78.0	4.2	533.4	17	127.1	2.6
September	23.2	32.4	85.0	77.0	5.3	260.9	11	98.3	3.3
October	23.4	31.2	89.0	82.0	2.3	887.6	26	58.0	1.5
November	22.7	32.5	87.0	74.0	4.6	500	17	82.0	1.4
December	22.3	31.9	87.0	75.0	3.8	356.8	12	104.0	1.3
Total						4776.5	181.0	1093.9	
Mean	23.4	32.8	87.1	75.0	4.1	734.8	27.8	168.3	1.7

TRI Mid-Country Research, Advisory and Extension Centre, Kandy

(Lat. 7.26' N; Long. 80.63 Elevation 762 m amsl)

Month	Air Temperature (^{0}C)		Soil Temp. (°C) 20cm		Mean Relative Humidity		Mean Sunshine hrs per day	Evaporation. (mm)	Rainfall (mm)	Wet days (No /Month)	Mean Velocity (km/hr)
	Max.	Min.	8.30 am	3.30 pm	8.30 am	3.30 pm					
January	27.8	18.8	23.9	26.3	81.8	71.1	6.6	72.8	56.2	3	3.5
February	29.3	18.8	25.1	28.0	81.9	67.9	6.2	78.8	25.7	3	3.4
March	29.8	19.9	33.8	29.3	85.4	69.9	6.2	80.5	11.4	6	2.1
April	29.4	20.2	25.7	28.0	89.1	82.1	5.3	56.6	266.1	14	1.1
May	27.2	20.9	25.3	27.2	89.3	83.4	3.3	39.9	231.5	16	2.7
June	27.8	20.6	25.0	28.0	86.3	81.2	4.7	58.9	16.9	3	2.6
July	26.9	20.2	24.3	26.6	89.9	83.0	3.2	46.2	270.2	13	3.4
August	26.6	19.9	23.8	26.0	92.4	86.5	3.5	47.8	346.1	10	2.4
September	26.6	19.5	24.4	27.3	88.4	80.5	5.6	60.1	256.5	6	2.3
October	25.2	19.5	23.9	25.2	91.7	88.2	3.2	35.4	291.2	18	1.5
November	25.5	18.9	23.7	25.4	90.3	81.1	5.3	35.2	337.6	9	1.4
December	24.4	18.4	22.9	24.0	88.1	85.0	3.2	42.9	336.4	15	2.20
Total								655.1	2445.8	116.0	
Average	27.2	19.7	25.3	26.8	88.4	80.8	4.5	52.9	217.2	10.3	2.3

TRI Advisory and Extension Centre, Passara

(Lat. 6.57'N; Long. 81.07 E; 1120m amsl)

Month	Mean Temperature		Mean Relative Humidity		Mean Sunshine hrs per day	Rainfall Total (mm)	Wet days	Evaporation (mm)
	Max	Min	8.30am	3.30 pm				
January	25.5	16.5	78	74	4.8	61.5	8	65.7
February	25.8	16.4	75	70	5.0	77.7	8	63.6
March	28.0	19.2	80	74	6.5	32.6	3	102.3
April	24.7	18.4	81	79	3.3	408.9	23	35.1
May	27.4	19.4	73	69	3.5	90.7	8	56.1
June	26.3	18.4	79	75	3.5	202.7	12	35.7
July	26.9	18.7	80	72	3.2	254.7	15	39.7
August	26.2	18.5	79	79	3.5	158.4	10	72.5
September	25.5	17.5	79	72	3.6	51.1	5	49.5
October	25.6	18.0	81	80	2.8	254.5	12	37.2
November	23.2	15.2	78	81	3.0	197.4	8	39.0
December	24.5	17.3	85	85	2.2	116.5	11	40.3
Total						1906.7	123.0	636.7
Mean	25.8	17.9	79.2	76.1	3.6	167.7	10.5	51.9

TRI Advisory and Extension Centre, Kottawa

(Lat. 6.05'N; Long. 80 E; 30 m amsl)

Month	Mean Temperature		Mean Relative Humidity		Mean Sunshine hrs per day	Total Rainfall (mm)	Wet days	Evaparation (mm)	Mean velocity (km/hr)
	Max	Min	8.30am	3.30 pm					
January	31.9	22.1	86	69	8.0	85.5	8	77.8	1.19
February	32.7	22.2	88	73	6.4	144.1	7	71.7	1.16
March	32.3	23.1	88	75	7.0	102.6	9	86.8	1.49
April	31.9	23.1	88	78	6.2	362.7	15	63.3	1.29
May	30.3	24.0	91	79	3.8	641.1	28	65.7	2.33
June	30.1	24.0	90	76	6.5	234.0	18	66.6	1.96
July	30.1	23.9	89	81	4.7	208.6	11	46.2	2.36
August	30.0	23.7	87	75	6.8	258.4	16	52.7	2.95
September	30.1	23.4	87	74	7.1	102.8	16	74.1	2.39
October	29.6	23.3	90	82	4.3	519.3	24	53.0	2.02
November	30.9	22.2	88	73	6.2	293.4	14	57.9	1.17
December	30.5	21.6	88	76	5.0	196.3	14	62.3	0.99
Total						3148.8	180	778.1	
Mean	30.9	23.1	88.3	75.9	6.0	262.4	15.0	64.8	

TRI Advisory and Extension Centre, Deniyaya

(LAT 6° 43´ N; Long. 80°E 33.3; 250m amsl)

Month	Mean Temperature		Mean Relative Humidity		Mean Sunshine hrs per day	Total Rainfall (mm)	Evaporation (mm)	Wet days
	Max	Min	8.30am	3.30 pm				
January	30.3	19.0	78	66	7.6	174.7	2.6	18
February	30.5	19.4	80	70	6.8	167.3	2.9	9
March	30.8	20.1	76	66	6.8	165.4	3.0	11
April	30.5	20.0	77	78	6.6	626.1	2.5	25
May	28.7	21.7	80	76	5.4	671.7	2.2	23
June	28.8	22.2	79	70	6.9	141.4	2.6	21
July	28.9	22.2	78	69	6.5	386.3	2.7	17
August	24.7	22.1	78	69	6.0	358.9	2.7	17
September	^-	21.9	76	68	7.2	166.7	2.7	12
October	29.6	21.3	79	77	3.5	448.8	1.7	24
November	29.2	20.2	76	70	6.0	548.8	2.4	19
December	28.9	20.1	77	67	4.5	213.1	2.0	17
Total					73.7	4069.2	30.0	177
Mean	29.2	20.8	78.0	70.4	6.1	339.1	2.5	

REPORT OF THE AUDITOR GENERAL

English translation of the Auditor General Report of National Audit Office, Reference No. PAL/D/TRB/1/2022/03 dated 22.08.2023 received on 15.09.2023 attched for information.

PAL/D/TRB/1/2022/03 22 August 2023

The Chairman
Tea Research Board

Report of the Auditor General on the Financial Statements and Other Legal and Regulatory Requirements of the Tea Research Board for the year ended 31 December 2022 in terms of Section 12 of the National Audit Act, No. 19 of 2018.

The above report is sent herewith.

W.P.C. Wickramarathne

Auditor General.

Copies ; 01. Secretary, Ministry of Plantation Industries

02. Secretary, Ministry of Finance, Economic Stabilization and National Policies

PAL/D/TRB/1/2022/03 22 August 2023

The Chairman
Tea Research Board

Report of the Auditor General on the Financial Statements and Other Legal and Regulatory Requirements of the Tea Research Board for the year ended 31 December 2022 in terms of Section 12 of the National Audit Act, No. 19 of 2018.

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1 . Financial Statements

1.1 Qualified Opinion

The audit of the financial statements of the Tea Research Board for the year ended 31 December 2022 comprising the statement of financial position as at 31 December 2022 and the statement of financial performance, statement of changes in equity and the cash flow statement for the year then ended, and the notes in relation with the financial statements, including a summary of significant accounting policies 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 provisions of the National Audit Act No. 19 of 2018, Tea Research Board Act No. 52 of 1993 and Finance Act No. 38 of 1971 . My report to Parliament in pursuance of provisions in Article 154 (6) of the Constitution will be tabled in due course.

In my opinion, except for the effects of the matters described in the basis for Qualified Opinion section of my report, the accompanying financial statements give a true and fair view of the financial position of the Board as at 31 December 2022 and of its financial performance and its cash flows for the year then ended in accordance with Sri Lanka Public Sector Accounting Standards .

1.2 Basis for Qualified Opinion

(a) Out of the machinery and equipment cost at Rs. 410,563,413 at the end of the year under review, although the machinery and equipment cost at Rs. 210,645,678 for which were fully depreciated and still being used , actions had not been taken to restate its useful life as per Paragraph 65 of Sri Lanka Public Sector Accounting Standard 07.

(b) Although the, revenue associated with the transaction shall be recognized by reference to the stage of completion of the transaction at the reporting date in terms of Paragraph 19 of Sri Lanka Public Sector Accounting Standards 10, though the estimated analytical fees amounted to Rs.2,822,425 for the soil samples received for laboratory tests from plantation owners and plantation companies were recognized as an income in the year under review, since the money had not been received or tests had been carried out for it so far, the income of the year had been over-calculated by that amount.

(c) When an uncertainty arise about the collectability of an amount already included in revenue, the uncollectable amount, or the amount in respect of which recovery has ceased to be probable, is recognized as an expense in terms of Paragraph 21 of Sri Lanka Public Sector Accounting Standards 10, it had not been so done in relation to analysis fees that have been accounted for in the years 2020 and 2021 amounted to Rs. 328,920 for which no analysis activities had been done so far.

(d) There are 5,654 number of tall shade trees such as mahogany, jackfruit and eucalyptus existed at the Regional Offices of Thalawakelle, Ratnapura, Hanthana, Passara and Kottawa had not been recognized as biological assets and valued and accounted for in accordance with Paragraphs 13 and 16 of Sri Lanka Public Sector Accounting Standards 18 .

(e) Three vehicles registered under the Sri Lanka Tea Board had been revalued for Rs. 3,735,000 and included in the financial statements of the Tea Research Board and the ownership of those vehicles had not been taken over to the Tea Research Board. Likewise, there was no even a disclosure made about this in the financial statements.

(f) Since the depreciation value of machinery and equipment in the year under review amounted to Rs.382,787 and the opening balance of accumulated depreciation value amounted to Rs.91,712 had been overstated, the net value of machinery and equipment had been understated by Rs.474,499 by the end of the year 2022 .

(g) The depreciation value of 9 types of assets such as buses, equipment and roads which had been capitalized in the year under review cost at Rs. 23,873,451 had been over-calculated by Rs.313,122 due to an error in computation.

(h) The Board had constructed Regional Office buildings in Walahandua, Deniya and Kottawa in lands belonging to the Land Reform Commission, Thalawakelle Plantation Company and the Government respectively at a cost of Rs.72,956,788 and accounted for as assets of the Board. Even though the lands had not been transferred in the name of the Board, the disclosures had also not been made about it in the financial statements.

I conducted my audit in accordance with Sri Lanka Auditing Standards (SLAuSs) . My responsibilities, under those standards are further described in the Auditor's Responsibilities for the Audit of the Financial Statements section of my report. I believe that the audit evidence I have obtained is sufficient and appropriate to provide a basis for my qualified opinion.

1.3 Other Information Included in the Annual Report 2022 of the Board

The other information comprises the information included in the Annual Report 2022 of the Board, but does not include the financial statements and my auditor's report thereon, which I have obtained prior to the date of this auditor's report. The Management is responsible for these other information.

My opinion on the financial statements does not cover the other information and I do not express any form of assurance conclusion thereon.

In connection with my audit of the financial statements, my responsibility is to review the other information identified above and, in doing so, consider whether the other information is materially inconsistent with the financial statements or my knowledge obtained in the audit or otherwise appears to be materially misstated.

When reading the Board's 2022 Annual Report, if I conclude that there are material misrepresentations, the matters should be communicated to the controlling parties for correction. If there are any further uncorrected misrepresentations,

If, based on other information obtained by me and work performed by me prior to the date of this auditor's report, I conclude that this other information is materially misstated, I need to report that fact. I have nothing to report in this regard, those will be included in the report tabled by me in Parliament in due course in accordance with Article 154 (6) of the Constitution.

1.4 Responsibilities of Management and Those Charged with Governance for the Financial Statements

Management is responsible for the preparation of financial statements that give a true and fair view in accordance with Sri Lanka Public Sector Accounting Standards, and for such internal control as Management determine is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, Management is responsible for assessing the Board's ability to continue as a going concern and it is also the responsibility of Management to keep accounts on a going concern basis and to disclose matters related to the going concern of the Board except for the Management intends to liquidate the Board or cease operations in the absence of any other alternative.

Those charged with governance are responsible for overseeing the Board's financial reporting process.

As per Section 16 (1) of the National Audit Act No. 19 of 2018, it is required to maintain proper books and records of all its income, expenditure, assets and liabilities, to enable annual and periodic financial statements to be prepared of the Board.

1.5 Auditor's Responsibilities for the Audit of the Financial Statements

My objective is to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes my opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with Sri Lanka Auditing Standards will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

As part of an audit in accordance with Sri Lanka Auditing Standards, I exercise professional judgment and maintain professional scepticism throughout the audit. I also:

- Identifying and assessing the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for my opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.

- Though an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances was obtained, it was not for the purpose of expressing an opinion on the effectiveness of the internal control.

- Evaluated the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by the Management.

- Concluded on the appropriateness of the Management's use of the going concern basis of accounting and based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the Board's ability to continue as a going concern. If I conclude that a material uncertainty exists, I am required to draw attention in my auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify my opinion. However, future events or conditions may cause to cease to continue as a going concern.

- Evaluated the overall presentation, structure and content of the financial statements, including the disclosures, and whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.

I communicate with those charged with governance regarding, among other matters, significant audit findings, including any significant deficiencies in internal control that I identify during my audit.

2. Report on Other Legal and Regulatory Requirements

2. 1 Special provisions for following requirements are included in the National Audit Act, No. 19 of 2018 .

2.1.1 I have obtained all the information and explanation that required for the audit and as far as appears from my examination except for the impact of the matters described in the section on the Basis for the Qualified Opinion in my report and proper accounting records had been kept by the Board as per the requirement of Section 12 (a) of the National Audit Act, No. 19 of 2018.

2.1.2 The financial statements presented by the Board is consistent with the preceding year as per the requirement of Section 6 (1) (d) (iii) of the National Audit Act, No. 19 of 2018 .

2.1.3 The financial statements presented includes all the recommendations made by me in the previous year as per the requirement of Section 6 (I) (d) (iv) of the National Audit Act, No. 19 of 2018, except for the observations in Paragraphs 1.2 (d) and (e) of this report.

2.2 Based on the procedures performed and evidence obtained were limited to matters that are material, nothing has come to my attention to make declaration on following;

2.2.1 To state that any member of the governing body of the Board has any direct or indirect interest in any contract entered into by the Board which are out of the normal cause of business as per the requirement of Section 12 (d) of the National Audit Act, No. 19 of 2018 .

2.2.2 To state that the Board has not complied with any applicable written law, general and special directions issued by the governing body of the Board as per the requirement of Section 12 (f) of the National Audit Act, No. 19 of 2018 except for the observations appear below;

	Reference to Laws , Rules Directives	Observation
(a)	Financial Regulation of Democratic Socialist Republic of Sri Lanka	
(i)	F. R. 571 (3)	Actions had not been taken even by the end of the year under review to settle a sum of Rs.449,198 retained from contracts from the year 2015 to 2019.
(ii)	F. R. 756 (9)	Although the Board should conduct the Annual Board of Survey as per the time frame for completion and the Board of Survey Reports should be forwarded to the Auditor General before June 15 of the next financial year, the reports for the years 2021 and 2022 had not been submitted to the Auditor General by 31 July 2023 .

2.2.3 To state that it had not performed according to Board's powers, functions and duties as per the requirement of Section 12 (g) of the National Audit Act, No. 19 of 2018 .

2.2.4 To state that the resources of the Board had not been procured and utilized economically, efficiently and effectively within the time frames and in compliance with the applicable laws as per the requirement of Section 12 (h) of the National Audit Act, No. 19 of 2018 .

2.3 Other Matters

(a) The Staff Provident Fund of the Tea Research Institute under Section 27 (1) of the Employees Provident Fund Act No. 15 of 1958 had been certified by the Labour Commissioner on 30 October 2014 as an approved provident fund from 01 June 1959. Although the Board of Trustees of the Fund should be consisted 07 members including, the Director of the Tea Research Institute (Chairman of the Board of Trustees), 02 members nominated by the Chairman of the Fund from among the Directors and two members appointed by the Annual General Meeting from among the members of the Fund, two officers who are not members of the Fund nominated by the Sri Lanka Tea Board in terms of Section 4 (i) of the Code of Management Rules of this Provident Fund, the Chairman had not appointed the two members of the Tea Board to the Board of Trustees even by the date of audit 31 July 2023 .

(b) Although there is a debtor balance of 10,299,327 in the financial statements as lost amount for more than 05 years due to the financial fraud committed by two Accountants of the Board and three Factory officials in 2017 and 2018 because of internal control weaknesses at St. Coombs Estate, the Board had not taken actions to complete the relevant investigations and recover the money from the responsible parties.

(c) The equipment purchased from India (Walk in Type Environmental Controlled Facility) on 24 November 2017 at a cost of Rs.12,554,583 to study adaptive responses of tea plant to climate changes under special projects of the Board had remained inactive and could not be used for research though 5 years had elapsed, due to non-conformance to the expected specifications and lack of performance of it at the expected level.

(d) Due to the violation of the contracts entered into with the Board from the year 2005 to 2009 by 04 officers who did not return to duties from abroad after taking study leave with full pay and left the service before the end of the compulsory service period after returning to work, the relevant bond value of Rs.15,054,891 had not been recovered even by the end of the year 2022.

(e) A sum of Rs. 527,414 receivable to the Tea Small Holdings Development Authority, the Ministry of Plantation Industries and the Tea Board on tea sales had been included in the Sundry Debtors Account of St. Coombs Estate for more than three years and the said amount had not been recovered even at the end of the year under review.

(f) Actions had not been taken complete the works of planting rubber trees, establishing a processed container showroom for a tea shop and preparing a file rack and to adjust a sum of Rs. 1,296,164 remained in the work-in-progress account in the years 2017, 2018 and 2020 related to that even by the end of the year under review.

(g) The balances of Rs. 480,000 and Rs.699,717 respectively which were to be settled by the Board to the Tea Small Holdings Development Authority and the General Treasury over 03 years had not been settled at the end of the year under review and even though the amount of Rs. 110,224 which was additionally spent in the year 2018 for the Special Project on Mechanization had been shown in the financial statements as an amount due from the Treasury, actions had not been taken to reimburse it even by the date of audit.

(h) Actions had not been taken to settle creditor balances totaling Rs. 1,906,780 payable to various wholesale suppliers of St. Coombs Estates for years 02 to 10 or make necessary adjustments for the same if it is confirmed that there was no claim at the end of the year under review.

(i) Although a receivable balance of Rs. 937,102 has been carrying forward from the year 2017 due to inability to recover festival advance and other special advances granted to check roll employees of St. Coombs Estate, actions had not been taken to recover or settle it. It was also observed that there are no schedules to identify Rs. 912,696 included in the above receivable balance.

(j) Even though the 1.367 hectare in extent of Lamelyer Estate, Thalawakelle owned by the Tea Research Institute, the factory and all the buildings had been leased out to a private company in 2003 for a period of 50 years, even though the property in question had been repossessed in the year 2016, due to failure of paying rent as per agreement, thus the 07 years had elapsed from the date of acquisition to 07 June 2023, those assets remained idle without being utilized.

(k) The contract was handed over to Sri Lanka Telecom Service Limited on 22 April 2020 for an amount of Rs. 4,228,700 to design, implement and maintain a Management Information System for the Sri Lanka Tea Research Board and an advance amount of Rs. 1,141,749 had been paid to the Company on 20 August 2020. Although the works should be completed within 120 days from the date of issue of order according to the tender documents submitted by the service provider, though 3 years had elapsed by 30 June 2023, it was observed during the audit that its progress was only 51 per cent.

(l) The sundry income of the factory cannot cover any of its expenses as per the internal control recommendations of the Board and although it should bank if the sum of insurance coverage limit of Rs. 500,000 is exceeded, it was observed that the cases where the collected money of Rs.1,268,935 in December 2022 were retained in the factory for a period of 5 to 16 days from that date to the date of deposit, in the audit test check carried out on the daily cash collected at the St. Coombs Factory.

(m) Although there were 36 Senior Management posts in the approved cadre of the Board, 23 posts out of that were in vacant during the year under review. Although, among those vacant posts, 04 posts of Head of Division, 11 posts of Chief Research

Officer and 05 posts of Chief Advisory Officer should be filled through internal promotions, these posts have been vacant for more than 03 years.

(n) There were 52 per cent of the Operations and Advisory Officer posts, 42 per cent of Technical and Non-Technical Management Assistant posts, 55 per cent of Primary Level (Trained) posts and 46 per cent of Primary Level (Untrained) posts were vacant in the Board. Similarly, although there were 17 posts of Senior Academic and Research Officer and 27 posts of Academic and Research Officer, 5 and 14 posts were in vacant respectively by the end of the year under review. It was observed during the audit that the vacancy in these posts directly affects the continuation of the research activities of the institution .

(o) Although 93 employees who were recruited on temporary or casual basis for more than 180 days were given permanent appointments with effect from 24 October 2014, as per Public Administration Circular No. 25/2014 dated 12 November 2014, the approval of the Department of Management Services had not been obtained for the inclusion of those employees in the cadre of the Board.

(p) Preparation of a Procedural Rule Manual related to the formulation of rules and regulations for Human Resource Management and obtaining the approval of the Secretary of the Treasury had not been completed even in the year under review.

W.P.C. Wickramarathne
Auditor General