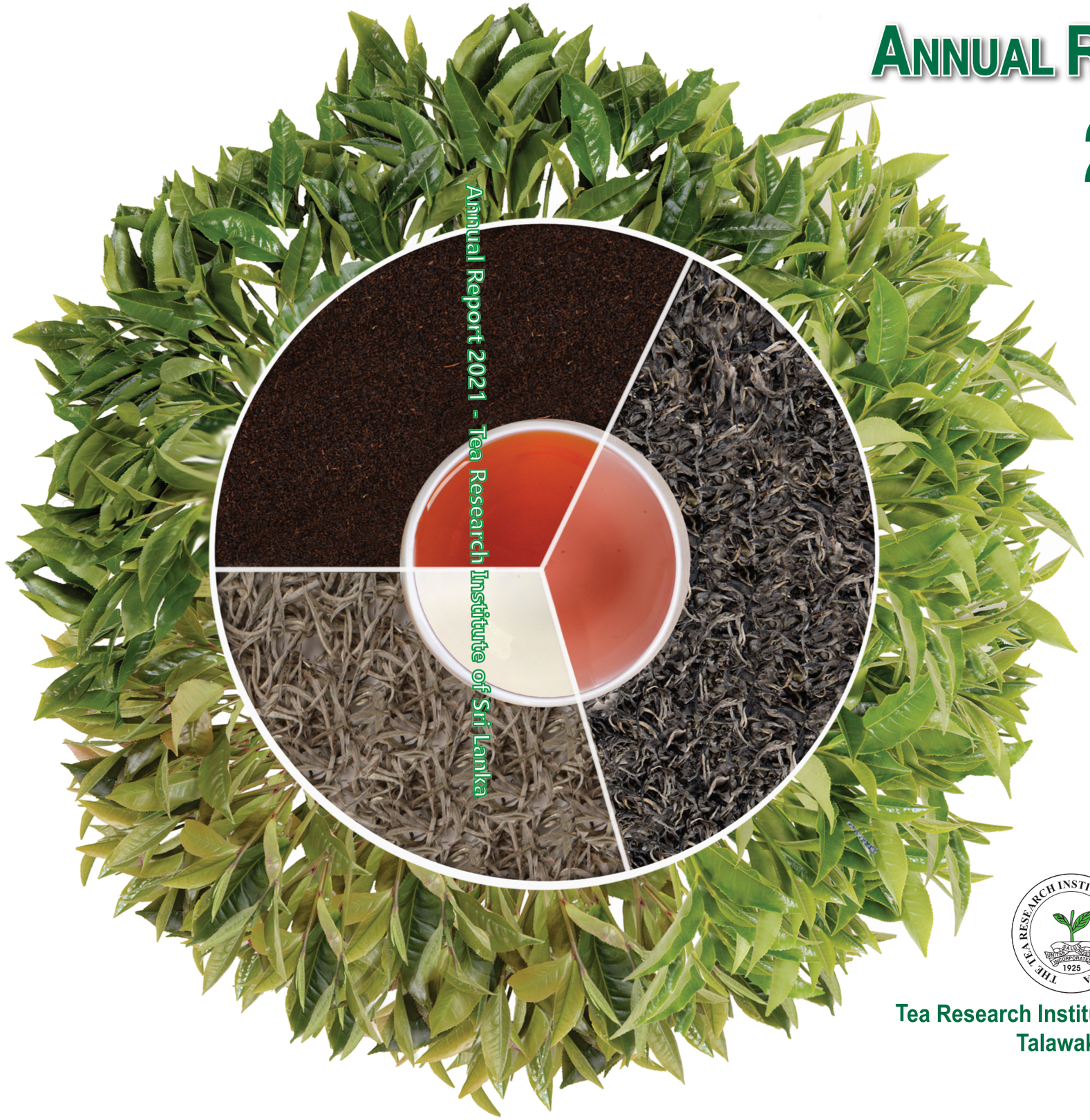
Annual Report

2021



Tea Research Institute of Sri Lanka
Talawakelle

Annual Report 2021



Tea Research Institute of Sri Lanka
Talawakelle
Sri Lanka

Annual Report 2021

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TRI 5000 Series for productivity, quality, sustainability and speciality: TRI recommended TRI 5002, 5005 and 5006 cultivars characteristics with high yield, quality, drought tolerance and resistance to Blister Blight and parasitic nematodes for Uva tea growing region of Sri Lanka. TRI 5006, a potential cultivar for producing “Sliver tips” and “Purple tea”.

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TEA RESEARCH INSTITUTE OF SRI LANKA

The Tea Research Institute of Sri Lanka (TRISL) was founded in 1925 in accordance with the provisions of an Ordinance passed in the Legislative Council of Ceylon to enrich the tea industry through professional tea research. The TRISL 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 TRISL 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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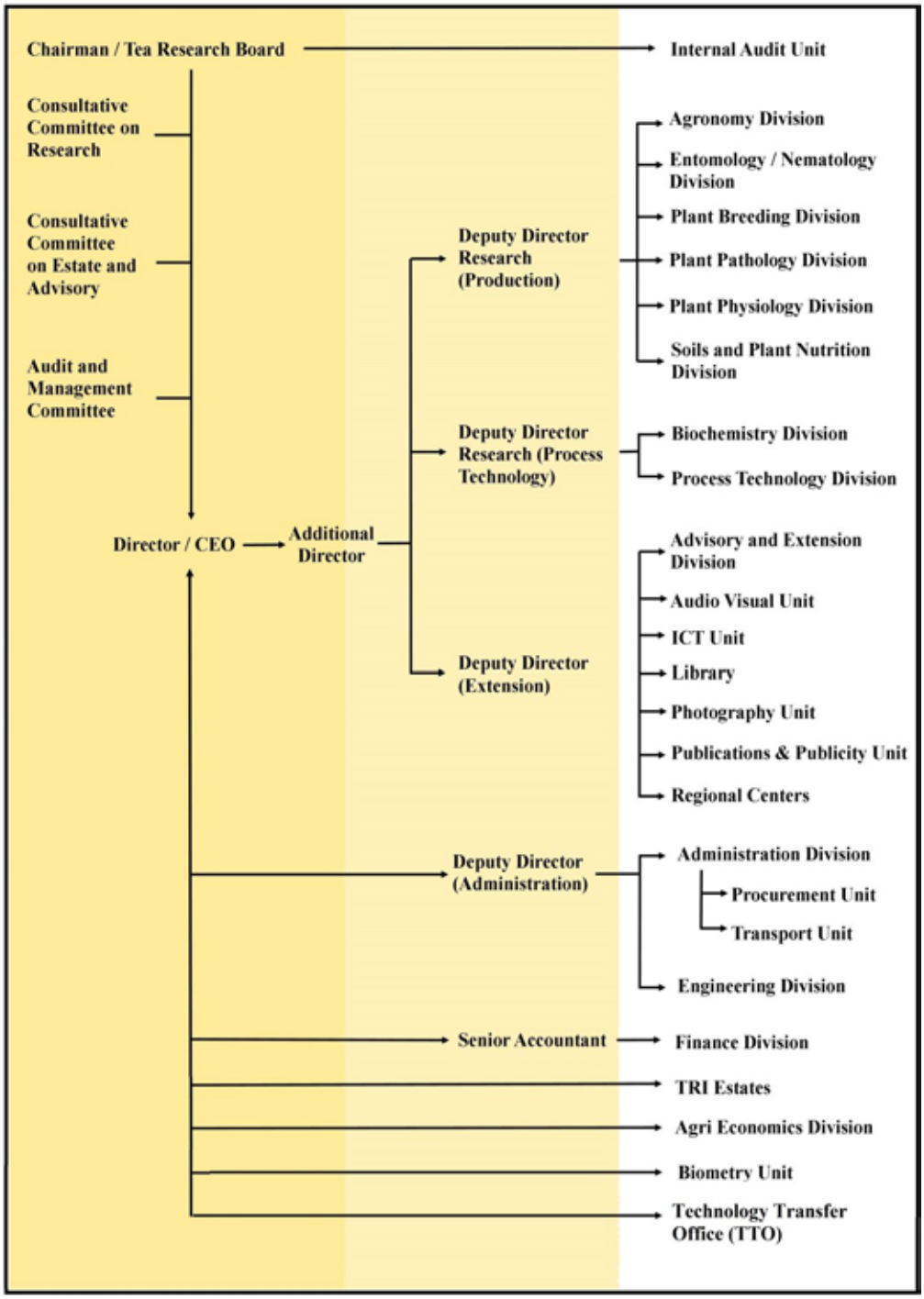
ORGANIZATIONAL STRUCTURE OF THE TRISL



REVIEW BY THE CHAIRMAN



Dr M W N Dharmawardene
Chairman
Tea Research Board

Introduction

The year 2021 under review was a good year for all rain fed crops in Sri Lanka including tea, being an *Enso* year, giving plenty of rainfall throughout the year, keeping soils near field capacities. Even with shortages of some inorganic fertilizers experienced during the year, and disturbance to normal work routines, due to Covid-19 pandemic restrictions imposed by health authorities to contain the spread of the disease, an increased in made tea production by 20.64 million kilograms over the previous year (278.85 MKg) was possible giving a production (299.49) near to that of 2019 (300.12 MKg), a year which had no such imposed restrictions except less rainfall (Transue ratio (TR) ranged from 2.1, 2.7 and 3.9 at mid, up and low elevations respectively).

The significant difference between the year 2020 and the year under review 2021, was that the former had normal supplies of subsidized fertilizer, but less rainfall (TR range from TR 2.2, 2.5 and 2.9 in mid, up and low elevations respectively), while latter year had plentiful well distributed rainfall (TR ranged from 3.4, 4.0 and 4.5 at mid, up and low elevations) but less of imported fertilizer. Thus, even with a restricted supply of inorganic fertilizers, but with a well distributed good rainfall throughout the year, tea crop seemed to have responded positively by giving a crop volume almost similar to that of 2019 , which seems to indicate that rainfall and soil moisture content are the overriding environmental factors that determine the tea crop production in Sri Lanka, by conditioning all the other environmental factors including soil mineralization in the tea growing areas of Sri Lanka. It is evident from the above that, restoration of soil fertility status should include measures to restore water holding capacity of degraded tea soils as well, because predictions are that rainfall would be erratic and heavy due to climate change effects. Year 2021 also tells us, that these are pre-requisites to increase yield and crop volume from the current growing areas.

Restoration of fertility status including the water holding capacity of degraded tea soils

Some detailed studies had been done by TRI scientists as early as 2007 (Wijeratne *et al.*, 2007 in JNSF), on the above subject which now becomes increasingly relevant with climate change phenomenon taking its toll. In this

connection, I wish to highlight here that the tea industry stakeholders should begin serious dialogue on the same and make collective effort to take action on those priority factors that limit crop yield. It is apparent now that apart from the dearth of the availability of new high yielding clones amenable to climate change effects, tea production, year after year, is limited by moisture deficit and the degradation of soils in the tea growing areas. Immediate action should be made to restore soil fertility in degraded tea soils, together with agronomic practices to resolve soil moisture deficits as well, in order to rectify manageable factors that are now continually contributing to significant yield losses in the country.

This fact itself is evident from the variations of the Transue ratios and the made tea production for the three years mentioned above, for the tea growing areas of the country, which should give plenty of food for thought for research scientists and the professional cultivators of tea here. It is evident from the foregoing that, by practicing moisture conservation measures as recommended by TRI and perhaps improving on the same by site specific basis, from the present crop area as prevailed in 2021, Sri Lanka should be able to achieve a made tea crop volume above 300 million kilograms per year by using Farm Yard Manure or bulk manure at fifteen tons per annum in each of the four successive years on tea immediately prior to its being brought into bearing as recommended by Dr. T Eden, even if no imported chemical fertilizers would be available to the farmer at a reasonable price in the future. As suggested by him this requires that current monocrop tea cultivation be modified to a crop livestock integrated farming system which also assures the economic and environmental sustainability of the crop. Thus, in order to achieve a sustainable tea industry here, priority attention should be given to restore soil fertility and its water content at optimum levels throughout the year by improved agronomic practices for each of the AERs.

Although the weather was very favorable to tea cultivation, Covid-19 epidemic, having taken the foot hold in Sri Lanka in the previous year, continued unabated into the year 2021, limiting most of the activities, as it also spread to tea growing areas including Head Quarters of TRI at St. Coombs Estate by April 2021 forcing us to

close the TRI HQ campus for nearly one month. It is only with the island wide vaccination campaign by the government, some head way could be made thereafter in the latter part of the year to begin normal activities. This together with the limited movement of personnel, and other limitations in resources, already mentioned in my previous review, curtailed the activities planned by the TRI.

Some of the key achievements made during the year

As the general research programme consisting of major research thrusts, basic applied and supportive projects are detailed elsewhere, some key achievements that received the attention of the industry and the TRB during the year are only mentioned here:

- **Variety improvement programme**

  Three pre-commercials from TRI 5000 series were on evaluation in the Uva region for higher yields, with resistance to pest and diseases and tolerance to drought. Accessions 89 (TRI 5002), 199 (TRI 5005) and 243 (TRI 5006) recorded 18%, 16% and 1% yield increase over the standard cultivar TRI 2025 respectively. Accession 89 is highly resistant to blister blight disease, produces high quality black tea and high tolerant to drought. Accession 199 is high tolerant to drought, produces moderate quality black tea and shows stability and adaptability across locations. Accession 243 is highly resistant to blister blight disease and has the potential for producing White tea "silver tips". New high yielding drought tolerant, pest and disease resistance clones with high tea quality is the dream of all stakeholders. This multidisciplinary integrated programme supported by all the core divisions is being pursued with vigour but is limited by a narrow germplasm collection, support facilities and trained manpower. The collaborative project commenced with the University of Bristol, UK, the Royal Botanical Gardens at Kew, UK and Peradeniya University titled "Improving drought resistance and water use efficiency of tea in Sri Lanka" with the objective of identifying physiological parameters to strengthen cultivar screening for drought resistance in tea crop should prove useful in the future breeding programmes for drought tolerance and in mitigating climate change effects on tea cultivations here.

- **Integrated Nutrient Management for sustainable tea production**

  The Presidential Task Force was appointed by the Government, during the year to come up with proposals for "Creating a greener Sri Lanka with sustainable solutions to climate change effects". The Chairman, being a member of the task force, submitted a technical report together with Prof. B N F Basnayake, titled "Climate change mitigation through sustainable tea production for a greener Lanka" which, opened up discussions on new vistas in the integrated nutrient management of tea in Sri Lanka where it was shown that TRI fertilizer recommendations as practiced now, based on inorganic fertilizers, estimates based on yield goal approach, while actual recovery coefficients were much less had led to excessive urea applications

to tea soils which in the absence of bulk manures, could lead to degradation of soils due to heavy depletion of organic matter and the natural biome. The use of activated biochar has been shown to stimulate tea growth elsewhere and has been considered a suitable soil amendment to increase organic carbon, retain soil moisture and fertilizers allowing efficient use of inorganic fertilizers, avoiding pollution and excessive costs and wastage. TRI would commence experiments as appropriate now along the said directions after the committee appointed for the purpose of revision of existing fertilizer recommendations make their report paving way for creating a greener Sri Lanka with sustainable solutions to climate change effects. I am grateful to the scientists of the Consultative Committee on Research and the Director, TRI, for having agreed to make a critical scientific review of the existing fertilizer recommendations in the light of new findings already mentioned above to assure sustainability of the tea cultivation, which will lead to restoring soil health and minimizing climate change effects and to move towards a natural ecosystem dynamics. It is hoped that collaboration established between TRI and Arthur C. Clerk Centre for Modern Technologies would be most useful in this regard as well the collaborative efforts enlisted by TRI with the Swiss Federal Institute of Technology, Zurich and the University of Peradeniya on "Can organic farming practices increase nitrogen use efficiency and decrease nitrogen losses in mature tea plantations (*Camellia sinensis* (L.) O. Kuntze) in Sri Lanka?" using N15 enriched Urea fertilizer to trace pathways through measuring atom% excess N15 abundance.

- **Mechanization of farming practices in tea cultivation**
  As cost of manual labour contributes nearly 60-65% of COP of made tea, mechanization of field and factory practices through mechanization and their automation is a priority research area at TRI. Due to the lack of an Engineering Division, mechanization of field practices has been handled by the Agronomy Division while factory aspects had come under the purview of Technology Division of TRI. However, limitations to progress has been realized at all levels. As it was realized that best resources by way of professional Engineers and knowledge base are available at Institute of Engineers, Sri Lanka (IESL) and the Universities, a much-needed collaboration was forged between TRI and the said Institutions through IESL. IESL professional Engineers, University Academics in Engineering Faculties and TRI got together for a detailed discussion in the first quarter of 2021. This collaboration has led to the filing of a report by the “TRI- IESL (MESC) innovation committee for tea industry development” which has made a road map for priority collaboration between the Institutions including improvement to devices for tea plucking.

The other areas which have made notable advances are in the field of biological control of pests and diseases, reviving the collaboration on nano pesticide formulations and nano urea formulations with SLINTEC, continuing on the collaborative project with Atomic Energy Board of Sri Lanka to establish origin verification of made tea here, giving Chemical, Environmental and Geographical parameters to authenticate "Ceylon Tea", Technology Division of TRI devising a Heat control system which could save up to 30% heat energy during withering process of tea leaves during manufacturing and the policy decision to redevelop St. Joachim factory serving Low Country stakeholders, as the Process Technology Experimental Factory of TRI for Low Country and develop it as the model factory for orthodox black tea manufacture. It was decided that it be developed as a bought leaf factory on a business plan basis with capital infusion from government and other stakeholders to serve as the process technology experimental factory which would be used to authenticate manufacturing data required for regulatory purposes of the national tea industry. During the year, it was possible to carry out a complete boundary survey of St. Joachim Estate by the Surveyor Generals Department and identify all the encroachments.

- **Evidence based study on national yield decline in tea production**

  I am pleased to note here, that above study was carried out by TRI, after this was brought to the notice of the authorities by me at the annual technical briefing of TRI in December 2020. This was thereafter deliberated at the first CCR of the year under review, and decided that there was sufficient grounds to commission an evidence based study on the national tea production trends in the new millennium considering available data for period beginning 2003-2012 (period 1) and compare that with next 08 years beginning 2013- 2020 (period 2). The study report by TRI Scientists has shown that:

  - Compound Annual Growth Rate (CAGR) for tea production has declined from positive 0.47 % to negative (- 2.46 %) between the two periods. CAGR of Tea yield too has declined by 0.47 % to (-) 2.43 %.
  - Key contributory factors for national tea yield declined have been identified.
  - Measures that should be adopted to reverse this trend are also outlined in the report.

  I would like to urge here, that all stakeholders of the industry including the subject ministry should now join together to plan the way ahead on a priority basis together with the TRI on resolving the same.

- **Regulatory and advisory guidelines to Sri Lanka Tea Board**

  Scientifically validated regulatory guidelines on maximum permissible sugar levels in made tea and such other compounds were issued during the year.

TRI assisted the Sri Lanka Tea Board in handling minimum residue levels of weedicide and pesticide contaminations reported in exported made tea consignments which helped the industry to protect the good name of Sri Lanka's made tea.

- **Annual technical briefing on key industry issues by the TRI**
  TRI was able to continue this year, the practice that was initiated last year by the Chairman, TRB of briefing the board and key stakeholders of the industry on key industry issues that have come up during the year, prior to holding the last Board meeting of the year. It would have been ideal, if we had the opportunity of having an Annual Research Review and Planning workshop together with all stakeholders as envisaged since 2020, but had to be postponed owing to Covid-19 health guideline restrictions in the country. The aims and objectives of such an event were to reflect back on the achievements, identify key industry issues limiting the growth of this vital export industry and bring in new ideas to solve the same.

  In the absence of a such a well-organized event, we had to do the second best of organizing the technical briefing at the end of year 2021, during the morning hours before the last board meeting for the year. It was a pleasure to note, that TRI has expanded the event in a meaningful manner, to highlight the felt needs of the year under review and actions proposed by TRI with regard to key issues which were discussed in the technical presentations by (i) Dr. L S K Hettiarachchi, Director, TRI titled "Highlights of the research findings including weather and climate outlook in the year ahead" (ii) This year guest scientist was Prof. B N F Basnayake, Emeritus professor of Agricultural Engineering at University of Peradeniya, who spoke on "Biochar, the sustainable solution" a topic very appropriate for us as restoration of soil fertility of degraded tea soils has been selected as the key development theme for the year 2022 by the Ministry of Plantation (iii) Drs. V Sidhakaran, M A Wijeratne, H W Shyamalie and M/s G S Pradeep, K G Lakmali, R Muralithasan and delivered by Dr. V Sidhakaran, Head Advisory and Extension Division titled "National Tea Production Decline since 2013: Evidence based analysis" (iv) Dr. M W N Dharmawardene following on the aforesaid presentation, offered a possible solution by his presentation titled "Restoration of Soil Fertility and Poor adoption of Replanting - A Possible Indian Solution" (v) Dr. Mrs. H W Shyamalie, Head, Agricultural Economics Division, TRI on "Update on Cost of Production and profitability of tea during the last five years" and (vi) Mr. Jayampathy Molligoda, Chairman, Sri Lanka Tea Board made a presentation titled "Global Tea Value Chain". Due to limitation of time, there was little time for discussion, and Director TRI made a short summing up of the entire proceedings.

The Board while commending TRI for organizing the "TRI Annual Technical Briefing on some key industry issues" requested TRI to convene a similar session with a wider participation of industry stakeholders including the key officials of the Cabinet and State Ministries as the information gathered by TRI in such critical and constructive discussions are most useful not only to the subject Ministry but for planning and implementing strategic solutions to the entire national tea industry economic sub sector.

During the year, eight meetings of the Tea Research Board were held in spite of Covid-19 pandemic and in the first quarter itself, it assisted TRI to correct an irregularity noticed in the tender award for the provision of security services to the Institute, which the Institute could not correct by themselves by summoning all the parties to the issue before the Board, so that there was neither a financial nor a reputation loss to the Institute. It was towards the end of the year under review that all the vacancies in the Board were filled. 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 issues on research were followed up through Consultative Committee on Research, the Board having made the decision that all matters pertaining to Estates, Research and Management must be brought before the Board after having been considered by Board appointed consultative committees. The Board has also given its due attention on the need to restructure TRI in order to strengthen its capabilities with a view to improving its capacity to meet the emerging new challenges of the industry so that it could always be well ahead of the industry needs to give technical leadership to a highly competitive sophisticated overseas market with innovative products and technologies at a competitive price in comparison to the immediate competitors. It is not an industry which fits the infant industry argument for continuation of subsidies. Although we have a highly mature industry, it still needs various subsidies at different levels to stay afloat is a concern that should receive priority attention of the authorities and all the stakeholders of the industry.



Dr. M W N Dharmawardene
Chairman, Tea Research Board
24th March 2022

REVIEW OF THE DIRECTOR



Dr. L S K Hettiarachchi
Director/ CEO
BSc (Peradeniya, Sri Lanka)
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TRI continued to strictly follow all mandatory health guidelines given by the health authorities and instructions given by the government to manage Covid-19 pandemic situation, ensuring uninterrupted services to stakeholders during the year 2021. Travel and work place restrictions imposed by the health authorities due to the third wave of the Covid 19 pandemic spread in the country and as well as the isolation of St. Coombs Estate premises where TRI Headquarters is situated, affected the Institute work and St. Coombs Estate and Factory operations badly during 07th May - 08th June 2021. Despite such limitations, Director TRI from the Head Quarters continued coordination with the senior management staff and other staff categories in all the Regional Centers and 02 Estates *via* virtual and work from home strategy *etc.* ensuring essential R and D, Outreach activities, Estate and Administrative matters and providing the services.

The Office of the Cabinet of Ministers released the Cabinet decision dated 1st June, 2021 (CD/21/0726/326/020) on "Establishment of Plantation Research and Management University" based on the Cabinet paper jointly submitted by Honorable Ministers of Education and Plantation Ministries. Director, TRI has been nominated as a member of the Special committee to submit insights to the Cabinet along with recommendations. A series of consultative meetings were held with the senior management of Crop Research Institutes under the purview of the Ministry of Plantation in preparing the concept paper. Opinions and proposals were also obtained from the TRI staff and the Trade Unions in this regard. The Mechanical' Engineering Sectional Committee, Institute of Engineers Sri Lanka (IESL) expressed its willingness to partner with TRI to share technical experiences and facilities available with their members.

A series of meetings was held to understand the tea industry needs. Following up with the decisions taken at the kick off meeting convened by the Chairman, TRB to prioritize R and D areas on mechanization as to harvesting in tea *etc*., TRI organized a workshop on tea cultivation and Low Country tea processing to demonstrate practices and available machinery at its Research, Advisory and Extension Centre and St. Joachim Tea Factory at Ratnapura to the IESL members.

In order to facilitate the government expectations in line with the gazette on "Transformation of Sri Lanka to a Green Economy with Sustainable Solutions for Climate Change and Restriction of Imports of Synthetic and Mineral Agrochemicals", TRI participated at weekly monitoring and evaluation meetings convened by the Secretary to Ministry of Plantations and at Inter-Ministerial meetings. Dr. L S K Hettiarachchi, Dr. K M Mohotti, Dr. M A Wijeratne, Dr (Mrs). G D Sinniah, Mr. W M S Wijayathunge, Dr. V Sidhakaran and Mrs. M A H Nishanthi provided appropriate technical inputs at these meetings, especially on alternate nutrient sources in view of meeting their requirements at nursery, young and mature tea fields. The Heads of Divisions together with Advisory Officers affiliated to TRI Regional Centers continues to facilitate the field evaluations of the local sources of biological nutrient inputs coordinated by the TSHDA in the small-holder farmer fields while the small-scale demonstration sites on composting and green manuring *etc.* have also been laid down.

Chairman, TRB and Director, TRI along with senior staff of the TRI participated at the ceremonial signing of the MOA on pilot project titled "Geochemical approach on verification of the origin of Ceylon tea" between the Sri Lanka Atomic Energy Board (SLAEB), TRI and SLTB held on 02nd February at SLAEB premises in Colombo. Honourable Minister of Plantation and Honourable State Minister of Science and Technology were also present to witness the signing of the Memorandum of Agreement.

Director, TRI participated at the exposure field visit to the Kadurugashena village in Galle along with the senior officials of the Export Agriculture Department, Sri Lanka Tea Board, Coconut Research Institute, Coconut Cultivation Board, Tea Small Holding Development Authority and National Institute for Plantation Management. The Secretary, Ministry of Plantation was also attended. It is intended to develop this village to showcase as model mixed home garden plantation crop in the southern region as the community has clearly shown diverse interests in the supply and/or value chains but lacks technical knowhow.

Dr. L S K Hettiarachchi and Mr. J L P Amarasinghe Project Director STaRR convened an inter organizational meeting on 29th September 2021 along with the TRI and STaRR project teams to update on the progress of the activities conducted by the TRI and obtained concurrence on one year extension period for the balance project activities available at the TRI Low Country Research and Advisory Center and Soils and Plant Nutrition laboratory complex, Walahanduwa.

Dr. L S K Hettiarachchi, Dr. K M Mohotti and Dr. M A Wijeratne represented the TRI at the virtual meeting of the CTTA AGM held on 29th September 2021.

Chairman, TRB and Director, TRI participated at the virtual meetings organized by the Secretary to His Excellency the President of the Democratic Socialist Republic of Sri Lanka to deliberate on the progress made to-date and address key issues at the Chairmen of the SOEs forum on 27th October and 02nd November 2021 *via* Webex.

The Secretary of the Ministry of Plantation reviewed the financial and physical progress of the (i) Institute and (ii) Ministry of Plantation funded special projects under Budget Speech and Budget Line on 29th October 2021 as against the Activity Plan during the period January - September 2021. The TRI was commended for having progressed well in recurrent and capital fund allocations while advised to make backup arrangements to expedite the progress and successful completion of the activities in connection with the poorly progressed Ministry of Plantation funded special projects handled by the Agronomy and Advisory and Extension Divisions, ensuring proper utilization of the funds before end of the year.

Director, TRI also participated at the meeting presided by the Honorable Minister of Plantation to review the development projects handled by the Institutes coming under the purview of the line Ministry in order to plan out effective utilization of the limited budget allocations. As the capital budget allocations for the individual Institutes had been significantly lesser in year 2021, it is anticipated to allocate reasonable sums from the line Ministry allocation to cope up with workloads.

TRI participated in planning and programming interim and alternate measures to address the shortages of fertilizers and pesticides with appropriate recommendations on the importation of agrochemicals *via* restricted basis. As per line Ministry

requisition, TRI prepared the estimated Nitrogen supplementation *via* collective sources and activities by the TRI, SLTB and TSHDA including potential coverage by the local suppliers.

TRI also participated at the meeting convened by Honorable Minister of Plantation on "A novel program for tea growers" where an accelerated process has been sought to improve land use efficiency and promote sustainable income towards small and medium tea growers. TRI submitted a proposal with feasible options based on experimental evidence.

Chairman, TRB and Director, TRI participated at the 03rd meeting of the Consultative Committee of Ministry of Planation held on 22nd November 2021 at the Parliament to provide appropriate responses to the queries raised in relation to TRI 2018 Annual Report and as to the promotional issue of the Photographer of the Institute.

The GOSL directives for the ban on importation of all chemical fertilizers, insecticides and herbicides used in agriculture as per Extra Ordinary Gazette Notification No. 2226/48 dated 6th May 2021 were revoked. It is envisaged that the restricted agrochemicals would be permitted to import for the benefit of the tea industry in line with rational and integrated approaches of their usage. The government gazette notification No. 2238/20 dated 29th July 2021 on the subject of "Creation of a Green Socio-economy with Sustainable Solutions for Climate Changes" issued by His Excellency the President remains in force. TRI will facilitate activities towards "Green Economy with Sustainable Solutions for Climate Change and Restriction of Imports of Synthetic and Mineral Agrochemicals" as per the road map submitted to the line Ministry.

Chairman TRB, Director TRI and Internal Auditor TRI participated at the Audit and Management Committee meeting of the line Ministry where the write-off of the R and D expenditure on LTP project commenced in 1979, biological assets valuation and their update, review of special projects in 2021, board of survey 2020, review of disciplinary investigations with CID and the Internal audit plan 2021 received its attention.

Director, TRI participated at the ceremonial signing of the three party FECTE partnership agreement for supporting Ceylon tea value creation through the development of Geographic Indication (GI) and international quality/sustainability certifications where Honorable Minister of Plantation and Ambassador of France were present as the chief guest and guest of honor respectively. SLTB and French Development Agency organized the event in Colombo.

TRI provided technical inputs at the following meetings during 2021;

- Presidential task force meeting on economic revival of tea export earning target of USD 1.5 Bn in 2021 which was presided by the Honorable Minister

of Plantation together with the Secretary to the Ministry of Plantation held at the Central Bank Colombo 01.

- Preparation of draft Act on plantation management monitoring at the Ministry of Plantation.
- Fertilizer Advisory Committee meeting at the State Ministry of Production and Supply of Fertilizer and Regulation of Chemical Fertilizer and Insecticide Use on issues in relation to contaminated levels of Cadmium and Arsenic in imported chemical fertilizers and locally produced composts.
- Meeting on pesticide regulation at the State Ministry of Production and Supply of Fertilizer and Regulation of Chemical Fertilizer and Insecticide Use on issues in relation to pesticide regulations for their safe and rational use in agriculture, including plantation.

Her Excellency the Ambassador of Viet-Nam to Sri Lanka Mrs. Ho Thi Thanh Truc and the embassy staff paid a courtesy call to the Tea Research Institute, Talawakelle on 23rd October 2021. TRI arranged a hybrid meeting with H. E. the Ambassador along with an excursion tour to the Information Centre briefing the Sri Lankan tea industry, history and tea cultivation and processing, Plant Breeding, Biochemistry, Plant Pathology, Entomology and Nematology laboratories and the tea processing factory at nearby Mattakelle Estate. The letter of appreciation to TRI by H. E. the Ambassador of Viet-Nam to Sri Lanka Mrs. Ho Thi Thanh Truc for the excellent arrangements made in receiving her and exposed to a fruitful program and anticipating formal affiliations with the Institute for mutual benefits.

Mr. Daniel Bood, the Counselor (Political and Trade) of the High Commission of Canada called over TRI for a technical dialogue to explore possible collaborations on bio-fertiliser with potential Canadian companies. A briefing was arranged on the Sri Lankan tea industry, and trade and future directions, *via* interactions for further interventions for the benefit of delegates.

RESEARCH, ADVISORY AND EXTENSION MATTERS

The 89th, 90th and 91st Consultative Committee Meetings on Research (CCR) were held on 05th July, 15th September and 15th November 2021 respectively *via* virtual platform.

A common Regional Technical and Extension Forum (RTEF) was conducted by the TRI for all the tea growing regions on 8th November 2021 *via* virtual platform. The subject covered was "Preparation and establishment of tea fields in view of mechanizing field practices in the future" which is a topic of current interest to the smallholder sector. The General Manager, Deputy General Manager, Regional Managers, Assistant Regional Managers and Tea Inspectors of TSHDA participated at this forum.

TRI scientists participated at the Ministry initiated Sri Lanka Broadcast Corporation (SLBC) Radio program "Subharathi" to educate and promote sustainable plantation agriculture under its "*Vevili Saviya*". Drs. L S KHettiarachchi, K M Mohotti, M A Wijeratne, M A B Ranatunga, Mrs T L Wijeratne, Mrs H W Shyamalie and Mrs K G N Piyasena took part at weekly programs broadcasted live on SLBC. The technical expertise of current relevance delivered by the TRI, had been well received by the general public and tea growers.

TRB covering approval was granted for the duly signed MOU between the TRI and Dialog Axiata PLC on the deliveries of stylized voice messages to stakeholders held at the TRI Mid Country Research, Advisory and Extension Center, Hantane. Both parties disclosed the plans to disseminate advises and messages on timely important industry issues where Dialog Axiata PLC agreed to expand the service lines to reach maximum number of recipients especially small holders in the rural villages.

"Solutions Center for Climate Change Mitigation and Precision Agriculture" was virtually opened at the TRI as on 17th December 2021 as a Joint Initiative of the Tea Research Institute and Ceylon Tea Road Map 2030. At the ceremonial event, Dr. L S K Hettiarachchi, Director, TRI gave the welcome and opening remarks while Dr. K M Mohotti, Deputy Director Research (Production), TRI presented the Vision for the Solutions Centre. Other speakers included Jenny Costelloe, Executive Director, ETP and Rachel Cracknell, Environment and Climate Change Lead Lucie Pluschke, Water and Energy for Food - East Africa Hub Manager, Eng. Sanath Panawennage, Director General / CEO, Arthur C. Clarke Institute for Modern Technologies and Mr. Raveendra Hewavitharana, Secretary, Ministry of Plantation. Dr. Roshan Rajadurai presented the role of CTRM 2030 as an enabler. "The Solution Center for Climate Change Mitigation and Precision Agriculture" located at the TRI has to offer assistance to all small, medium and large producers, manufacturers, processors, exporters and policy makers with specific guide on climate change mitigation and précised tea cultivation and manufacturing practices and resource efficient land use appropriate for different sectors, elevations, regions and management practices. The data and information gathered *via* satellite and drone images and automated weather stations set up in the different tea-growing regions will be monitored at this cell and analyzed to provide the guidance on climate smart and precised GAPs and GMPs to the stakeholders. The information are also be used for R and D directions as well as for academic purposes, training and awareness programs and market promotions. The Solution Center, is contactable through the TRI call center, website (www.tri.lk), by phone and *via* email at SolutionCenter@tri.lk.

RESEARCH HIGHLIGHTS

CROP IMPROVEMENT

New TRI 5000 series cultivars for Uva

Three potential high yielding TRI 5000 series cultivars with drought tolerance, quality, resistance to blister blight and tolerance to nematodes have been identified for Uva tea growing region and submitted to the Institute's Technology Release Committee for its formal approval as to the issuance of recommendation.

Establishment of new mother bush areas

A total of 22 ha of mother bush area, 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.

Optimization of light conditions for Photoautotrophic micropropagation of tea on liquid cultures

Photoautotrophic micropropagation utilizes ability of *in vitro* plants to perform photosynthesis in carbon free medium for developing 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 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 photomixotrophic micropropagation of tea.

LAND PRODUCTIVITY IMPROVEMENT AND CROP MANAGEMENT

Application of Soil Quality index (SQI)

Soil Quality Index (SQI) analysis done in tea small holder lands enabled 119 sites to have access on the suitability for minimizing time period with soil rehabilitation thus direct planting with the aim of encouraging replanting among tea growers, and ensuring productivity and profitability.

Integrated nutrient management in tea

Based on experimental evidences, guidelines have been prepared for integrated nutrient management in tea minimizing chemical and synthetic inputs. An updated Guideline on Composting (Guideline 1/2021 Sinhala) in tea lands was released for the stakeholder use. Experiments have been carried out to identify the effect of inputs *viz* Compost, Biochar, *Gliricidia*, Wood and Refuse/spent tea *etc*. on soil quality of tea lands.

Minimising use of synthetic/mineral nutrient sources, TRI promoted tying - up with adoption of at least key Good Agricultural Practices *viz.* Burying of *pruning* and

incorporation of pruned chips, promotion of soil tests-based use of nutrient-input approach, recycling of residues from the reclaimable tea to condition soils and factory ash to supplement K inputs and commercializing Plant Growth Promoting Rhizo-bacteria (PGPR) based on bio-fertiliser in the mid country region for the practical use.

CROP PROTECTION

Nano formulations of systemic fungicides

TRI in collaboration with Sri Lanka Institute of Nanotechnology (Pvt) Ltd on R and D approaches in developing and screening biological methods for pest and disease management and Nano formulations of systemic fungicide, has been able to formulate nano-sized Hexaconazole and Entomo-pathogenic fungus *Beauvaria bassiana* against Blister blight and Shot-hole borer respectively as compared to current recommendations.

TRI develops new bio pesticides

TRI continued collaborative studies on mass production of bio-pesticides using the technical expertise and resources of the Synkromax Pvt. Co. Ltd., India. Based on the findings, a patent has been filed for *Trichoderma* based biopesticide at the NIPO (Application No.21988). A bioprocessing lab has been established with special Treasury funding aiming mass production of biopesticides.

Alternatives to synthetic herbicides

TRI in collaboration with the University of Peradeniya and NRC funding, conducts investigation to determine herbicidal properties of green manure plant viz. Wild Chrysanthemum (*Artimesia vulgaris*) and preliminary work elucidated herbicidal effects as compared to conventional synthetic herbicides.

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. Furthermore, preparing guidelines for mitigating climate change effects on tea and establishing activities to encourage carbon neutral tea industry have also been made. Arrangements have also been made to establish a precision agriculture cell at TRI.

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 2021, calling of Expression of Interests, evaluation of proposals and selection of entrepreneurs were completed. The proposals submitted by Messrs. Arthur C Clerk Center Institute for Modern Technologies, and B and N Optimus (Pvt) Ltd. were selected for development of selective harvester/s.

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.

Development of a model factory for tea processing research

Work has been initiated to develop St Joachim Tea Factory in Ratnapura district as an Experimental Process Technology Development Factory for tea processing R & D activities.

Establishment of Geographical Indicators for Ceylon and Regional Tea

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 TRISL.

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.

SOCIO ECONOMICS AND RESOURCE PLANNING

Causal factors for worker shortage in tea small holder sector

The results of the study on Investigation on worker shortage in small holder sector revealed that about 52% of smallholdings were facing problem of worker scarcity. The main causative factors for labour shortage in tea smallholders were a) demand for

higher wage, b) low satisfaction level of labours, c) poor youth participation in tea cultivation due to lesser wage system, d) out migration due to urbanization, e) higher job opportunities in urban areas, f) non-cash benefits and g) higher absenteeism due to adverse weather conditions.

Impact of product innovation towards Firm performance in the Sri Lankan tea industry

The study on Impact of Product Innovation towards Firm Performance in the Sri Lankan Tea Industry revealed that producing tea-based radical innovations has a significant positive impact towards firm performance. The determinants tea-based radical innovations in Sri Lanka are firm strategy (no. of food technologists, no. of market destinations, no. of CIM/CIMA qualified employees) firm resources (direct links to plantations and processing factories); and CEO's science and technology qualifications.

Radical innovations play a major role in making the Sri Lankan tea industry an outstanding performer among its competitors, hence study undertaken recommend promotion of production of tea-based radical innovations in Sri Lanka rather than focusing on incremental innovations of flavoring, bagging and packaging.

AWARDS, RECOGNITIONS AND SPECIAL PRESENTATIONS

Dr. L S K Hettiarachchi, Director, TRI was invited to make a presentation at the "Global Tea Initiative" for the study of Tea Culture and Science 6th Annual Colloquium under the theme "The Stories We Tell Myths, Legends, and Anecdotes about Tea" by the College of Letters and Science. Director TRI made the presentation titled "Tea breeding in Sri Lanka" co-authored by Dr. M A B Ranatunga and Dr (Mrs) K G N P Piyasena of TRI, via Online by Zoom on 21st January 2021.

Dr. L S K Hettiarachchi, Director, TRI delivered a presentation on "Latest developments on Tea Science and Tea Industry in Sri Lanka" at the International Tea Conference and 3rd Global Forum for Directors of Tea Research Institutes, hosted by China Tea Science Society (CTSS) and Tea Research Institute, Chinese Academy of Agricultural Sciences (TRI CAAS) during 25th - 26th November 2021.

Dr. J H N Piyasundara, Mr. J D Kottawa Arachchi, Mr. K K Ranaweera and Ms C J Ratiyalage affiliated to the Plant Breeding Division delivered presentations at the aforesaid International Tea Conference and 3rd Global Forum for Directors of Tea Research Institutes, hosted by China Tea Science Society (CTSS) and Tea Research Institute, Chinese Academy of Agricultural Sciences (TRI CAAS) during 25th - 26th November 2021.

Dr. L S K Hettiarachchi, Director, TRI has been invited to serve in the Academic Board by the NIPM, following its recognition as a degree awarding Institution in Sri Lanka.

The scientific collections on fungal diseases of tea generated by the TRI and authored by A K Pandey, G D Sinniah, B K Azariah and A Tanti, have been incorporated in the online publication Plant Disease, 2021 on "How the Global Tea Industry Copes up with Fungal Diseases-Challenges and Opportunities".

Dr. L S K Hettiarachchi, Director, TRI has been appointed as a member of the Special committee to submit the comprehensive report on "Establishment of Plantation Research and Management University" by the Honourable Finance Minister following the recommendation of the Plantation and Education Ministries.

Dr. L S K Hettiarachchi, Director, TRI has been appointed as a member of the Pesticide Technical Advisory Committee (PeTAC) by the Honourable Minister In-charge of the Ministry of Agriculture.

Dr. L S K Hettiarachchi, Director, TRI has been appointed as a member of the Review Committee on Integrated Nutrient Management (INM) in Agricultural Crops by the Chairman, National Science Foundation (NSF).

Dr. M W N Dharmawardene, Chairman, TRB has been appointed as a member of taskforce on "Transformation of Sri Lanka to a Green Economy with Sustainable Solutions for Climate Change and Restriction of Imports of Synthetic and Mineral Agrochemicals" by His Excellency the President of Democratic Socialist Republic of Sri Lanka

Dr. K M Mohotti, Deputy Director Research (Production), TRI has been appointed as a member of the Bio-pesticide Sub Committee of the PeTAC by the Director General, Department of Agriculture.

Dr. K M Mohotti, Deputy Director Research (Production), TRI has been appointed as a member of review committee on Biological, Organic, Non-chemical and Sustainable Agriculture Research projects by the Secretary to the Ministry of Science and Technology.

Dr. M A B Ranatunga, Head, Plant Breeding Division, TRI has been appointed to the Board of Study in Biotechnology and Molecular Biology at the Post Graduate Institute of Science (PGIS), University of Peradeniya for the 04th March 2021 - 18th April 2023 period.

INSTITUTIONAL IP POLICY

The Institutional IP Policy was drafted and submitted to the Tea Research Board for its approval. The IP Policy establishes the protocols applicable to all IP related rights arising from the R & D projects carried out at the Institute and it describes the requirements for the effective management, protection, and commercialization of intellectual property at the Institute.

PATENTS

During the year 2021, one patent application was submitted titled "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". This invention was an outcome of the collaborative research project conducted by the TRI and the Synkromax Biotech Pvt Ltd. In addition, amendments were submitted to two previously filed patent applications namely "Mathematical model-based control system for trough withering of tea", and "Spicy Tea Sauce and Method of Preparation".

DEVELOPMENT OF MANAGEMENT INFORMATION SYSTEM (MIS)

As a crucial part of decision making of TRI management, it is essential to manage necessary data/information more efficiently and accurately. The proposed MIS shall be fully integrated system interconnecting divisions/units/offices and also Regional and Extension centers. This system shall satisfy necessary operational requirements and also provide analytical tool for the purpose of information analysis. This system shall also provide a platform with a modular architecture where it has a higher level of flexibility to changes and capable of adding new services and features. Selected software development team, M/s. Sri Lanka Telecom (Servicers) Limited., already commenced developments adhering to the finalized Software Requirement Specification (SRS) document and detailed functional requirements of proposed system. So far, master data entering facility for Human Resource Management, Payroll, Procurement, Finance and Accounting, Inventory, Staff Transport Management and Expenses Reimbursement modules was completed by the developer and inputs appropriate for the operationalization have been entered by responsible officers attached to respective divisions.

MOUs AND RESEARCH GRANTS

Memorandum of Understanding (MoU) signed between the Tea Research Institute of Sri Lanka (TRISL), and Council of Scientific and Industrial Research-Institute of Himalayan Bio-resource Technology (CSIR-IHBT), India in February, 2021 to carry out a research project on "High throughput genotyping to expedite genetic characterization and dissection of important agronomic traits of tea".

SPECIAL PROJECTS

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 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.

Renovation and rearrangement of a bioprocessing laboratory has been carried out with Treasury funding under special project GL 391. A patent application (No.21988) was filed for *Trichoderma* based biopesticide.

Improvement of soil organic matter in tea lands by burying of tea pruning, planting shade and green manure crops, incorporation of compost and soil conservation measures as a strategy of mitigating climate change effects.

This project has been initiated by TRI with the financial assistance from the Ministry of Plantations through the funds allocated by the budget speech 2021. The Advisory and Extension Division with the assistance of Agronomy Division implemented the project

Due to the continuous tea cultivation operations and unsatisfactory adoption of Good Agricultural Practices, soil organic matter content found to be drastically declined leading to poor ability to face climate change effects owing to soil compaction, poor soil physical properties, water holding capacity and aeration *etc*. Burying of tea pruning 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;

a. Establishment of demonstration sites in TRI lands, RPC estates, proprietary estates and small holder lands to demonstrate burying of pruning practices.
b. Establish shade trees and green manure crops and other important GAPs in the selected demonstration sites.
c. Conduct awareness programs on climate change mitigation, essential agronomic and cultural practices for small holders, medium scale planters, RPC and state sector planters.
d. Selection, re-designing and fabricating of chopping machine to chop tea pruning.
e. Selection, re-designing and fabricating of trenching machine/s to cut trenches for burying of pruning.
f. Pre and post assessment of field applications of chopping machine and trenching machines.

Provision of an Efficient Onsite Analytical and Extension Service through Mobile Laboratory

The TRI currently offers analytical services to tea growers from its regional laboratories located at Talawakelle, Walahanduwa, Ratnapura and Hantane. Timely provision of basic analytical services including extension service is an important support service to tea growers to rationalize and ensure efficient use of inputs. However, tea growers in rural areas especially, tea small holders and medium scale

growers including plantations find it difficult to obtain these services timely as they have to travel long distances and bring their samples to the said laboratory locations. Therefore, the concept of mobile laboratory and extension unit built in a motor coach could provide the necessary on-site analytical (soil, root, leaves, pest and disease identification) and extension services at places convenient to farmers. The special 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 the following objectives;

a. To make the TRI analytical and extension services easily accessible to tea growers and deliver these services onsite
b. Provide analytical and extension services on time and at appropriate cultivation seasons
c. To save farmers time and resources.
d. Improve farmer compliance with the TRI fertilizer application and other field recommendations thru onsite help and supervision

This project was planned and implemented in three major steps as follows by the Advisory and Extension Division in collaboration with other research divisions (Soils and Plant Nutrition, Plant Pathology, Entomology and Process Technology)

TRI Advisory and Extension Centre at Deniyaya involved in establishing a model tea garden at Berubeula Estate in Urubokka under the special project of the Ministry of Plantations on "Improving soil Carbon to Mitigate Effect of Climate Change on Tea". This Centre has initiated project works in a plot of land (0.6 acres) at TRI Deniyaya premises as well.

Establishment of tea seed gardens to increase the production of improved seeds as a source of planting materials in drought prone areas

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 period.

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. It is proposed to establish 15 seed gardens in TRI Regional Centers, RPC Estates and lands belongs to TSHDA Regional Centers in order to ensure uniform dissemination of improved seeds to all stakeholders. Establishment of five seed gardens commenced during 2021.

Development and Introduction of Motorized Selective Tea Harvester/s Suitable for local Tea Lands

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 2021, calling of Expression of Interests, evaluation of proposals and selection of entrepreneurs were completed. The proposals submitted by Messrs. Arthur C Clerk Center Institute for Modern Technologies and B and N Optimus (Pvt) Ltd were selected for development and evaluation at field scales.

STUDY PROGRAMMES

Overseas

Mr. J D Kottawa Arachchi, Research Officer, Plant Breeding Division, TRI continued his post graduate studies (PhD level) at the Himachal Pradesh Agricultural University, Palampur, India commenced effectively 08th January, 2018.

Mrs. L A S P Jayasinghe, Research Officer, Agronomy Division, TRI continued her post graduate studies (PhD level) at the University of The Philippines, Los Banos commenced effectively 06th August 2018.

Mr. C J Liyanaarachchi, Advisory Officer, Advisory and Extension Division, TRI continued his post graduate studies (PhD level) at the University of The Philippines, Los Banos commenced effectively 06th August 2018.

Mr. L R M C Liyanage, Research Officer, Soils and Plant Nutrition Division, completed his post graduate (PhD level) research work at the University Putra in Malaysia and resumed the duties at the Division effective 19th September 2018.

Ms. H M C G Pilapitiya, Research Officer, Agricultural Economics Division, TRI continued her post graduate programme (PhD level) at Saga University, Japan commenced effectively 27th September, 2018.

Mr. S Raguraj and Ms. R K Amali, Research Officers, Soils and Plant Nutrition Division, TRI 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 program 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 in Sekolah Pengajian Siswazah School of Graduate Studies, University of Putra, Malaysia, commenced effectively 13th November 2021 from 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, TRI completed research work of his PhD studies at the PGIA and resumed duties effective 05th August, 2021 after completing the study leave period. Thesis is being prepared.

Messrs. K G J P Mahindapala, and S P Rathnayake, Senior Advisory Officers affiliated to Advisory and Extension Division, TRI continued their PhD study programmes 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 post graduate studies (PhD level) at the PGIS, University of Peradeniya, Sri Lanka commenced effectively 01st August 2019.

ST. COOMBS ESTATE

The Estate made a loss of Rs. 41 Mn for the year.

ST. JOACHIM ESTATE

The Estate made a loss of Rs. 11.6 Mn for the year. Total production of made tea; quantity of leaf manufactured at St. Joachim Tea Factory showed an increase of 91,753 kg in 2021 as against the previous year.



Dr. L S K Hettiarachchi
Director/CEO
Tea Research Institute of Sri Lanka

TRI STAFF MEMBERS 2021

DIRECTORATE

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

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

Deputy Director Research (Process Technology)

Deputy Director (Extension)

Deputy Director (Administration)
Capt (Rtd) D S M Vithanage, BA in Defense Studies (KDU,Sri Lanka) MPM (SLIDA, Sri Lanka)

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)
S D K Nadeeshani (Clerical) – From Sep 2021

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, BSc Agric (Peradeniya, Sri Lanka) MSc (PGIA Peradeniya, Sri Lanka) PG, Dip (Applied Statistics)TRI Low Country Research, Advisory and Extension Centre, Ratnapura

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

S P Ratnayake, BSc Agric (Ruhuna, Sri Lanka) MBA (WHUT, China)

Advisory Officer

K R W B Kahandawa, BSc Agric (Peradeniya, Sri Lanka) MSc (PGIA Peradeniya, Sri Lanka) Officer-in-Charge, TRI Mid Country Research, Advisory and Extension Centre, Hantana

A L R U Kumara, BSc Agric (Peradeniya, Sri Lanka) MSc (PGIA Peradeniya, Sri Lanka)

P K R C E Munasinghe, BSc Agric (Wayamba, Sri Lanka) MPhil (PGIA, Peradeniya, Sri Lanka) Head, TRI Advisory and Extension Centre, Deniyaya

M A H Nishanthi, BSc Agric (Peradeniya, Sri Lanka) MSc (PGIA Peradeniya, Sri Lanka)

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H I G S Piyaruwan, BSc Agric in Soil Science (Ruhuna, Sri Lanka)

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Extension Officer

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Technical Officer
N S Ekanayake

Management Assistant (Clerical)
A M E T Attanayake

General Worker
P Vijayakumarn – up to June 2021
B Manonmany
K Gnanasoundary

AGRICULTURAL ECONOMICS DIVISION

Head of Division
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General Worker
P D S S De Silva

AGRONOMY DIVISION

Head of Division

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General Worker

N Sivasubramaniam

R Ganeshan

BIOCHEMISTRY DIVISION

Head (Attending Duties)/ Senior Research Officer

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Technical Officer

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A Mahendran
G Selavaraj
S Rajendran

ENTOMOLOGY AND NEMATOLOGY DIVISION

Head - (Attending Duties)/ Senior Research Officer
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Research Officer
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Experimental Officer
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U B Herath, TRI Mid Country Research, Advisory and Extension Centre, Hantana
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N A I M Nissanka, BSc in Biological Science (OUSL)

General Worker
S Hettiarachchi
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

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Research Officer

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Experimental Officer

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H W M M M Jayarathne, Higher National Diploma in Technology (Agric) (Sri Lanka Institute of Advanced Technological Institute, Gampaha)

General Worker

B K Jayanthi

K Vishvanathan

S Jegadesan

PLANT PATHOLOGY DIVISION

Head of Division

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Research Officer

M Niranjan, BSc (Peradeniya, Sri Lanka), MSc (Kelaniya, Sri Lanka)

Experimental Officer
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General Worker
R P Perera

PLANT PHYSIOLOGY DIVISION

Head (Attending Duties) / Senior Research Officer
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Research Officer
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General Worker
R Puwaneshwaran
R Velmurugan

PROCESS TECHNOLOGY DIVISION

Head of Division
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Senior Research Officer
S Koneswaramoorthy, BSc in Mechanical Engineering (Peradeniya, Sri Lanka) TRI Low Country Research, Advisory and Extension Centre, Ratnapura – Up to April 2021

Research Officer
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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
S H P Waduge, National Diploma in Technology (Moratuwa, Sri Lanka) – Up to July 2021
L Jayasinghe

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 (Attending Duties) / Research Officer
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Senior Research Officer
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Research Officer
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Experimental Officer
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W T B D Priyantha, BSc (Sri Jayewardenepura, Sri Lanka) Soils and Plant Nutrition Laboratory Complex, Walahanduwa
J R Y Abeywardane, Soils and Plant Nutrition Laboratory Complex, Walahanduwa
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
V A N Wickramasinghe, BSc (OUSL), MSc (PGIA, Peradeniya) - up to Sep 2021
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)
H M U I Abeywardhana, Higher National Diploma in Agricultural Production Technology (Sri Lanka School of Agriculture, Kundasale) – Up to Aug 2021

General Worker
D Silvester
V Rathakrishnan
S Parameswaran

SOILS AND PLANT NUTRITION LABORATORY COMPLEX, 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
Mr. A A Upendra, BSc in Computer Science, National University of Ireland – From May to Aug 2021

Network Administrator (Attending Duties) /Experimental Officer
U D Alagiyawadu, Higher Diploma in Information Technology (Colombo, Sri Lanka) – From Aug 2021

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), Diploma in Graphic Design (Esoft Metro Campus, Sri Lanka)

Management Assistant (Clerical)
I A G N Attanayaka

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

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
W M S R Wanasinghe – Up to Nov 2021
C Jayaram
A A H Chinthaka – Up to Nov 2021
R A C Lasantha
S D K Nadeeshani (Clerical) – Up to Sep 2021
W M M I K Wijesinghe

General Worker
N Pushparaj
A Dhiwyakumar
V Jasinthamery
M B W Samanthika
S Rejinamery
A Selvanayagam
N Sridevi

ELECTRICAL UNIT

Engineering Assistant (Elec)
S H P Dayaratne, Higher National Diploma in Engineering (HNDE) (Institute of Advance Technological Education, Sri Lanka) – From Jul to Oct 2021

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

General Worker
K Jayarathnam
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
S Thangaraj
R Pakiyanathan
P Weeramuttu
M Peiris
P Sarawanaraj
P Kalimuttu
S Sabapathi
S Sylvester
S M Kenady

K Balendran
G Kanagaraja
M Irudayaraj
G Jayapragasam
R Ravi
A Augusteen
P Letchumar
S Christopher
S Muthukumar
P Vijayakumaran
D A Sirishantha
L Vigneshwaran

GUEST HOUSES/ CIRCUIT BUNGALOWS/ HOSTELS

Guest House Keeper
R M B D Ratnayake, Colombo – Up to Nov 2021
G Weerapperuma, Talawakelle

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
T Balakrishnan

TELEPHONE EXCHANGE

Telephone Operator *cum* Receptionist
M P Karunarathna

General Worker
P Vythilingam Pillei
D Gabriel

TRANSPORT UNIT

Engineering Assistant (Mechanical)
Mr. D T Gunawardane – From Jun 2021 National Diploma in Engineering Science (NDES), Institute of Engineering Technology

Management Assistant (Station)
S S Kumari

Driver
L Murugesu - Up to June 2021
W G Senewirathna – Up to June 2021
R M N Prematthilaka
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
S L Joseph
M Thasarathan
A Muniswaran

MOTOR GARAGE

Motor Mechanic
A P G I H Anwarama

General Worker
V Krishnamoorthy
Mohanaselvam

FINANCE DIVISION

Acting Senior Accountant /Accountant
M V Mohan, (APFASL)

Accountant
W M T B Weerasekara, (APFASL)

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

Stores
Management Assistant
A A A P Amarathunga, (Accounting)
R M N M Ariyarathna, (Accounting)
D S C Weerasuriya, (Accounting)
H P P Sanjeewa, (Accounting)
V E Kumara (Accounting) – Up to Aug 2021
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)

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

Engineering Assistant (Elec)
Mr. S H P Dayarathna – From Oct 2021

Technological Officer (Civil)
K Gunawardena

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

Plumber Mechanic

Electrician
J M R K Bandara – Up to Oct 2021

Guest House Keeper
M D Sarath

Driver
P D R De Silva
S S Sunil – Up to June 2021
S M C M Senanayaka
G V S Jayalath
J T S Weerakkody
K M T T Bandara

General Worker
A K J Athukorala
D V S P Denagama
W M D C Perera
H A T K K Sumanaweera
I D Subasinghe
P D N B D Silva
A M U Liyanage
M Dewaraj

R Chandrakumar
K P T Karunarathne
T Rajendran
K A Karunathilake
M Parwathi
K P N Darmadasa
S Manikkavasagam
M Maheswaran
S Selwendran
G K Priyantha
G G Chandrakeerthi
S 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, HANTANA

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Management Assistant
R M D K Rathnayake (Clerical)
B K S Herath (Accounting) – Up to Feb 2021

Electrician
J M R K Bandara – From Oct 2021

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
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Management Assistant (Station)
W S T Wijesinghe

Driver
M D Chandana

TRI ADVISORY AND EXTENSION CENTRE, KOTTAWA

Officer-in-Charge/Extension Officer
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Management Assistant (Station)
Y C N Gunarathne

Field Supervisor
P S Kulasiri

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

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Management Assistant (Clerical)
A A H Chinthaka – From Nov 2021
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
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Driver
K M T Senevirathna

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

RESEARCH HIGHLIGHTS

CROP IMPROVEMENT



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

2021 Programme
Controlled hybridization was performed using Gamma irradiated pollens of TRI 2043 cultivar and 144 crosses carried out. Details of the crosses are given in Table 1;

Table 1. Details of crosses - Hybridization Programme 2021

Combinations	No. of crosses
A: PBGT 41 x TRI 2043	74
B: PBGT 49 x TRI 2043	27
C: PBGT 48 x TRI 2043	43

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

2019 Programme (Backcross Breeding)
A progeny consisted with 88 hybrid seedlings generated from 2019 programme has been established in Field No 9, St. Coombs Estate in July 2021 for further evaluations and details are given in Table 2.

Table 2. Details of the progeny

Combinations	No. of Seedlings
A; F1 (TRI 3055 x PBGT 41) x TRI 3055	25
B: F1 (TRI 3055 x PBGT 48) x TRI 3055	43
C: F1 (TRI 3055 x PBGT 49) x TRI 3055	20

2018 Programme (Backcross Breeding)
Bringing into bearing operations continued of 192 seedlings planted in field No. 9, St. Coombs Estate.

2017 Programme
Bringing into bearing operations continued of 50 hybrid seedlings planted in Field No. 09 St. Coombs Estate.

2016 Programme
A: Part of 2016 programme - planted in 2017
1st Cycle harvesting at weekly intervals continued
B: Part of 2016 programme - planted in 2019
Bringing into bearing operations 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 commenced.

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, KK Ranaweera, CJ Ratiyalage and M Jayarathne

Evaluation of accessions in Phase I and II trials
Details of the Phase I trials are given in Table 3.

Table 3. 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
VP 94	2015	L	119	K 136, TC 10, TRI 4071, TRI 4052, DEL 40, DUN 7, TRI 2025	1st Pruning carried out in July 2021
VP 95	2016	K	88	TRI 2025, TRI 3019, TRI 4052	1st Cycle yield recording continued
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, CJ Ratiyalage and M Jayarathne

Estate Cultivar selection programme

Fairlawn selections (VP 93)

3rd Cycle harvesting continued.

Glenanore selection

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

MAB Ranatunga, KK Ranaweera, CJ Ratiyalage and M Jayarathne

Use of radiation induced mutation in genetic improvement of tea

Funding agency: International Atomic Energy Authority (IAEA), Vienna

A project funded by the International Atomic Energy Authority (IAEA), Vienna on "Supporting genetic improvement of tea" has been continued since January 2020.

One hundred and fourty somatic embryos generated from cotyledons of seeds collected from three cultivars (PK 2, TRI 5004 and TRI 2043) were treated with gamma rays (46 Gy) and survival was observed. Since the survival was low, 191 somatic embryos were treated with a lower dose of 20 Gy and observations have been continued along with untreated somatic embryos. A total of 405 nodal cuttings of TRI 2043 and 2025 cultivars were exposed to a dose of 100 Gy gamma rays and observed low survival rate. Another set of 405 nodal cuttings of both cultivars were treated with 50 Gy and survival has been monitored.

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

MAB Ranatunga, KK Ranaweera, CJ Ratiyalage, M Jayarathne,
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 TRI 3055 X TRI 2043 hybridprogeny for blister blight resistance

Hybrid progeny of TRI 3055 X TRI 2043 consisting of 133 hybrid plants and TRI 2043 and TRI 3055 parents were screened for blister blight resistance during July to November 2021. Individual hybrid and parent plants were rated using the scale: 0- Healthy shoots, 1- Shoots having translucent spots only, 2- Shoots having translucent spots and blisters 3- Most of the shoots having stem blisters. Seven accessions showed blister blight severity comparable to TRI 2043 and 50 accessions showed blister blight

severity lower than TRI 3055. Rest of the hybrid plants showed blister blight severity comparable to or higher than TRI 3055.

M Niranjan, DGNP Karunajeewa and GD Sinniah & Plant Breeding Division

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

NAIM Nissanka, AMP Sammani and PD Senanayake

Project A 1.4. Screening cultivars against *Pratylenchus loosi* for Up-Country
Experiment **:** N 1A (2019/2020)
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.

Results and Conclusions: Test cultivars (PBGT 10, PBGT 64, PBGT 53, PBGT 37, PBGT 24, PBGT 66, PBGT 29 and PBGT 68) and standard cultivars (TRI 2024, TRI 2025 and DT 95) were screened against *P. loosi* nematodes in cultivar screening tanks at TRI, Talawakelle.
Final assessments were completed and data are being analyzed.

PGDS Amarasena, UB Herath, BMGK Godavita and B Jananey

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 4 and 5 respectively.

Table 4. Details of Accessions under evaluation in the Mid-Country: Phase I, at 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	Commenced 2nd Cycle Harvesting
MVP 14	2014	I	26	DN, TRI 2025	Commenced 2nd Cycle Harvesting
MVP 15	2014	L		TC 10, DEL 40, GF 7/6, LLEF 2, TRI 62/3, TRI 2137	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, 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 5. Details of Accessions under evaluation in the Mid-Country: Phase II, at 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 cycle yield recording continued

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, 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)

MAB Ranatunga, CJ Ratiyalage and M Jayarathne

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

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

NAIM Nissanka, AMP Sammani and PD Senanayake

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

Experiment : N1B (2019/2020)

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.

Results and Conclusions:

Screening of test cultivars of VP 80 (15, 89, 272, 582), TRI 4042 and standard cultivars (TRI 2024, TRI 2025, TRI 4052 and DN) against *R. similis* nematode has been continued. Final assessments are due in 2022.

PGDS Amarasena, UB Herath, BMGK Godavita and B Jananey

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 characters 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 and Covid-19 pandemic situation. The field was pruned in April 2021. Soil moisture content together with some physiological parameters such as relative water content (RWC) and stomatal conductance were measured. Leaf samples were also collected to determine the total soluble sugar content. The measurements were taken at two moisture levels namely 15.44% and 19.75%. However, as these soil moisture levels were too close, calculation of drought susceptibility index was not possible.

Significant differences were observed in RWC (p= 0.05) among different accessions as well as among known cultivars at both soil moisture levels (Figure 1).

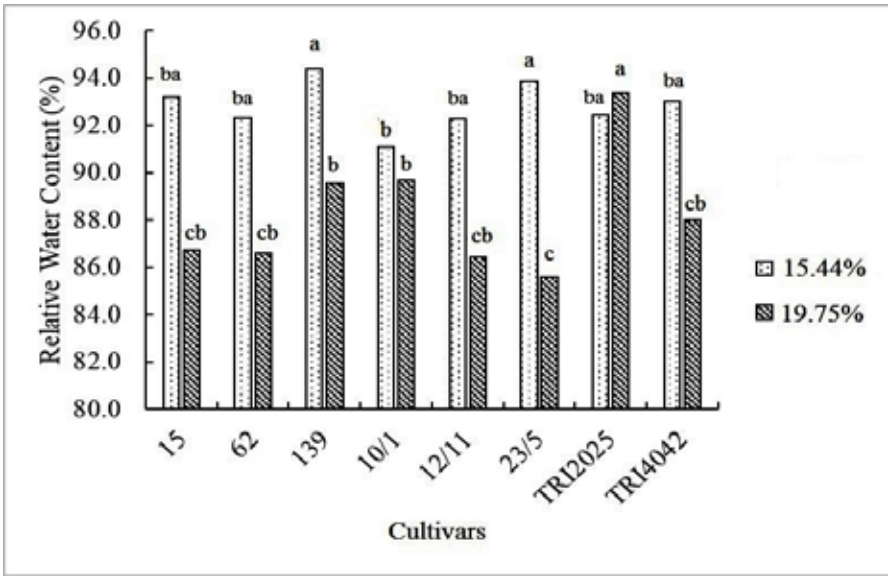

Figure 1. Change in relative water content content in different accessions and known/standard cultivars (The similar patterned bars with the same letters are not significantly different at p=0.05).

Stomatal conductance declined with the depletion of soil moisture content in cultivars/accessions with varied degree of reduction except for accession 139 and cultivar TRI 2025. Significant differences were observed among cultivars/accessions at both moisture levels. At the lower soil moisture level, accession 139, cultivar TRI 2025 and TRI 4042 showed significantly (p= 0.05) the highest stomatal conductance whereas accession 10/1 showed the lowest stomatal conductance (Figure 2).

The total soluble sugar content was significantly different among different cultivars/accessions at both moisture levels. At the lower soil moisture level accession 15 showed significantly the highest total soluble sugar content whereas accessions 139 showed the lowest total soluble sugar content. However, the total soluble sugar content of the two standard cultivars tested namely TRI 2025 and TRI 4042 were not

significantly different to that of accession 15 or accession 139 at the lower soil moisture level (Figure 3).

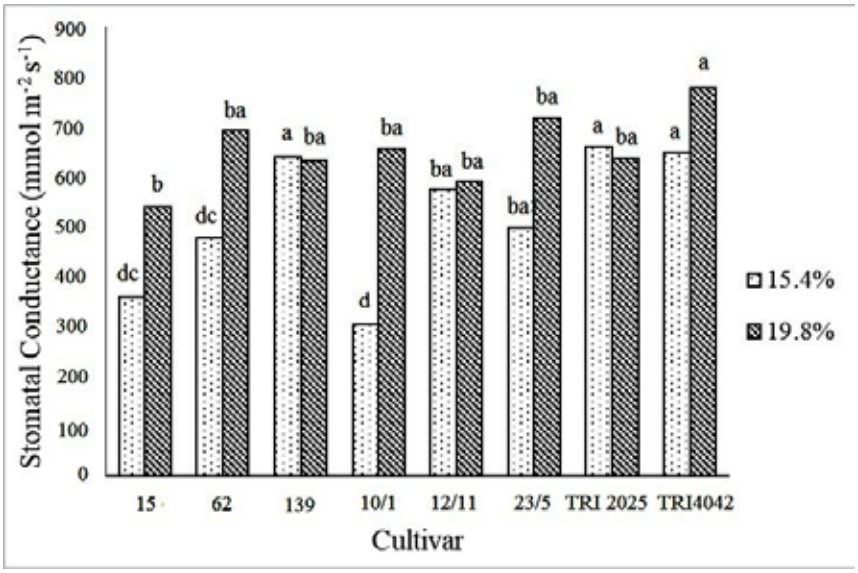

Figure 2. Change in stomatal conductance in different accessions and known/standard cultivars (The similar patterned bars with the same letters are not significantly different at p=0.05).

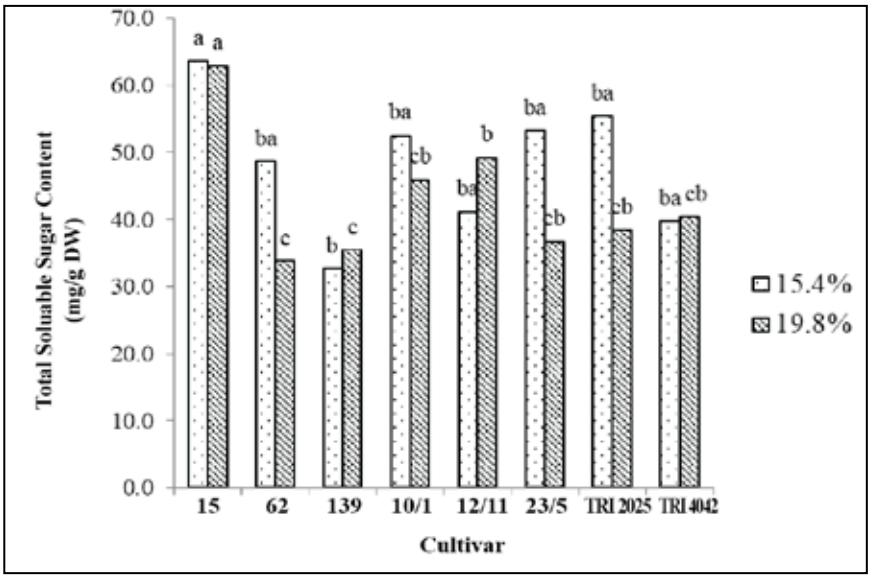

Figure 3. Leaf total soluble sugar content in different accessions and known/standard cultivars (The similar patterned bars with the same letters are not significantly different at p=0.05).

The proline content was increased with the depletion of soil moisture content in all the cultivars/accessions. At lower soil moisture level accessions 23/5 and 10/1 showed significantly the highest proline content whereas accessions 15 showed the lowest leaf proline content. The proline content of the two standard cultivars tested namely TRI 2025 and TRI 4042 were not significantly different between each other, but significantly lower to that of accessions 23/5 and 10/1 and higher than that of accession 15 at the lower soil moisture level (Figure 4).

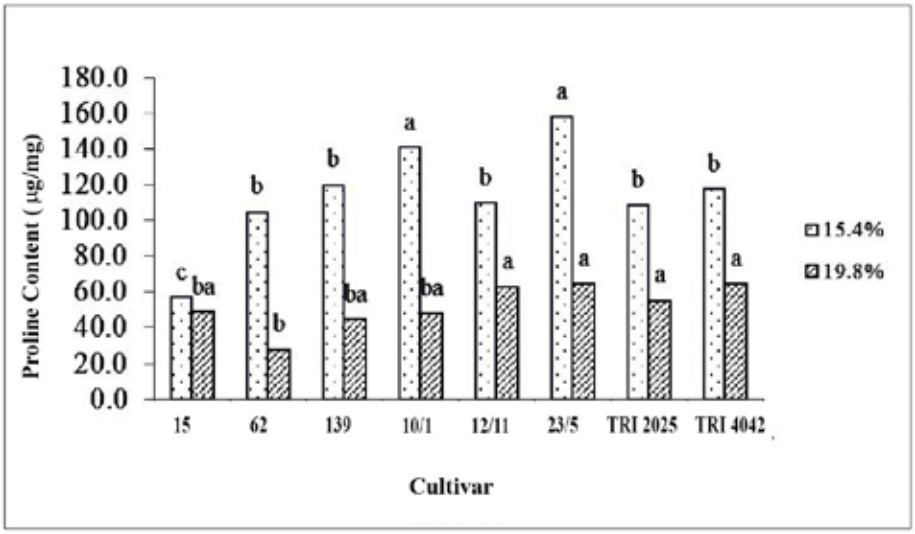

Figure 4. Change in leaf proline content in different accessions and known/standard cultivars (The similar patterned bars with the same letters are not significantly different at p=0.05).

The experiment is in progress.

DMS Navaratne, ADIU Jayawardhane, NM Vithanage and TL Wijeratne

Thrust A 3. Development of high yielding tea cultivars suitable for agro-ecological regions in 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 cultivars	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	1st cycle yield recording continued

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)

Recommendation and release of new series (TRI 5000 Series) Cultivars for Uva
Evaluation of TRI 5000 Series has been completed and detailed report submitted to Technology Release Committee (TRC) for recommendations.

MAB Ranatunga, KK Ranaweera, CJ Ratiyalage and M Jayarathne

Project A 3.3. Screening lines for resistance/ tolerance to SHB for Uva region
Assessments at first pruning were carried out to evaluate the resistance/susceptibility of 21 new accessions along with TRI 2025 and TRI 4071 against SHB under natural infestation in trial (UVP 14) at TRI Advisory and Extension Centre, Passara. Three accessions were moderately resistant (MR), 9 accessions were moderately susceptible (MS) and 9 accessions were found to be susceptible (S) to SHB. These results will be confirmed at next prune time.

NAIM Nissanka, AMP Sammani and PD 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, nematode population build up in screening tanks at Passara has been continued. Test and standard cultivars have been maintained in the nursery at Talawakelle. Introduction of nursery plants of test and standard cultivars to screening tanks is planned for 2022.

PGDS Amarasena, UB Herath, BMGK Godavita and B Jananey

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

Controlled Hybridization

Hybrid Seedlings (2004/2005 planting): Crosses carried out during 2002-2003 at St. Joachim - 4th Pruning carried out.

Hybrid Seedlings (2008 planting): Crosses carried out during 2004-2007 at St. Joachim - 3rd Pruning carried out.

MAB Ranatunga, JHN Piyasundara and AK Mudalige

Evaluation of accessions in Phase I

Details of the Phase I trials are given in Table 8.

Table 8. Details of accessions under evaluation in the Low-country: Phase I 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	50	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	16	TRI 2026, TRI 4042, TRI 4049	1st Cycle yield recording commenced
LVP 90	2017	N	12	TRI 2026, TRI 4042, TRI 4049	1st Cycle yield recording commenced
LVP 91	2018	O	106	TRI 2043, TRI 3055, TRI 4042	1st Cycle yield recording 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)

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

N Vegetativily 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 9.

Table 9. Details of accessions under evaluation in the Low-country: Phase II Field No. 2, St. Joachim, Ratnapura.

Trial No.	Year of planting	Origin[#]	No. of Accessions tested	Standard cultivars	Remarks
LVP 75 -I LVP 75 - II	1997 1997	VP 37 LVP 42	11 21	TRI 2023, TRI 2025, TRI 2026, TRI 2027	7th Cycle harvesting commenced (in LVP 75 I to IV)
LVP 75- III	1997	LVP 28	05	TRI 2025, TRI 2027	
LVP 75 - IV	1997	Pettigala Selections	08	TRI 2023, TRI 2025, TRI 2026, TRI 2027	
LVP 76	1999	LVP 42	22	TRI 2023, TRI 2025, TRI 2027	7th Cycle harvesting commenced
LVP 77	1999	LVP 46	13	-do-	11 promising breeding lines were propagated in the PB nursery for future trials

Table 9. Cont.,

Trial No.	Year of planting	Origin[#]	No. of Accessions tested	Standard cultivars	Remarks
LVP 78	1999	Pettigala Selections	18	-do-	
LVP 79	1999	Assam Introductions	06	-do-	
LVP 83	2000	LVP 46	18	TRI 2023, TRI 4042	5th pruning carried out 10 promising breeding lines were propagated in the PB nursery for future trials

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 04 commercial evaluation trials established at TRI Kottawa, Cecilton, Indola and Deniyaya Estates have been monitored. These trials are managed by TRI Kottawa and respective Estate managements.

TRI 5000 series observation plots

Performances of 04 observation 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 in the Low-Country
Selected plants from TRI 5000 series accessions and recommended tea cultivars showing canker resistance and susceptibility (reference plants) were maintained for bioassay using artificial inoculation until they achieve sufficient stem thickness for wounding.

GD Sinniah, M Niranjan, 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 PD 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.

PGDS Amarasena, UB Herath, BMGK Godavita and B Jananey

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 characters.

This study was conducted using TRI 5000 series adaptive trial (phase III) in a smallholding land at Siridola Estate, Palawella in Ratnapura using known cultivar TRI 2026, TRI 4042, TRI 4049 and accessions 29, 93, 168, 195, 278, 741, 751, 23/5, 12/11. Soil moisture content was measured along with physiological parameters such as relative water content (RWC), rate of photosynthesis, rate of transpiration and stomatal conductance while collecting leaf samples for the analysis of total soluble sugar and leaf proline content. Drought susceptibility index was calculated by using the rate of photosythesis and relative water content taken as the reference parameters of known cultivars and accessions under moisture stressed and non-stressed conditions. Although the measurements were taken at three moisture levels *viz* 9.2 %, 9.6% and 18.1 %, only the lowest and the highest moisture levels are presented in the

graphs to increase clarity. The results of gas exchange parameters, RWC, total soluble sugar content and the tentative drought susceptibility index were already presented in the annual report in year 2020.

At the lower soil moisture level (9.2 %) accessions 29, 93 and 168 showed significantly the highest (p = 0.05) leaf proline content compared to cultivars TRI 4049 and TRI 4042 (Figure 5).

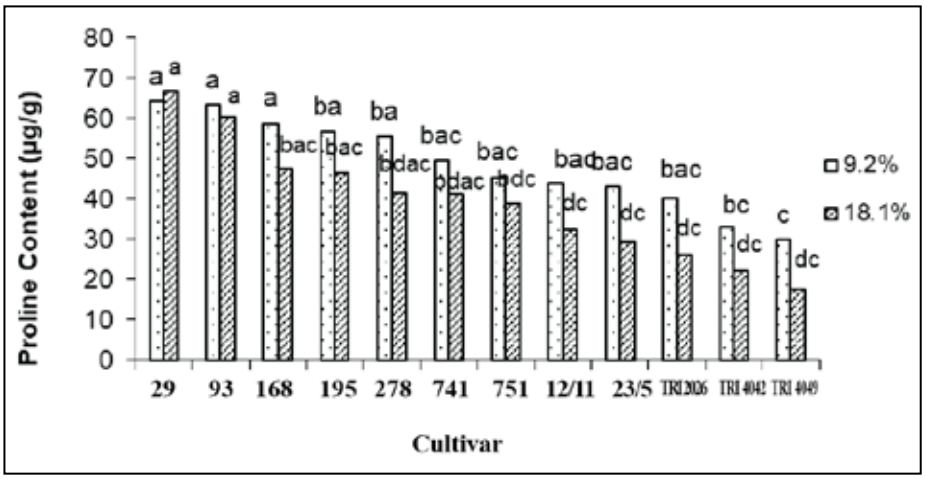

Figure 5. Change in leaf proline content in different accessions and known/standard cultivars (The similar patterned bars with the same letters are not significantly different at p=0.05).

Collecting new data was not possible due to malfunctioning of the instruments and Covid-19 pandemic situation.

The experiment is in progress.

DMS Navaratne, ADIU Jayawardhane, NM Vithanage 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.

Bi-clonal and Poly-clonal seed gardens

Establishment and Maintenance of tea seed gardens

A new Poly-clonal tea seed garden was established in Wilpita Estate, Akuressa with following parental combination: TRI 2016, TRI 2022, TRI 2025, TRI 3055, KEN 16/3, KP 204 and S 106.

Maintenance activities have been continued in the following six Poly-clonal and one Bi-clonal tea seed gardens;

Poly-clonal: Salawa, Halpe, Sapumalkanda, Rambukkanda, Kiriporuwa and Peenkanda

Bi-clonal : Reucastle

Bringing into bearing activities of seven new gardens established during 2012 – 2020 continued.

Six Poly-clonal gardens– TRI Kottawa, TRI Ratnapura, TRI Hantane, TRI Passara, Kiriwanganga Estate, Deniyays and Carolina Estate, Watawala

One Bi-clonal garden – Keeripitiya Estate, Deniyaya

Distribution of improved seeds among the growers

Division continued to link the growers to the respective seed gardens as per their requests.

- Nineteen requests received in 2021 and 40 kg of tea seeds distributed among the stakeholders collected from St. Coombs, Rambukkanda and Kiriporua gardens
- 10 kg of seeds collected for experimental purposes from Rambukkanda and Passara gardens.
- 10 kg of seeds collected from Keeripitiya Garden were propagated in Kiriwanganga Estate Nursery

MAB Ranatunga, JHN Piyasundara, AK Mudalige, KK Ranaweera, CJ Ratiyalage and M 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 and PD Senanayake

Thrust A 51. Germplasm conservation, characterization and evaluation

Commercial evaluation trial of potential green tea accessions selected from exotic germplasm of Field No 19B, Lower Division, Radella Estate (2018 planting)

Bringing into bearing activities of 15 accessions continued

MAB Ranatunga, CJ Ratiyalage, M Jayarathne and Manager - Radella Estate

Monitoring of tea seeds of Tieguanyin tea from China and 20 seedlings from Myanmar continued.

MAB Ranatunga, CJ Ratiyalage and M Jayarathne

High throughput genotyping to expedite the genetic characterization and dissection of important agronomic traits of tea
Funding agency: Ministry of Science and Technology
After receiving the Cabinet approval a Memorandum of Understanding (MoU) between the Tea Research Institute of Sri Lanka (TRISL), and Council of Scientific and Industrial Research -Institute of Himalayan Bio-resource Technology (CSIR-IHBT) was signed in February, 2021. Freeze dried samples of 365 accessions of the germplasm collection and 120 samples of biparental population between TRI 3055 and TRI 2043 have been sent to CSIR-IHBT for High throughput genotyping.

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.

Biochemical characterization of accessions completed and genotyping is being continued.

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

Genetic analysis and linkage mapping of pigments of tea
Funding agency: Sri Lanka Council for Agriculture Research Policy, Ministry of Agriculture
High throughput genotyping of accessions in progress.

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)

Molecular diversity analysis and biochemical profiling of Sri Lankan tea (*Camellia sinensis* (L.) O. Kuntze) genotypes
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, study of the evolutionary or domestication history, phylogenetic relationships and genetic diversity analysis, and map construction and marker-assisted trait selection.

The objectives of the current study were molecular and biochemical characterization of potential cultivars of Sri Lanka tea germplasm and establishing correlations for identification of potential genotypes to expedite genetic improvement in tea.

Fresh leaf flavan-3-ols; catechin (+C), epicatechin (EC), epicatechin gallate (ECg), epigallocatechin (EGC) and epigallocatechin gallate (EGCg), caffeine and gallic acid of 128 accessions including different seed stocks from exotic origins, old seedling selections, improved cultivars and un-adapted accessions of the Sri Lankan tea germplasm were performed using HPLC. Variation 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, EC and +C. Ward's linkage hierarchical clustering of 128 accessions based on metabolite diversity resulted two major clusters and there was a clear relationship with the origin and ancestry of accessions. High caffeine (>30 mg g-1) containing accessions with Indian origin and improved TRI cultivars clustered together whereas accessions with low caffeine contents (< 20 mg g^{-1}) were grouped separately. DNA extraction of 96 diverse gemplasm accessions for genotyping completed. Surveying of 38 SSR primers (12 tea unigenic SSRs, 3 miSSRs, 3 qtl_SSRs, 20 TF_SSRs) with selected genotypes completed.

Genotyping of 96 Sri Lankan tea germplasm with 25 polymorphic SSR primers (7 tea unigenic SSRs, 3 miSSRs, 1 qtl_SSRs, 14 TF_SSRs) completed and data analysis being continued.

JD Kottawa-Arachchi, MAB Ranatunga, HK Chaudhary, VK Sood, R Katoch, DK Banyal (CSK-Himachal Pradesh Agriculture University, India), and RK Sharma (CSIR- Institute of Himalayan Bio-Resource Technology, India)

Establishment and maintenance of field gene banks

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

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

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

Land preparation was carried out at TRI Regional Stations at Hantane and Passara for safe duplication of selected accessions of germplasm.

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.

Summary of the adaptive trials established and activities during 2021 are given in Table 10.

Table 10. Summary of TRI 5000 series trials in small holder sector – Phase III

No	Location	Senior Tea Inspector Region	AER	Year of Planting	Remarks
1	Lihiniyawa	Meegahathenna	WL1a	2012	2nd Cycle harvesting continued
2	Akuressa Deniyaya	Akuressa	WL2a	2013	2nd Cycle harvesting continued
3	Morawaka Deniyaya	Kotapola	WL1a	2013	2nd Cycle harvesting continued
4	Rannigewaththa	Horana	WL1a	2013	2nd Cycle harvesting continued
5	Pelawaththa	Pelawaththa	WL1 a	2013	2nd Pruning carried out
6	Neluwa - Galle	Hiniduma	WL 1a	2013	2nd Pruning carried out
7	Unanwitiya Galle	Elpitiya	WL 1a	2013	2nd Pruning carried out
8	Ihala Keembiya Galle	Wanduraba	WL 2a	2013	2nd Cycle harvesting continued
9	Thalgampola Galle	Akmeemana	WL 2a	2013	2nd Cycle harvesting continued
10	Malberry Waththa, Galaha	Hewaheta	IM3a	2013	2nd Cycle harvesting continued
11	Kotmale	Kotmale	WU2b	2013	2nd Cycle harvesting continued
12	Hali Ela	Hali Ela	IU3c	2013	2nd Cycle harvesting continued
13	Eheliyagoda	Ratnapura	WL1a	2014	2nd Cycle harvesting continued
14	Palawela	Ratnapura	WL1a	2015	2nd Cycle harvesting continued
15	Batapola	Ambalangoda	WL2a	2017	1st Cycle harvesting continued

MAB Ranatunga, JHN Piyasundara, AK Mudalige, CJ Ratiyalage and M Jayarathne

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 continued.

Experiments have also been continued to generate somatic embryos using stem nodal and leaf explant in liquid culture medium.

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

MAB Ranatunga, KK Ranaweera and M Jayarathne

Development of economically viable rapid *in vitro* propagation method for new tea cultivars of tea

1. Effect of light intensity and qualities on absorbed CO_2 concentration and fluorescent based photosynthetic parameters

Microshoots of TRI 5001 were subcultured on to the sugar free liquid media (MS + 5µm TDZ + 10µm NAA) with 3 uniform size microshoots per culture bottle and solid medium with same growth regulators (30g/Sucrose + 8% agar) used as the control of the experiment. Different light qualities and intensities were maintained as described in the Table 11. CO_2 sensor was fixed to the culture bottle and CO_2 concentration inside the culture bottle was recorded with 30 second time intervals for 24 hours while maintaining 15 hours photoperiod with different light intensities and nine hours dark period. Absorbed CO_2 concentration was calculated using the following equation:

$$\text{Absorbed}[\,CO2](\text{mg/L}) = Avg\ [CO2]\ (\text{mg/L}) in\ the\ Dark - Avg\ [CO2]\ (\text{mg/L}) in\ the\ Light$$

$[CO_2]$ - CO_2 Concentration

Avg –Average

Table 11. Different light qualities and intensities used for the experiment

Treatment	Light Intensity µmoll photons $m^{-2}s^{-1}$	Light Quality Red: Green: Blue
T1	100	0:0:1
T2	100	0:1:0
T3	100	1:0:0
T4	100	1:1:1
T5	120	1:1:1
T6 (Control)	30	1:1:1

Fluorescent based photosynthetic parameters were measured using MultispeQ.

Results are summarized in Table 12. Among the treatments, significantly highest absorbed CO_2 concentration was observed in treatment T1 (100 µmol photons $m^{-2}s^{-1}$ light intensity with Blue light only) compare with other treatments. Results revealed that around 300 mg/L utilized CO_2 concentration will be sufficient for maintaining quantum yield of photosystem 11.

Table 12. Absorbed CO_2 concentrations and fluorescent based photosynthetic parameters under different light intensities and qualities

Treatment	Absorbed CO_2 (mg/L)	Phi2	PhiNPQ	PhiNO	NPQt	LEF
T1	571 ± 17.88^{A}	0.11 ± 0.05^{CD}	0.61 ± 0.04^{B}	0.27 ± 0.02^{A}	2.2 ± 0.13^{B}	6.78 ± 0.88^{C}
T2	238 ± 18.55^{D}	0.04 ± 0.02^{D}	0.84 ± 0.05^{A}	0.07 ± 0.04^{B}	13.2 ± 0.91^{BA}	3.86 ± 0.51^{C}
T3	515 ± 30.98^{B}	0.11 ± 0.03^{D}	0.78 ± 0.02^{A}	0.18 ± 0.01^{BA}	19.26 ± 2.1^{A}	5.25 ± 0.87^{C}
T4	322 ± 11.12^{C}	0.4 ± 0.02^{A}	0.29 ± 0.02^{C}	0.21 ± 0.01^{A}	1.37 ± 0.26^{B}	20.45 ± 1.1^{A}
T5	325 ± 32.61^{C}	0.22 ± 0.02^{CB}	0.60 ± 0.07^{B}	0.18 ± 0.01^{BA}	4.1 ± 0.78^{BA}	12.39 ± 1.25^{B}
T6	270 ± 13.81^{D}	0.32 ± 0.06^{B}	0.58 ± 0.07^{B}	0.09 ± 0.02^{B}	7.73 ± 0.02^{BA}	4.47 ± 0.78^{C}

Phi2 = highest quantum yield of photosystem 11; PhiNPQ = energy dissipation;
PhiNO = photo damage light energy; NPQt = dissipated incoming light energy as the heat; LEF = linear electron flow

Therefore, significantly highest quantum yield (Phi2) of photosystem 11 was recorded in treatment T4, where plants were kept under 100 µmol photons $m^{-2}s^{-1}$ light intensity with Red: Green: Blue 1:1:1 ratio of light quality and 322 mg/L CO_2 concentration. Based on the absorbed CO_2 concentration and the light conditions, photoautotrophic micropropagation system can be established to generate good quality microshoots while maintaining higher multiplication rate. Further comparatively highest energy dissipation (PhiNPQ) was shown in treatments T2 and T3.

Highest photo damage light energy (PhiNO) was observed in T4. However, dissipated incoming light energy as the heat (NPQt) was significantly higher in T3. The significantly highest linear electron flow (LEF) was observed in 100 µmol photons $m^{-2}s^{-1}$ photosynthesis active radiation light intensity with Red: Green: Blue 1:1:1 ratio of light quality (T4).

2. Effect of light quality and quantity for microshoots proliferation and micro shoot height under Photoautotrophic, Photomixotrophic and Photoheterotrophic conditions.

Microshoots of three cultivars, TRI 5001, TRI 5002 and TRI 2025, were used for the experiment. In order to observe shoot proliferation and also growth, the uniform microshoots of above cultivars were subcultured to the liquid MS media supplemented with 5µm TDZ + 10µm NAA. Growth performance of the microshoots were observed in media containing two difference sucrose concentrations (30g/L and

15g/L) and without sucrose while maintaining photoautotrophic and photomixotrophic conditions as mentioned in Table 13. The experiment layout was arranged as five culture bottles per treatment. , Number of microshoots and height of shoots were recorded at 6 weeks and 12 weeks after sub-culture.

Table 13. Different sucrose concentrations, light qualities and intensities used as treatments in the experiment

Treatment			
Treatment No.	Light Intensity µmol $m^{-2}s^{-1}$	Light Quality Red: Green: Blue	Sucrose concentration
T1	100	1:0:0	
T2	100	0:1:0	
T3	100	0:0:1	
T4	75	1:1:1	30 g/L Sucrose
T5	100	1:1:1	
T6	120	1:1:1	
T7	100	1:0:0	
T8	100	0:1:0	
T9	100	0:0:1	
T10	75	1:1:1	15 g/L Sucrose
T11	100	1:1:1	
T12	120	1:1:1	
T13	100	1:0:0	
T14	100	0:1:0	
T15	100	0:0:1	Without Sucrose
T16	75	1:1:1	
T17	100	1:1:1	
T18	120	1:1:1	
T19	30	1: 1: 1	30 g/L Sucrose

2.1 Effect of sucrose on shoot proliferation and relative height growth

Results revealed that both shoot proliferation and relative height growth of microshoots vary with different sucrose concentrations. Both shoot proliferation in terms of number of microshoots produced and relative height growth of microshoots in sugar free medium were less compared to 30 g/L sucrose level indicating that it is difficult to achieve photoautotrophic micropropagation in tea. However, comparatively higher relative height growth rate and shoot proliferation was observed in all cultivars in 15 g/L sucrose concentration. Furthermore, microshoots grown on 15 mg/L Sucrose medium with 75 or 100 µmol $m^{-2}s^{-1}$ light intensities (T10 and T11) recorded highest relative height growth rate. Thus, results warrant that reduced sucrose level could be effective as a photomixotrophic condition in micropropagation of tea.

2.2 Effect of light intensity on shoot proliferation and relative height growth

Comparatively higher relative growth was observed in 75 µmol $m^{-2}s^{-1}$ light intensity compared to other light intensities of all sugar levels for cultivarTRI 5002. Even the cultures without sucrose showed comparable growth with the cultures grown at low light intensity with 30 g/L Sucrose (Control treatment - 30 µmol $m^{-2}s^{-1}$). Therefore, it may be possible to develop photoautotrophic cultures for TRI 5002 and TRI 5001 at 75 µmol m^{-2} s^{-1} (R:G:B 1:1:1) light intensity. However, TRI 2025 did not perform better compared to the control under photoautotrophic condition.

2.3 Effect of light quality on shoot proliferation and relative height growth

Results revealed that the relative height growth of tea microshoots affected with the light quality. Significantly higher relative height growth was observed in Red light and the R: G: B 1:1:1 ratio compared to Blue and Green light alone.

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BLS Thilakaratne (Department of Engineering Technology, Faculty of Technology, UoR),
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Project GL 340. Establishment of a mechanism to multiply and disseminate quality planting materials of tea cultivars and improved seeds

A grant of Rs. 86.5 million was approved in 2017 by the Ministry of Plantation Industries to establish a mechanism to multiply and disseminate quality planting materials of new tea cultivars and improved seeds among stakeholders. Project duration is from 2017 to 2021. About 22 hectare of Mother Bush sites have been established during 2017-2021 period. Details of progress of the project in 2021 are included in Tables 14 and 15.

Table 14. Establishment of Mother Bushes in 2021

Location	Extent in ha (Approximately)	
	TRI 5000 Series	TRI 3000, 4000 series and Other
Up country (Nuwareliya District)		
St. Coombs – Field No 1, Upper division	0.30	
Meddecombra estate, Watagoda	0.50	
Mid-Country (Kandy District)		
TRI, Hantane	0.50	0.10
Uva (Badulla District)		
TRI, Passara		0.52
TSHDA, Bandarawella	0.10	0.30
TSHDA, Hali-ela	0.04	0.12

Location	Extent in ha (Approximately)	
	TRI 5000 Series	TRI 3000, 4000 series and Other
Low-Country - Ratnapura District		
St. Joachim Estate, Ratnapura	0.48	0.07
TSHDA , Sannasgama	0.20	0.05
Kegalle District		
TSHDA , Hingula	0.10	
Demonstration	0.60	
Kalutara District		
Dartenfield estate Agalawattta	0.20	0.10
TSHDA, Mathugama	0.41	0.10
Galle District		
TSHDA , Neluwa	0.20	
TSHDA , Dellawa	0.10	
TRI , Kottawa	1.80	
Demonstration	0.17	
Matara District		
TSHDA , Eramudugoda	0.10	
TSHDA , Alapaladeniya	0.60	0.21
TSHDA , Kotapola	0.12	
Kiriwanganga Estate, Demiyaya	0.50	
Morawakorale Cooperative Society, Diyadawa	0.20	

Table 15. Number of nursery plants of new tea cultivars propagated in 2021

Location	No. of Nursery Plants
Up country	
Plant Breeding Nursery, Talawakelle	8670
Uva	
TRI, Passara	6499
Low-Country	
Plant Breeding Nursery, Ratnapura	4960
TRI, Deniyaya	2677
TRI Kottawa	22320

ALRU Kumara (Mother bush coordinator) OICs of TRI, Hantane, TRI Passara, TRI Kottawa, TRI Deniyaya, TRI Mathugama, Managers and Staff (St. Coombs, St. Joachim, Kirivanganga and Vogan estates) TSHDA officials in respective locations, Staff of Morawak-Korale Co. Op. Land, Deniyaya, *MAB Ranatunga, JHN Piyasundara, AK Mudalige, KK Ranaweera, CJ Ratiyalage and M Jayarathne*

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.

Two sets of experiments commenced at Plant Breeding nurseries at Talawakelle and Ratnapura. Cuttings of four recommended cultivars were used for the experiment. Same number of cuttings on conventional nursery bags as recommended by TRI was used as the control.

Bringing into bearing operations continued of 24 plants planted in Field No. 9, St. Coombs, Ratnapura in 2020.

Field evaluation of sixty-one plants raised using Jiffy pellets and conventional nursery bags (TRI 3072- 21, TRI 4052 -20 and TRI 5002- 20) planted in Field No. 09 St. Coombs Estate has been continued.

Bringing into bearing operations continued of 78 plants planted in Field No. 2A, St. Joachim, Ratnapura in 2020

M Jayarthne, AK Mudalige, JHN Piyasundar and MAB Ranatunga

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 distribution of improved seeds to all stakeholders.

Land selection for 15 gardens was completed and propagation of nursery plants has been carried out in 04 sites (Plant breeding nurseries at Talawakelle and Ratnapura and nurseries of TRI Regional Centers at Deniyaya and Passara).

MoUs for establishment of 08 gardens were signed with TSHDA and RPCs. MoUs with RPCs for another 07 gardens is in progress

One new tea seed garden has already been established at Wilpta Estate, Akuressa in 2021. Establishment of 05 new gardens have been commenced (TSHDA lands at

Walimada, Hali-ela and Passara, Vogan Estate, Mathugama and Raygam Estate, Ingiriya).

Land preparation continued in another 05 sites (Endana Estate, Kahawatta, TRI Regional Centre, Kottawa, Lankaberiya Estate, Ithhakanda, Homodola Estate, Udugama and Lalwela Estate, Wanduramba)

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

NRC - 20 - 123. Conservation and Utilization of Old Seedling Teas: 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. Tea breeders would be beneficial by identifying diverse materials for crossing programmes and selection of accessions for conducting Estate cultivar selection programmes as well. Comprehensive maps generated and database of OSTs could be useful for Managers of respective Estates in decision making. TRI will assist them in future management of OSTs and diversity "hotspots". Diversity "hotspots" could be useful in promoting tea tourism, value addition to the made tea (ancient tea) and promoting respective garden marks in global tea trade.

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. The selected estate list is given below.

M1a: 3 estates (Roberry, Glen alpin, Spring Valley) / IM2b: 2 estate (Dammaria B, Shawlands) / IU2 : 1 estate (Mahadowa) / IU3a : 2 estates (Craig, Poonagalla) / IU3b :4 estates (Udaveriya, Kahagalla, Pitarathmale, Glennanore) / IU3c: 10 estates (Wewesse, Cannavaraella, Nahavilla, Oodoowerre, Neluwa, Uva Highlands, Sarnia, Aislaby, Chelsea, Gowerakelle) / IU3d : 1 estate (Warwick) / IU3e : 2 estates (Welimada, Dyraaba).

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 small sub plot. Bush assessment has been completed in Wewesse Estate, Badulla and initiated in Dammaria B Estate, Meedumpitiya, Passara and Nahavilla Estate, Demodara.

Phenotypic characterization was done using 10 morphological characters (Tree habit, Young leaf pigmentation, Petiole pigmentation, Young leaf pubescence, Leaf shape, Leaf upper surface, Leaf waviness, Leaf size, Waviness of the leaf margin and Shoot density) and three biotic stress conditions (Blister Blight, Stem Canker and Shot Hole Borer). Data were analyzed and Shannon-Weiner Index was calculated for each field to get an idea about the morphological diversity of seedling teas and the appropriate conservation method (either *in-situ* or *ex-situ*) was suggested for each field.

Based on diversity of seedlings, diversity maps will be developed for each site. If in-situ conservation to be practiced, TRISL will enter into agreements with respective estate managements to preserve seedlings without uprooting. Vacancies in those sites will be infilled with known cultivars and "improved seeds". Sites where *in situ* conservation could not be practiced, unique accessions will be propagated and preserved in field germplasms at Talawakelle and Passara. One hunders and seven unique seedling tea bushes were identified in Wewesse Estate based on the above morphological characters and the cuttings are yet to be taken for propagation.

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/yr with refuse tea or compost at 20 MT/ha/yr along with urea at 270N kg/ha/yr 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 and refuse tea/compost as plant nutrient sources for mature tea under growers' conditions. This experiment was commenced at Kiruwanagange estate, Kirilipana – Low-Country in January 2019.

1) 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 ($p \leq 0.05$). All wood ash containing treatments increased the soil pH $_{(water)}$ significantly compared to the current inorganic fertilizer recommendation. The higher pH values were recorded with the wood ash 1000kg/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	Soil pH $_{(water)}$	Soil pH $_{(CaCl2)}$
Wood ash (WA) (500kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	4.69ab	3.82c
Wood ash (WA) (1000kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	5.00ab	4.15b
Wood ash (WA) (500kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	5.07a	4.49a
Wood ash (WA) (1000kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	5.08a	4.52a
Current recommendation (VPLC880)	4.66b	3.92b
LSD	0.391	0.261
CV%	2.878	2.251

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

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.

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

The soil available P and K are shown in Table 2. Significant differences were observed among treatments ($p \leq 0.05$) on soil available P and K.

Concentration of Soil K recorded in Wood ash (WA) (1000kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr) treated pots was significantly higher compared to all the other treatments as well as VPLC 880 treated pots.

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

Treatments	Soil P (mg/kg)	Soil K (mg/kg)
Wood ash (WA) (500kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	61.5b	83.0b
Wood ash (WA) (1000kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	152.5a	139.5a
Wood ash (WA) (500kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	152.0a	66.5b
Wood ash (WA) (1000kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	46.5b	98.0b
Current recommendation (VPLC880)	76.5b	62.5b
LSD	48.16	39.95
CV%	17.73	14.40

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

3) 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. Significantly higher values of both soil Ca and soil Mg were observed only with treatment 2 and 3 compared to the control. Soil Ca and Mg values are comparable among all the 4 treatments tested ($p \leq 0.05$). Wood ash is a rich source of mineral Mg and Ca and thus resulting higher available Mg and Ca in wood ash treated plots.

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

Treatments	Soil Mg (mg/kg)	Soil Ca (mg/kg)
Wood ash (WA) (500kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	31.5ab	127.5ab
Wood ash (WA) (1000kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	60.5a	232.5a
Wood ash (WA) (500kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	60.0a	235.5a
Wood ash (WA) (1000kg/ha/yr) + Refuse tea	50.0ab	195.5ab

(20t/ha/yr) + Urea (270kg /ha/yr)		
Current recommendation (VPLC880)	12.0b	56.0b
LSD	42.76	172.17
CV%	35.98	36.61

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

Higher mineral Ca content in wood ash increased the available Ca in the soil.

4) 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 (OC%) among treatments at p≤0.05. Faster mineralization of added organic materials may be the reason for not showing the effects of addition of compost or refused tea.

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

Treatments	Soil OC %	Soil CEC (meq/100g)
Wood ash (WA) (500kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	1.88a	19.30c
Wood ash (WA) (1000kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	1.79a	20.5b
Wood ash (WA) (500kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	1.80a	22.2a
Wood ash (WA) (1000kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	1.65a	21.1b
Current recommendation (VPLC880)	1.88a	14.7d
LSD	0.715	0.895
CV%	14.322	1.648

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

The CEC of the soil was significantly increased (p≤0.05) with the application of wood ash compared to the current recommendation and it was highest in wood ash refused tea combination.

5) 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≤0.05) in N, P and K contents were observed in the mother leaves among treatments as well as with the control (current recommendation).

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)	3.95a	0.25a	1.60a
Wood ash (WA) (1000kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	3.97a	0.25a	1.76a
Wood ash (WA) (500kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	3.87a	0.24a	1.66a
Wood ash (WA) (1000kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	3.88a	0.24a	1.61a
Current recommendation (VPLC880)	3.92a	0.25a	1.75a
LSD	0.312	0.057	0.680
CV%	2.871	8.448	14.608

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

6) Effect of application of wood ash on leaf Mg and Ca concentration

The Mg and Ca contents in mother leaves are shown in Table 6. Significant differences ($p \leq 0.05$) in Mg and Ca contents in the mother leaves were observed in wood ash containing treatments compared to the control. Application of wood ash showed significant increase in leaf Mg and Ca contents. These effects were also confirmed by soil Mg and Ca as well (Table 3). Among the treatments, wood ash application (1000 kg/ha/yr) with refuse tea (20t/ha/yr) recorded the highest leaf Mg and Ca.

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

Treatments	Leaf Mg %	Leaf Ca %
Wood ash (WA) (500kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	0.21ab	1.09ab
Wood ash (WA) (1000kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	0.22ab	1.11ab
Wood ash (WA) (500kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	0.22ab	1.04b
Wood ash (WA) (1000kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	0.24a	1.22a
Current recommendation (VPLC880)	0.20b	0.97b
LSD	0.031	0.149
CV%	5.200	4.941

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

7) 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.

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)	4125a
Wood ash (WA) (1000kg/ha/yr) + Compost (20t/ha/yr) + Urea (270kg /ha/yr)	3982a
Wood ash (WA) (500kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	4100a
Wood ash (WA) (1000kg/ha/yr) + Refuse tea (20t/ha/yr) + Urea (270kg /ha/yr)	3933a
Current recommendation (VPLC880)	4240a
LSD	671.06
CV%	5.93

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

JRY Abeywardana, SK Weeratunga and WMS Wijayatunga

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 1000 kg/ha/year 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 growers' field condition.

The main objective of this experiment was to investigate the suitability of tea factory wood ash and refuse tea as a plant nutrient source and liming material for rehabilitation grass under growers' conditions. This experiment was commenced at Talgaswela estate, in the Low-Country in January 2018. Results were presented in annual report 2020.

Outcomes of research trials and adaptive trials will be used to prepare a document to be submitted to Technology Release Committee (TRC) for making a recommendation.

JRY Abeywardana, WTBD Priyantha and WMS Wijayatunga

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

Plant Growth Promoting Rhizobacteria (PGPR) are beneficial free living, associative or symbiotic soil bacteria inhabiting the rhizosphere of plants, which have been shown to improve plant growth and yield. The main objective of this study is to evaluate the

most efficient strains of PGPR under field conditions at soil series level, in combination with organic and chemical fertilizers.

Field experiments were conducted in five different locations with both early and latter stages of mature tea fields representing the three main soil series. Dual inoculants were tested along with a modified VP/UM 910 fertilizer mixture composed of $2/3^{rd}$ of N and ½ P and compared with three non-inoculated controls; untreated control, non-inoculated modified VP/UM 910 fertilizer control and VP/UM 910 recommended fertilizer control with three replicates.

Experiments are conducted at the following locations.

Mature tea fields (20 – 25 years old)
Kandy series – New Peacock estate, Pussellawa
Matale soil series – Ratwatta estate, Ratwatta
Ukuwela soil series – Midland estate, Rattota

Mature tea fields (5-6 years old)
Kandy series – New Peacock estate, Pussellawa
Matale series – Elkaduwa estate, Elkaduwa

Treatments
T1- Absolute control
T2- Modified fertilizer control (2/3 N +1/2 P of VP/UM 910)
T3 - Inoculated treatment with common consortium of N_2 fixer + P solubilizer + T2
T4 - Inoculated treatment with series specific consortium of the N_2 fixer + P solubilizer of respective soil series + T2
T5- Recommended dose of VP/UM 910

Significant difference in made tea yields could be observed at the end of fifth year in all five locations. Inoculated treatment with series specific consortium was able to show comparable yields with recommended rate of fertilizer treatment in all five experiments and the yields were significantly greater than the modified fertilizer treatment. However, both consortia showed comparable yields with recommended rate of fertilizer in two experiments conducted in Newpeacock (mature) and Elkaduwa (Yield data given in Annual Report 2020). Significant difference in leaf N and soil P contents could be observed in all five locations. Except in Newpeacock (mature) in all other four locations, inoculated treatment with series specific consortium (T4) showed comparable leaf N contents with recommended rate of fertilizer treatment (T5). In Elkaduwa and Ratwatta, only the inoculated treatment with series specific consortium (T4) showed comparable soil P contents to that of T5 while in other three locations, both inoculated treatments T3 and T4 showed comparable soil P contents with T5. Significant difference in leaf P contents among the treatments could be observed only in both experiments conducted in Newpeacock (Tables 8, 9 and 10).

Experiments were terminated in February 2020.

Table 8. Effect of application of PGPR inoculants on leaf N content at the end of 5th year (Tested on 3 main soil series level)

Treatments	Kandy soil series		Matale soil series		Ukuwela soil series
	New Peacock (Y)	New Peacock (M)	Elkaduwa	Ratwatta	Midland
	Leaf N content (%)				
T1	2.31 d	2.60 c	2.25 d	2.02 c	2.16 c
T2	3.00 c	2.87 c	2.64 c	2.93 b	2.60 b
T3	3.21 b	3.73 b	3.03 b	3.00 b	2.96 ab
T4	3.61 a	4.00 b	3.40 a	3.23 a	3.16 a
T5	3.67 a	4.33 a	3.42 a	3.34 a	3.33 a
LSD ($p \leq 0.05$)	0.1988	0.308	0.301	0.198	0.415

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

Table 9. Effect of application of PGPR inoculants on leaf P content at the end of 5th year (At soil series level)

Treatments	Kandy soil series		Matale soil series		Ukuwela soil series
	New Peacock (Y)	New Peacock (M)	Elkaduwa	Ratwatta	Midland
	Leaf P content (%)				
T1	0.140 b	0.150 c	0.123	0.120	0.136
T2	0.146 b	0.150 c	0.140	0.150	0.153
T3	0.153 ab	0.190 ab	0.140	0.166	0.243
T4	0.176 a	0.196 a	0.163	0.173	0.163
T5	0.176 a	0.180 b	0.153	0.183	0.173
LSD ($p \leq 0.05$)	0.023	0.012	NS	NS	NS

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

Table 10. Effect of application of PGPR inoculants on Soil P content at the end of 5th year (At soil series level)

Treatments	Kandy soil series		Matale soil series		Ukuwela soil series
	NewPeacock (Y)	NewPeacock (M)	Elkaduwa	Ratwatta	Midland
	Soil P (ppm)				
T1	12.3 b	9.33 b	12.3 c	11.6 c	8.66 c
T2	16.0 ab	16.0 a	19.3 b	12.3 c	11.3 bc
T3	17.0 ab	18.0 a	21.6 b	17.6 b	14.3 ab
T4	21.6 a	21.6 a	28.3 a	23.3 a	18.6 a
T5	20.0 a	20.6 a	29.0 a	21.6 ab	16.6 a
LSD (p=0.05)	6.178	6.09	5.73	4.909	4.945

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

(b) Evaluation of PGPR inoculants for immature tea (after field planting) at Field No 09, Upper Gonavi Division, Loolecondera Estate, Hewaheta. Cultivar : TRI 4053.

The objective of this study was to evaluate the best stage of growth to apply PGPR inoculants to tea plants. This experiment is conducted with eight treatments as follows.

T1 - Recommended rate of fertilizer (T 65) in nursery and Recommended rates of fertilizers (T 200 and T 750) after field planting.

T2 - Application of Common consortium (CC) in nursery with modified T65 and application of CC at field planting with modified T 200 / T 750 after field planting.

T3 - Application of Series specific consortium (SS) in nursery with modified T 65 and application of SS at field planting with modified T 200 / T 750 after field planting.

T4 - Application of CC only at field planting with modified T 200/ T 750 after field planting.

T5 - Application of SS only at field planting with modified T 200 / T 750 after field planting.

T6 - Modified T 65 in nursery + modified T 200/T 750 after field planting.

T7 - Recommended rate of fertilizer (T 65) in nursery and Modified T 200 / T 750 after field planting.

T8 - Recommended rate of fertilizer (T 65) in nursery and No fertilizer after field planting.

Plots were laid out as RCBD with two replicates. Inoculants were applied at the time of planting. Chemical fertilizers were applied as per the treatment schedule, at 3 month intervals. Plant growth measurements were taken at the inception and at centering. Bringing into bearing was done in the year November 2017. Significant difference in made tea yield could also be observed at the end of second year from commencement of plucking (Bearing) (Table 11).

Table 11. Effect of application of PGPR inoculants in nursery and /or in field planting on made tea yields at the end of second year from commencement of plucking

Treatment	Made tea yield (kg/ha/yr)
T1	2875 a
T2	2568 a
T3	2818 a
T4	2428 ab
T5	2382 ab
T6	947 c
T7	1529 bc
T8	865 c
LSD=*p(0.05)*	942

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

According to the results, there was no significant difference in yields due to time of application of inoculants as treatments T2, T3, T4 and T5 showed comparable yields with recommended rate of fertilizer treatment at the end of second year from commencement of plucking. Further, both common and series specific consortia, were able to show comparable yields with recommended fertilizer treatment. Significant differences in soil pH, organic carbon content, Leaf N, Soil N and soil P contents could be observed among the treatments (Table 12). Experiment was terminated after the 1st formative pruning in June 2020.

Table 12. Effect of application of PGPR inoculants in nursery and/ or in field planting on Soil pH, organic carbon content, leaf N and soil P contents at the end of 2nd year from commencement of plucking

Treatment	Soil pH	C %	Leaf N %	Soil N %	Soil P ppm
T1	4.42 ed	1.50 b	3.25 ab	0.250 a	50 ab
T2	4.96 a	1.69 ab	3.00 bc	0.255 a	51 a
T3	4.70 bc	1.57 b	3.30 ab	0.200 b	47 ab
T4	4.77 ab	2.02 a	3.40 a	0.240 a	43 bc
T5	4.59 bcd	1.65 b	3.35 a	0.265 a	52 a
T6	4.56 cd	1.57 b	2.50 d	0.100 d	38 c
T7	4.47 de	1.50 b	2.80 cd	0.140 c	38 c
T8	4.30 e	1.13 c	2.50 d	0.100 d	28 d
LSD (*p*=0.05)	0.198	0.349	0.322	0.036	8.384

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

(C) Based on Scientific Advisory Committee recommendation, an 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

This experiment continues with field activities including collecting yield data, soil and leaf samples.

Soil sampling from low-country region

Soil samples were taken from low-country tea estates in Galle, Matara, Kaluthara and Ratnapura districts representing Malaboda, Weddagala, Dodangoda and Pallegoda soil series, for the development of PGPR inoculants for low grown teas. Isolation, purification and maintenance of N_2 fixing and phosphate solubilizing bacteria were continued from the collected soil samples. Research work continues.

PLK Tennakoon and WMS Wijayatunga

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 apply 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.

a) St. Coombs estate - Mattakelle soil series
b) Opalgala estate - Ukuwella soil series
c) El Teb estate - Badulla soil series
d) Craighead estate - Kandy soil series
e) Moragolla estate - Pallegoda soil series

Treatments imposed in this study were 1: Absolute Control (No Dolomite Application), T2: Dolomite application according to the Present TRI recommendations, T3: Dolomite application based on pH the Buffering Capacity.
The results from Craighead estate trial were presented in the table 13.

1) Effect of different statergies of application of dolomite on soil pH

Table 13 showed that the application of dolomite based on buffering capacity significantly improves soil $pH_{(water)}$ at both 0-15cm depth and 15-30cm depth ($p \leq 0.05$). Dolomite application based on pH buffering capacity recorded the highest pH followed by current application method. However, $pH_{(CaCl2)}$ did not show any significant difference among treatments.

Table 13. 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)	4.50b	4.39b	4.15a	4.11a
Present TRI Recommendation	4.55ab	4.56ab	4.09a	4.13a
Dolomite application based on buffering capacity	4.78a	4.66a	4.29a	4.13a
LSD	0.23	0.27	0.34	0.26
CV%	2.20	2.65	3.63	2.80

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

2) Effect of different stratergies of application of dolomite on available Mg and Ca in the soil

A significant increase of soil exchangeable Mg and Ca were observed with the application of dolomite based on pH buffering capacity in 0 – 15cm soil depth ($p \leq 0.05$). However, soil exchangeable Mg and Ca were not significantly different among the treatments at sub-surface soils (15-30cm) as shown in Table 14.

Table 14. Effect of different stratergies of application of dolomite on available Mg and Ca at two soil depths

Treatments	Exch. Mg		Exch.Ca	
	0-15cm	15-30cm	0-15cm	15-30cm
Without Dolomite (Control)	51.29b	57.68a	253.7b	297.9a
PresentTRI Recommendation	65.61b	64.99a	301.2b	257.6a
Dolomite application based on buffering capacity	100.39a	80.60a	412.0a	378.5a
LSD	21.94	45.45	95.4	121.4
CV%	13.36	29.59	13.06	17.20

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

The nutrient sufficiency range of available magnesium for tea plant is 60 mg/kg and that has been attained in both dolomite applying T2 and T3 treatments.

3) Effect of application of dolomite under different stratergies on soil Cation Exchange Capacity (CEC)

The cation exchange capacities in both surface and sub-surface soils are shown in the table 15. The CEC of the surface soil recorded with dolomite application based on buffering capacity was significantly highre than the control ($p \leq 0.05$). Dolomite application based on pH buffering capacities recorded the highest CEC. However, no significant difference observed on CEC at sub-surface soil.

Table 15. Cation exchange capacity of soil samples in depths of 0-15cm and 15-30cm

Treatments	CEC	
	0-15cm	15-30cm
Without Dolomite (Control)	13.09b	12.64a
Present TRI Recommendation	13.23ab	11.73a
Dolomite application based on buffering capacity	14.33a	12.31a
LSD	1.19	2.51
CV%	3.88	9.06

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

JRY Abeywardana and WMS Wijayatunga

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)

Based on results of research trials, following treatments were selected to conduct adaptive trials to validate it under growers condition.

T1 - 100% N through (Urea +Nano HA) + 100% K through MOP (4 splits)
T2 - 100% N through (Urea +Nano HA) + 100% K through MOP (2 splits)
T3 – 50% N through (Urea +Nano HA) + 100% K through MOP (2 splits)
T4 – 100% NPK through conventional fertilizers

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

These trials were conducted at Montmartre Estate, Ehaliyagoda and Houpe estate, Kahawatte. These trials were successfully terminated in 2019 and the results were given in annual reports 2019 and 2020.

Results of research trials and adaptive trials have been used to make a recommendation and relevant documents are being processed which will be submitted to Technology Release Committee (TRC).

OGK Gunaratne & WMS Wijayatunga.

Project A 15.6. Introduction of micro-nutrient fortified foliar formulation based on micro - nutrient status in tea growing soils (Adaptive trials)

Based on results of research trials, Zn (11 kg/ha/yr), Zn (11 kg/he/ha/yr)+Mn (3.32 kg/ha/yr) and Zn (11 kg/ha/yr) + Mn (3.32 kg/ha/yr) + B (1.18 kg/ha/yr) have been selected as treatments for adaptive trials to validate them under growers' 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, Karalliyadda b) Deniyaya estate, Deniyaya
c) Aislaby estate, Bandarawelaresults of the Natuwakelle estate trial are presented below (Table 16).

Experiment 1. Effect of application of micro nutrient fortified foliar formulation on soil/ plant nutrient status and yield, Natuvakelle Estate.

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

Zinc concentration in mother leaves was not significantly different among treatments at $p<0.05$ (Table 16). The optimum Zn concentration in mother leaves in the plucking table ranges from 10-40 mg/kg.

Manganese concentration in the mother leaf was not significantly different among treatments but comparatively higher values were observed in all plots compared to the sufficiency level of 100 mg/kg. It was reported that tea plants were able to accumulate metals, particularly Mn and Zn to a lesser extent. Manganese concentration of more than 4000 mg/kg in mother leaf would be able to affect tea plant growth adversely, while 12 to 45 mg/kg Mn concentration in the flush produced Mn deficiency (Table 16).

Table 16. Effect of foliar application of micro nutrients on Zn, Mn and B concentration in mother leaves

Treatments	Zn (mg kg^{-1})	Mn (mg kg^{-1})	B (mg kg^{-1})
Ground NPK (Control) + Zn	52.1a	681a	15.6b
Ground NPK (Control) + Zn+Mn	46.0a	703a	15.1b
Ground NPK (Control) +Zn+Mn + B	52.2a	696a	23.0a
Ground NPK (Control)	37.5a	653a	10.8b
LSD	16.6	53.8	4.9
CV%	11.098	2.472	9.613

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

Boron concentration in mother leaves was significantly different among treatments. Highest value was observed in Zn + Mn + B applied plots. Zinc and Mn concentrations were not significantly different among the treatments at $p<0.05$.

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

Made tea yield was not significantly different among treatments (Table 17).

Table 17. Effect of foliar application of micro nutrients on tea yield

Treatments	Made tea (kg ha^{-1} yr^{-1})
Ground NPK (Control) + Zn	4344a
Ground NPK (Control) + Zn+Mn	4352a
Ground NPK (Control) +Zn+Mn + B	4452a
Ground NPK (Control)	4437a
LSD	NS
CV%	3.892

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

WMS Wijayatunga and JRY Abeywardana

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 (Field No. 13, St. Coombs estate, Talawakelle).
The main objectives of this study are, 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 were evaluated with six cultivars; TRI 2023, TRI 2025, TRI 3072, TRI 4071,

DT1, DN and Seedling of immature and mature stage of growth. Now, the experiment is in mature stage after 1st pruning.

Experiment in progress.

SK Weerathunga, DMS Nawaratna and WMS Wijayatunga

Project B 125. The survey on possible factors of contamination of made tea with Rare Earth Elements (REEs) in made tea in Sri Lanka.

Soil and leaf sampling were done from 40 estates and made tea were prepared from flush taken from selected field by miniature manufacture at Technology division, TRI. The survey was completed. The chemical analyses have also been completed. The final report is being prepared now.

VAN Wickramasinghe and WMS Wijayatunga.

D/SPND. Activities of Soils and Plant Nutrtion Division

Division has received an ICP-OES (thermo-scientific) analytical instrument and installed at the main laboratory of the SPND. A flam photometer (FP 910, PG instruments) was also installed to the SPND laboratory at Walahanduwa, Galle.

Staff of Soils and Plant Nutreient 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 *viz.* Hybrid Napier (*Pennisetum Purpureum* x *Pennisetum americanum*) (Variety CO-3) and East Indian Lemongrass (*Cymbopogon flexuosus*) were tested along with Guatemala (*Tripsacum laxmum*) and Mana (*Cymbopogon confertiflorus*) and also No-Rehabilitation treatment at four locations. Lemon grass and Mana were planted at 2' x 9" (60cm x 22.5cm) spacing, while other grasses were planted at 2' x 1' (60cm x 30cm) spacing. In addition to above grass species, one other new Hybrid Super Napier species (*Pennisetum Purpureum* x *Pennisetum americanum*) (Variety-*Pakchong 1)* was included as a treatment in the experiment at St. Coombs Estate (Up-country).

The four locations of the experiment are as follows

1. TRI Extension Center, Kottawa, Galle (2011)
2. Gonakelle Estate, TRI, Passara (2018)
3. TRI Mid-Country Center, Hantane (2019)
4. St. Coombs Estate, Talawakelle (2019)

1. TRI Extension Center, Kottawa

The experiment was established in October, 2011 and was terminated after pruning.

2. Gonakelle Estate, TRI, Passara

This experiment was established in February, 2018 with 5 treatments and 4 replicates. Plot size was 24' X 16'. After rehabilitation period, cultivar TRI 4078 was planted in January 2021. Growth performances of 11 months old tea plants are given in Table 18.

Highest girth of the tea plant was observed in plots rehabilitated with Guatemela grass. The lowest was recorded in no-rehabilitation treatment. Plots rehabilitated with Guatemala, CO3, Mana and Lemon grass showed significantly higher tea plant girth in comparison with no-rehabilitation. Development of secondary branches were also significantly higher in all grass rehabilitated plots, while Mana treatment showed the highest number of secondary branches (9.7 ± 1.69). This was more than double compared to no-rehabilitation treatment. Though, plant height, primary branches and number of leaves per plant were marginally higher in the rehabilitated plots, though there were no significant difference between rehabilitated and no-rehabilitated plots.

Table 18. Growth measurements of tea after 11 months of planting

Rehabilitation grass	Plant Girth (mm)	Height (cm)	Branches (No.)		Leaves (No)
			Primary	Secondary	
CO3	9.71 ±0.21^{ab}	77.92 ±2.6	7.9± 2.33	7.2± 1.54^{ab}	88.9± 20.6
Mana	9.49± 0.26^{b}	77.65 ±5.5	8.5± 2.05	9.7± 1.69^{a}	109.1± 17.6
Guatemala	9.93± 0.09a	78.48± 3.4	9.4 ±1.46	8.1± 1.42^{a}	110.4± 23.7
Lemon grass	9.40 ±0.18^{bc}	75.05± 4.4	7.7 ±1.78	9.0± 2.33^{a}	94.1± 16.5
No rehabilitation	9.00 ±0.07^{c}	67.69 ±1.5	7.1 ±1.72	4.5± 0.47^{b}	83.8± 13.1
CV%	2.89	8.42	27.79	24.35	24.23
P	0.0054	NS	NS	0.0173	NS
LSD	0.423	NS	NS	2.894	NS

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

Table 19 shows the weight of branches removed at centering. Although rehabilitated plots showed somewhat higher centering weights, the figures were not significantly different ($p> 0.05$).

Table 19. 1st Centering Weight (g/plant)

Rehabilitation grass	Fresh weight (g/plant)	Dry weight (g/plant)
CO3	103.3 ±8.18	31.0± 2.45
Mana	105.5 ±21.27	31.6± 6.38
Guatemala	106.8 ±14.01	32.0 ±4.2
Lemon grass	100.7± 9.78	30.2 ±2.9
No Rehabilitation	90.2± 11.65	27.1± 3.50
CV%	25.10	25.10
P	NS	NS
LSD	NS	NS

Soil samples were taken 11 months after tea planting (2021) for the analysis of pH, soil carbon, total nitrogen, potassium and phosphorus. This experiment is in progress.

3. TRI- Mid-Country Center, Hantane

Treatments were arranged in a CRD with 3 replicates. Plot size was 24' X 16'. Fresh weight and dry weight (t/ha) of grass lopping at 21 months after planting are shown in Table 20. CO3 and Guatemala grasses produced significantly highest lopping weights (fresh weight) in comparison with two other grass species. However, significantly high dry weight of loppings was recorded only by CO3.

Table 20. Lopping weight (t/ha) 21 months after planting

Treatments	Fresh wt (t/ha)	Dry wt (t/ha)
CO3 (T1)	202.94± 9.5[a]	55.89± 2.9[a]
Mana (T2)	75.05± 13.8[b]	23.44± 4.2[b]
Guatemala (T3)	198.30± 26.1[a]	34.63 ±4.5[b]
Lemon grass (T4)	70.40 ±14.5[b]	21.08± 4.2[b]
CV%	22.45	21.40
P	0.0023	0.0037
LSD	61.32	14.43

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

Soil samples were taken in 2021 for the analysis of pH, soil carbon, total nitrogen, potassium, phosphorus, Available Water Content (mm/cm), Bulk Density (g/m3), Soil Microbial Biomass Content and Nematode assessments. Cultivar, TRI 4042 was planted in October 2021 after soil rehabilitation with above four grasses species. This experiment is in progress.

4. St. Coombs Estate, Field No 13, TRI- Talawakelle (2019)

This experiment was established in September, 2020 with following six treatments in 4 replicates. Plot size was 32' x 10'. In this experiment, Mana and Lemon grass were planted at 2' x 6" spacing, while other grasses were established at 2' x 1' spacing.

Treatments

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

One year after planting, biomass production (loppings) of *Packchong* was the highest. It was followed by CO3, Guatemala, Mana and Lemon grass ($p< 0.05$) (Table 21).

Table 21. Lopping weight after one year of planting

Treatments	Fresh wt (Mt/ha)	Dry wt (Mt/ha)
CO3	159.97(±18.9)^{b}	36.30(± 4.1)^{a}
Packchong 1	251.17(± 33.1)^{a}	54.56(±7.0)^{b}
Mana	90.00(± 10.9)^{cd}	21.11(±2.7)^{c}
Guatemala	130.38(± 6.6)^{bc}	24.09(±1.1)^{c}
Lemon grass	43.78(±5.6)^{d}	14.89(± 1.9)^{c}
CV%	25.30	24.55
P	<0.0001	<0.0001
LSD	52.641	11.418

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

The soil samples were taken for the analysis of pH, soil carbon, total nitrogen, potassium and phosphorus. This experiment is in progress.

NPSN Bandara, NS Wijesekara, MGS Liyanage and EMGPB Ekanayake

Project A 10.3. Soil Quality index

Under this project, a demonstrative experiment has been conducted at Pedro Estate, Nuwara Eliya to evaluate the impact of soil rehabilitation and forking on tea yield. There were 3 plots. One was planted after soil rehabilitation. Second plot was a directly planted plot, without forking, while the third was planted directly after forking. Yield data was recorded randomly during 2021, in a replicative manner. Made tea yield was calculated based on random green leaf harvest. Though there was no significant difference among treatments, rehabilitated field and forked field produced 18% more made tea yield than the plot planted without forking (Table 22)

Table 22. Made tea yield under different Cultivation Methods

Treatments	Yield Made Tea (kg/ha/yr)
Tea planting after rehabilitation	1,064.16±93.2
Direct planting without forking	878.75± 59.6
Direct planting with forking	1,034.15±20.3
CV%	12.31
P	NS
LSD	274.76

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

Project A 10.5. Soil erosion and conservation in mid elevation tea lands as affected by water-induced erosion in Sri Lanka (2020)

Data collection from the experiment at the Kenilworth Estate, Ginigathhena, was completed in November 2021. Before imposition of the treatments, initial soil sampling was done in August 2020 and thereafter sampling continued covering all the monsoons. Soil physical, chemical and biological parameters were assessed. Runoff water and sediment sampling were done for 26 rainfall events in order to determine the soil and nutrient losses through erosion (runoff). Data processing and analysis are continued.

LASP Jayasinghe

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 evaluate the efficacy of drip and sprinkler irrigation methods on growth of tea in comparison with no-irrigation (rainfed). In **Experiment A**, two tea cultivars, *TRI 4061* and *TRI 2021* were planted with and without drip irrigation in June 2013. (Initially, planted with *TRI 2023*, which was replaced with *TRI 2021 due to theft of plants*). **Experiment B** is for 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 in these two trials separately.

In Experiment A, significant difference was observed under irrigated and rainfed treatments in both cultivars.

Table 23. Plant girth (cm)

Cultivar	Rainfed	Irrigated
TRI 2021	5.35(±0.17)	6.14(±0.18)
TRI 4061	6.27(±0.32)	6.98(±0.27)

In Experiment B, the highest girth of plant 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 under rainfed condition. Difference in growth was not significant for the cultivar TRI 2027 and TRI 4004. Following table shows the girth of three different cultivars under rainfed and irrigation conditions.

Table 24. Plant girth (cm)

Cultivar	Rainfed	Irrigated
TRI 2023	4.96 (±0.31)	6.52 (±0.18)
TRI 2027	6.83 (±0.55)	6.49 (±0.51)
TRI 4004	4.74 (±0.14)	6.12 (±0.42)

Effect of Sprinkler Irrigation in Tea Coconut Intercropping Field

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

Plant girth was measured at the end of year 2020, selecting 10 plants each from sprinkler irrigation and rainfed plots and from each cultivar; TRI 2021, TRI 2026 and TRI 2027. Results are given in table 25.

Table 25. Shoot composition (number/plant)

Cultivar	Rainfed	Irrigated
TRI 2021	4.59 (±0.24)	4.74 (±0.20)
TRI 2026	4.89 (±0.23)	4.96 (±0.14)
TRI 2027	4.96 (±0.19)	5.12 (±0.16)

Weekly green leaf yield was recorded from 6 plots (3 rain-fed and 3 irrigated) of TRI 2021 cultivar. Each plot consists of 51 (±1) plants. Yields were recorded from February 2020 and there were disruptions for harvesting in some months, due to Covid-19 pandemic. Following table shows the total harvested green leaf yield for 2020 as made tea kg/ha. Irrigated plots showed a significantly higher yield (16%) than rainfed plots. Interrupted working conditions of the year, less drought stress

(nature of field) and irrigation for mature plants could be the reasons for less yield response for irrigation when compared with other trials in low elevation tea growing areas.

Table 26. Green leaf yield (MT kg/ha)

Rain-fed	Irrigated
1721.39 (±12)	1999.12 (±66)

NPSN Bandara and EWTP Prematunga

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

Designing and modifications have been continued for *in situ* rain water harvesting device. However, field experiments could not be carried out due to Covid restrictions and unavailability of research staff.

NPSN Bandara and EWTP Prematunga

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 7 treatments arranged in RCBD with 3 replicates. *Gliricidia sepium* was established as medium shade 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 for data collection and field operations during the year 2021 due to Covid-19 pandemic situation. 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 Table 27.

Table 27. Growth performance of high shade trees

Treatment	Trunk girth at collar region (cm)	Trunk girth at chest height* (cm)	Plant height (m)	No. of secondary branches	Canopy diameter (m)
DM-40x40	76.0^{b}	73.8^{b}	9.7^{bc}	7.9^{a}	8.8^{bc}
DM-30x30	85.1^{b}	85.1^{b}	11.5^{ab}	8.7^{a}	10.0^{b}
DM-20x30	69.4^{b}	69.4^{b}	9.3^{bc}	7.2^{a}	7.8^{c}
CN-40x40	78.9^{b}	63.9^{b}	12.5^{ab}	10.1^{a}	8.6^{bc}
CN-30x30	72.7^{b}	71.7^{b}	4.5^{c}	9.3^{a}	9.2^{bc}
CN-20x30	69.5^{b}	67.2^{b}	5.4^{c}	7.3^{a}	8.2^{bc}
AM-40x40	194.2^{a}	187.9^{a}	16.1^{a}	8.8^{a}	17.1^{a}
CV%	18.6	12.0	18.7	18.9	8.6

Values sharing the same letter within colomns are not significantly different at p=0.05. *Chest height = 1.25 m from the ground level

Albizzia (control) plants showed significantly (p=0.05) larger trunks (girth at both collar region and chest height) compared to that of *Derris* and *Cassia* (Table 27) and thereby, management of shade was easier in the latter 2 species than the control. Further, the plant height of *Derris* planted at 40'x40' and 20'x30' spacing were significantly lower than *Albizzia* while there was no significant variation in the number of secondary branches among treatments. Canopy diameters of both *Derris* and *Cassia* were significantly less than that of the control (*Albizzia*).

There were casualties in *Cassia* due to porcupine attacks (Plate 01). Some *Albizzia* plants were dead while some other plants had collar canker. Interestingly, there was no record of casualties or pests and diseases on *Derris* since planting. It was also observed that mature *Derris* pods could be harvested during late March to April for seed extraction. However, *Derris robusta* planted in an adjoining site (just as an observation plot) showed deciduous characters (leaf fall) during December - January and had a poor leaf canopy during February - March when shade is critically important for tea (Plate 01).



Plate 01. Canopies of *Derris microphylla* (left) and *Derris robusta* (middle) during dry (February) period and collar region of *Cassia nodosa* (right) attacked by porcupines.

Table 28 presents the details on the growth of tea measured as girth of the trunk under different high shade systems.

Table 28. Growth of tea

Treatment	Trunk girth at Collar region (cm)
DM-40x40	5.1[a]
DM-30x30	3.7[a]
DM-20x30	4.1[a]
CN-40x40	4.9[a]
CN-30x30	4.4[a]
CN-20x30	4.4[a]
AM-40x40	3.7[a]
CV%	20.3

Values sharing the same letter are not significantly difference at p=0.05. Girth was measured as cross-sectional diameter.

Growth (girth) of tea under different new shade systems were not significantly (p=0.05) different from that of *Albizzia* (control) (Table 28). Tea yields and soil parameters could not be recorded due to Covid-19 pandemic situation.

Experiment is in progress.

SRW Pathiranage, MSG Liyanage, EWTP Prematthunga and PB Ekanayake

b) High shade + Medium shade – Middle Division, Thalgaswella Estate, Galle
Growth assessments in both shade trees and tea were continued during year 2021 in addition to maintaining shade. The experiment was established in 2014. Treatments (high shade) were arranged in RCBD with 3 replicates in combination with *Gliricidia sepium* 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')

Result of growth perfomances in high shade trees is given in table 29.

Table 29. Growth of high shade trees

Treatment	Trunk girth at collar region (cm)	Trunk girth at chest height* (cm)	Plant height (m)	No. of secondary branches	Canopy diameter (m)
DR-40x40	79.1^{c}	62.9^{c}	14.9^{c}	4.5^{a}	6.7^{c}
CS-40x40	103.6^{b}	89.2^{b}	15.2^{b}	5.2^{a}	7.9^{b}
AM-40x40	183.5^{a}	126.5^{a}	19.0^{a}	4.4^{a}	13.1^{a}
CV%	5.25	7.45	8.34	9.2	4.28

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.

Significant differences (p=0.05) were observed among all tretaments in terms of trunk girth (both at collar region and chest height), plant height and canopy diameter and the highest values were recorded in *Albizia,* followed by *Cassia* and *Derris* (Table 29). Management of shade was easier with smaller trees (*Cassia* and *Derris*) than trees with larger trunks (*Albizia*). The number of secondary branches did not show any significant variation among the treatments. However, *Derris robusta* has reported deciduous characters and poor growth in several locations elsewhere in the low-country tea growing region. Therefore, *D. robusta* may not be able to provide adequate shade for tea during the dry period (January – March).

Table 30. Growth and yield of tea

Treatments	Trunk diameter at collar region (cm)
DR-40x40	5.4^{a}
CS-40x40	4.7^{a}
AM-40x40	5.0^{a}
CV%	5.36

Values sharing the same letter are not significantly difference at p=0.05.

The growth of tea measured as trunk diameter at collar region showed no significant (p=0.05) difference among the treatments (Table 30). Yield data could not be collected due to travel restrictions and other difficulties met with Covid-19 situation.

Experiment is in progress.

SRW Pathiranage, MSG Liyanage, EWTP Prematunga and PB Ekanayake

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')

The growth assessments could not be recorded due to Covid-19 pandemic situation.

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

d) High shade + Medium shade –Pitarathmale Estate, Haputale
This experiment was established in December, 2017 and 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')

The experiment will be re-established in a new location due to heavy drought casualties occurred during Covid-19 pandemic period.

SRW Pathiranage, MSG Liyanage, EWTP Prematunga, PB Ekanayake. and SN Wijesekara

e) High shade + Medium shade – Meddecoombra (Medakumbura) Estate, Talawakelle
This experiment was established in December, 2019 with following treatments 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')

The experiment will be re-established in a new location due to heavy casualties caused both by dry weather and damage by cattle during the Covid-19 pandemic period.

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

Project A 34.3. Development of pests and diseases management strategies for shade trees in different Agro Ecological Regions (AERs)

Treatment application for testing wound dressing using field infected tress was completed at St. Coombs Estate and monitoring is being continued.

M Niranjan and GD Sinniah



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* in Moliche's solution, Potato Dextrose broth (PDB) and rice cultures has been continued to initiate a new field trial.

NAIM Nissanka, AMP Sammani and PD Senanayake

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

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

Objective: To determine the effective trapping height for mass trapping of SHB using tea stem bark volatiles (kairomones).

Experimental site: Field No. 10, Attampitiya Estate, Attampitiys

Experimental Design: Split-plot design with 3 replicates

Treatments:

T1 - Blend of tea stem bark volatiles (Linalool: Trans-2- hexen-al: Cis- 3-hexen-al: Pentanal: Methyl Salicylate (5:1:1: 20:2)

T2 - Ethanol 70%

T3 - Control

In order to determine the effective trap hihght to place the blend of tea stem bark volatiles for mass trapping of SHB, two different trapping heights were seleted. Blend of stem bark volatiles was placed at 3 ft and 6 ft from the ground level. Multifunnel traps imported from the Company of Synergy Semiochemicals were placed 15 m apart in the field. Trap counts were monitored at monthly intervals. The experiment was abandoned due to Covid-19 epidemic condition and continued with new site.

NAIM Nissanka, AMP Sammani and PD Senanayake

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

Project A 23.3. Development of decision support system for management of blister blight

Developing a statistical model for forecasting the blister blight disease

Increasing concern on fungicide residues in tea and impact on environment emphasizes that growers should give more attention on effective and efficient use of fungicides in blister blight disease management. A decision-making system would be useful for growers to decide when to commence fungicide application and to decide on the schedule of next application thereby reducing number of application rounds that can ultimately save the cost. Peiris *et al.* (2012) developed a logistic regression model for forecasting blister blight disease epidemics in the field. The model is based on most correlated and easily measurable weather parameters viz. weekly average temperature (T), weekly total rainfall (RF), weekly average relative humidity (RH), and weekly average sunshine hours (SSH). A week could be classified as an epidemic, if the predicted probability in logistic regression model >0.5. The objective of this experiment is to validate the above model/s and test the feasibility of using the model at all tea growing regions.

Newly purchased automated weather forecasting system was installed at field No 3B in Upper Division of St. Coombs Estate, Talawakelle and weather data were gathered online. Four experimental blocks were established as given in Figure 01. One block was used as control and Cu fungicide was not applied throughout the experiment period. Rest of three blocks were sprayed with Cu fungicide whenever necessary.

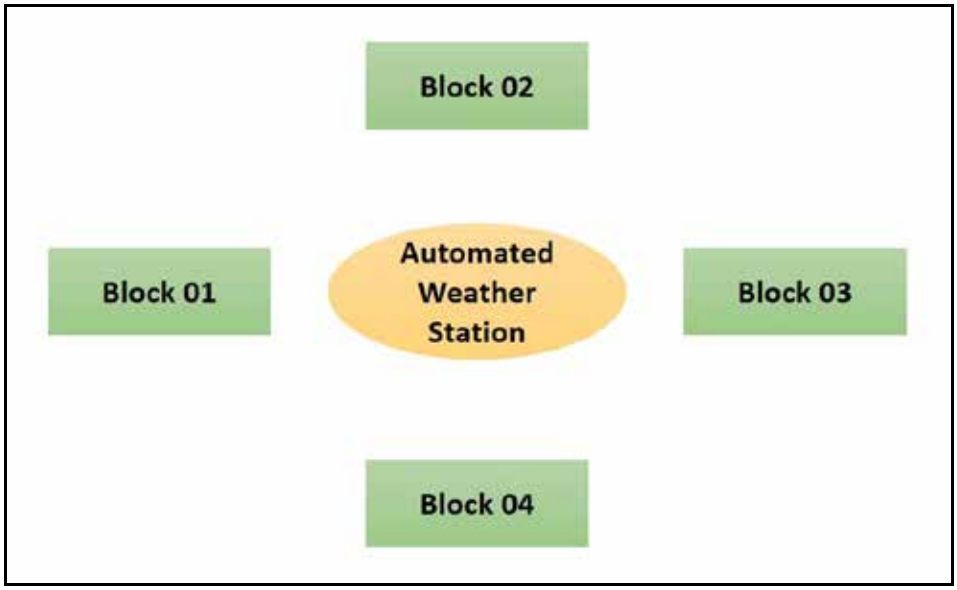


Figure 1. Field layout of the experimental site

Weather data (T, RH, RF, SSH) was collected since 12th August 2020 to 06th October 2020 and prediction was made at weekly interval. Values of *LogitP* for both models A and B were calculated by substituting the weather data to the equations. Probability of disease incidence for each week was calculated separately for model A and B as follows.

$$LogitP = \ln\left(\frac{p}{1-p}\right)$$

$$\ln\left(\frac{p}{1-p}\right) = a + bx_1 + cx_2 + \cdots + Nx_n$$

$$\frac{p}{1-p} = e^{a+bx_1+cx_2+\cdots+Nx_n}$$

$$p = \frac{e^{a+bx_1+cx_2+\cdots+Nx_n}}{1 + e^{a+bx_1+cx_2+\cdots+Nx_n}}$$

Blister blight disease severity was assessed from 19th August 2020 to 07th August 2020 at weekly interval. Assessment was done on both 2nd and 3rd leaves using blister blight disease assessment key (Sinniah *et al.,* 2016). Finally, the prediction was compared with actual disease severity.

In general, the disease severity on 2nd and 3rd leaves showed a declining trend up to 4th week and then an increasing trend in both unsprayed control block and sprayed blocks. However, severity of the disease in sprayed blocks is low compared to unsprayed control blocks except in some assessment dates (Figures 02 and 03). This indicates that natural disease incidence in the field is comparatively low on 4th, 5th and 6th weeks of assessment compared to rest of the weeks. Hence, it is expected that the prediction by the model should give low values for 4th, 5th and 6th weeks compared to rest of the weeks.

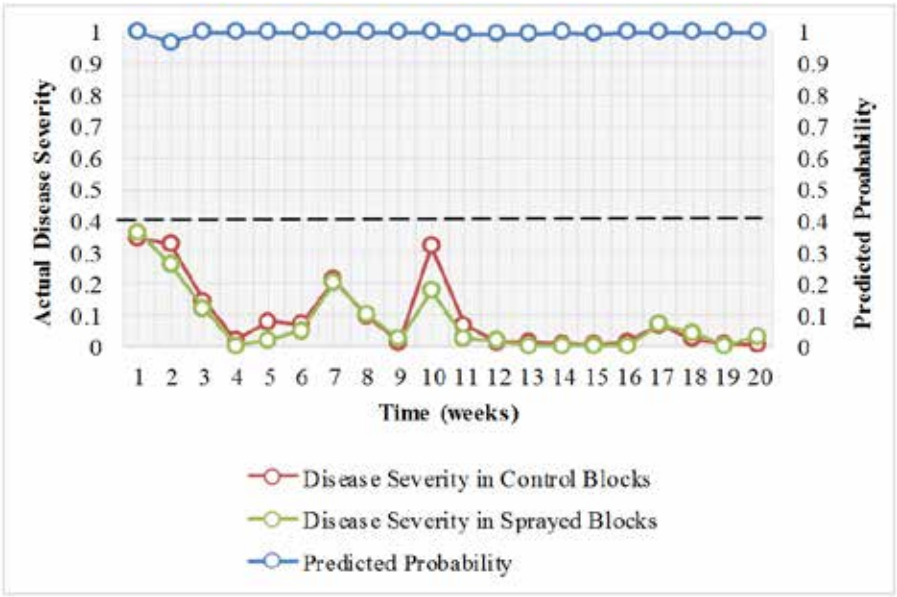


Figure 2. Actual disease severity of 2nd and 3rd leaf from the bud of harvested shoots and the predicted probability using the Model A.

It was evident that forecasted disease probability was significantly high compared to actual disease severity on both 2nd and 3rd leaves infection (Figure 3).

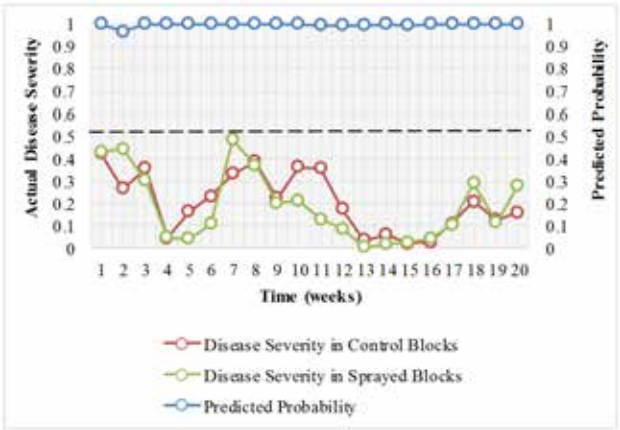


Figure 3. Predicted probability for disease incidence by using Model A and actual disease severity on 2nd leaf (A) and 3rd leaf (B) in experimental blocks sprayed with Cu fungicide and control block.

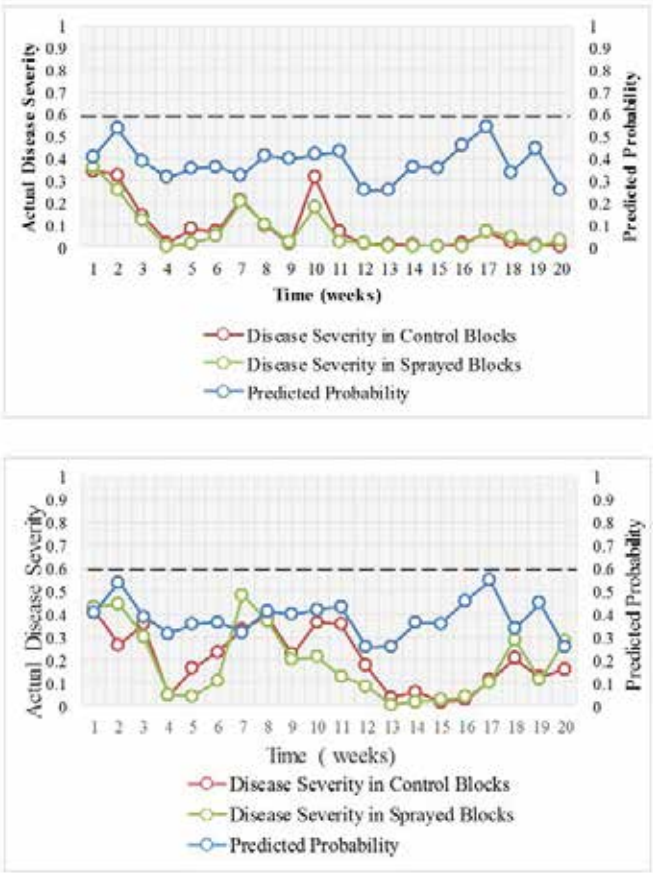


Figure 4. Predicted probability for disease incidence by using Model B and actual disease severity on 2nd leaf (A) and 3rd leaf (B) in experimental blocks sprayed with Cu fungicide and control block.

The predicted probability using Model B (Figure 4 A and B) also did not follow the actual disease severity in the field. However, that Model B could be further refined to predict blister blight severity accurately in the field.

M Niranjan, DGNP Karunajeewa and GD Sinniah

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

Screening Copper hydroxide (50% WG) against blister blight disease
Bioefficacy trial in plucking field

The objective of this study was to test and confirm (confirmation trial) the efficacy of Copper hydroxide (WG) against the blister blight disease in tea and to determine the effective concentration. The experiment was carried out at Field N0.9 of St. Coombs Estate, Talawakelle. The experiment design was Randomized Complete Block Design (RCBD) with 6 treatments namely T1- 0.12% Copper hydroxide WG, T2-0.16% Copper hydroxide WG, T3-0.20% Copper hydroxide WG, T4-0.24% Copper hydroxide WG, T5-0.2% Copper Oxide WP (Control) and T6-Unsprayed Control. Each treatment was replicated 3 times. Experimental plots had about 30-35 tea bushes of cultivar TRI 2025. Chemical spraying was carried out at weekly interval. Harvestable shoots with bud and three leaves were harvested at 7 days' interval and assessment of blister blight severity was carried out using standard methods.

Efficacy trial 1

Figure 5Ashows the changes in disease severity with time after application of treatments. Slight reduction inArea Under the Disease Progress Curve (AUDPC) was observed in Copper hydroxide WG and Copper oxide treatments compared to untreated control (Figure 5B). However, AUDPC values did not show statistical differences among the treatments at 95% confidence level ($F=1.61$, $p=0.243$). Plots treated with 0.16%, 0.20%, 0.24% Copper hydroxide WG treatments did not show dose dependent response in blister blight control.

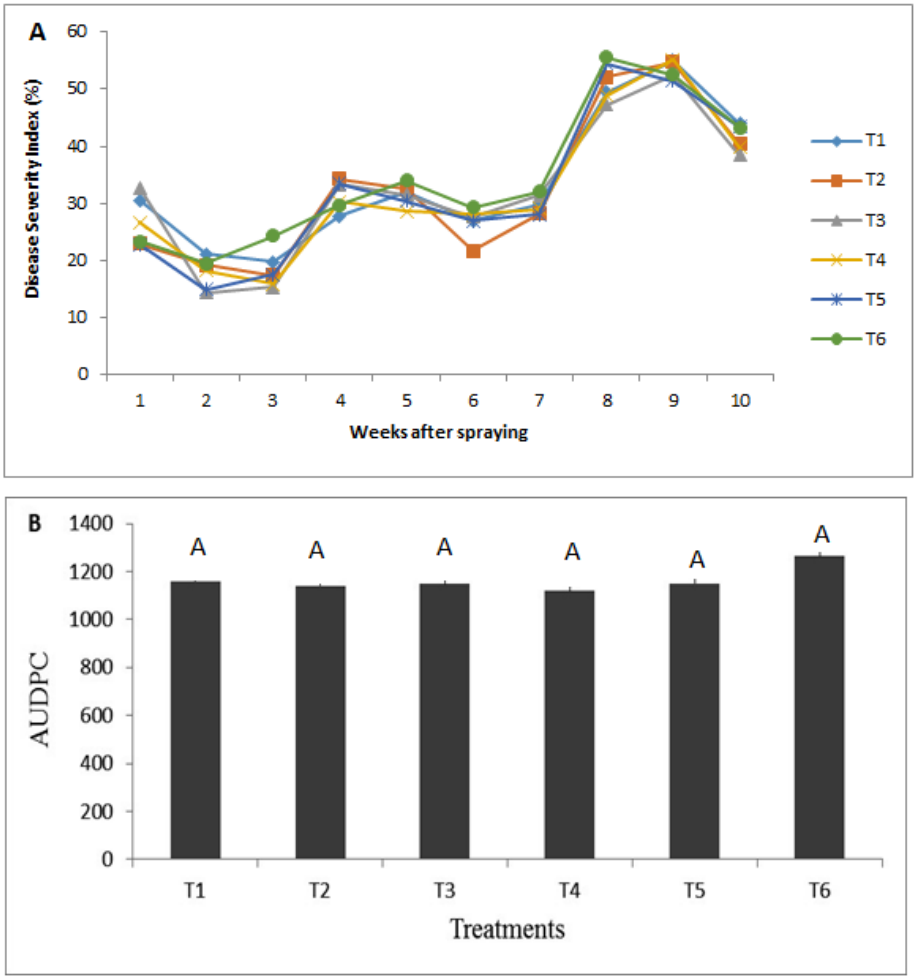


Figure 5. Disease progress curve (A) and a graph showing AUDPC (B) values in experimental plots treated with different concentration of Copper hydroxide WG (T1- 0.12%, T2- 0.16%, T3- 0.20%, T4-0.24%), 0.20% Copper oxide (T5) and unsprayed control (T6) in Trial 1 conducted during August to November, 2019.

Efficacy Trial 2

Disease severity and AUDPC values were significantly lower in the plots treated with Copper hydroxide WG and standard copper oxide fungicides ($F=11.90$; $p=0.001$) compared to the untreated control (Figure 6). Plots treated with 0.20% and 0.24% Copper hydroxide WG showed slightly lower AUDPC values compared to the standard copper oxide treated plots. However, the reduction in AUDPC values in Copper hydroxide WG treated plots was not statistically significant compared to that of standard copper oxide. When Copper hydroxide WG treatments were compared, significant difference in AUDPC was not observed with increased concentration of the fungicide.

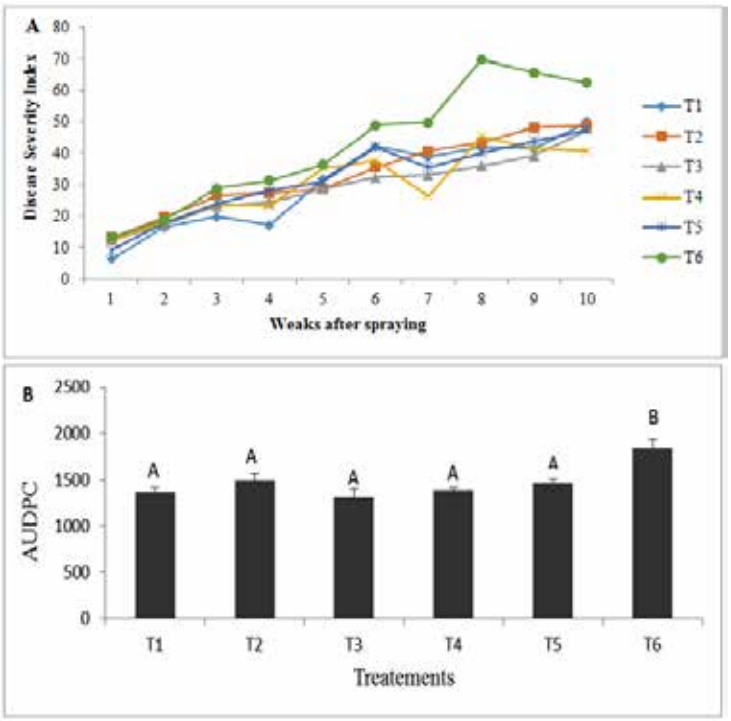


Figure 6. Disease progress curve (A) and a graph (B) showing AUDPC values in experimental plots treated with different concentration of Copper hydroxide WG (T1- 0.12%, T2- 0.16%, T3- 0.20%, T4-0.24%), 0.20% Copper oxide (T5) and unsprayed control (T6) in Trial 2 conducted during June to August, 2020. [Bars with same letter are not significantly difference at p=0.05]

Pruned Field Trial

The trial was conducted at Field No.14, Lower Division of St. Coombs Estate, TRI during November, 2020 to February, 2021. Tea cultivar grown in the field was TRI 2025. The field was just after pruning.

The experiment design was Randomized Complete Block Design (RCBD) with 4 treatments as follows;

T1 - 0.20% Copper hydroxide WG
T2 - 0.24% Copper hydroxide WG
T3 - 0.24% Copper oxide WP
T4 - Unsprayed Control

Each treatment was replicated thrice. The basic experimental unit, a plot, had 20-25 tea bushes. The treatments were applied 5-7 days interval depending on weather conditions. Disease severity of individual bushes in each plot was assessed using the disease assessment key for pruned fields. AUDPC calculation and statistical analysis

were carried out as described above. Tipping weight (flush weight and branch weight separately) of each plot was measured at the time of tipping.

Disease severity in Copper hydroxide WG and Copper oxide treated plots was slightly low compared to untreated control. However, AUDPC values did not differ significantly at 95% confidence level. The lowest AUDPC was observed in plots treated with 0.20% Copper hydroxide WG followed by 0.24% Copper oxide. Copper hydroxide treatments yielded higher tipping weight (in terms of both flush and branch weight) compared to unsprayed control. Highest flush and branch weights were recoded for 0.20% Copper hydroxide WG. The difference between the flush weight of Copper hydroxide WG treated and untreated control plots was statistically significant, while the difference between branch weight of Copper hydroxide WG treated and untreated control plots was statistically insignificant (Figure 7A and B).

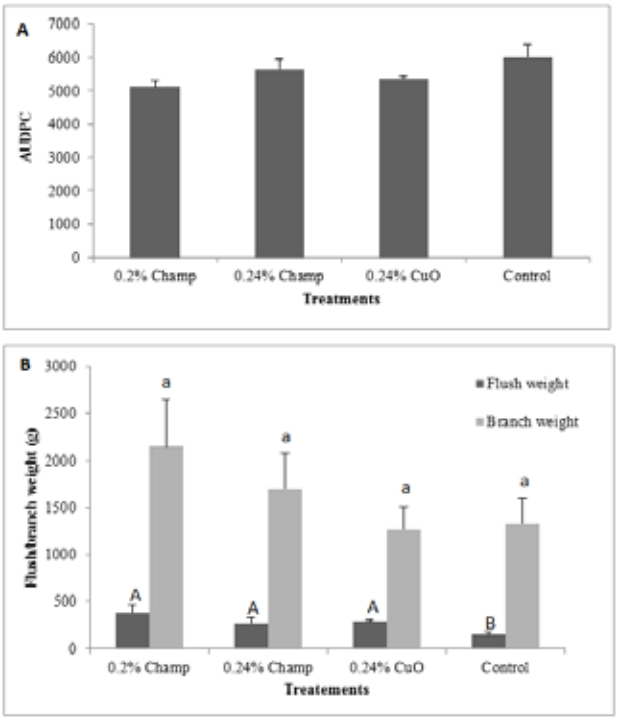


Figure 7. Graphs showing AUDPC values (A) and tipping weight (B) in experimental plots treated with different concentration of Copper hydroxide WG, Copper oxide and unsprayed control in pruned field trial conducted during November 2020 to February, 2021. (Bars with same letter are not significantly difference at p=0.05)

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. Copper hydroxide WG concentration tested was 0.24% with two

replicated blocks. This concentration was selected as it resulted lower blister blight disease severity in both trials conducted in plucking fields. Samples were taken at 0, 1, 3, 5, 7, 10, 14, 21 days after the application of the chemical. Samples were subjected to miniature processing and copper residue was analyzed at Soils and Plants Nutrition Division, TRI.

Figure 8 shows the levels of Cu residue in the final product processed in the miniature scale when Copper hydroxide WG was sprayed at 0.24%. At the recommended pre harvest interval for Cu fungicide *i.e*. 7 days after spraying, Copper hydroxide WG resulted higher Cu residue (87.25 ppm) than the Maximum Residue Limit (MRL) allowed by European Union (EU) for Cu 40 ppm.

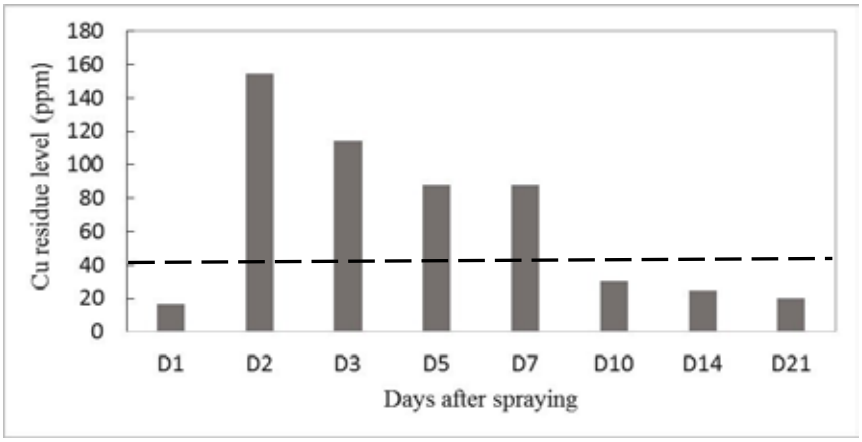


Figure 8. Levels of copper residue in the final product when Copper hydroxide WG was sprayed at 0.24%. The line indicates the European Union (EU) Maximum Residue Limit (MRL) for Cu (40 ppm).

Copper hydroxide WG treatments gave comparable blister blight control to standard Copper oxide treatment. Increasing concentrations of Copper hydroxide WG from 0.12 to 0.24% did not result in significant reduction in blister blight severity. Slight reduction in blister blight disease severity in pruned field by Copper hydroxide WG application at 0.2-0.24% and considerable improvment in tipping weight were noted. Champ WG at 0.24%, resulted in 87.25 ppm Cu residue 7 day after application and thisis two times higher than MRL set by the EU for Cu.

Screening Hexaconazole (5 SC) against blister blight disease

The objective of this study was to test and confirm the efficacy of Hexaconazole (5 SC) against blister blight disease in tea and to determine its effective concentration. The experiment was carried out at St. Coombs Estate, Talawakelle. The experimental design was randomized complete block design (RCBD) with 4 treatments and 3 replicates. The treatments were T1 –Hexaconazole 5 SC at 0.0125%, T2 – Hexaconazole 5 SC at 0.025%, T3 –Hexaconazole 5 SC at 0.05%, T4 –Hexaconazole 5 EC at 0.05% (positive control), T5- unsprayed control. Spraying was carried out at 2

week intervals during rainy periods. Blister blight severity of the harvested shoots was assessed at 7 days' interval using standard methods.

Efficacy trials

Figure 9 shows disease severity and AUDPC in bioefficacy trials. Significant differences in AUDPC was not observed among the treatment in trial 1 (P>0.05). However, the lowest disease severity was recorded in 0.05% Hexaconazole 5 EC application and higher disease severity was observed in untreated control.

Significant difference in AUDPC was observed among the treatments in bioefficacy trial 2 (P<0.05). Significantly lowest disease severity was observed in 0.05% Hexaconazole 5 EC treatment followed by 0.05% Hexaconazole 5 SC treatment compared to untreated control. The untreated control showed the highest disease severity. Application of 0.0125% and 0.25% of Hexaconazole 5 SC resulted in blister blight disease severity comparable to the untreated control.

Hexaconazole SC formulation did not show better blister blight disease control under the field conditions when compared to the already recommended Hexaconazole EC formulation for the management of blister blight by TRISL.

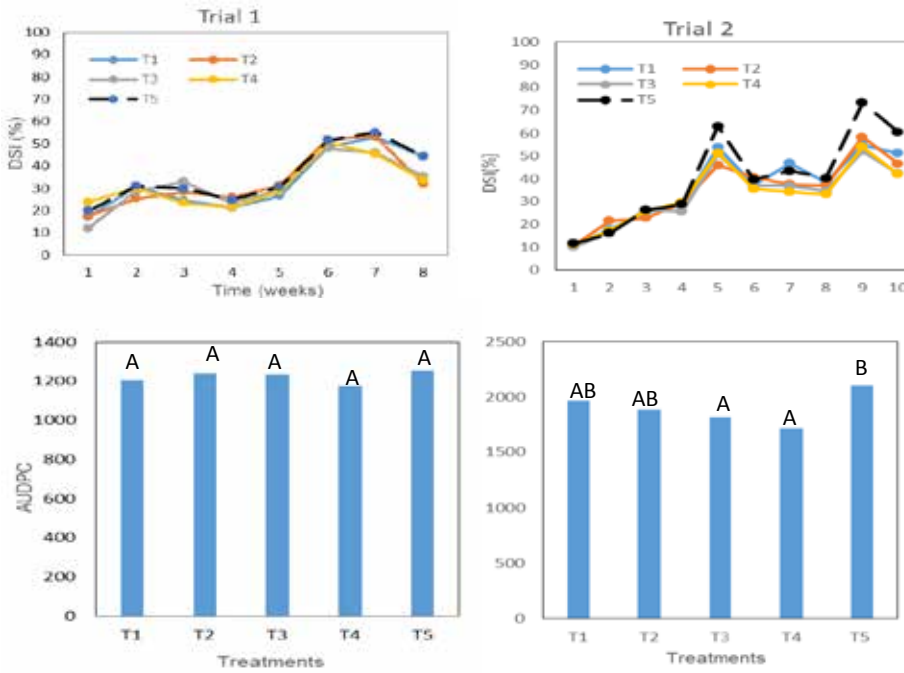


Figure 9. Disease progress curves (A, B) and graphs (C, D) showing AUDPC values in experimental plots treated with different concentration of Hexaconazole SC in Trials 1 and 2 conducted during August to November, 2019 and June to August 2020, respectively. T1 –Hexaconazole 5 SC at 0.0125%, T2 –Hexaconazole 5 SC at 0.025%, T3 –Hexaconazole 5 SC at 0.05%, T4 –Hexaconazole 5 EC at 0.05% (positive control), T5- unsprayed control. Bars with same letter are not significantly difference at p=0.05.

Pruned field trial

The experiment was carried out at Field N0.14 of St. Coombs Estate, Talawakelle. The experiment design was Randomized Complete Block Design (RCBD) with 4 treatments namely T1-0.05% Hexaconazole SC, T2-0.05% Hexaconazole EC T3-0.24% and 0.24% Copper oxide, and T4-Unsprayed Control. Each treatment was replicated 3 times. Experimental plots had about 20-25 tea bushes of cultivar TRI 2025. Chemical spraying has been carried out as per the TRI recommendations.

Blister blight disease severity was higher in untreated control compared to the fungicide treated plots. However, the observed reduction in disease severity in the treated plots was not statistically significant (P>0.05). Increase in tipping weight (flush +branch) was recorded in plots treated with Hexaconazole formulations when compared to the copper oxide sprayed plots and in the unsprayed control though the differences were not statistically significant (P>0.05) figure number

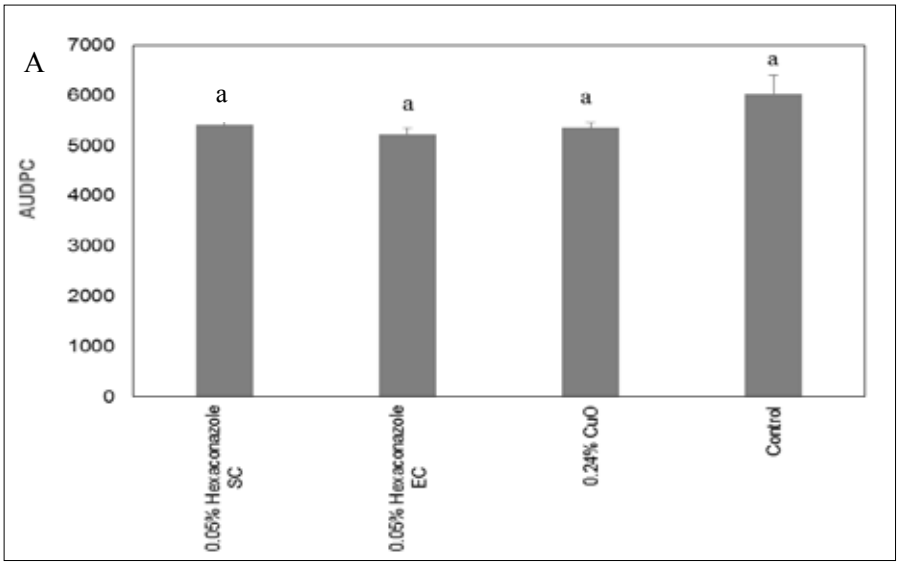


Figure 10. Graphs showing AUDPC values (A) and tipping weight (Cont.)

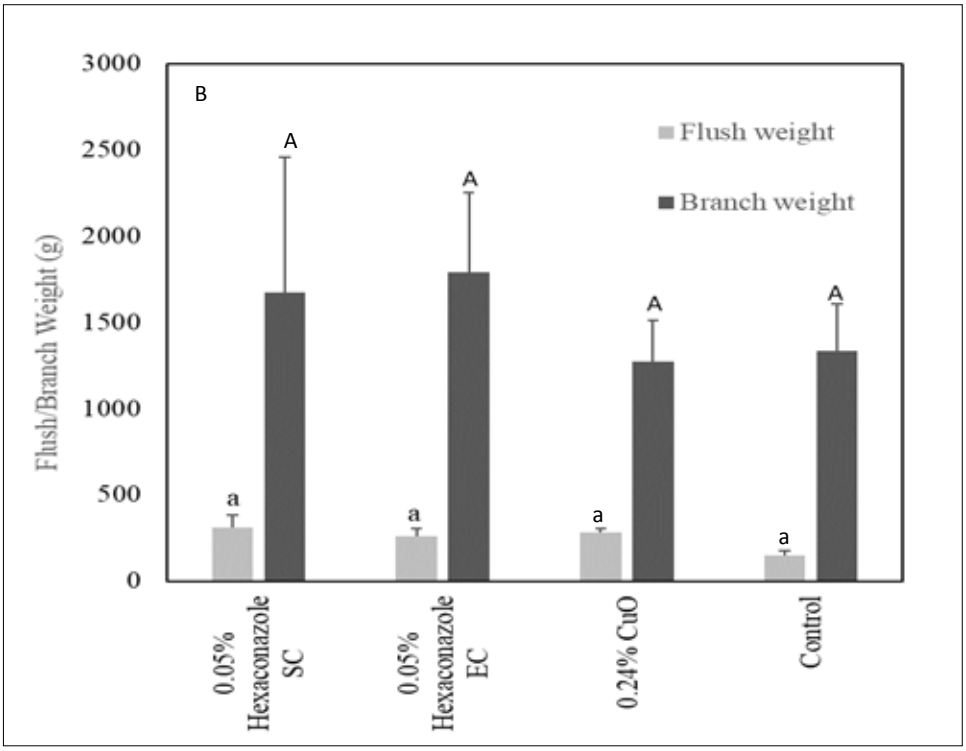


Figure 10. Graphs showing AUDPC values (A) and tipping weight (B) in experimental plots treated with different formulations of Hexaconazole and Copper oxide in pruned field trial conducted during November 2020 to February, 2021. [Bars with same letter are not significantly difference at p=0.05.]

Screening nano copper formulation against blister blight disease in tea

The objective of this study was to test the efficacy of a nano copper formulation against blister blight disease in tea and to determine its effective concentration. A confirmation 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 - 0.1% Nano copper, T2 - 0.2% Nano copper, T3 - 0.3% Nano copper, T4 - 0.1% Copper hydroxide WDG (Control) and T5 - unsprayed control. Each treatment was replicated 3 times. Experimental plots had about 30 - 35 tea bushes of cultivar TRI 2024. Chemical spraying was carried out at weekly interval. Harvestable shoots with bud and three leaves were harvested at 7 days' interval and assessment of blister blight severity was carried out using standard methods.

GD Sinniah, M Niranjan and DGNP Karunajeewa

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

Testing fungicides and biocontrol agent against Horse Hair Blight pathogen

A field trial to test the efficacy of bio control agent (*Trichoderma* sp.) against Horse Hair Blight fungus was established at St Joachim Estate. Following treatments were imposed.

T1	-	Untreated control
T2	-	*Trichoderma* application after cleaning existing HHB threads and burial of pruning
T3	-	*Trichoderma* application without cleaning existing HHB threads and burial of pruning
T4	-	Application of systemic fungicide

Experiment is being continued.

DGNP Karunajeewa and GD Sinniah

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

To evaluate underlying defence mechanisms activated by defense elicitors, selected products, Salicylic acid, silicic acid, *etc*. are applied to micro plots. A new set of green leaf samples were harvested and freeze dried. Analysis of defence related compounds is being carried out.

GD Sinniah, M Niranjan and DGNP Karunajeewa

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, 32 endophytic fungal strains were isolated from healthy young leaves of 20 tea cultivars. In order to identify the potential endophytic fungal strains isolated from tea plant, dual plate culture assays were conducted to evaluate in *vitro* antagonistic activity of the endophytes against *F. ambrosium.* Three potential endophytic fungal strains were identified from three tea cultivars, against Shot-Hole Borer fungus, *F. ambrosium.*

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 24.1 and A 24.3. Integrated Weed Management

A new trial was started to evaluate the field performance of Avenger AG Optima Burndown herbicide. It is a botanical herbicide, which contains d-Limonene (Citrus oil) as active ingredient. Three trials were started in Up, Mid and Low-country three locations in 2021 November / December period.

NPSN Bandara, S Liyanage, P Prematunga and N Wijesekara

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

1. **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**

Location: Tea Research Institute, Talawakele

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.

Results and Conclusions:

During the period under review, collection 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 has been continued and parameters such as yield, pest and disease incidences in TRIORCON and BIDORCON trials were monitored during the period.

Nursery plants from 7 cultivars (TRI 5002, TRI 5003, TRI 4052, TRI 4071, TRI 3073, TRI 2043, DT1, KEN 16/3) were introduced in 3 replicates each to assess the response to nitrogen inputs under four tratments at TRIORCON Trial. Experiment is continued.

KM Mohotti, PGDS Amarasena and B Jananey

2. **Harnessing underutilized plant species as potential supplements of essential nutrients for tea**

In view of harnessing potential supplements of essential nutrients for tea, underutilized different plant species were analysed in dry matter basis for their nutrient composition (Table 01).

Table 01. Nutrient composition of different plant species (dry basis)

No.	Source	N%	P%	K%	Mg%	Ca%	Fe (ppm)	Cu (ppm)	Mn (ppm)	Zn (ppm)
1	*Cestrum auranticum (Source: Hakgala gardens)*	3.40	0.27	4.81	0.31	306.5	125	11.8	54	18
2	*Saprosma foetens*	1.40	0.12	1.10	0.37	315.8	296	9.1	299	18
3	*Eichhornia crassipes*	3.70	0.40	5.77	0.24	303.8	1759	18.9	291	33
4	*Cestrum auranticum (Source: TRI, Talawakelle)*	4.00	0.25	3.62	0.37	439.8	158	383.5	32	35
5	*Tithonia diversifolia*	4.99	0.36	4.37	0.23	601.9	149	22.7	21	225
6	*Adathoda vasica*	2.80	0.18	1.99	0.32	371.6	259	22.6	42	19
7	*Toona sinensis*	3.07	0.18	1.34	0.16	299.3	119	12.4	40	21
8	*Erythrina lithosperma*	3.72	0.24	2.70	0.12	241.3	196	16.3	31	13
9	*Artemisia vulgaris*	3.94	0.33	3.07	0.23	312.3	247	32.1	126	10
10	*Anredera cordifoila*	3.68	0.30	8.96	0.58	405.6	174	31.9	41	246
11	*Duranta repens*	2.40	0.18	2.32	0.15	346.6	96	17.8	52	67
12	Wireweed	1.56	0.18	2.83	0.18	131.1	228	15.6	88	19
13	*Gliricidia sepium*	3.53	0.18	1.42	0.16	1.27	167	7.3	40	20
14	Ice cream bean seeds *(Inga edulis)*	2.70	0.21	1.16	0.10	0.15	178	10	25	25
15	*Lantana camara*	3.00	0.25	1.36	0.27	1.7	43	16.3	137	49
16	Substandard tea leaves	3.38	0.25	1.60	0.18	189.7	1029	24.1	153	2
Reference values for tea leaves		3.0-4.0	0.2-0.3	1.25-2.0	>0.2				>100	10-40

Based on the analysis results, *Cestrum auranticum, Eichhornia crassipes, Tithonia diversifolia, Erythrina lithosperma Anredera cordifoila* and *Gliricidia sepium* were identified as nitrogen rich sources. *Tithonia diversifolia* and *Anredera cordifoila* were identified as Zinc rich sources (Table 01).

Further, liquid manures were prepared using the same plant species, vermiwash and leachates form the composting process were anlaysed for nutrient composition and results are given in Table 02.

Table 02. Nutrient composition of liquid manures

No.	Source	N (g/l)	P (ppm)	K (ppm)	Mg (ppm)	Ca (ppm)	Fe (mg/l)	Cu (mg/l)	Zn (mg/l)	Mn (mg/l)
1	*Cestrum auranticum (Source: Hakgala gardens)*	0.21	153.75	375.00	8.50	26.90	3	0.1	1.1	0.4
2	*Saprosma foetens*	0.03	89.69	100.00	4.90	4.60	2	0.0	1.3	1.2
3	*Eichhornia crassipes*	0.01	128.13	288.00	4.60	19.40	2	0.0	1.3	0.3
4	*Cestrum auranticum (Source: TRI, Talawakelle)*	0.03	102.50	88.00	1.70	6.60	2	0.0	1.1	0.2
5	*Tithonia diversifolia*	0.14	102.50	288.00	4.70	20.30	1	0.0	1.2	0.5
6	*Adathoda vasica*	0.13	115.31	213.00	9.90	41.70	2	0.0	1.2	0.3
7	*Toona sinensis*	0.03	102.50	63.00	1.80	10.70	2	0.0	1.1	0.4
8	*Erythrina lithosperma*	0.13	153.75	300.00	8.20	23.10	3	0.0	1.4	0.6
9	*Artemisia vulgaris*	0.36	153.70	913.00	10.40	49.00	4	0.0	1.4	0.6
10	*Anredera cordifoila*	0.09	76.80	326.00	8.60	14.80	3	0.0	0.7	0.8
11	*Duranta repens*	0.06	89.60	176.00	2.40	14.30	3	0.0	1.4	0.6
12	Wireweed	0.03	102.50	113.00	2.50	9.30	3	0.0	1.3	0.6
13	*Gliricidia sepium*	0.04	76.80	150.00	3.10	19.20	4	0.0	1.1	0.5
14	*Lantana camara*	0.03	30.70	58.80	34.40	96.90	1	0.6	0.8	0.9
15	Substandard tea leaves	0.04	640.60	113.00	2.40	10.60	3	0.0	1.1	0.7
16	Vermiwash	0.10	115.30	1450.00	17.60	37.20	28	0.0	0.9	2.0
17	Compost Leachate	0.16	166.50	1000.00	19.50	38.40	10	0.0	1.1	2.9

Experiments are in progress to develop and use selected botanicals with potential application methods as nutrient sources and pesticidal purposes.

KM Mohotti, PGDS Amarasena and B Jananey

Thrust A 45. Development of integrated nematode management strategies

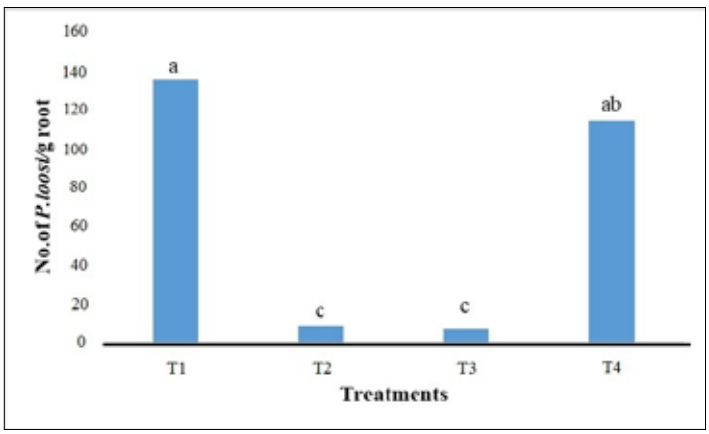
Project A 45.1. Introducing user friendly alternate tea propagation and soil sterilizing techniques, protected tea nursery concepts to minimize contamination and prevent dissemination of tea nematodes through planting materials

Experiment: Screening of biofumigant materials against nematodes in tea soils
Objective **:** Evaluation the potential of biofumigants on nursery soil
Experimental Site **:** Nematology nursery, Tea Research Institute, Talawakelle

An experiment was initiated to compare the effect of agricultural wastes, particularly plants from genus *Brassica*, as biofumigants of tea nursery soils. The mixture of the biofumigants was tested for its nematicidal effect. Three different dosages of biofumigants were tested along with the untreated control.

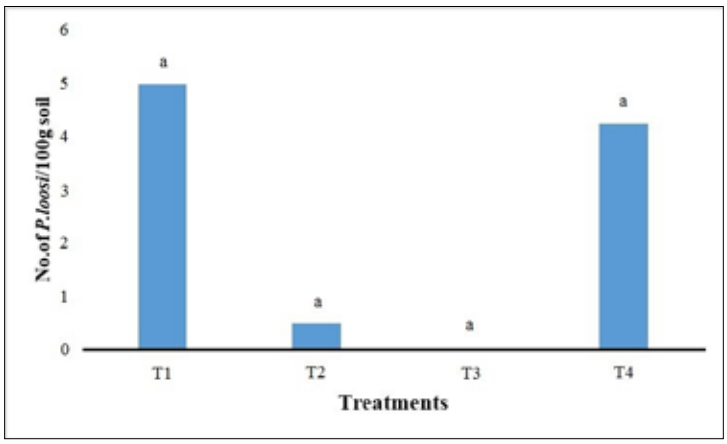
Treatments
T1 - 1 g biofumigant mixture /100g infested soil basis
T2 - 3 g biofumigant mixture /100g infested soil basis
T3 - 5 g biofumigant mixture /100g infested soil basis
T4 - Untreated control

Preliminary studies showed the potential use of biofumigant materials to eradicate *Pratylenchus loosi*, plant parasitic nematode species in tea soils. Therefore, a pot trial was conducted using fumigated soils with above treatments and untreated control. TRI 2024 tea plants were planted in treated soils and monitored for 6 months under glasshouse condition. Plants were uprooted separately after 3 months; soil and root population of *P. loosi* were assessed. Results revealed that biofumigant mixture 5 g /100g infested soil is effective in reducing population of *P. loosi* in soil although results are not significant (Figure 11).



The bars with the same letters are not significantly different at p=0.05
Figure 11. Population density of *P. loosi in soil* - 6 months after treatment

P. loosi population in roots of is significantly lower with higher doses of biofumigant mixture (3 g and 5 g biofumigant mixture /100g infested soil) compared to that of lower dose of biofumigants and untreated control.



The bars with the same letters are not significantly different at p=0.05

Figure 12. Root population of *P. loosi* 6 months after treatment

Further studies are being continued to confirm and fine tune the application method of biofumigants.

PGDS Amarasena, BMGK Godavita and B Jananey

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

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 firld sampling and the nematode estimation.

Four hundred and twenty-six numbers 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.

Table 03. TI Ranges

District	TI ranges
Ratnapura	Palmadulla, Wewalwatta, Karawita, Kalawana, Weddagala, Kukulegama, Waleboda, Potupitiya, Rakwana, Ayagama, Rassagala, Gilimale, Eheliyagoda
Galle	Hiniduma, Pitabaddara, Akuressa, Opatha, Panangala, Halvitigala, Habarakada, Udugama, Neluwa
Matara	Morawaka, Kalubovitiyana, Kotapola, Pitabeddara, Akuressa
Kandy	Wattegama, Alawathugoda, Pujapitiya, Nawalapitiya, Ulapane, Hewaheta, Danthure

PGDS Amarasena, UB Herath, BMGK Godavita and B Jananey

Thrust A 54. Development of IPM Strategies for managing Low-Country Live Wood Termite (LCLWT)

Project B 29. Refining techniques for sampling, laboratory and field evaluation

Experiment E 413. Development of methodologies to screen cultivars against SHB in an enclosed environment in Up Country

Objective : To evaluate cultivar resistance against SHB under artificial infestation in up country
Experimental site : TRI, Talawakelle
Experimental design : CRD with 6 replicates
Cultivars/accessions : TRI 4052, TRI 4006, TRI 2025, TRI 2023 (known cultivars) and accessions 272, 10/1, 12/11

Two year old plants of above cultivars/accessions planted in the enclosed environment (polytunnel) and maintained until introduction of beetles. SHB beetles which were reared on an artificial diet were introduced to plants (10 beetles per plant/month) up to 2 months. Average daily temperature and relative humidity inside the polytunnel during the experimental period were 26 °C and 71 % respectively. The post-assessments were undertaken after 6 months by assessing SHB gallery count, SHB population, height of the plant, stem diameter, No. of branches, No. of leaves and fresh weight of plant. Cluster analysis was performed using SAS software.

Results and Discussion

Among these parameters, gallery count, SHB population, height of plant, stem diameter were identified as highly contributing factors to SHB damage. Tested cultivars were grouped into two clusters as Susceptible (TRI 2025, TRI 4006 and new accessions 12/11, 10/1 and 272) and Moderately Resistant (TRI 2023 and TRI 4052)

(Figure 13). Artificial infestation of SHB in an enclosed environment has the potential to screen cultivar resistance/susptibility against SHB infestation.

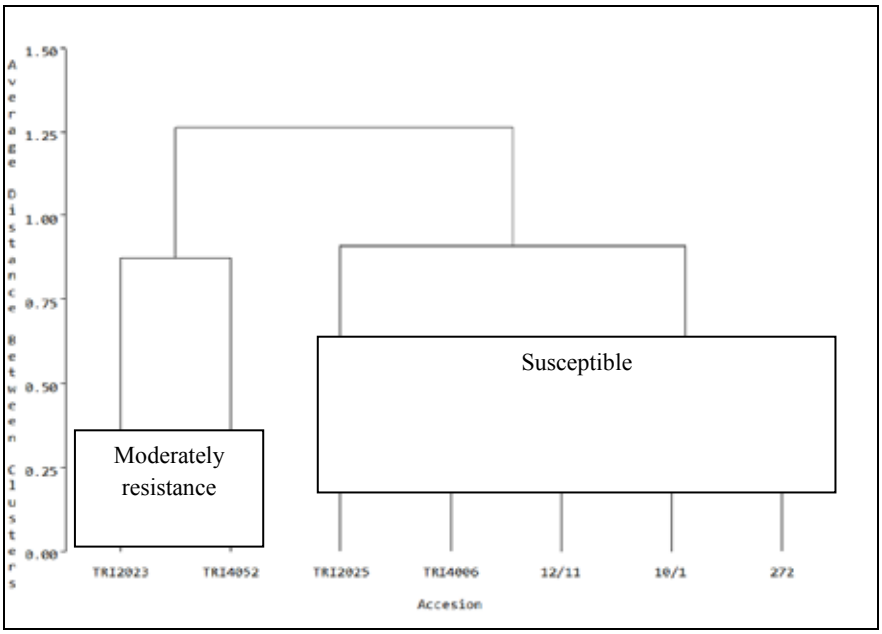


Figure 13. Clusters showing cultivar resistance/susceptibility against SHB

AMP Sammani, NAIM Nissanka and PD Senanayake

Experiment LE 145. Development of methodology to screen cultivars against SHB in an enclosed environment in low-country

Objective : To evaluate cultivar resistance against SHB under artificial infestation in low-country

Experimental site : TRI Low-Country Regional Centre, Ratnapura

Experimental design : CRD with 10 replicates

Cultivars/accessions : TRI 4006, TRI 4042, TRI 2025 and TRI 2026 (known cultivars) and accesions 23/5, 12/11, 10/1

Shot-hole borer beetles which were reared on an artificial diet were introduced (5-6 beetles per plant) to 2 year old plants of above mentioned cultivars and accessions in the net house to determine the resistance/susceptibility against SHB infestation. However, the development of SHB population inside the net house was not appropriate for the assessment.

BS Vitana, AMP Sammani and *PD Senanayake*

Project: Establishment of Actual Yield Loss Caused by *Pratylenchus loosi (P. loosi)* and *Radopholus similis (R. similis)* in Susceptible and Tolerant Tea Cultivars

Objective: To determine the yield loss due to nematode infestation, validate fresh and dry parameters and establish yield loss severity index

Set of existing experimental data from Talawakelle, Deniyaya, Passara (2016- 2019) gathered by Nematology Division were used to establish actual yield loss caused by plant parasitic nematodes in tea.

Yield loss was calculated as the difference between fresh shoot weights from the infested and healthy plants of each cultivar, according to Walker, (1983). Results of the present study, revealed that under control conditions, young tea plants gets nematode infestation resulting actual yield loss between 55.5 – 92% and 0.9 – 48.5% due to infestation of *P. loosi* and R. *similis* respectively in nursery plants.

Correlation between fresh weight and dry weight was calculated. Simple linear regression was used to obtain correlation between fresh and dry weights of shoots and roots. Fresh shoot weight vs. dry shoot weight and fresh root weight vs. dry root weight in every location were significantly different ($P \leq 0.05$). There was a strong positive relationship between fresh weight and dry weight. Based on the results, dry weight assessments can be excluded from future studies.

Based on the Fischers and Maurer's stress susceptibility index (1978), a new yield loss severity index (YiLoS index) was proposed. YiLoS index also followed similar ranks to conventional ratings except for TRI 2025. Although TRI 2025 was previously ranked as moderately tolerant cultivar, the same was grouped as susceptible to *P. loosi* damage according to YiLoS index.

KM Mohotti, PGDS Amarasena and BMGK Godavita

Validity of Using CRD (Completely Randomized Design) and RCBD (Randomized Complete Block Design) for Tea Cultivar Screening Against *Pratylenchus loosi* and *Radopholus similis* in Controlled Experuimens

The selection of tolerant tea cultivars is the prime important strategy in integrated nematode management in tea which is being practiced by the Tea Research Institute of Sri Lanka. This study was focused on determining the statistically appropriate experimental design for cultivar screening using conventional protocol based on growth parameters such as fresh and dry weights of shoots and root, plant height, number of branches and nematode index which is laborious. In view of cutting down the additional resources, five existing data sets from five different trials conducted in three locations (Talawakelle, Passara and Deniyaya) were statistically analysed using analysis of variance (ANOVA) for the Randomized Complete Block Design (RCBD) and Completely Randomized Design (CRD) separately. Results of the analysis of data

sets showed that CRD was much more appropriate while blocking variance did not show significantly in RCBD. Amongst the growth parameters evaluated, only fresh shoot weight showed a low correlation with nematode index. When the data were analyzed as CRD, it resulted in significant levels (<0.0001) and a significantly low Coefficient of Variance (CV%) value close to the value ranged between 30.37 to 57.69 with more than three replicates. In general, analysis of the data showed that the RCBD could be replaced by CRD with more than three numbers of replicates for high precision while reducing space, time and cost.

KM Mohotti, PGDS Amarasena and B Jananey

Project B 69. Identification and use of semio-chemicals for reducing insect, nematode and mite pest damages

1. Olfactometer bioassay continued with Alpha pinene.
2. Extraction and quantification of secondary metabolites of stems of tolerant and susceptible tea cultivars against LCLWT

The known resistant/susceptible cultivars are being raised in Plant Breeding nursery to estimate the catechin, polyphenol and caffeine content in the wood.

BS Vitana, NAIM Nissanka, AMP Sammani, KGN Piyasena and PD Senanayake*
(Collaborative research with Biochemistry)*

Project B 115. Development of a Multiplex PCR diagnostic kit to identify fungal pathogens in tea

The objective of this study is to develop a diagnostic PCR kit for the rapid detection of root and stem pathogens in tea. Samples showing clear symptoms of the root diseases were collected from different estates to compare the variability of the pathogenic strains among different agro-ecological sites. ITS, LSU and *tef-α* sequences of more *Poria hypolateritia* isolates were generated to confirm the identity of Sri Lankan red root pathogen and to develop species specific markers for identification.

M Niranjan and GD Sinniah

Project B 116. Development of qPCR technique to screen tea cultivars for Blister blight resistance

The objective of the project is to develop a qPCR method to screen tea cultivars for blister blight resistance. This method would help to screen cultivars at the early stages of breeding cycle where the availability of plant materials is scarce. *tef* region of more *E. vexans* isolates was amplified and sequenced using primer pairs (EF1 983F, EF1 2218 R). Specific primers were developed using *tef* sequences. Attempts made to reproduction of blister blight uniformly by artificial inoculation technique enabling large scale screening of resistant cultivars under controlled conditions were not successful.

GD Sinniah, M Niranjan and DGNP Karunajeewa

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. The spectral reflectance of healthy and blister blight infected tea leaves was captured (non-destructively) using commercially available platforms; RGB smartphone device, thermal camera attached to smartphone and multispectral camera handheld to see sensitivity of different imaging platforms on blister blight sensing and data analysis is in progress.

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

Tea plants are being raised in the nursery and SHB reared on an artificial diet for introduction.

NAIM Nissanka, TL Wijeratne and PD Senanayake*
*(Collaborative research with *Plant Physiology Division)*

Project B 133. Development of Nano pesticides for managing pests and diseases

Micro encapsulated *Beauveria bassiana* and nano hexaconazole were developed by the SLINTEC for the experiments at TRI. Experiments are being continued.

PD Senanayake and NAIM Nissanka (Collaborative research with 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.

Renovation and rearrangement of a bioprocessing lab has been carried out with Treasury funding under special project GL 391. A patent application (No.21988) was filed for *Trichoderma* based biopesticide.

Experiments to study the effect of application of *Trichorderma* and *Pseudomonas* biocontrol agents in microbial quality of made tea during dry and wet seasons were completed. Testing of effect of *Trichoderma, Pseudomonas*, *Beauveria* and *Metarhizium* pesticides on earthworms was completed. None of the biopesticides had

detrimental effects on survival and fecundity of earthworms. Preliminary screening of *Trichoderma* and *Pseudomonas* biopesticides against BB was conducted. Established field trials for *Trichoderma* and *Pseudomonas* for root diseases are in progress.

A laboratory bioassay was conducted to evaluate the bio-efficacy of *Metarhizium* spp. (Meta 1) against LCLWT. Results showed that 100% mortality in LCLWT 5 days and 9 days after applying treatments in direct contact and stem dipping application, respectively. Laboratory bio assay was carried out using the same *Metarhizium* sp (Meta 1) isolate for UCLWT. There was a significant difference ($P< 0.05$) in mortality of UCLWT among treatments when compared with untreated control. Direct contact method resulted 100% mortality at 7 DAT and dipping method at 9 DAT. All dead termites collected from treatment of fungal suspension showed the mycosis due to *Metarhizium* spp. showing the higher bio-efficacy against LCLWT and UCLWT under laboratory conditions. Culture conditions were optimized by changing C:N ratio for mass production of *Metarhizium* spp.

A pot trial was carried out to evaluate bio efficacy of *Metarhizium* spp. (MS) against white grub. However, satisfactory control of white grubs was not achieved in the pot trial. A pot trial to evaluate bio efficacy of *Beauvaria* spp. against white grubs is in progress.

GD Sinniah, M Niranjan, DGNP Karunajeewa, Plant Pathology Division
AMP Sammani, NAIM Nissanka, BS Vitana, BMGK Godavita and PD Senanayake, Entomology and Nematology Division

Project D/ENTO: Screening insecticides, acaricides and termiticides for strengthening IPM and Divisional activities

Experiment E 411. Observational trial to assess scavenging termite damage

Objective	:	To evaluate the effect of Brunolium 15% and Fipronil 50 g/L SC against scavenging termite in tea
Experimental site	:	Field No. 14, Lower Division, Imboolpitiya Estate, (Each treatment has one experimental block which consisted of 250 tea bushes)
Cultivar	:	DN
Treatments	:	T1- Brunolium 15% T2- Fipronil (1 mL/L of water) T3- Untreated control

Number of earth runs/mud tubes resulted on tea stems due to scavenging termites were recorded in each block as pre assessment. All earth runs/mud tubes were removed and cleaned before applying above mentioned treatments. The treatments were applied on tea stems to cover damaged areas and soil with 1ft radius at the rate

of 150 mL/bush. Tea bushes with new earth runs and scavenging termites were recorded monthly.

Results and Discussion

The scavenging termite species was identified as *Hyptotermes obscuriceps*. According to the observations 11 months after treatment application, 30 bushes in Fipronil treated block and 122 bushes in control block while 175 bushes in Brunolium treated block were infested with scavenging termites. The efficacy of Fipronil (1 mL/L of water) as compared with Brunolium 15% and untreated control against scavenging termite damage 11 months after application is shown in Figure 14.

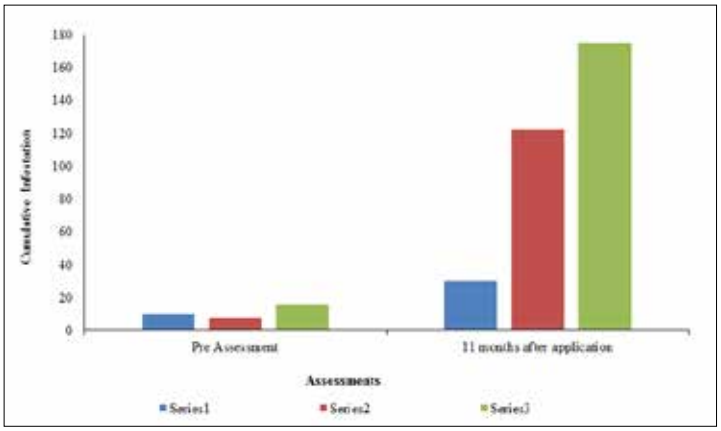


Figure 14. Scavenging termite infestation prior to and after application of treatments

UB Herath, AMP Sammani and PD Senanayake

Experiment E 412. Evaluation of the effect of Neem oil cake for scavenging termite infestation

Objective : To reduce the scavenging termite infestation in tea
Experimental site : Field No. 45, Lower Division, Imboolpitiya Estate,
Experimental design : RCBD with 3 replicates (about 73 tea bushes/plot)
Cultivar : Mixed cultivars (DN, CY 9, TRI 2023)
Treatments : T1- Application of Neem oil cake (250 g/bush)
T2- Control

Number of earth runs resulted on tea stems due to scavenging termites, soil temperature and soil pH were recorded in each plot before and after applying above mentioned treatments. All the earth runs on tea bushes were removed and cleaned prior to applying Neem oil cake. The rhizosphere around the tea bushes about 1ft radius from basal region of stem was forked and Neem oil cake was added to soil at the rate of 250 g/bush. Observations on number of new earth runs on tea bushes and presence of scavenging termites were recorded. Data were analyzed using R and R Studio software. The percentage infestation of scavenging termites was converted to arcsine values prior to analysis.

Results and Discussion

According to the results, there was no significant difference of earth runs between Neem oil cake treatment (P > 0.05) and untreated control (Figure 15).

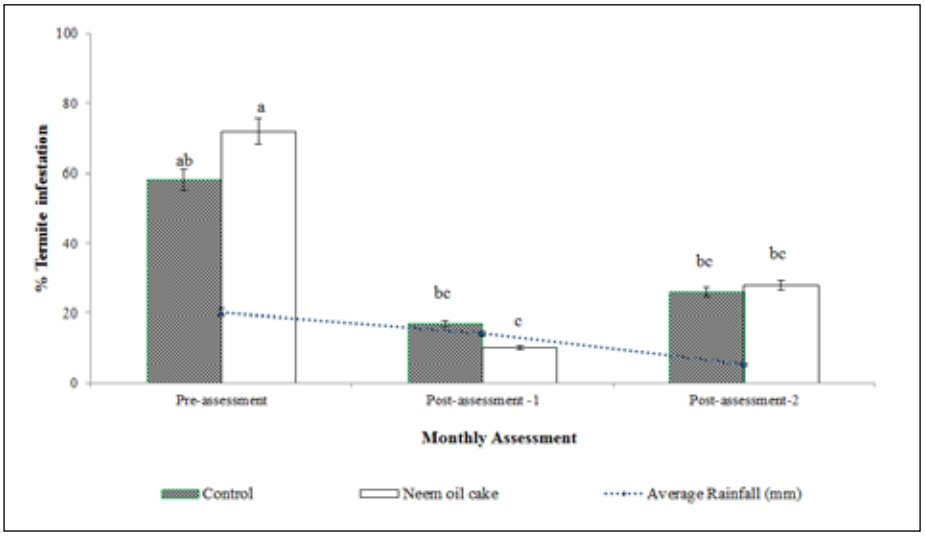


Figure 15. Percentage scavenging termite infestation prior to and after application of Neem oil cake

At post-assessment 1, treatmet blocks, (both neem oil cake untreated control) showed significant reduction of scavenging termite infestation when compared with pre-assessment. The application of Neem oil cake with proper sanitary conditions help to reduce the scavenging termite infestation. The pre-assessment of average soil temperature and soil pH of experimental blocks were 25.7 °C and 5.4 respectively. After application of Neem oil cake, the treated blocks showed 27 °C of average soil temperature and 5.4 of average soil pH and control blocks showed 27 °C of average soil temperature with 5.3 average soil pH. The application of Neem oil cake didn't affect soil temperature and soil pH when compared with control.

AMP Sammani, NAIM Nissanka, UB Herath and PD Senanayake

Experiment LE 142. Observational trial to study the response of Low-Country live wood termite (*Glyptotermes dilatatus*) and white grubs to light traps

Objective : To study attraction of LCLWT and white grubs to light traps

Experimental site: Field No. 01, TRI Low-Country Regional Centre, Ratnapura

Treatments **:** Trap 1: 1 m above ground level
Trap 2: 1.5 m above ground level

Two light traps (12 W CFL bulbs) were installed at above mentioned heights from ground level 15 m apart. Light traps were switched on evening till following day

morning (From 6.00 p.m. to 5.30 a.m.). Light traps were checked daily to record trapped alates of LCLWT and White grubs. Observations of the trial were completed.

Results and Discussion

According to the observations, trapped swarmers of LCLWT was minimum in both traping heights during the observational period (Trap 1: 24 alates, Trap 2: 14 alates). High trap counts were observed for other swarmers of termite species (Trap 1: 1252, Trap 2: 1337). According to the results (Figure 16) different white grub beetles (scarabaeid beetles) were observed in both trapping heights during the observational period. Light traps has the potential to trap adults of white grubs.

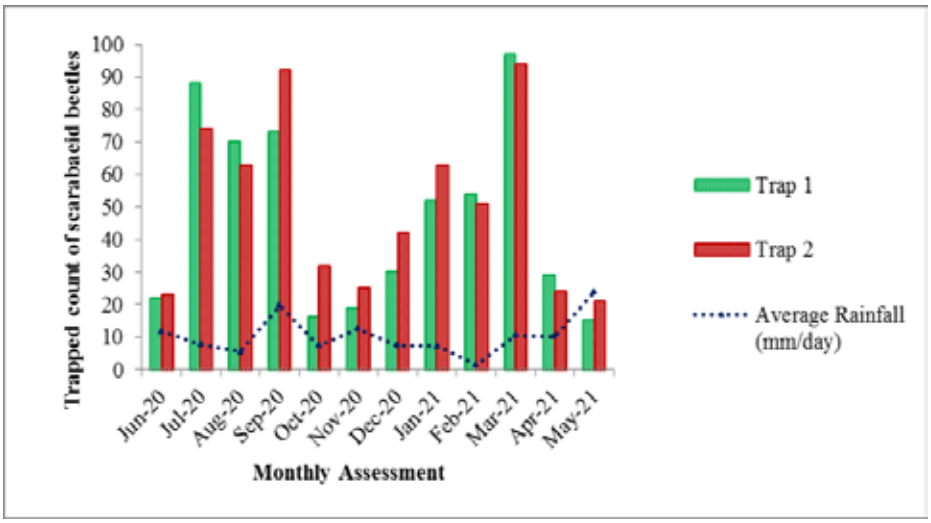


Figure 16. Trapping of different species of scarabaeid beetles to light traps

BS Vitana and PD Senanayake

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 continues.

BS Vitana and PD Senanayake

Experiment LE 144. Evaluaton of anti-termitic activity of Vetiver grass against scavenging termites

Objective : To use Vetiver grass to reduce Scavenging termite infestation in tea fields
Experimental site : TRI Low-Country Regional Centre, Ratnapura
Experimental design : Pot trial, CRD with 6 replicates
Treatments :

T1- Vetiver grass + scavenging termites
T2- Coconut husk mixed with soil + water extract of vetiver roots + scavenging termites
T3- Coconut husk mixed with soil + scavenging termites

Scavenging termites (50-60 termites) were introduced to each pot assigned for above treatments. Observations (Presence/Absence of termites) were taken at 2 days interval for a week. Experiment was completed.

Results and Discussion

According to results (Table 04), in T1, there were no scavenging termites after 4 days of treatment. However, T2 showed the presence of scavenging termites up to 4 days after treatment. T3 showed the presence of scavenging termites throughout the observational period. Results imply that Vetiver grass shows the repellent activity against scavenging termites in pot trial.

Table 04. Repellent activity of *Vetiver grass* against scavenging termites

Treatment	Availability of scavenging termites		
	2 DAT	4 DAT	6 DAT
T1	+	-	-
T2	+	+	-
T3	+	+	+

Presence (+), Absence (-)

BS Vitana and PD Senanayake

Mass rearing and augmentation of *Macrocentrus homonae*

Mass rearing and augmentation of larval parasitoid of Tea tortrix, *M. homonae* for the management of Tea tortrix has been continued to support the IPM programme.

NAIM Nissanka and PD Senanayake

Project D/PL/PA/1. Activities of Plant Pathology Division

Disease diagnosis and recommendation of remedial measures

Samples were received for diagnosis. One has been identified as Poria. Other samples did not show any pathogenic association.

Quantifying the 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. An experiment was conducted to quantify the effect of different plucking intervals on disease severity and green leaf yield.

The experiment was conducted at Field No.9, Lower Division of St. Coombs Estate, TRI during November to December, 2021. Tea cultivar grown in the field was TRI 2025. The experimental design was Randomized Complete Block Design (RCBD) with 3 treatments namely T1-harvesting at 5 days interval, T2-harvesting at 7 days interval, T3- harvesting at 10 days interval. Blister blight severity on the 2nd leaf was assessed using standard method.

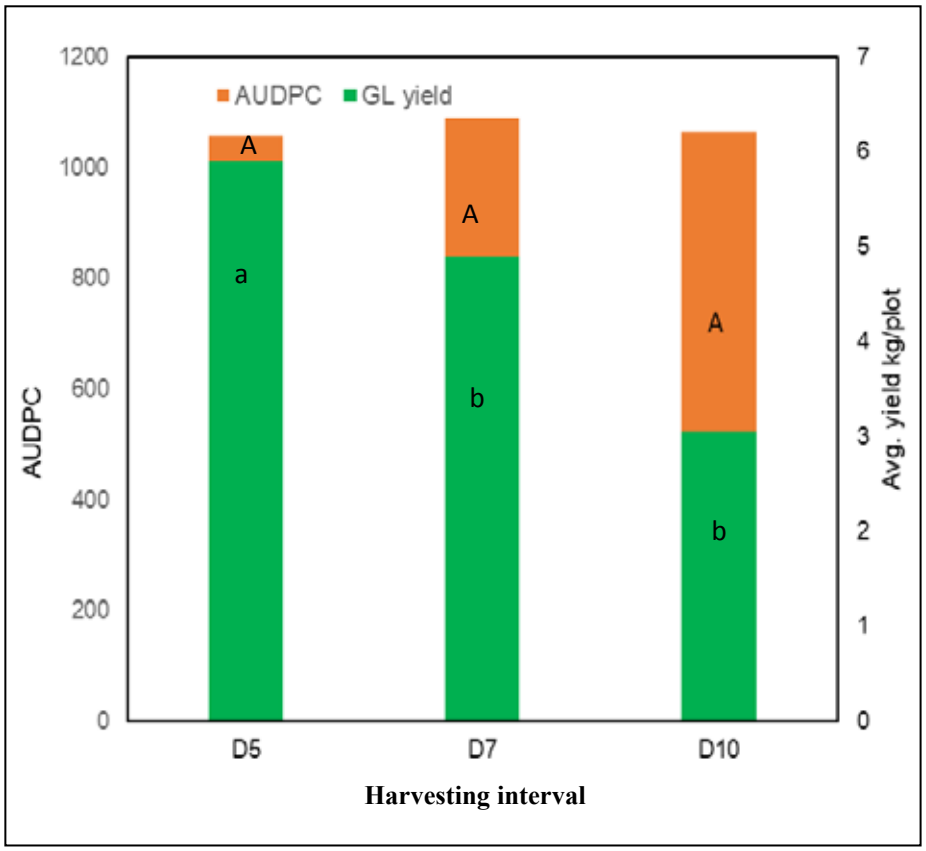


Figure 17. Blister blight disease severity in terms of Area Under the Disease Progress Curve (AUDPC) and average green leaf yield recorded in altered harvesting intervals. D5- harvesting at 5 days interval, D7-harvesting at 7 days interval, D10 - harvesting at 10 days interval.

Blister blight disease severity increased with increasing harvesting interval from 5 to 10 days, though the differences were statistically insignificant (Figure 17). A total of 11, 8 and 6 rounds of harvesting were carried out in 5, 7 and 10 plucking intervals, respectively. Significantly higher average green leaf yield was recorded in 5 days plucking round ($P<0.01$) and lowest yield was recorded in 10 days plucking round.

DGNP Karunajeewa GD Sinniah and M Niranjan

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. Climate change and its effect on pest incidences

Development of pest simulation model was initiated prioritizing *Pratylenchus loosi* nematode species. Literature search was initiated to develop a suitable model using existing data. *P. loosi* nematode densities in root and soil, weather parameter data (rainfall, soil temperature) were collated for the period of 2014-2017 in six locations
and were summarized to be used in developing a simulation model. Further work in progress.

PGDS Amarasena and BMGK Godavita

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 made available in the TRI Website for information of TRI staff and stakeholders. 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 presented in Figures 1-5.

Low-country Center, Ratnapura has received significantly higher annual rainfall than that of the last year (Figure 1) Six months of the year have recorded higher rainfalls than the decennial means while the month of February has received less rainfall. In TRI, Talawakelle and Mid-Country center, Kandy, the months of February and December have received lower rainfall quantity than the decennial means. Five months of the year have recorded higher rainfalls at Talawakelle and there were only 3 such months in the Mid- Country Center (Figure 2 and 3).

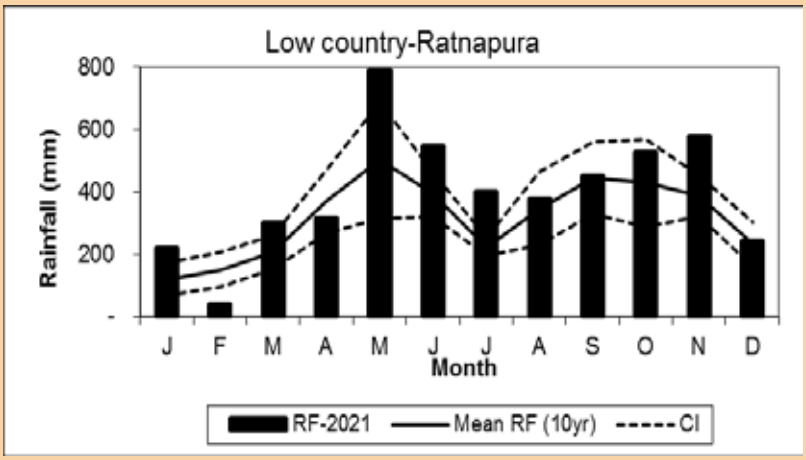


Figure 1. Monthly rainfall at TRI, Low-country Regional Center, Ratnapura (CI-Confidence Interval p=0.05)

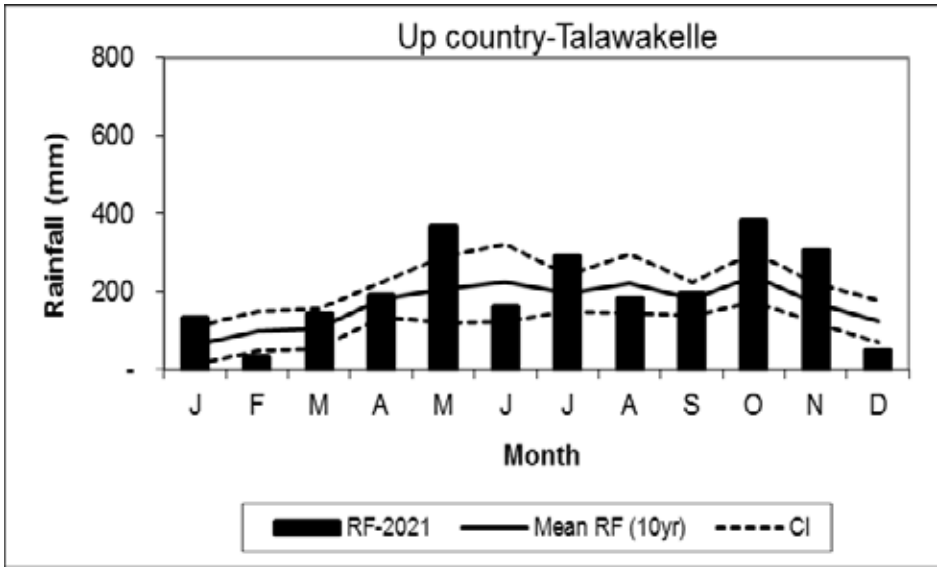


Figure 2. Monthly rainfall at TRI, Mid-Country Regional Center, Kandy (CI-Confidence Interval p=0.05)

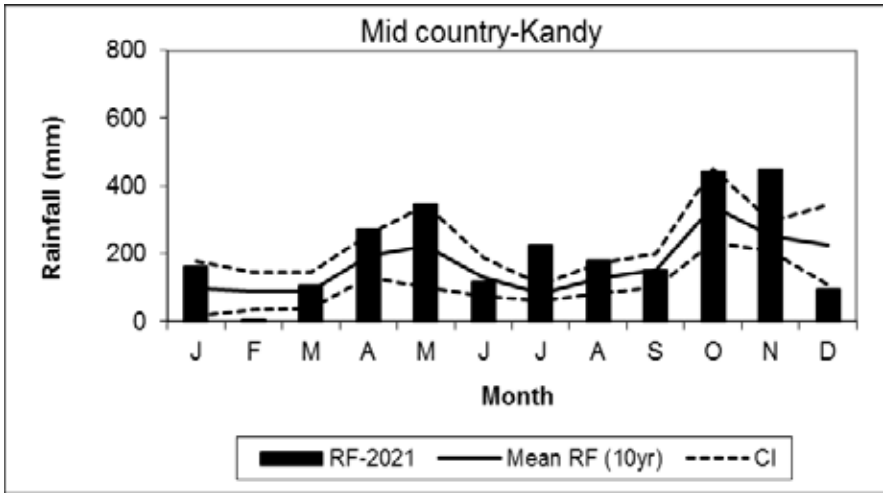


Figure 3. Monthly rainfall at TRI, Talawakelle (CI-Confidence Interval p=0.05)

Although there was no marked variation in temperature in the Low-country during the month of December, it was 1.2 ^{o}C higher than that of the decennial mean (Fig. 4). In contrast, a lower temperature was recorded during the month of November. A similar pattern was found in Mid-Country as well (Fig. 5). A new set of thermometers was installed at TRI Talawakelle due to loss of the old ones.

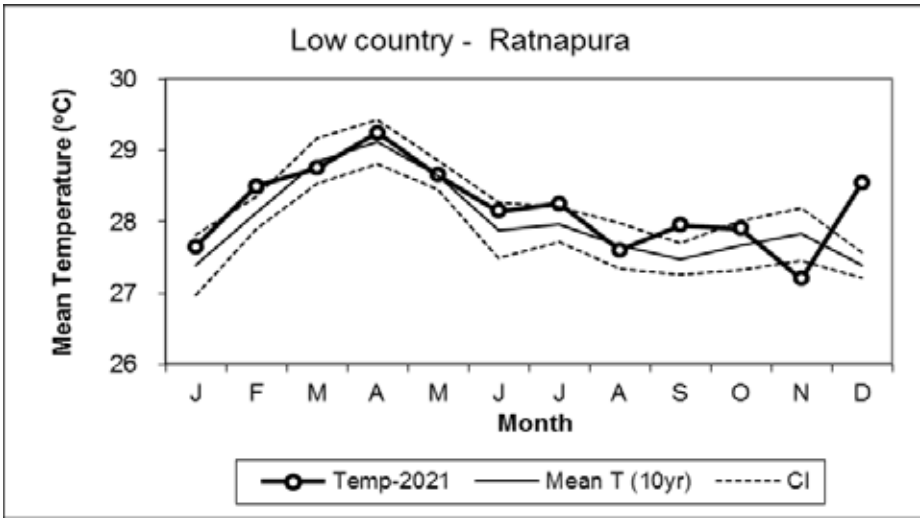


Figure 4. Mean monthly temperature at TRI, Low-country Regional Center, Ratnapura. (CI-Confidence Interval p=0.05)

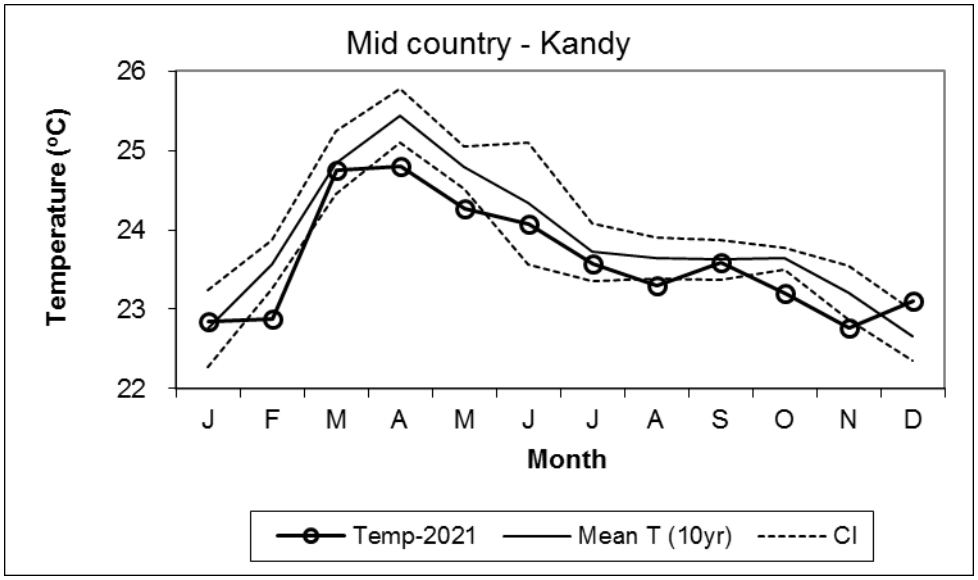


Figure 5. Mean monthly temperature at TRI, Mid-Country Regional Center, Kandy. (CI-Confidence Interval p=0.05)

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 planned in this regard to be conducted under glasshouse conditions at the Tea Research Institute of Sri Lanka (TRI), Talawakelle (1382 m amsl).

Experiment 1: Plant hormonal regulation on physiological changes in tea (*Camellia sinensis*) during drought stress.

The objective of this experiment was to understand the relationship between exogenous application of plant hormones such as Salicylic Acid (SA), Abscisic Acid (ABA) and Gibberellic Acid (GA) and their combinations as cross talk with physiological and biochemical responses in different cultivars of immature tea plants under drought stress condition and to evaluate the potential of plant hormones applications on improving survival under short term drought conditions.

Repeated evaluation of Abscisic acid (ABA) hormone at glasshouse

This experiment was conducted in a glasshouse at the Tea Research Institute of Sri Lanka, Talawakele using one-year-old potted tea plants of cultivars, which are known to be drought tolerant (TRI 2025) and susceptible (TRI 2023) respectively. The experiment was arranged according to Randomized Complete Block Design (RCBD) with 2 blocks and wih 24 replicate plants per cultivar per treatment using uniform potted tea plants. When plants were at moderate moisture stress, they were foliar sprayed with Abscisic acid at various concentrations [0 (water-spray – WS), 50, 100, 150 and 200 ppm] along with well-watered (WW - positive control) and no-spray (NS - negative control) treatments. Data were collected at 18 hours and 3, 7, 14 and 21 days after applying the treatments from randomly selected plants. Soil moisture content of the root zone at the depth of 8 cm was measured along with the physiological and biochemical parameters. After collecting the data at 21 days after applying the treatments, plants were re-watered and the recovery of plants was visually assessed after another 7 days.

Following physiological parameters were measured along with the soil moisture content throughout the experiment. Gas exchange parameters (rate of net photosynthesis, transpiration and stomatal conductance) were measured at saturated light under constant temperature on randomly selected plants using the most recently fully matured leaves. At ten days after applying treatments, the dark respiration was also measured in another set of leaves. Leaf relative water content (RWC) and leaf pigments (Chlorophyll a, b and total carotenoid) concentrations were also measured during all the measurement intervals. Leaf samples were collected and prepared for the measurements of leaf total soluble sugar content, leaf proline content, leaf polyphenol analysis and antioxidant assays too. Relative values for each treatment

were calculated using the corresponding values of well-watered plants taken as the reference using SAS statistical software.

The mean soil moisture contents expressed as volumetric water content (VWC) averaged across all treatments (except well-watered plants) were 29.48%, 28.41%, 18.06%, 11.29% and 7.99% on 18hrs, 3days, 7days, 14 days and 21days after spraying respectively.

Initially, exogenous ABA application resulted in declining of gas exchange parameters in both tea cultivars. At latter stage, *i.e*. 14 and 21 days after application of ABA, resulted higher relative photosynthetic rate and stomatal conductance compared to water spray and no-spray treatments in both cultivars showing the benefits of ABA application in mitigating drought effects.

ABA application resulted in declining of relative transpiration rate in both tea cultivars up to 7 days after spraying. The maintenance of comparable RWC was observed in ABA sprayed plants up to 21 days after spraying in both cultivars. Drought stress and ABA application resulted in increasing of accumulation of total soluble sugar and proline in both tea cultivars compared to well-watered conditions.

Repeated evaluation of Gibberellic acid (GA) hormone at glasshouse

As explained previously, another experimental was conducted using GA instead of ABA and the same measurements were taken in the explained frequencies. Chemical analysis is in progress. Effective dose of GA will be determined and taken for further evaluation in the field at a later stage.

The mean soil moisture contents expressed as volumetric water content (VWC) averaged across all treatments (except well-watered plants) were 26.5%, 20.55%, 15.11%, 9.51% and 6.69% on 18hrs, 3days, 7days, 14 days and 21days after spraying respectively.

Drought stress resulted in declining of leaf relative water content in both tea cultivars compared with well-watered conditions. When drought progressed especially at latter stage (21 days after spraying), the maintenance of comparatively higher RWC was observed in 50 ppm and 100 ppm GA sprayed plants in both cultivars compared to water spray and no-spray treatments.

All the gas exchange parameters declined along with the progression of drought in all the plants. Application of GA resulted, comparatively higher photosynthesis, stomatal conductance and rate of transpiration compared to water spray and no-spray treatments in both cultivars especially at 21 days after spraying.

In contrast to decrease in RWC and gas exchange parameters, drought stress resulted in increasing accumulation of total soluble sugar and proline in both cultivars

significantly compared to the well-watered treatment. Further, no clear pattern of variation was observed for total soluble sugar and proline content among different treatments. Total chlorophyll content also decreased with the increase of water deficit. The total chlorophyll content was significantly higher in well-watered plants compared to all other treatments throughout the experiment. Although no clear pattern of variation was observed, there was a tendency for GA treated plants to exhibit comparatively lower total chlorophyll content and carotenoid content in both cultivars.

Evaluation of hormonal cross talk of tea plants under glasshouse condition

This experiment was also conducted in a glasshouse at the Tea Research Institute of Sri Lanka, Talawakele using one-year-old potted tea plants of cultivars, which are known to be drought tolerant (TRI 2025) and susceptible (TRI 2023) respectively. The experiment was arranged according to Randomized Complete Block Design (RCBD) with 2 blocks and 24 replicate plants per cultivar per treatment using uniform potted tea plants. When plants at moderate moisture stress, they were foliar sprayed with different plant hormone combinations [ABA x SA, ABA x GA and SA x GA] along with water-spray (WS), well-watered (WW - positive control) and no-spray (NS - negative control) treatments. The same measurements were taken in the explained frequencies from randomly selected plants. Statistical analysis of collected data and chemical analysis are in progress.

The experiment is in progress.

MMN Damayanthi, TL Wijeratne and
J Damunupola (From PGIS, University of Peradeniya, Sri Lanka)

Experiment 2: Evaluation of Betaine on improving the physiological and biochemical responses in tea (*Camellia sinensis*) during drought stress.

This experiment was also conducted using the same methodology described above under glasshouse conditions at the Tea Research Institute of Sri Lanka. When plants were moderately stressed, they were foliar sprayed with various concentrations of Betaine 0 g / L water (WS), Betaine 20 g / L water (GB20), Betaine 12 g / L water (GB12) and 4 g / L water (GB4) along with well-watered (positive control - WW) and no spray (negative control - NS) treatments. Except for the WW treatments, all the other plants were continued to be exposed to a drying cycle. Data were collected at 3, 7, 14 and 21 days after applying the treatments (DAS) from randomly selected plants. Soil moisture content of the root zone at the depth of 8 cm was measured along with the physiological and biochemical parameters. After collecting the data at 21 days after applying the treatments, plants were re-watered and the recovery of plants was visually assessed after another 7 days.

Following parameters were measured along with the soil moisture content throughout the experiment. Gas exchange parameters (rate of net photosynthesis, stomatal

conductance and transpiration) leaf relative water content (RWC), leaf total soluble sugar content and leaf proline content.

Relative rates of gas exchange parameters namely the rate of photosynthesis, stomatal conductance and transpiration in comparison to well-watered treatment were decreased with the progression of drought in both TRI 2023 and TRI 2025 cultivars. Significant differences were observed among treatments within different measurement intervals in both cultivars tested, but no clear patterns of variation were observed among any of these parameters tested.

Relative rate of photosynthesis decreased with the progression of drought stress in both cultivars. Although significant differences were observed among treatments within different measurement intervals in both cultivars tested, no clear pattern of variation was observed (Figure 6).

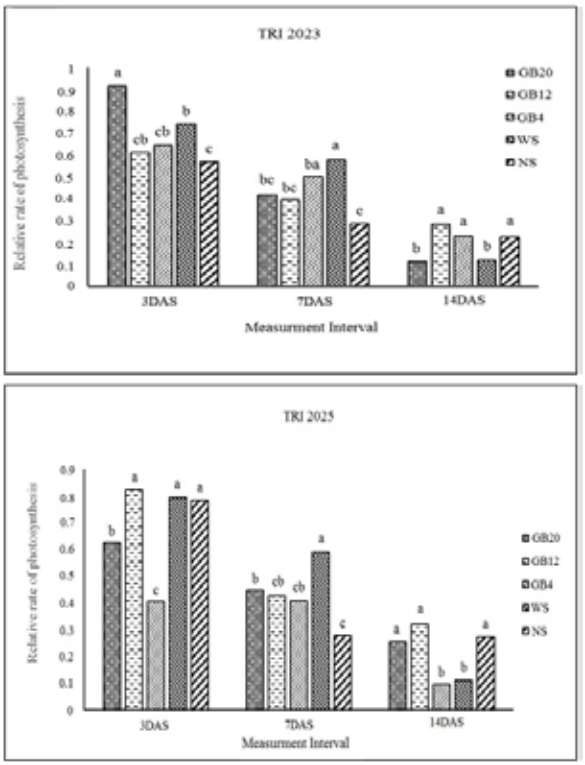


Figure 6. Variation of relative rate of photosynthesis over the experimental period in comparison to the well-watered condition for cultivar TRI 2023 and TRI 2025 where Betaine anhydrous 0 g / L water (WS), 20 g / L water (GB20), 12 g / L water (GB12) and 4 g / L water (GB4) respectively, no spray (negative control - NS) and 3DAS, 7DAS and 14DAS are 3, 7 and 14 days after spraying respectively (bars with the same letters are not significantly different at alpha = 0.05 in each measurement interval)

Relative stomatal conductance also decreased with the progression of drought stress in both cultivars. Although significant differences were observed among treatments within different measurement intervals in both cultivars tested, no clear pattern of variation was observed in stomatal conductance too (Figure 7).

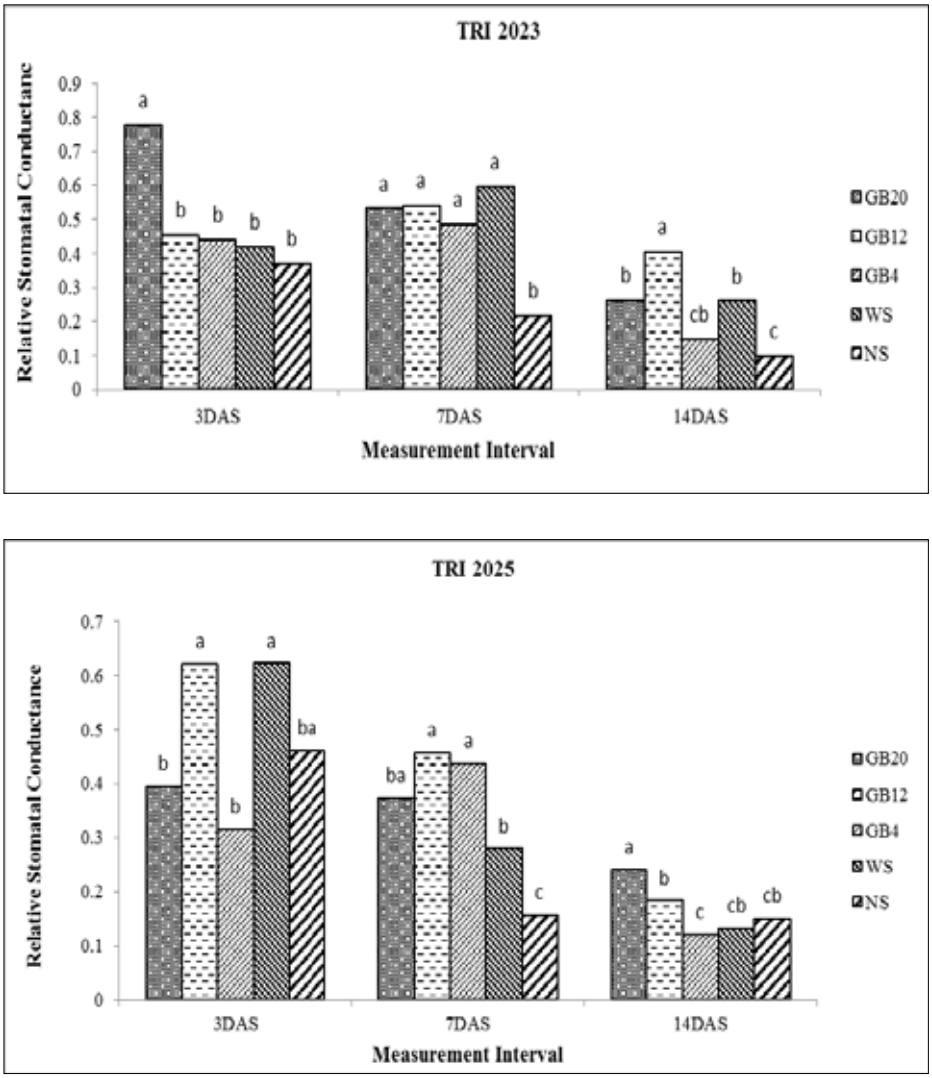


Figure 7. Variation of relative stomatal conductance over the experimental period in comparison to the well-watered condition for cultivar TRI 2023 and TRI 2025 where Betaine anhydrous 0 g / L water (WS), 20 g / L water (GB20), 12 g / L water (GB12) and 4 g / L water (GB4) respectively, no spray (negative control - NS) and 3DAS, 7DAS and 14DAS are 3, 7 and 14 days after spraying respectively (bars with the same letters are not significantly different at alpha = 0.05 in each measurement interval)

The relative rate of transpiration also decreased with the progression of drought. The GB20 treatment showed significantly higher relative transpiration rate in both cultivars tested at 14DAS (Figure 8).

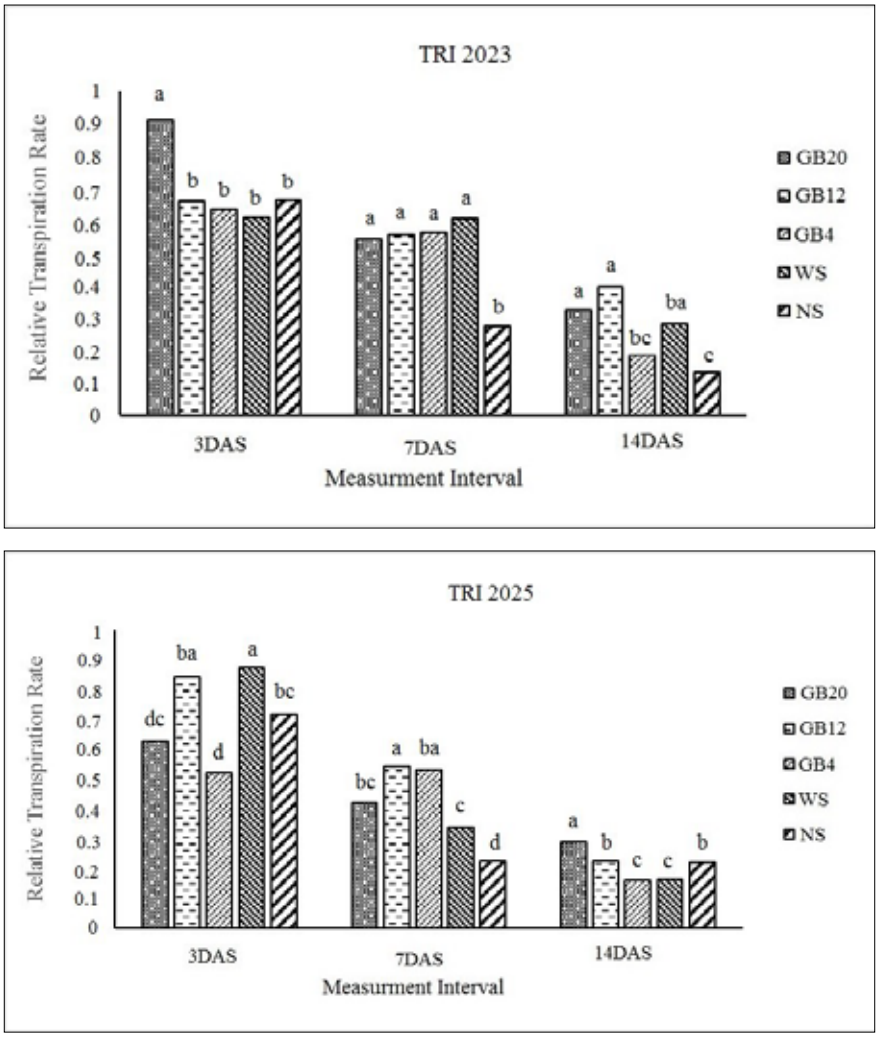


Figure 8. Variation of relative rate of transpiration over the experimental period in comparison to the well-watered condition for cultivar TRI 2023 and TRI 2025 where Betaine anhydrous 0 g / L water (WS), 20 g / L water (GB20), 12 g / L water (GB12) and 4 g / L water (GB4) respectively, no spray (negative control - NS) and 3DAS, 7DAS and 14DAS are 3, 7 and 14 days after spraying respectively (bars with the same letters are not significantly different at alpha = 0.05 in each measurement interval)

Leaf temperature was comparatively stable through out the experimental period. Significantly highest relative leaf temperature was observed in the NS treatment in both cultivars at all measurement intervals (Figure 9).

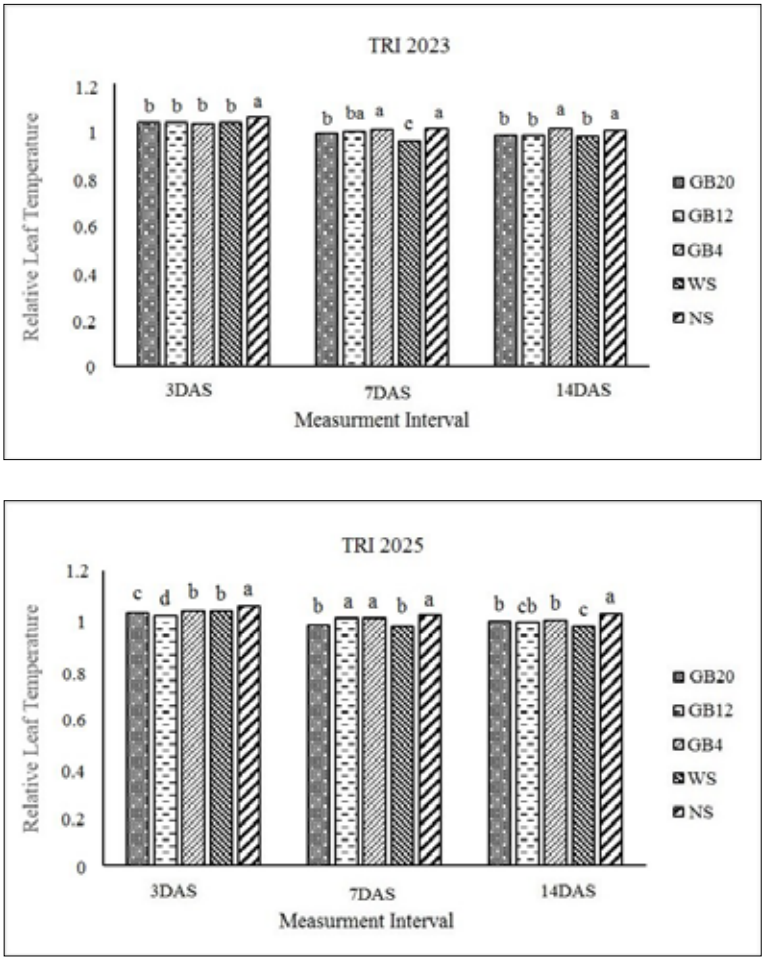


Figure 9. Variation of relative leaf temperature over the experimental period in comparison to the well-watered condition for cultivar TRI 2023 and TRI 2025 where Betaine anhydrous 0 g / L water (WS), 20 g / L water (GB20), 12 g / L water (GB12) and 4 g / L water (GB4) respectively, no spray (negative control - NS) and 3DAS, 7DAS and 14DAS are 3, 7 and 14 days after spraying respectively (bars with the same letters are not significantly different at alpha = 0.05 in each measurement interval)

The statistical models for the data on relative water content, total soluble sugar content, leaf proline content and recovery assessments were not significant and therefore, a final conclusion could not be made.

The experiment is in progress.

TL Wijeratne, DMS Navaratne, V Sidhakaran, ADIU Jayawardhana and NM Vithanage

Experiment 3: 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 long chain fatty alcohol application on improving survival under short term drought conditions.

This experiment was conducted using one-year-old potted tea plants of two cultivars with known drought tolerances namely TRI 2025 (drought tolerant) and TRI 2023 (drought susceptible) under glasshouse conditions at the Tea Research Institute of Sri Lanka. The experiment was arranged according to RCBD. The plants were brought up to the field capacity and watering was withheld before applying the following treatments. Plants were exposed to a drying cycle and once moderately stressed they were foliar sprayed with a commercial product of a fatty alcohol 660 mL / 200 L water / ha (GM660) and 1000 mL / 200 L water / ha (GM1000), water 200 L/ha (WS), 2 % Sulphate of Potash (K2SO4), 2 % Murate of Potash (KCL) along with well-watered (positive control - WW) and no spray (negative control - NS) treatments. Data were collected at 3, 7, 14 and 21 days after applying the treatments from randomly selected plants.

Physiological parameters such as gas exchange and relative water content were measured along with the soil moisture content throughout the experiment and the data were already presented in the annual report 2020. Leaf total soluble sugar content and leaf proline content were measured at 21 days after applying treatments. However, the statistical models for the data on total soluble sugar content and leaf proline content were not significant and therefore, it was not possible to comment on the impact of foliar application of long chain fatty alcohol on such traits. The plants sprayed with GM660 behaved similar way to those sprayed with the current TRI recommendations of 2 % Sulphate or Murate of Potash when sprayed to drought susceptible cultivars. Further, spraying long chain fatty alcohols to mitigate the drought impacts for drought tolerant cultivars might not show any additional benefits. In order to confirm the results, the experiment was repeated twice. The data and chemical analysis are in progress.

In order to test the efficacy of spraying long chain fatty alcohols to mitigate the drought impacts on immature tea plants under Up-Country conditions, a field trial was also established at the Bearwell Estate, Lindula.
The experiment is in progress.

TL Wijeratne, DMS Navaratne, V Sidhakaran, ADIU Jayawardhana and NM Vithanage

Project C/MET. Meteorological data

Project C/MET involves data collection, analysis as well as maintenance of agro meteorological stations of Deniyaya, Hantane (Kandy), Kottawa (Galle), Passara, Ratnapura and Talawakelle stations. Dr NPSN Bandara participated in the Monsoon Forum organized by RIMES and Department of Meteorology and made presentations, representing tea sector.

NSPN Bandara

D/PHYS. Activities of Physiology Division

This study was conducted at the Field No. 12, St Coombs Estate, Talawakelle to compare the drought tolerance abilities of different tea cultivars prior to the proposed collaborative study with the University of Peradeniya, Sri Lanka and University of Bristol, United Kingdom. TRI 2043, TRI 3072 and TRI 4052 were selected to test the methodologies. Gas exchange parameters (Figures 10 to 12) and relative water content (Figure 13) were measured in ten randomly selected plants at 34.6% gravimetric moisture content (dry weight basis) in the field. Additionally, leaf water potential and stomatal density were also measured and leaf samples were collected for the carbon isotope discrimination (data not shown).

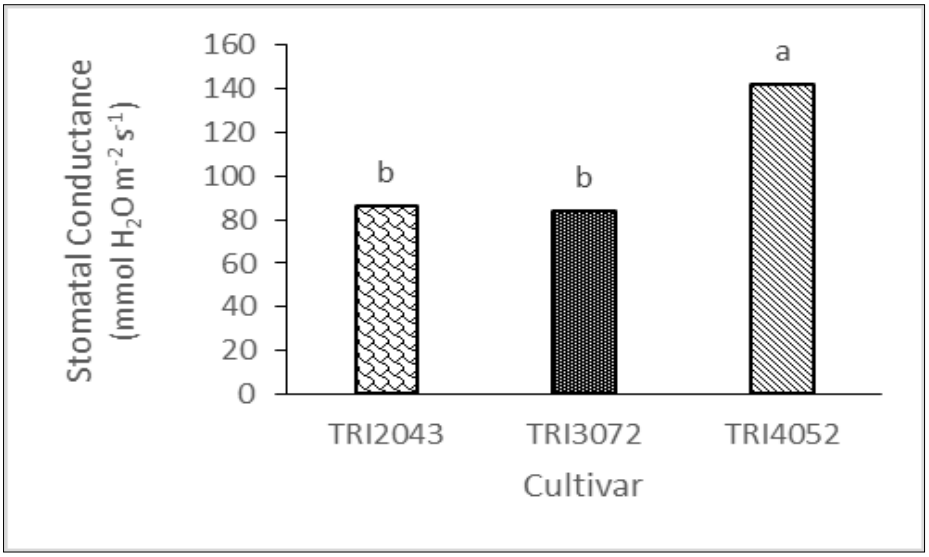


Figure 10. Comparison of stomatal conductance in different cultivars (The bars with the same letters are not significantly different at p=0.05).

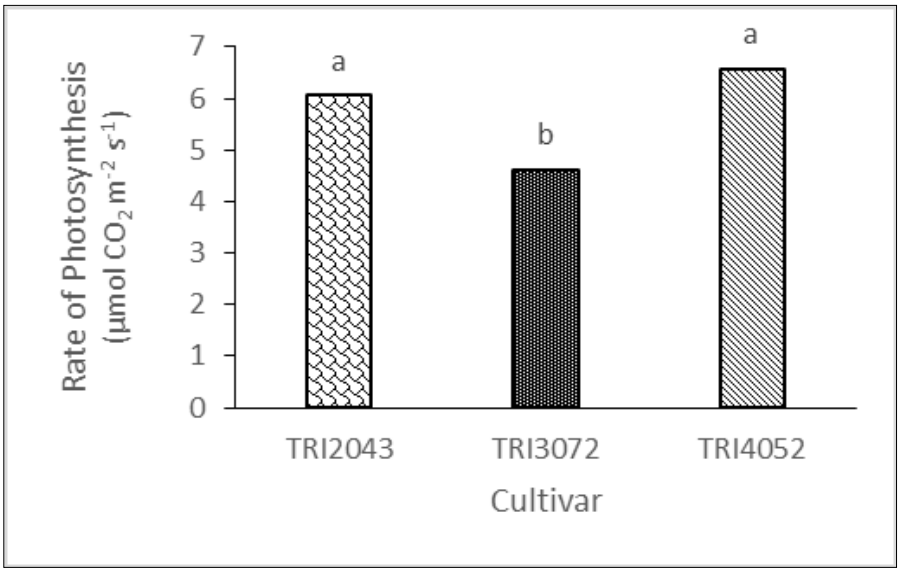


Figure 11. Comparison of rate of photosynthesis in different cultivars (The bars with the same letters are not significantly different at p=0.05).

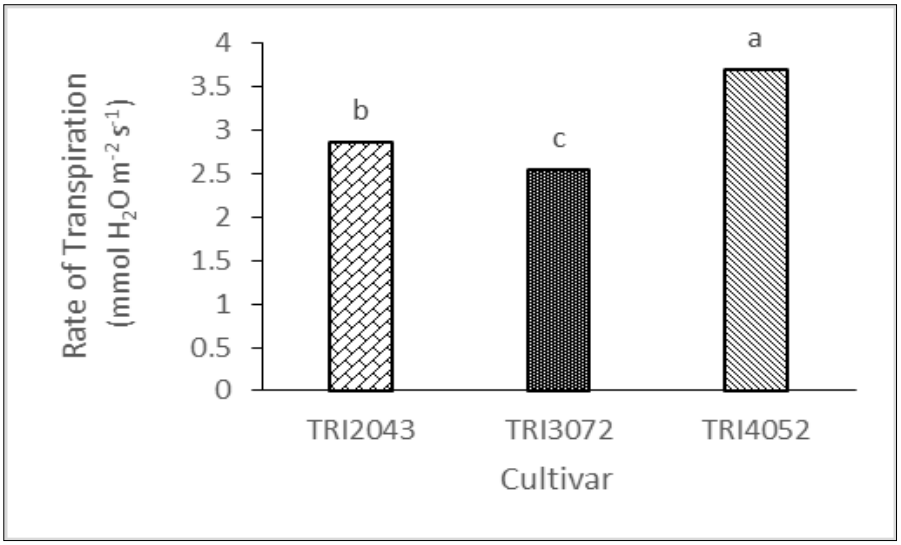


Figure 12**.** Comparison of rate of transpiration in different cultivars (The bars with the same letters are not significantly different at p=0.05).

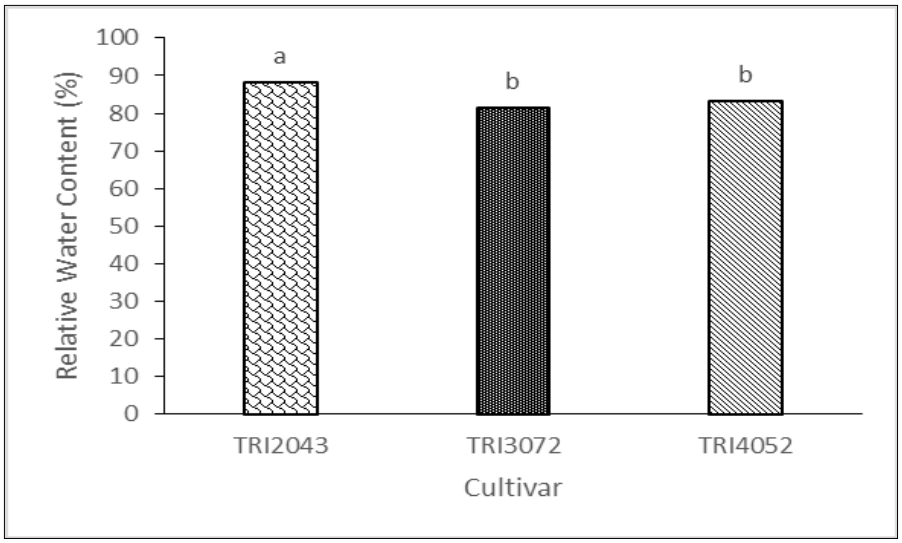


Figure 13. Comparison of relative water content in different cultivars (The bars with the same letters are not significantly different at p=0.05).

TL Wijeratne, DMS Navaratne and ADIU Jayawardhane, MAB Ranathunga, KM Mohotti (TRI) and AJ Mohotti (University of Peradeniya)

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 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 only (control)
2. Ground + Foliar Zn (standard)
3. Ground + New Foliar formulation

Ground – *310 kg/ha/application of T1240 (mature tea fertilizer mixture) - 4 applications per year. In addition, 400L/ha of water sprayed on foliage monthly.*

Foliar Zn –*2.75 kg/ha/application of $ZnSO_4$ in 400L/ha water, sprayed on fliage - 4 applications per year 7 days after ground fertilizer appplication*

New Foliar formulation – *2.75 kg of $ZnSO_4$ + 0.86 kg of $MnSO_4$ + 0.31 kg of H_3BO_3 in 400 L of water per hactar per application, repeated monthly.*

a) Rassagala Estate

This experiment could not be continued due to travelling restrictions imposed during Covid-19 pandemic situation and therefore, it is planned to re-establish the experiment in a new location in 2022.

MA Wijeratne, SRW Pathiranage, Soils and Plant Nutrition Division

b) St. Coombs estate

Tea Yield

No significant (p=0.05) interactions found between method of harvesting and application of fertilizers.

Table 01. Made tea yield

Method of fertilizer application	Yield (kg/ha/yr)
Ground fertilizer only	3425.4[a]
Ground fertilizer + Foliar Zn application	3442.7[a]
Ground fertilizer + Foliar Zn, B and Mn application	3407.8[a]
CV%	6.9

Values with the same letter are not significantly different at p=0.05.

Table 02. Made tea yield vs. method of harvesting

Methods of harvesting	Yield (kg/ha/yr)
Manual harvesting	4053.3[a]
Motorized mechanical harvesting	2797.3[b]
CV%	6.10

Values with the same letter are not significantly different at p=0.05.

There was no significant (p=0.05) difference in tea yield as affected by method of fertilizer application (Table 01). Non-selective mechanical harvesting was practiced at 14-21-day intervals depending on shoot growth and it recorded about 69% yield loss (Table 02) with an average of 10% coarse leaves in the fresh yield, in comparison with selective manual harvesting practiced in 7-14 day intervals. Plucking rounds of both the harvesting systems were dependent on shoot growth as affected by prevailing weather conditions mainly dependent on rainfall and temperature. Due to Covid-19 situation, data collection and other field practices were disturbed considerably.

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 TRISL experiments reported different tea cultivars responding differently to non-selective mechanical harvesting with significantly different yield reductions compared to manual (selective) harvesting. This study further tests amenability of different tea cultivars to mechanical harvesting. Experiments have been set up at Passara and Ratnapura TRISL Centers where TRI 5000 series tea accessions were already established and maintained by the Plant Breeding Division of the TRISL.

a) Uva Extension Center, Passara

Method of harvesting: Manual harvesting (control) and Mechanical harvesting (Kawasaki NV60H)
TRI 5000 series accessions tested: 243, 208 and 5
Control cultivars: TRI 2025 and TRI 3019

Treatments were arranged as split-plots in RCBD with 3 replicates considering method of harvesting as the major plot. Imposition of treatment was commenced in October, 2019.

During the year 2021 plucking operations and data recording were severely affected by Covid-19 pandemic situation. Table below presents the estimated tea yields and mechanical yield reductions in each tea accession/cultivar. There found no significant (p=0.05) interactions between method of harvesting and tea accession in made tea yield.

Table 03. Estimated made tea yield and yield reduction with machines

Accession /cultivar	Made tea yield (kg/ha/yr)		Yield Reduction
	Manual	Mechanical	(%)
243	9946[a]	4914[a]	50[a]
208	11428[a]	4428[a]	56[a]
5	6497[a]	1916[b]	70[a]
TRI 2025 (Control 1)	12951[a]	4359[a]	65[a]
TRI 3019 (Control 2)	11799[a]	3732[a]	68[a]
CV%	25.84	18.76	16.14

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 methods.

There found no interactions between the tea accessions/cultivars and method of harvesting. All tea accessions/cultivars have equally affected by continuous mechanical harvesting that percentage yield reduction was comparable among the accessions/cultivars. Further, in comparison with control cultivars, all tea accessions showed comparable (p=0.05) tea yields under manual harvesting (Table 03). However, accession number 5 reported the lowest ($p<0.05$) tea yield for mechanical harvesting while accession numbers 243 and 208 showed comparable tea yields (mechanical) to that of the 2 control cultivars.

Mechanical harvesting was done using Kawasaki NV60H fuel operated non-selective tea harvester with hair-clipper-type sharp blades (60 cm) at 14-30-day intervals and manual (selective) harvesting was practiced at 7-21-days. Plucking rounds of both the harvesting systems were dependent on shoot growth as affected by prevailing weather conditions mainly rainfall and temperature.

It should be noted that there were continuous disturbances for harvesting and data recording during the first 6 months of year 2021 due to Covid-19 situation until the experimental plots were rested in early June before pruning.

The experiment was completed and terminated.

MA Wijeratne, SRW Pathiranage, TRISL Passara centre

b) Low Country Regional Center, Ratnapura

Method of harvesting: Manual (control) and Mechanical harvesting (Kawasaki battery-operated machine)

TRI 5000 series tea accessions tested: 62, 107, 139, 174, 12/11, 23/5,

Control cultivar: TRI 4042

There were no significant (p=0.05) interactions between method of harvesting and tea accessions/cultivars. Tea yield and % yield reduction of each cultivar as affected by method of harvesting are given in the table below.

Table 04. Estimated made tea yield and yield reduction

Accession/cultivar	Made tea yield (kg/ha/yr)		Yield Reduction (%)
	Manual	Mechanical	
62	6893.0[a]	3042.1[a]	50[a]
107	5768.4[ab]	2492.8[a]	58[a]
139	3081.1[d]	1159.4[a]	59[a]
174	5505.1[abc]	2773.5[a]	48[a]
12/11	4438.6[bcd]	2279.3[a]	47[a]
23/5	5705.1[ab]	2284.4[a]	60[a]
TRI 4042 (control)	4044.5[dc]	2762.2[a]	41[a]
CV%	12.2	18.9	19.4

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 harvests.

No significant interactions could be found between the method of harvesting and tea accessions/cultivars tested. Mechanically harvested tea yield of all test accessions was comparable to that of TRI 4042 with an overall mechanical yield reduction of around 50% compared with manual harvesting (Table 04). Therefore, all tea accessions/cultivars have performed equally in mechanical harvesting. Under manual harvesting, accessions 62, 23/5, 107 and 174 recorded significantly (p=0.05) higher tea yields than cultivar TRI 4042 (control). Further, both accession 12/11 and 139 showed comparable tea yield with the control under manual harvesting.

Mechanical harvesting was carried out using Kawasaki battery operated non-selective hair-clipper-type (30 cm) harvester at 14-day intervals depending on the shoot growth. Manual harvesting was practiced at 7-day intervals selectively as recommended by TRISL.

Comparison of shoot counts in manually harvested plots just before harvesting is depicted in the table below with respect to tea cultivars/accessions.

Table 05. Shoot counts in the manually harvested plots (count/feet^2) as affected by tea cultivars/accessions

Accession/cultivar	*Arimbu*	*Banji*	Pluckable*	Total
107	17.3^{a}	5.8^{bc}	12.4^{b}	29.7^{a}
12/11	13.1^{b}	4.0^{c}	8.2^{cd}	21.3^{bc}
139	12.7^{b}	5.8^{bc}	10.7^{bc}	23.5^{bc}
174	13.7^{ab}	4.4^{bc}	6.0^{d}	19.7^{c}
23/5	12.5^{b}	7.0^{b}	12.5^{b}	25.0^{b}
62	8.5^{c}	13.5^{a}	21.0^{a}	29.5^{a}
TRI 4042 (control)	6.7^{c}	5.0^{bc}	6.2^{d}	13.0^{d}
CV%	5.5	9.2	6.6	3.6

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 and *Banji shoots*.

In manually harvested plots, the highest (p=0.05) *Arimbu* shoot count was recorded in accessions 107 & 174 followed by accessions 12/11, 139 and 23/5 while accessions 62 and TRI 4042 (control) being the lowest (Table 05). The highest *Banji* count was recorded by accession 62 followed by accessions 23/5, 139, 107, control, 174 and 12/11. Further, the highest pluckable shoot count was found in accession 62 followed by accessions 23/5, 107, 139, 12/11, control and 174. The highest total shoot density was found in accessions 107 and 62 followed by 23/5, 139, 12/11, 174 and control.

Composition of shoots in plucking tables just before harvesting is presented in the table below, with respect to the method of harvesting.

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	12.84^{b}	5.69^{a}	9.89^{a}	22.73^{b}
Machine	15.77^{a}	7.10^{a}	12.13^{a}	27.91^{a}
CV%	9.15	16.59	14.36	8.05

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 and *Banji shoots*.

Arimbu and total shoot counts found to be higher (p=0.05) in mechanically harvested plots, than those of manually harvested (Table 06). However, counts of *Banjies* and pluckable shoots did not vary between methods of harvesting.

The experiment is in progress.

MA Wijeratne, SRW Pathiranage and EWTP Prematunga

Project A 20.12. Testing of new machines

This project tests newly introduced tea field machinery. In 2021, there were no new machines introduced for testing.

MA Wijeratne, SRW Pathiranage and EWTP Prematunga

NURSERY MANAGEMENT TECHNIQUES



Thrust A 53. Development of nursery management techniques

Project A 53.0 Nursery Management

Maintenance of a nursery, affiliated to Agronomy Division, Low-country Center was continued to provide tea plants and medium shade tree plants for experimental and commercial purposes. During the year, 175 *Derris* plants were issued for commercial purpose and another 480 plants were sold for tea growers. 1200 tea plants were planted in Ratnapura and Hantane for experimental purposes.

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 to fluid bed dryer (TRI-CCC FBD) at St.Coombs tea factory. Necessary procurement procedure was followed regarding fabrication and installation of the system. Quotations received from Engineering Firms were evaluated. The price quotaed exceeded the budgeted amount due to price escalation of fabrication materils. Therefore, the project has been postponed to 2022.

K Raveendran, WMS Weerawardena, L Jayasinghe and SH Priyanthie

Project A 48.12. Development of monitoring and controlling method for rolling parameters for orthodox roller

An Engineering Firm was consulted to develop a control system to monitor and control pressure on leaves during rolling in Orthodox roller with a view to improve quality, appearance and grade mix of final made tea. A project proposal was prepared in consultation with Dr. Sarath Samaraweera, member of Scientific Advisory Committee. It will be submitted to CCR for approval. This project is a continuation of A 48.11.

MA Chamindra and K Raveendran

Project A 48.14. Validation of process automation in fluid bed drying (2019)

Installation of a commercial type PLC based monitoring and control system to the fluid bed dryer (TRI-CCC FBD) at St. Coombs tea factory was completed. Validation trials were conducted and the results showed that the system facilitates drying the teas within acceptable moisture content of 3.0% (w/w, wet basis) while maintaining rated output of the dryer and required black appearance in tea.

K Raveendran and L Jayasinghe

Project A 48.15. Development of an efficient hot air supply system through radiating steam and hot water circulation

Development of the control system to suit hot air supply through Hot Water Generator-Radiator system has been continued. The commercial – scale withering control system developed in collaboration with an Engineering Firm was modified to control hot water flow through the radiator and to measure inlet and outlet temperature of the hot water. The improved control system was successfully tested and two validation trials were conducted.

WMS Weerawardena, Dr. K Raveendran and L Jayasinghe

Project D/TECH. Activities of the Technology Division

Establishment of experimental process technology development factory at St. Joachim Estate

St. Joachim Estate tea factory that belongs to Tea Research Institute of Sri Lanka is the only tea processing factory available for process technology development and making recommendations to the industry in the Low and Mid-Country regions. Further, data generated from this factory is used for establishing standards for the industry. Tea Research Institute and Sri Lanka Tea Board guidelines were generated by using the factory data and research findings. Stakeholders who need practical experience on tea visit this factory and get familiar with the process. Personnel who works for the tea industry, trainers of the industry, Researchers, Undergraduate students, apprentices and school children are the routine visitors for the factory.

This project was designed to improve machinery and infrastructure of the factory to par with the present standards for process technology development and data generation. Further, new technologies/ systems/ machineries need to be tested for their effectiveness before recommendation and such technologies must be made available for demonstration/ technology disseminations purposes.

Fund obtained for the project is Rs.50 million and activities were carefully identified prioritizing urgent needs on new machinery and repairs to machinery and infrastructure. A new Colour sorter was installed and commissioned with necessary power supply and compressed air line. Rolling room operation was conveyorized/ automated with modified rollers and roll breakers suitably re-cited with necessary power supply arrangement. Eight numbers of withering trough units, stand-by tea drier and part of the first floor were repaired. Leaks in concrete slabs over worker rest room and furnace room was attended. Roof, gutters and down pipes to ground floor and first floor were replaced with new one.

K Raveendran and MA Chamindra

Verification survey on Net Out-Turn of made tea in tea factories

Small holders contribute for more than 70% of the tea production in Sri Lanka. Their green leaf is mostly processed, in private bought leaf factories. The price paid per kg of green leaf is based on nett out-turn (NOT) of made-tea to green leaf (MT/GL) and the net sale average price (NSA) achieved by the factory. Price formula where a definite percent of NSA was apportioned for the factory and smallholder, initially 30:70 which was revised to 32:68 in April 1987 and holds to-date was introduced in February 1984. The outturn % of MTGL is a component of GL pricing formula.

The net outturn % MTGL, which had hitherto been assumed as 22.22% was revised from time to time. As per the circular TC/CIR (204)-06(6)2021, net outturn is 21.0% for the wet months (April, May, June, September, October, November and December) and it is 21.5% for the balance 5 months.

Earlier a commercial-scale experiment was carried out in the Low-Country and average nett out-turn of made-tea to green leaf (MTGL) was found as 21.5%. The nett out-turn could be predicted using the linear relationship, NO = 91.8 -0.908 MC. Where, NO is the percentage nett out-turn of made-tea to green leaf and MC is the percentage moisture content in green leaf.

SLTB has requested to verify the achievable NOT again. Therefore, it was decided to conduct a survey to study achievable NOT.

A survey method was developed by the staff of Process Technology Division and finalized in discussion with Professor Suriyagoda, Department of Crop Science, Faculty of Agriculture, University of Peradeniya. The details of survey was presented to CCR and members' views were obtained. Procurement procedure was followed to purchase two numbers of laboratory ovens and 22 numbers of digital laboratory balances required to conduct the survey. In the meantime, three trials were conducted at St. Joachim tea factory to verify developed equation to predict net outturn.

K Raveendran, MA Chamindra and WMS Weerawardena

Divisional activities including miniature manufacture of green leaf samples (ongoing)

- 150 Green leaf samples collected from different experiments of Entomology and Nematology and Plant Pathology Divisions were manufactured using miniature tea manufacturing facility and the made tea samples were graded, cleaned, packed and sent to the respective Divisions.
- Biochar production was tested at St. Joachim tea factory after attending to necessary modification to furnace/air heater.
- A project proposal on "Establishment of experimental process technology development factory at TRI Main Station" was prepared and submitted to MPI for approval.
- Prepared quarterly reports on energy consumption at TRI Head office at Talawakelle and other six Regional Centres.
- The “Industry Guidelines for Copper alloy cast components in rotorvanes” prepared by the staff was published by the TRI.

K Raveendran, MA Chamindra, WMS Weerawardena, SH Priyanthie and L Jayasinghe

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)

Fuelwood logs of 0.5 to 1m size, in cut, split and dried form are combusted in conventional furnace/air heaters for generating hot air for the drying process in tea factories. Improvement of combustion efficiency by burning fuelwood in the form of chips of 6.7 to 24 mm size was tested at a tea factory. Development of a semi-automatic feeding system to feed wood chips into the furnace/air heater was completed. The feeding system consisting of screw conveyor, a rotary spreader and a control unit with a software programme was developed for continuous feeding of the wood chips without any accumulation on the fire grate. This system was retrofitted to the conventional furnace/air heater - drier system without any modification. Hot air with a temperature of 120 ± 3 °C was generated by operating the system and combusting the wood chips in the furnace/air heater and teas were dried in the drier to a moisture content within 2.5 - 3.0 % (w/w, wet basis). Acceptable moisture content in wood chips was found to be about 25% (w/w, wet basis). Flue gas temperature was maintained at 210 °C to achieve the hot air temperature of 120 °C. Percentage of excess air and level of CO varied between 103 - 219 % and between 2,370 - 4,791 mg/m^3 respectively in the flue gas. The result showed stack heat losses and opportunity for more heat exchanging. Combustion efficiency was found to be 96.2%. Specific wood chip consumption was 1.16 kg/kg dried-tea. Higher wood chip combustion was mainly due to stack heat losses.

S Koneswaramoorthy, Nandana Edirisinghe, K Raveendran, V Senanayake and L Jayasinghe

Project A 25.6. Investigation on combined IR and Fluid-bed drying in relation to quality and cost against conventional fluidized-bed drying (2015)

A FIR (Far Infrared) experimental dryer has been designed to dry the tea and fabrication of the unit was commenced.

K Raveendran, L Jayasinghe, WMS Weerawardena and SH Priyanthie

Project A 25.8. Efficient hot air supply system for withering trough

A trough of size 60 ft. x 6 ft. was selected for the study. The transformation duct of the trough was improved and extended for smooth air movement at reduced pressure drop after the fan housing. The old and higher capacity motor was replaced with a 4.0 kW size foot mount type 6 pole induction motor by calculating the actual size

requirement. The fan blade angle was adjusted to deliver required airflow for withering leaf at the recommended loading rate of 2.5 kg/sq.ft. Power supply to the motor was given through a newly installed 4.0 kW capacity VFD unit. A radiator designed by Mr.Maldeniya, Director of SEA was fabricated and connected to the trough with the assistance of an Engineering Firm. Also, the Engineering Firm installed main hot water circulation arrangement and hot water circulation through the radiator with necessary valves, temperature transducers, pressure transducers, pressure relief valve and pressure meters. A PLC (Programmable Logic Controller) based control system was installed to monitor hygrometric difference of the withering air and accordingly regulate hot water circulation through the radiator. Dry and Wet bulb sensors were installed to measure the capacity of withering and ambient air and the measurements were sent to the control unit. A feedback signal was sent to control unit to gradually regulate hot water flow through the radiator and maintain a hygrometric difference of 6 °F. Regulating the hot water flow through the radiator was done by fixing a ball valve in the hot water line to radiator and operating it using a stepper motor. The stepper motor is controlled by the control unit. A software programme was written and uploaded to the control unit. Further, temperature sensors were installed to measure hot water inlet and outlet temperature in the main circulation line as well as in the radiator circulation line. A dash board was developed to monitor the withering parameters and operation of hot water flow control valve. The control programme includes logging of data such as dry bulb and wet bulb temperatures of ambient air and withering air, ball valve open positions and pressure and temperature of the hot water in the hot water circulating lines.

A validation trial was conducted and the results showed that, withering of 900 kg green leaf loaded at the recommended rate of 2.5 kg/sq.ft. on the trough could be achieved within 12 hours with specific thermal energy consumption of 6.43 MJ/kg and specific electrical energy consumption of about 0.19 kWh/kg MT.

K Raveendran, PS Maldeniya, L Jayasinghe, SH Priyanthie and WMS Weerawardena

Project A 25.10. Development of combustion control system to air heaters

A combustion control system was designed to control combustion of firewood in the Hot Water Generator at St. Coombs factory. Hot water from the unit is circulated through a radiator to generate hot air at 125 ± 1 °C for drying tea in a fluid bed drier. The Induced Draft Fan (ID Fan) of the Hot Water Generator was coupled with a Variable Frequency Unit. A software programme has been developed to maintain the temperature of the hot air for drying by controlling combustion through regulating speed of the ID fan. The system will be tested and validated.

K Raveendran, L Jayasinghe and WMS Weerawardena

Made tea quality improvement

Thrust A 46. Development of technologies to enhance made-tea quality and made-tea keeping quality

Project B 58. Identifying factors affecting blackness and curliness of Low-Country teas

Heads/OIC of Biochemistry, Plant Breeding and Plant Pathology Divisions discussed the factors affecting blackness and curliness of tea and a decision was made to study indirect parameters such as chemical substance/s contributing for blackness and curliness of made tea. Arrangements were made to purchase necessary chemicals for the chemical analysis.

S Koneswaramoorthy, K Raveendran and MA Chamindra

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 to Verification of the Origin of 'Ceylon Tea'

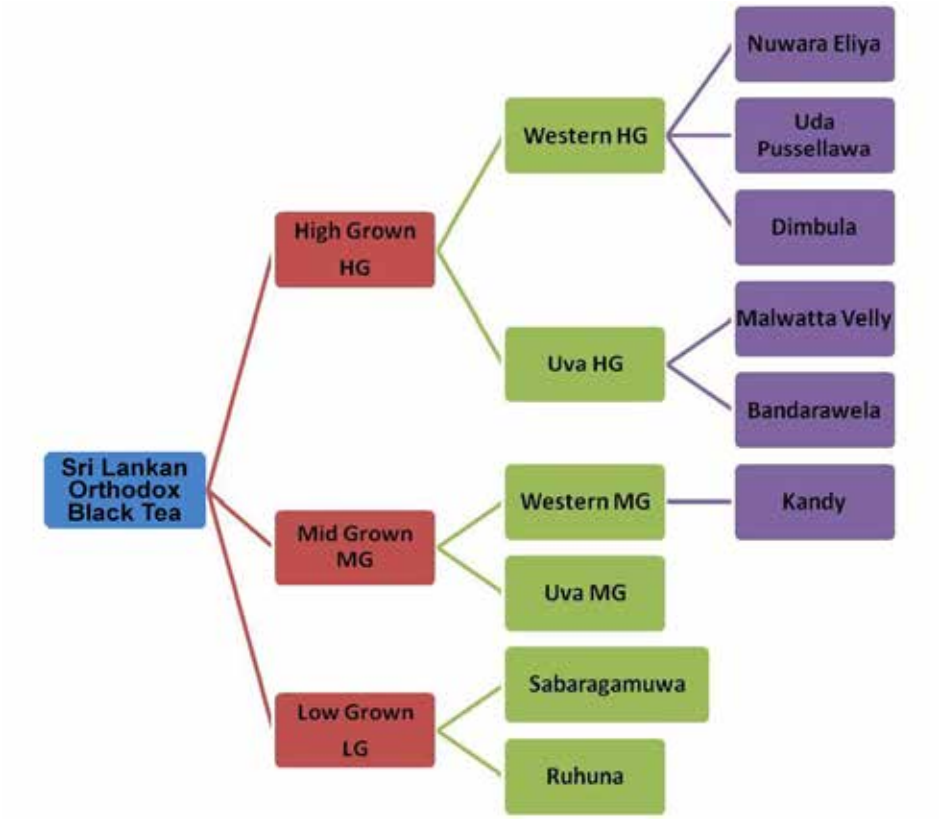
This project will be implemented as a joint project of the Sri Lanka Atomic Energy Board (SLAEB), Sri Lanka Tea Board (SLTB), and the Tea Research Institute of Sri Lanka (TRI) with the technical cooperation of the International Atomic Energy Agency (IAEA). The aim of the pilot project is to demonstrate that the chemical fingerprinting technique can differentiate 'Ceylon Tea' from other origin teas using stable isotope and trace element analysis and to develop chemical fingerprints for tea growing regions within Sri Lanka. The Sri Lankan tea industry has embarked on a program that will include the registration of Ceylon tea as a product of a specific Geographical Indication (GI). To support the GI registration and to protect the brand advantage gained, it is imperative that the origin of Ceylon tea can be independently verified. Results of the proposed pilot project will lead to exploring the possibility of using geochemical fingerprinting information as supporting evidence to file intended applications for GI and Regional GIs for tea.

The scientific method works by measuring the natural properties of the product which are trace elements and stable isotopes. Proportionally most of the chemical properties may reflect in harvested plant materials too. These properties are referred to as a 'chemical fingerprint' of origin.

The proposed pilot project also aims at upgrading laboratory facilities at SLAEB to undertake chemical analysis and obtain accreditation which will be beneficial in the long run. The results of the pilot project will create opportunities for future collaborations between all joint organizations and we may explore possibilities to continue beyond the pilot project to develop a certification of origin verification and to support GI registration.

Sampling Plan

Five factories representing geographical locations of Nuwara Eliya, Dimbula, Uda Pussellawa, Ruhuna, and Sabaragamuwa regions, 15 factories from Uva region, and 08 factories from Kandy region were selected. The selected grades for high grown, mid grown, and low grown are 4, 6, and 6 respectively (see Fig.1). Tea samples are to be collected 03 times covering three different invoices separately during wet and dry seasons. Sample collections were completed in all regions during the wet season and pre-processed black tea samples (538 Nos.) were prepared as per the Standard



Operating Procedures (SOPs) for isotope analysis.

Figure 1. Sampling strategy for the collection of black tea samples

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)

Establishment of Baseline Information on Concentrations of Fructose, Glucose, and Sucrose in Black tea from Up-Country elevation in Sri Lanka

This work is the continuation of the study on "Establishment of Baseline Information on Fructose, Glucose and Sucrose Concentrations in Black Tea". In order to prevent adulteration of black tea with sugar, the TRISL has successfully developed and introduced the sugar baseline for Low and Mid-Country elevations. Based on the data, this study attempted to establish the sugar baseline levels in black tea from Up Country elevation.

Sampling Plan

A total number of thirty-four (34) different factories were randomly selected from Up Country elevation representing Uva High and Western High regions (Table 1).

Table 1. Factories selected from Up Country elevation

Region	Total no. of factories in the region	No. of factories selected for the study
Uva High	51	
Malwattavelly		5
Bandarawela		8
Western High	104	
Dimbula		9
Nuwaraeliya		5
Udapussallawa		7
Total	155	34 (22.58%)

Different black tea grades that were available including Pekoe, Fannings, OP, Dust, BOPF, BOP, FBOP and BM have been collected from each factory. A total of one hundred seventy-two (172) black tea samples were analyzed for this study.

Analytical technique applied

For the extraction and analysis of sugar components in black tea, AOAC Official Method 977.20, 1977, Separation of Sugars in Honey, Liquid Chromatographic Method was adopted with appropriate optimizations and recovery studies applicable to tea matrix. After the complete validation study of the High-Performance Liquid Chromatographic (HPLC) methodology, the accuracy of the method was further confirmed by an inter-laboratory testing, with two accredited laboratories in Sri Lanka and Germany. The validated HPLC methodology was adopted for the quantitative determination of Fructose, Glucose and Sucrose concentrations in tea brew. All the concentration values are expressed as mg/g, dry weight basis. The range and average concentrations of Glucose, Sucrose, and Fructose in each region are shown in Table 2.

Table 2. Summary of the Fructose, Glucose, and Sucrose concentrations in Up-Country region

Region	Concentration (mg/g)					
	Fructose		Glucose		Sucrose	
	Range	Average	Range	Average	Range	Average
Uva High	4.38-15.42	10.87[a]	1.62-16.26	9.42[a]	2.47-17.64	9.40 [b]
Western High	7.46-16.27	10.89[a]	6.30-14.86	10.31[a.]	4.11-20.56	11.3 [a]
Up Country	4.38-16.27	10.88	1.62-16.26	9.87	2.47-20.56	10.35

Means with the same letter within a column are not significantly different

One-way ANOVA statistical analysis followed by General Linear Model was carried out for the determination of the effect of region on Fructose, Glucose and Sucrose concentrations in black tea and the effect of black tea grades on Fructose, Glucose and Sucrose concentrations in black tea. According to the results obtained, there was a significant difference ($P \leq 0.05$) among two regions for Sucrose concentation in black tea whereas there was no significant difference ($P \geq 0.05$) among two regions for Fructose and Glucose concentations in black tea. And also, there was no significant difference ($P \geq 0.05$) either in Fructose, Glucose or Sucrose concentarations in black tea, among the selected black tea grades.

Experiment 2: Establishment of basic information in relation to concentrations of Sucrose, Glucose and Fructose in fresh tea leaves and Black tea

An investigation on changes in Sucrose, Glucose, and Fructose concentrations in different leaf standards

The bud and first two leaves, bud and first three leaves, bud and first four leaves and bud and first five leaves of tea cultivar (TRI 777) were collected separately, from St. Coombs Estate, Talawakelle, in December 2020. Samples collection was done in three different days. Black tea was miniature-manufactured at Biochemistry Division, Tea Research Institute. Tea samples were analyzed for Fructose, Glucose and Sucrose concentrations, and the results are summarized in Table 3.

Table 3. Summary of the sugar profile of black tea processed using different leaf standards

Leaf standard	Concentration (mg/g)		
	Fructose	Glucose	Sucrose
Bud and first 2 leaves	6.77[c]	5.99[c]	0.97[c]
Bud and first 3 leaves	10.34[b]	10.94[b]	2.42[c]
Bud and first 4 leaves	12.67[a]	14.73[a]	5.87[b]
Bud and first 5 leaves	12.73[a]	15.73[a]	10.14[a]

Means with the same letter within a column are not significantly different

Significantly (P ≤0.05) lowest Glucose, Sucrose and Fructose concentrations were found in black tea manufactured using the bud and the first two leaves. Significantly highest Glucose and Fructose concentration was found in black tea manufacture using bud and first three leaves, and bud and first four leaves whereas significantly (P ≤0.05) highest content of Sucrose was reported in black tea manufactured using bud and fifth leaves.

KGNP Piyasena, ENU Edirisinghe, AAB Abayarathne and WS Jayasinghe

Project B 140. Refinement of critical points in tea manufacturing to minimize microbial, contamination to meet food standards

The objective was to study 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. Aflatoxin standard was derivatized using TFA and then subjected to HPLC. In general aflatoxin B1, B2, G1, and G2 were detected at retention times of 3.2, 5.6, 2.6, and 4.1 respectively. Dilution series of standards was run to check the linearity. High correlation between concentration and peak area was observed. R2 values obtained for B1, B2, G1, G2 were 0.99, 0.99, 0.99, and 1.0 respectively. Sample analysis is being continued.

M Niranjan, GD Sinniah (Plant Pathology Division)
and ENU Edirisinghe, KGNP Piyasena (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 (2019)

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, havestable 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 was used in this study. α-amylase, α-glucosidase, tyrosinase, acetylcholine esterase and lipase inhibition bioassays were carried out using freeze-dried tea brew and methanol extracts. Range of IC_{50} (Half-maximal inhibitory concentration) and percentage inhibition of respective enzyme bioassays were given in table 4 and 5 respectively.

Table 4. Range of IC_{50} (Half-maximal inhibitory concentration) of tea cultivars

Enzyme assay	Black Tea (Freeze dried tea brew) IC_{50} Range (ppm)		Harvestable tea shoot (Methanol Extract) % IC_{50} Range (ppm)	
	Season		Season	
	Wet	Dry	Wet	Dry
α-glucosidase	17.44-111.00	2.57-122.00	3.56-109.60	4.77-130.40
Tyrosinase	78.08-356.21	103.37-439.20	97.26-341.72	87.26-241.52
Acetylcholine esterase	27.24-136.21	37.35-96.31	34.36-18.31	27.24-136.20

Table 5. Range of percentage inhibition of tea cultivars

Enzyme assay	Black Tea (Freeze dried tea brew) % Inhibition (1000 ppm)		Harvestable tea shoot (Methanol Extract) % Inhibition (1000 ppm)	
	Season		Season	
	Wet	Dry	Dry	Wet
α-amylase	16.87-45.67	31.84-48.57	16.97-44.45	14.73-45.91
Lipase	16.28-80.35	19.28-55.10	31.37-76.31	38.21-83.33

Optimizations of xanthine oxidase and elastase inhibition assays are in progress.

KGNP Piyasena, AAB Abayarathne, G. Sinniah and PD Senanayake
(A collaborative study with Plant Breeding Division, National Institute of fundamental Studies and University of Peradeniya)

Project D/Bioch 1. Divisional activities of Biochemistry Division

Experiment 1: Development of a process for encapsulation of tea aroma and evaluation of potential applications of encapsulated tea aroma

This study focuses on evaluating suitable materials and techniques to optimize processing conditions for concentration and encapsulation of tea aroma. Further, the potential of enhancing the quality and thereby the value of tea concentrate and instant tea powder by incorporating developed tea aroma powder will be studied.

In instant tea manufacture, tea aroma is generated as a co-product during the extraction of soluble solids from tea using Spinning Cone Column (SCC) machine. Tea aroma generated from the SCC is in much diluted liquid form. Difficulties in handling, storing, transportation and high perishability are some of the limitations of tea aroma generated from SCC. To limit aroma degradation or loss during processing and storage, it is beneficial to encapsulate volatile ingredients prior to use in foods or beverages. Different carrier materials such as maltodextrin, gum arabic, gelatin, cyclodextrin *etc*. and different techniques such as spray drying, spray chilling or spray cooling, extrusion, freeze drying, coacervation, molecular inclusion *etc*. are used in encapsulation of volatile compounds. The choice of appropriate carrier material and encapsulation technique depends upon the physicochemical properties of volatile

compounds, end use of the product and the processing conditions involved in manufacturing the product. The expected outcome of the proposed project is the development of a protocol for converting liquid tea aroma generated during instant tea manufacture into a high-valued tea aroma powder.

The liquid tea aroma was distilled using a simple distillation unit at different temperatures (85^0C, 90^0C, 95^0C) and collected the distillates of each respective temperature. The collected distillates of each temperature were tested for their aroma profiles by Solid Phase Microextraction- Gas chromatography Mass spectrometry (SPME-GCMS) and 2 µl of 2-ethylbutyric acid was used as an internal standard. Relative Response Factors (RRF) of the aroma standards (Linalool, Geraniol, Methyl Salicylate, cis-3-hexenal, Trans-2-hexenal, pentanal, 2-phenylethanol, ionone) were studied. Data analysis is in progress.

KGNP Piyasena and ENU Edirisinghe
(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.

The conventional method of tea manufacturing involves several stages. These are plucking, withering, rolling, fermentation, and firing. The fermentation stage involves the distribution of tea particles on a flat surface as a thin layer for a specific time until the desired level of aroma and color of tea particles are achieved. The polyphenolic biochemical compounds present in tea will then undergo oxidation during this period to produce aroma and taste in made tea. The current method of practice involves humans detecting the optimum fermentation by smelling tea particles and observing color changes. These are subjective and often lead to over or underestimation of optimum fermentation time. Therefore, the proposed project will focus on monitoring the variation of biochemical compounds during the fermentation stage and develop a correlation between the Digi-nose device and the e-vision system to replace human intervention. The successful completion of this project will have a significant impact on the tea industry of Sri Lanka to produce high-quality tea with the latest technology.

The research project intends to develop a statistical model to correlate the Digi-nose (aroma detection unit) and E-vision system (Device to monitor color changes of tea particles) with changes in biochemical compounds (total polyphenol content, theaflavin, thearubigins, and aroma profile) in tea particles during fermentation (oxidation) stage to predict the optimum fermentation time. The "Digi-nose" aroma detection unit was tested at the St. Coombs Tea factory where online aroma measurements and biochemical parameters were evaluated. The analysis of samples was completed for 11 batches where each batch contain 6 samples collected at 15 min. intervals depending on the tea oxidation duration set by the factory. In addition,

miniature tea manufacturing studies were conducted as control samples. Analysis of total polyphenol content, theaflavin, thearubigins, and aroma profile of the collected samples was completed and the statistical analysis is currently ongoing to develop a relationship with the "Digi-nose" aroma detection system with measured chemical parameters.

KGNP Piyasena (A collaborative study with Department of Export Agriculture, Faculty of Animal Science and Export Agriculture, Uva Wellassa University)

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 31.6. Investigation on worker shortage in small holder sector (Project period: 2017-2021)

Worker shortage is one of the issues in tea smallholdings sector and it affects cost of production and their profitability. Eventhough, small scale tea growers maintain tea lands with family labour, they also used hired labour for activities like pruning and spraying which require skilled labour. However, there is no clear information on degree of labour scarcity and factors that responsible for this situation. Therefore, the present study was conducted (i) to find out the degree of labour scarcity, (ii) to identify the factors affecting for labour shortage, (iii) to analyse the impacts of labour shortage on tea smallholding sector and (iv) to suggest strategies to minimize negative impacts.

Stratified random sampling technique was used to select the sample smallholders. Five hundred fifty smallholders were randomly chosen from different sizes of tea land and elevation. Primary and secondary data were collected. Primary data were collected though a pre-tested structured questionnaire. Descriptive statistics and Wilcoxon signed rank test were used to analysis data and data were analysed using SPSS version 22.

Severity of labour scarcity (%) was calculated by using the following formulas:-

$$\text{Demand and Supply Gap} = \text{labour requirement} - \text{labour availability}$$

$$\text{Severity \%} = \frac{\text{Demand supply gap}}{\text{Total labour requirement}} * 100$$

Demand and supply gap of labour were assessed by considering the labour requirement (demand of labour) and availability of sample smallholders (supply of labour).

Reliability test was conducted to identify internal consistency of the statements used in the questionnaire. Wilcoxon signed rank test analysis was used to identify determinants of labour scarcity in tea smallholding sector.

Description of the sample

Among the sample, 42% and 28% were having 10 to 20 years and 20 to 30 years of experience in tea cultivation, respectively. Majority of smallholders were engaged only in tea cultivation (61%) while the remaining was practicing both tea and other cultivation. When considered about family size of smallholders, highest percentage (43%) was recorded as having 2 family members, while 28.5% and 19.1% showed 3 and 4 family members, respectively. In this study, less participation of family members in tea cultivation was reported. According to the results, most of the small holders own land of less than 2 acres while few own more than 5 acres. The study also revealed that most of the smallholders were having VP type tea fields (89.5%) while 18 were having both VP and seedling tea fields. Moreover, only few smallholders own seedling tea fields.

The yield of tea green leaf above 7000 kg/ac/yr was recorded by 18% and average number of small holders achieved yields between 1000 to 6000 kg of green leaf/ac/yr.

Severity of worker scarcity

The results of the study revealed that about 52% of smallholdings were facing problem of worker scarcity. As given in the Table 1, severity of labour scarcity was categorized in to four groups such as surplus/adequate, less (when labour availability is 75% of requirement), average (when labour availability is 75.1-50% of the requirement) and high (when labour availability is below 50% of requirement). About 18% smallholders included in the sample had surplus or adequate labour. Majority of smallholders (60%) had less degree of labour scarcity while only 0.7% of the sample showed high degree of labour scarcity.

Table 1.Severity of worker scarcity

Category	Frequency	Percentage
Surplus/Adequate	100	18.2
75% of requirement (Less)	330	60.0
75.1-50% of requirement (Average)	116	21.1
Below 50% of requirement (High)	4	0.7
	550	100.0

Meanwhile, smallholders who are facing scarcity of labour stated that they experienced crop damage due to delaying plucking rounds, increase in weed density and delay in pruning (Table 2).

Table 2. Impact of labour scarcity

Impacts	Frequency	Percentage from the sample who faced labour scarcity
Crop damage due to delay of plucking round	342	76
Increase in weed density	315	70
Delay in pruning	297	66

Further results showed that 3 plucking rounds per month was the most practiced on tea land and 5 plucking rounds per month was the least practiced method among the respondents considered (Table 3). It may be due to the labor scarcity in tea plantation.

Table 3. Plucking rounds/month

Plucking rounds/month	Frequency	Percentage
2	100	18.2
3	330	60.0
4	116	21.1
5	4	0.7
	550	100.0

Reliability test was conducted using Cronbach's alpha for all five point likert scale statement questions to identify internal consistency of the responses. Each statement of research questionnaire was tested for its internal consistency.Satisfactory Cronbach's alpha values (alpha > 0.700) indicates that the internal consistencies of these questions are an acceptable level.

In this study, Wilcoxon signed rank test was used to identify differences between two related fields in the same samples. This study hypothesized that there is a considerable labour shortage in tea smallholding sector and labour shortage has a negative impact on tea smallholding sector, such as reducing profitability, increasing labour cost, and reducing the quality of the product. Required hypotheses were developed and tested for the statement questions by using Wilcoxon signed ranked test. (Ho) Null Hypothesis = There is no relationship between labour scarcity and statement (Ha) Alternative Hypothesis = There is a relationship between labour scarcity and particular statement.

Identification of Factors for Labour Shortage in Tea Smallholding Sector

According to the results presented in table 4, tea smallholders highly agreed that demand for higher wage, low satisfaction level of labours, low participation of young generation in tea cultivation due to lesser wage system, out migration due to urbanization, higher job opportunities in urban areas, non-cash benefits and adverse weather condition were the main causing factors for labour shortage.

Table 4. Factors affecting labour scarcity

Statements	Mean Value	Test Value	P Value	Decision
Demand for higher wage	1.46	2.78	0.005**	Significant relation exists
Worker consider jobs in tea cultivation as a jobs of low dignity	0.54	0.55	0.582	
Worker consider jobs in tea cultivation gives low satisfaction level	1.13	2.21	0.027**	Significant relation exists
Young generations are discouraged due to job insecurity	0.62	0.79	0.426	
Young generations are discouraged by low wage	1.37	2.50	0.012**	Significant relation exists
Urbanization causes out migration of workers	1.44	2.64	0.008**	Significant relation exists

Table 4. Cont.,

Statements	Mean Value	Test Value	P Value	Decision
Job availability in tea smallholdings are seasonal	0.33	0.82	0.411	
Higher job opportunities in urban areas cause worker shortage	1.65	3.05	0.002**	Significant relation exists
Providing facilities such as protective clothing andequipment are the motivation factors to attract the labour	0.27	0.745	0.33	
First aid facilities available near to the working place	0.42	0.737	0.34	
Non cash benefits such as lunch, tea, snacks attract the workers	0.84	0.088*	1.76	Significant relation exists *
Adverse weather condition cause higher absenteeism	1.21	0.040	2.05	Significant relation exists

Wilcoxon Signed Ranks Test ; Significant level at 0.05 level and 0.1 level
Source: Field Survey,Economics Division Agricultural Division 2019/20

Table 5. Strategies adopted to overcome labour shortage

Strategies	Frequency	Percentage
Contract work	27	5
Cash plucking	83	15
Contract farming	0	0
Block plucking	28	5
Use machines	26	5

According to the study (table 5) most of the smallholders were willing for cash plucking to overcome labour shortage in tea cultivation. While block plucking, contract work and machine usage showed almost same response by the smallholders considered in the sample. Further, tea smallholders stated that machine usages reduce the impact of labour shortage but usage of machines is low due to lack of training.

Contract works, cash plucking and block plucking were the other strategies adopted by the smallholder in the study areas.

HW Shyamalie, KWN Nadeeshani and ARMT Rathnayake

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

The popular method of tea cultivation is mono cropping, although, tea smallholders (TSHs) tend to cultivate tea in a mixed cropping pattern, under different farming systems in order to maximize the income from limited resources. About 67% of the extent under tea has been cultivated as mono cropping, the balance extent (33%) cultivated as mixed cropping (Census of tea smallholdings, 2005). However, there is no evidence or baseline information available regarding current land use scenario of TSHs farming systems. Also, tea small holders cultivate tea as a supplementary source of income with other income sources such as paddy cultivation, vegetable cultivation, carpentry and other occupations. Furthermore, currently there is a tendency to divert from mono crop to multi-crop cultivation system. Hence, the patterns and processes resulting from agricultural farming systems and the sustainability of these systems are topic of inquiry. Understanding the prevailing reality of marginal tea small holders is also important to tackle the socio-economic and environmental consequences of existing tea-based land use systems (FAO, 2012). Thus, a spatially explicit socio economic survey was conducted in tea smallholders in Sri Lanka focusing on studying tea -based peasant farming systems.

The identified research questions are: what is the existing Farming Systems; what are the issues on the present farming systems; performance of each system and what will be the viable farming system/systems.

Stratified random sampling technique was used to select the sample farming households. There were three hundred twenty farming households from forty four Grama Niladhari Divisions come under five Divisional Secretariat areas, in Ratnapura district, namely Ratnapura, Opanayaka, Kuruvita, Kalawana and Imbulpe.

As shown in the Table 6, the mean household size was 3.75, with a minimum of 1 and a maximum of 7 (SD = 1.38). Even though male and female ratio for working group is 4:3, male to female ratio of the sample was 1:1. The mean number of years of experience in sample smallholder was 25 years, with a minimum of 3 years and a maximum of 65 years (SD = 12.47). The average land size was 1.92 acres, with a minimum of 0.1 acres and a maximum of 13.5 acres (SD = 1.75).

Table 6. Descriptive statistics of household characteristics

	Minimum	Maximum	Mean	Std. Deviation
Farm Size	1	13.5	1.92	1.75
Head of HH age	23	87	54.29	12.96
Head of HH Education Level	1	8	2.84	1.07
HH Experience (yr)	3	65	24.75	12.47
Size of House hold	1	7	3.75	1.38
Employed Male members	0	4	1.05	0.67
Employed Female members	0	3	0.85	0.58
Unemployment	0	3	0.31	0.54
Engaged with Agricultural activities	0	6	1.94	0.89
Age of tea	1	150	19.84	15.38
SLT/ac	2	175	32.87	24.492
HT/ac	0	1296	285.37	205.213
% of Income from tea	20.81	100.00	88.66	11.45
% of Income (agriculiture) Non Tea	0.00	79.19	11.34	11.45
REV/ac	108,609	2,803,200	1,063,963	392,364
Invesment/ac (Rs)	24,275	609,229	224,489	93,485
GM/ac/yr (Rs)	-313,612	12,498,399	1,337,527	1,749,966

Although all farms were similar in growing tea, the presence of other crops and also the varying sizes of the farms created differences among farmers. Therefore, attempts were made to identify different farm types. Mostly farm typology was carried out using PCA followed by cluster analysis. Since data set consists of categorical data as well as continuous data, categorical Principle Component Analysis (CATPCA) was employed.

The results of classification procedure provided five clusters indicating clear gruoping. Although number of variables was chosen, tea mono crop (T), tea with mixed crops (T+M), coconut cultivation (CC), paddy and rubber cultivation were the predictor variables. Five clusters were identified as shown in the Table 7.

Table 7. Crop distribution corresponding to each cluster

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Tea	√	√	√	√	√
Tea with mixed crops	●	√	●	●	●
Coconut	√	√	√	●	●
Paddy	√	●	●	●	●
Rubber	●	●	●	√	●
	T+CC+P	T+TM+CC	T+CC	T+R	T

Although relatively large farms contain tea areas of above average size, smaller farms had a higher proportion of land devoted to tea, while larger farms devoted a higher proportion of land to other crops. Therefore, there is a tendency to grow more than one crop where land is adequately available. The average sizes of the five distinguished farm types are shown in the table 8. The presence of two major crops along with tea was associated with larger farm sizes, except with rubber. While the farm type contains more crops (Group 1) had the largest main size. However, the greatest area under one crop was always occupied by tea (Group 5).

Table 8. Variation in farm size among the groups (acres)

	Group 1 (T+CC+P) (ac)	Group 2 (T+TM+CC) (ac)	Group 3 (T+CC) (ac)	Group 4 (T+R) (ac)	Group 5 (T) (ac)
Average Extent	2.85	2.06	1.44	2.72	1.21
Mode of the farm size	2.00	1.50	1.00	1.00	0.75
Maximum farm size	13.50	10.00	7.00	8.00	5.00
Minimum farm size	0.25	0.16	0.05	0.25	0.25
SD	2.57	1.79	1.17	1.88	0.84

Labour-use and productivity in different farming systems, utilization of family labour and maximization of labour productivity are also the important determinants of the composition of a farming system. It is observed that productivity for unit of labour (for total labour as well as for family labour) was high for the farming system with tea mono crop. It may be due to easiness of management on farming system with tea mono crop and uniform field practices. However, it was observed that this group highly depends on hired labour.

KWN Nadeeshani and HW Shyamalie

Project B 127. Impact of Product Innovation towards Firm Performance in the Sri Lankan Tea Industry: insights from Japan

Specific objectives of the study were to: 1. Determine the effect of firm characteristics and innovative behavior on product innovation and how the latter effects firm performance; 2. Analyze the link between product innovation and market dimensions with respect to tea industry in Sri Lanka

Data was collected from 43 tea exporting firms (large-23, medium – 10 and small - 09) selected through stratified random sampling. These 43 firms exported nearly 60% of the total export volume of tea in Sri Lanka in the year 2019.

Table 9. Type of innovation and firm performance

	Category	Sales gain per unit export (Rs./kg)		
		n	Mean	Median
Radical innovations	Firms produced above average (n>1)	10	2186.79	2400.00
	Firms produced below average (n≤1)	33	1111.77	919.57
	Mann-Whitney U test results	U= 21.5, p=0.000		
Incremental innovations	Firms produced above average (n>1)	13	1370.91	1091.26
	Firms produced below average (n≤1)	30	1357.82	1045.40
	Mann-Whitney U test results	U=182.0, p=0.731		

Source: Author's analysis based on the field survey, 2019

Results revealed that the firms that produced above the average number of radical innovations (average number of innovations=1) had significantly higher sales gain (2186.79 Rs/kg) than the firm that did not (1111.77 Rs/kg). There is no significant difference between the firms that produced a higher number of incremental innovations than the average and the firms that produced below the average number of incremental innovations (Table 09).

The estimated model to find out determinants of number of incremental innovations and log of number of radical innovations is given below.

$$\ln(\lambda) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9$$

ln (λ) is the log of number of incremental innovations and log of number of radical innovations respectively. The determinants (X_1- X_9) and parameters (β_1- β_9) are given in Table 10.

Table 10. Parameter estimates for the determinants of producing tea-based innovations

Variable		Radical innovations			Incremental innovations		
		β	Exp (β)	p	β	Exp (β)	p
X_1 - Firm Strategy	β_1	0.37**	1.44	0.084	-0.36**	0.70	0.096
X_2 - Firm Resources	β_2	0.70*	2.01	0.000	-0.32**	0.73	0.092
X_3 - Expertise on tea	β_3	0.29	1.34	0.312	0.01	1.02	0.922
X_4 - CEO's science and technology qualifications (yes)	β_4	1.63*	5.13	0.007	-1.08*	0.34	0.041
X_5 - TRI contacts (yes)	β_5	0.78	2.19	0.123	0.14	0.88	0.753
X_6 - Collaborative research (yes)	β_6	0.56	1.76	0.189	0.26	1.30	0.458
X_7 - Training for RandD staff (yes)	β_7	-0.76	0.47	0.137	0.70	2.02	0.108
X_8 - Size of the firm (large)	β_8	-0.78*	0.46	0.090	0.06	0.94	0.861
X_9 - Foreign investments (yes)	β_9	-0.46	0.63	0.307	-0.47	0.63	0.196
Intercept	β_0	-0.35	0.71	0.672	-0.02	0.98	0.218

Goodness of fit	value	df	value/df	value	df	value/df
Deviance	30.95	31	0.99	37.83	31	1.22

	Likelihood ratio chi square	df	Sig.	Likelihood ratio chi square	df	Sig.
Omnibus test	52.82	09	0.00	15.43	09	0.08

Note - * significant at 0.05 significance level, ** significant at 0.1 significance level.

The estimated model for innovation – market diversification is as follows.

$$\ln(\lambda) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12}$$

ln (λ) is the log of number of incremental innovations and log of number of radical innovations respectively. All the variables (X_1-X_{12}) and parameters ($\beta_0 - \beta_{12}$) for above estimated GLM are mentioned in Table 11.

Since the dependent variables (*i.e.* no. of radical innovations and no. of incremental innovations) followed a Poisson distribution, Generalized Linear Modelling (GLM) was employed to examine the relationship between the dependent variables against independent variables. The derived GLMs were checked for their significance over the intercept only model by comparing the values for: 1) goodness-of-fit and 2) Omnibus test. If the model fits the data, the deviance value/degree of freedom and Pearson chi-square value/degree of freedom should approximately be equal to one.

Table 11. Parameter estimates for the determinants of producing tea-based innovations

Variable		No. of Radical innovations			No. of Incremental innovations		
		β	Exp (β)	p	B	Exp (β)	p
X_1 - Number of export market destinations (Breath)	β_1	0.03*	1.03	0.011	-0.01	0.99	0.441
X_2 - Ratio to non-traditional destinations (Depth)	β_2	2.96*	19.22	0.003	-0.61	0.54	0.284
X_3 - Supply to domestic market (True)	β_3	0.41	1.50	0.412	-0.36	0.70	0.315
X_4 - Buyers (True)	β_4	-0.74	0.48	0.233	0.65	1.91	0.284
X_5 - Agents (True)	β_5	-0.62	0.54	0.239	1.11*	3.04	0.023
X_6 - E-business (True)	β_6	-0.77	0.46	0.266	-0.15	0.86	0.752
X_7 - Sales outlets abroad (True)	β_7	-2.18*	0.11	0.017	0.51	1.67	0.255
X_8 - Consumer contacts (yes)	β_8	-0.09	0.92	0.901	0.06	1.06	0.873
X_9 - No. of Standards	β_9	-0.17	1.18	0.208	0.03	1.03	0.760
X_{10} - Have own brands (True)	β_{10}	-0.65	0.52	0.447	0.10	2.71	0.420
X_{11} - Supply to private brands (True)	β_{11}	-0.97	0.38	0.198	-1.16*	0.32	0.049
X_{12} - Participate to trade fairs (True)	β_{12}	-0.24	0.79	0.774	-0.27	0.78	0.708
Intercept	β_0	-1.05*	0.35	0.001	-0.65	0.52	0.948

Table 11. Parameter estimates for the determinants of producing tea-based innovations. Cont.,

Goodness of fit	Deviance value 23.95	Df 30	value/df 0.80	Deviance value 31.30	df 30	value/df 1.04
	Pearson chi square value 34.97	df 30	value/df 1.17	Pearson chi square value 29.86	df 30	value/df 0.99
Omnibus test	Likelihood ratio chi square 63.92	df 12	Sig. 0.00	Likelihood ratio chi square 22.02	df 12	Sig. 0.04

Note – Dependent variables: No of radical innovations and no. of incremental innovations

* significant at 0.05 significance level

Non-traditional destinations - Countries other than five Russian Federation, Turkey, Iraq, Iran and Syria.

Source: Analysis based on survey data, 2019

Survey revealed that though there are number of tea-based radical innovations that can be produced using the green leaves of tea, only 19 firms (44% out of 43) in Sri Lanka produced a radical innovation product during the time reviewed (2014-2019). Mann-Whitney U test revealed that producing tea-based radical innovations has a significant positive impact towards firm performance. Although producing incremental innovations showed positive impact on firm performance, its influence was not statistically significant. The Generalized Linear Model proved four determinants that significantly affect the production of tea-based radical innovations in Sri Lanka. Three of these determinants: 1) firm strategy (no. of food technologists, no. of market destinations, no. of CIM/CIMA qualified employees): 2. firm resources (direct links to plantations and processing factories); and 3) CEO's science and technology qualifications - have a significant positive impact on producing radical innovations. Firm size has a significant negative impact on producing radical innovations.

On average, a firm annually exported to 30 countries, and 50% of its volume was exported to traditional destinations. The GLM developed to identify the market dimensions' impact on radical innovations revealed that exporting to non-traditional destinations has a significant positive impact on radical innovations while the establishment of sales outlets abroad has a significant negative impact on producing radical innovations. GLM on incremental innovations found that exporting through agents has a significantly positive impact while supplying to private brands has a significantly negative impact.

Study recommends promoting production of tea-based radical innovations in Sri Lanka rather than focusing on incremental innovations of flavoring, bagging and packaging.

However, this does not mean that firms should stop incremental innovations. Since Sri Lanka is a major tea producer and supplier in the world, always the priority should be given to the mass market. However, the firms/industry as a whole should realize that continuation and complete dependence on incremental innovations may not bring added advantages or keep Sri Lankan tea industry sustainable in the long-run.This is where radical innovations can play a major role in making the Sri Lankan tea industry an outstanding performer among its competitors. Frms/industry can identify niche markets for specific tea-based radical innovations (e.g. organic tea, handmade tea, wild tea, bricks tea and tea infusions *etc.*). Identification and targeting these niches the breath of market diversification (Number of market destinations) and depth of market destinations (share to non-traditional destinations).

HMCG Pilapitiya

Thrust A 41. Analysing the impact of macto-economic policies on 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

Tea plantations currently practiced different alternative worker deployment models in order to minimize the negative impacts of worker shortage. Usually, workers are engaged in specific field practices for a longer period and thereby, they may have good knowledge about that particular activity. However, they do not have adequate knowledge on other field practices. When alternative worker deployment models are adopted, workers should have knowledge on all field practices, since the worker who engage in alternative worker deployment models has to manage allocated tea land by himself. Therefore, the purpose of this study is to examine the knowledge level of field practices of the above workers and to identify the factors attribute to their knowledge.

The study was conducted in two estates in Up Country where they practice different alternative worker deployment models. Sixty workers (10% of the workforce in each estate) were randomly selected for data collection. Data were collected using a pre-tested questionnaire which includes various statements related to different field activities in order to assess knowledge level of the workers. Five-point likert scale such as highly acceptable (5), acceptable (4), moderately acceptable (3) and poorly acceptable (2) and not acceptable (1) was used to measure the knowledge level of the workers. Data were analysed using Descriptive statistics and correlation analysis.

Results of the preliminary analysis revealed that most of the sample workers have highly acceptable or acceptable knowledge on plucking and moderate level of knowledge on weed management, pest and disease control and soil conservation. However, 40% and 36% of workers included in the sample have poor knowledge on pest and disease control and soil conservation, respectively. Meanwhile, 87% of the

workers in the sample did not have acceptable knowledge on soil fertility management strategies (Table 12).

Table 12. Workers' knowledge level on different field practices

	Percent respondents				
	Plucking	Weed management	Pest and Disease control	Soil conservation	Soil fertility managment
Highly acceptable	34	15	0	0	0
Acceptable	30	0	0	13	0
Moderate acceptable	26	68	60	47	13
Poor acceptable	11	0	0	4	0
Not acceptable	0	17	40	36	87
Total	100	100	100	100	100

The maximum aggregate value obtained for workers who have highly acceptable knowledge on considered agricultural practices is 25. According to the Table 10, majority of the workers' (98%) aggregate knowledge on field practices is below 15. The estates should consider this finding when adopt alternative worker deployment models. Improving workers' knowledge through training would be useful for the success of these models.

Table 10. Aggregate knowledge level

Category	Percent respondents
Below 10	38
10.1-15	60
15.1-20	2

Correlation analysis was conducted to examine relationship between knowledge level of the workers and their age, working experience, educational level and gender. However, there was no significant correlation between knowledge level and age, education, experience and gender.

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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 the stakeholders, and thereby contributing towards adoption of technologies and good agricultural practices at the 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 Mathugama. 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 the chapter under the Regional Centers.

Activities of Advisory and Extension Division

The 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 32 seminars/workshop/meetings at the auditorium. Demonstration facilities were provided at the Information Center for 150 visitors including students of schools and higher educational institutions.

Project D/ADV 1. Routine Advisory and Extension Activities

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 the 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	81	56	31	168
Advisory correspondence	245	55	32	332
Training programmes for stakeholders	27	21	35	83
Training programmes for students of higher educational institutions	16	1	1	18
Distribution of printed extension materials	370	60	75	505
Soil samples tested for pH	-	70	627	697
Inspection of commercial tea nurseries	2	11	42	55
Meetings attended	34	16	27	77
Field visits for survey studies	3	1	-	4

The 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/ establishment of tea plants in new clearing and drought effect and some other aspects.

Residential training programmes organized by the NIPM

The TRI has conducted residential training programmes organized by the NIPM mainly via Zoom platform due to the Covid-19 restrictions and details are given in Table 2. The programs were coordinated by the staff of Advisory and Extension Division (A R M A M Rathnayake).

Table 2. Residential training programmes of NIPM

Programme	Duration / Venue
National Diploma in Plantation Management 2019/20 batch	13th August to 6th September 2021, via Zoom platform at TRI, Talawakelle
National Diploma in Plantation Crop Technology - NVQ 5	24th to 29th November 2021, via Zoom platform at TRI, Talawakelle

Educational Programmes for Students of Higher Educational Institutions

Although requests were made by some higher educational institutions for educational programmes, they were postponed/ cancelled due to the government health regulations on Covid-19.

The objective of this project is to strengthen interaction with stakeholders and general public including school students. The following activities were undertaken during the year;

Regional Technical and Extension Forum (RTEF)

Table 3. The RTEF programmes were conducted via Zoom platform

Region	Subject Covered	Resource Person	Participants
Uva and Nuwara Eliya	(2021.03.03) තේ වගාව සඳහා දියර පොහොර භාවිතය	W M S Wijethunge Research Officer	Regional Managers, Assistant Regional Managers, Senior Tea Inspectors and tea inspectors of TSHDA Nuwara Eliya and Uva regions

Table 3. Cont.,

Region	Subject Covered	Resource Person	Participants
	තේ වගාව සඳහා දියර පොහොර භාවිතය (with practical session)	P G D S Amarasena Research Officer	
All the tea growing regions combined	2021.11.08 Conducted via Zoom platform Preparation and establishment of tea fields in view of mechanizing field practices in the future	M A Wijerathne Head, Agronomy Division, V S Sidhakaran Head, Advisory and extension Division, S R W Pathirage Research Officer	General Manager, Deputy General Managers, Regional Managers, Assistant Regional Managers, Senior Tea Inspectors and Tea Inspectors of TSHDA of all regions

Regional Scientific Committee (RSC) activities
Not conducted as scheduled due to Covid-19 health regulations

Experiment and Extension (E and E) Forum for the Smallholding Sector
Not conducted as scheduled due to Covid-19 health regulations

Experiment and Extension (E and E) Forum for the Corporate Tea Sector
Not conducted as scheduled due to Covid-19 health regulations

Exhibitions
No exhibitions were held due to health restrictions by the government.

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 4).

Table 4. 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	In press
Sticker	Let Us Build Up a Live Tea Soil	V S Sidhakaran G S Pradeep	In press
Video Clip	Double hedge-row planting to facilitate mechanization in tea fields	V S Sidhakaran R Muralithasan N S Ekanayake	Completed
	Burying of prunings in tea fields	S Piyaruwan N S Ekanayake	Completed
	Adopting Soil Quality Index (SQI) media (funded by STaRR project)	M A Hiromi (Coordinator, TRI)	Completed
	යහපත් කෘෂිකාර්මික පිලිවෙත් හඳුන්වා දීම (organized by Ministry of Plantation)	M A Hiromi	Completed
	කාළගුණික විපර්යාස හේතුවෙන් ඇතිවන බලපෑම් අවම කරගැනීම (organized by Ministry of Plantation)	M A Hiromi	Completed
	තේ වගාව සඳහා නව තාක්ෂණය හඳුන්වා දීම (organized by Ministry of Plantation)		

Type of material	Description	Prepared By	Status
Guidelines / Circulars	TRI guideline on "තේ ඉඩම් සඳහා කොම්පෝස්ට් නිපදවීම සහ භාවිතා කිරීම"	M A Hiromi	Issued
	TRI Advisory Circular - "තේ වගාවේ තිරසාර ඵලදායිතාවය, ශාක පෝෂණය හා පාංශු සාරවත් බව සුරක්ෂිත කිරීම උදෙසා ඒකාබද්ධ කළමනාකරණ ක්‍රමවේදයන්"	M A Hiromi	In progress
Newsletters	*Tae Thathu - Volume 16 (issue I)* *Tae Thathu - Volume 16 (issue II)* *Tae Thathu - Volume 17 (issue I)*	M A Hiromi	Issued In progress Issued
Books	Assist in compilation and editing of the Field Guide Book	M A Hiromi	In progress

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. However, the outcome of the project continued to be coordinated for the benefit of tea growers. Mr. A L R U Kumara, Advisory Officer continued to be the coordinator of the project until 30th November 2021.This is an important function of the Advisory and Extension Division to promote the recommended improved tea cultivars among the growers. The Division coordinated and monitored the mother bush sites and its' activities in different tea growing areas and provided necessary technical advice to achieve the desired goals.

A total of 4.2 million cuttings of TRI 3000 and TRI 4000 series cultivars have been issued to both smallholding and estate sectors from mother bush sites during the year against the estimated 6 million cuttings (Figure 1).

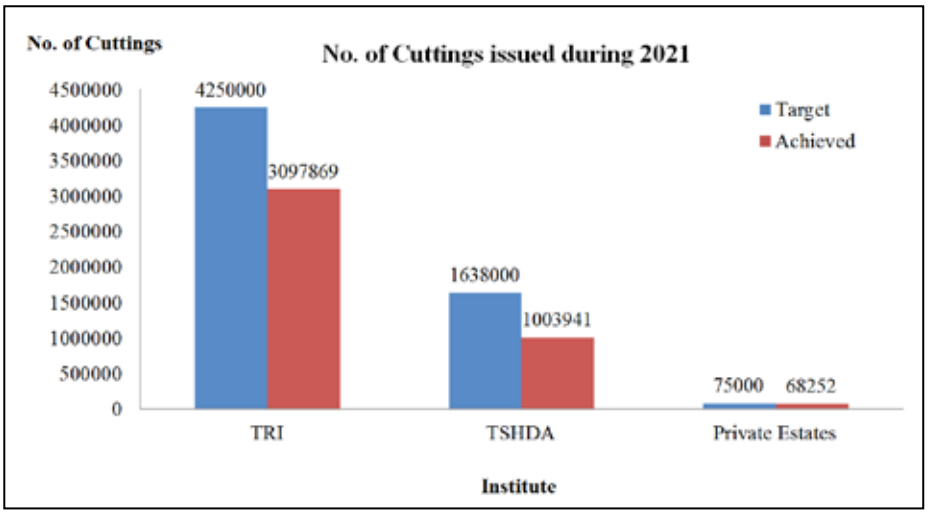


Figure 1. Number of cuttings issued during 2021

As a result of labour issues due to the Covid-19 pandemic and blister blight disease due to unfavorable weather conditions (misty whether conditions) prevailed during the critical periods, some of the mother bush sites have been converted to plucking fields. Less demand for certain cultivars, short supply of methum sodium for nursery fumigation, debilitation of mother bushes in some locations and management issues were the main contributory factors for non-accomplishment of the set target.

Mother Bush Programme TRI 5000 series (GL 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. Mr. A L R U Kumara, Advisory Officer, continued as the coordinator of the project up to 30th November 2021.

The coordinator involved in site selection and providing necessary guidance for establishing mother bush sites in TRI mother bush sites, TSHDA mother bush sites, RPC sites and for Morawakkorale tea development society. Also, from time to time the mother bush coordinator visited the sites for giving necessary technical advice and to monitor the progress of sites.

Fifty six visits were made to established / proposed mother bush sites in all tea growing regions to monitor the activities and to provide guidance. Twenty reports were sent out on related matters to site managers. At present, 26 lands have been identified in all tea growing regions to establish TRI 5000 series mother bush sites. During the year 2021, 7.9 ha have been established as new mother bush sites.

The project period ended on 31st December 2021 and cultivated total extent of mother bush in all the tea growing areas was 20.86 ha. which will be maintained by the respective site managers. Every mother bush site will be visited by the mother bush coordinator continously for technical advice and monitoring purposes.

Project D/ADV 3. Monitoring, Evaluation and Extension Research
Tea production decline in Sri Lanka
Two surveys were undertaken to study tea production decline in Sri Lanka.

National tea production decline in Sri Lanka particularly since 2013 has been a common concern among stakeholder experts and professionals. In comparison to the production in other major tea producing countries, it has been observed that there is steady and progressive decline in tea production in Sri Lanka. Besides, the line ministry has set a national tea production to be increased from the present level of 278.85 Mn kg (2020) to 360 Mn kg in 2025 (by about 81 Mn kg in the next five years). The issue of national tea production decline has been discussed by the Consultative Committee on Research (CCR) and emphasized the need for an Evidence-Based Analysis in order to identify reasons behind the production decline. Hence, investigations have been carried out by the Advisory and Extension Division in collaboration with Agronomy and Agricultural Economics Divisions. Relevant data from published documents, records, sample survey, advisory reports and stakeholder views (RPC sector) were used for the investigation. Factors such as production, yield, cultivated extent, rainfall/ drought, tea replanting/ new planting, fertilizer usage, age profile of tea, labour availability, pests and diseases, adoption of key agricultural practices, investment on Good Agricultural Practices (GAPs), Profitability and government policy changes were considered as relevant and analyzed accordingly. Wherever necessary, statistical analysis was performed using relevant statistical tools. Findings of this study to be used to formulate long and medium term policy interventions to address the issue concerned at various levels (government, organizations and growers) by means of appropriate policies, support services, research and extension interventions.

The following key observations and contributory factors for national tea yield decline since 2013 were made;

a) Changes of tea production in the Low-country contributes more towards national tea production in Sri Lanka
b) Majority of the tea production comes from smallholdings in the low-country region.
c) Continuous production decline has been observed in the RPC sector since early 2000.
d) The most productive extent of tea in the smallholdings and corporate sectors has declined from around 2013 due to senility and biotic and abiotic stresses.
e) Declining production growth rates have been observed in both sectors while a severe decline was evidenced in the Low-country.
f) Replanting has been very minimum in both sectors and very much less than the acceptable levels to sustain productivity
g) Labour scarcity is a key factor contributed for yield decline.Reduction of agricultural inputs such as fertilizers and herbicides and labour shortage negatively affected tea yield.
h) Low adoption levels of key good agricultural practices in tea lands were observed
i) Erratic weather changes such as long dry spells (eg. In 2016) negatively affected tea production and their carry over effects have been long lasting. Ageing and debilitated tea bushes are more vulnerable to such abiotic stresses.

Aging of tea and bush debilitation, lack of replanting and field consolidation by infilling, declining labour force and their productivity, impact of perennial pests and diseases especially in the Low-country, low adoption levels of key good agricultural practices in tea lands, erratic weather changes and dry spells, policy changes reducing agricultural inputs such as herbicides were identified as key contributory factors of national tea production decline since 2013. The outcomes of the finding were presented at two CCR meetings and at one TRB meeting. The relevant comments of the CCR, TRB members were incorporated in the final report which will be further discussed at a special stakeholder forum consisting of key stakeholders of the industry including policy makers in early 2022.

VS Sidhakaran, MA Wijeratne, H W Shyamalie, GS Pradeep, KG Lakmali and R Muralithasan

Survey on nematode infestation in Ravana Kanda GN Division, Balangoda

A survey was carried out to study the nematode infestation in Ravanakanda GN Division, Balangoda. In parallel with the "Gama Samaga Pilisandara" government programme, an investigation was carried out in 56 tea lands in Rawanakande GN Division, Balangoda. The study was finalized. Based on the study results four awareness programs have been conducted regarding measures on controlling nematodes in tea lands as field day sessions. Final report was submitted to the District Secretary, Ratnapura.

TGN Mahinda, SPAPK Jayarathne

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 are 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. Six tailor-made training programmes have been organized for three Regional Plantation Companies such as Balangoda, Madulsima and Elkaduwa for executives, field staff and workers during the year. The subjects covered were tea harvesting, soil fertility management, post-harvest handling of green leaf and weed management.

VS Sidhakaran, KRWB Kahandawa, A Abeysooriya, GS Pradeep and R Muralithasan

Establishment of automated weather stations with Arthur C Clarke Institute
The advisory staff assisted in the establishment of Automated weather stations which is a collaborative project between Arthur C Clark Institute and the TRI which is funded by Ethical tea partnership programme in eight sites in different tea growing regions.

A L R U Kumara

Project D/ADV 7. Cyber Extension
Due to the Covid-19 pandemic, the importance of implementing e-extension activities was highlighted and 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. 140 calls have been attended from June to December 2021.

The MOU was signed between TRI and Dialog Axiata Company, on sharing advisory and technical content in order to disseminate extension messages electronically.

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.

Farmer Centered field trials on organic fertilizer formulations

With the government decision on ban of chemical fertilizers and promotion of organic fertilizers with the initiative of the Ministry of Plantations, TRI commenced laboratory and field experiments on various commercially available organic fertilizer formulations. Among those, Advisory and Extension Division with the involvement of the TSHDA commenced farmer centered field trials in smallholder lands covering all the tea growing regions. Initially, 52 sites were selected by the TSHDA field staff of which the TRI advisory staff made visits to 42 sites and commenced trials in collaboration with the TSHDA and organic fertilizer dealers. Sixteen commercial organic fertilizer products have been received and applied. Observations were made periodically by advisory staff on yield, green leaf standards, soil carbon, nutrient and pH, soil microbial activities, weather and farmer responses too. The data collection is in progress. An interim report after analyzing the data will be submitted in early 2022.

VS Sidhakaran, CJ Liyanaarachchi, MAH Nishanthi and other Advisory staff of the regional extension centers.

Other Adaptive Trials in Progress

- 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, TRI and TSHDA.
- One Adaptive trial on foliar application for tea is in progress at Deniyaya Estate in collaboration with SPND.
- One adaptive trial on use of wood ash for tea at Kiruwanaganga Estate in collaboration with SPND.
- Seven (07) Farmer Centered Bio Fertilizer trials established on tea smallholder lands in Matara district are being monitored in collaboration with the Tea Smallholdings Development Authority, Matara.

  Two model tea lands demonstrating the TRI recommendations on management of tea bush debilitation problem established in Pallegama and Beverley areas of Deniyaya region are being successfully monitored

CE Munasighe and HB Tharangika

Project C/AVU. Audio Visual Services
The objective of this project is to produce and or multiply videos (CD / DVDs) on technical subjects to provide Audio Visual and IT services for technology dissemination at seminars and prepare AV and printed materials for TRI website and TRI publications.

In addition, preparation and issue of videos and maintainance audio/video library for the extension and Divisional research purposes have also been undertaken.

N Ekanayake, Technical Officer

The AV and IT services were provided by the Unit for 19 events for on-line Seminars, Divisional review meeting, presentations and other special events of the Institute.

440 DVDs with 1940 video films on Tea cultivation aspects were multiplied and issued to Publication Unit for distribution among the TRI regional Centers and among the stakeholders of the tea industry.

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 of mitigating climate change effects.
This project has been initiated by the TRI with the financial assistance of the Ministry of Plantations as a result of funds allocated in the budget speech 2021. The Advisory and Extension Division with the assistance of Agronomy Division implemented the project.



Due to continuous tea cultivation operations and unsatisfactory adoption of Good Agricultural Practices, soil organic matter content found to be drastically declined leading to soil compaction, poor soil physical properties, water holding capacity and aeration *etc* depriving the ability of tea plants to face climate change effects.. 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;

a. Establishment of demonstration sites in TRI lands, RPC estates, proprietary estates and small holder lands to demonstrate burying of pruning practices.
b. Establish shade trees and green manure crops and other important GAPs in the selected demonstration sites.

c. Conduct awareness programs on climate change mitigation, essential agronomic and cultural practices for small holders, medium scale planters, RPC and state sector planters.
d. Selection, re-designing and fabricating of chopping machine to chop tea prunings.
e. Selection, re-designing and fabricating of trenching machine/s to cut trenches for burying of prunings.
f. Pre and post assessment of field applications of chopping machine and trenching machines.

The following progress have been accomplished during the year;

Table 5. Progress of the project activities

Activity	Progress
1. Establishment of demonstration sites on burying of prunings and other relevant agronomic practices in the TRI including regional centers	Five demonstration sites were established in Talawakelle, Hantane, Deniyaya, Kottawa and Passara TRI regional centers
2. Establishment of demonstration sites on burying of prunings and other relevant agronomic practices in tea plantations (RPC and medium scale private estates)	Eighteen demonstration sites were established covering all tea growing regions in thirteen estates (Palmerston, Delmar, Liddesdale, Ingestre, Doloswella, Elteb, Glenanore, St. Clair, Sogama, Berubeula, Vilehena, Craig Head and Shannon)
3. Awareness programs on climate change mitigation and essential agronomic practices for plantations	Twenty-five awareness programmes were conducted for different grower categories including estate Managers, field staff and workers. A pamphlet on preparation of compost was released for smallholders through TSHDA
4. Selection of available chopping machines for the purpose of chopping tea prunings and for further modifications	Ten chopping machines were purchased and distributed to TRI regional centers and to two TRI estates for evaluation
5. Selection of available trenching machines to cut trenches for burying of prunings and for further modifications	Two proto-type trenching machines have been developed with private parties for testing and evaluation

6. Preparation of compost for application in demonstration sites	Compost was produced in all the demonstration sites and applied to the soil in demonstration sites
7. Evaluation of the impact of burying of prunings and other relevant agronomic practices	Evaluation of growth and other performances in the demonstration sites are in progress

VS Sidhakaran, Sandun Piyaruwan and G S Pradeep

Special Project GL 387. Provision of an Efficient On-site Analytical and Extension Service through a Mobile Laboratory

The TRI currently offers analytical services to tea growers from its regional laboratories located at Talawakelle, Walahanduwa, Ratnapura and Hantane. Providing basic analytical services including extension service timely is an important support service to tea growers to rationalize and ensure efficient use of inputs. However, tea growers in rural areas especially, tea small holders and medium scale growers including some plantations find it difficult to obtain these services on time as they have to travel long distances and bring their samples to the said laboratory locations. Therefore, the concept of mobile laboratory and extension unit built in a motor coach could provide the necessary on-site analytical (soil, root, leaf analysis , pest and disease identification) and extension services at places convenient to farmers. The special 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 the following objectives;

a. To make the TRI analytical and extension services easily accessible to tea growers and deliver these services onsite
b. Provide analytical and extension services on time and at appropriate cultivation seasons
c. To save farmers time and resources.
d. Improve farmer compliance with the TRI fertilizer application and other field recommendations through onsite help and supervision

This project was planned and implemented in three major steps as follows by the Advisory and Extension Division in collaboration with relevant research Divisions (Soils and Plant Nutrition, Plant Pathology, Entomology and Process Technology)

a. Purchase of a suitable motor coach by the TRI
b. Purchase of laboratory instruments, extension equipment and other required items by the TRI
c. Develop and convert the motor coach as a mobile laboratory by setting up and installing the above equipment along with system integration and validation which will be carried out by a suitable service provider.

One motor coach (Mitsubishi ROSA) and many of the laboratory equipment have been purchased for this purpose. The conversion of the coach is currently being undertaken by the selected service provider.

VS Sidhakaran and ARMAM Rathnayake

OTHER SERVICES TO STAKEHOLDERS

Project C/TECH. Services of Advisory Division

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 263 commercial tea nurseries were inspected during the year (Table 6).

Table 6. Commercial Nursery Inspection - 2021

Regional station	No. of Nurseries inspected
Talawakelle	2
Hantane	42
Ratnapura	11
Deniyaya	50
Kottawa	40
Matugama	-
Passara	118
Total	263

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 7).

Table 7. Number of Soil samples analyzed for pH and Carbon - 2021

Regional station	pH	Carbon
Talawakelle	-	-
Hantane	627	-
Ratnapura	70	-
Deniyaya	372	01
Kottawa	107	-
Matugama	73	-
Passara	1402	927

Other assignments

The Unit has prepared video clips for the following, on request.

1. Advisory and Extension – 02
2. Other TRI events - 02

The Audio Visual Unit has edited and prepared video films on following events of the Institute

1. Plantation Minister's Visit to the TRI
2. Visit of Deputy Minister of Plantation to the TRI
3. Promoting mechanization in tea plantations
4. Visit of State Minister of Plantations to the TRI

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;

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

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

Total number of analysis performed on soil, leaf, fertilizer and organic manure at Talawakelle, Walahanduwa and Ratnapura during period under review 9,369, 335, 1,167, and 240 respectively. Of these analyses, highest numbers of analysis were performed for soil pH (9,361) and soil organic carbon (5,838). Total number of analyses performed was 28,561.

OGK Gunaratna, PLK Tennakoon, JRY Abeywardana, SK Weeratunga, SPSK Wijesinghe, WTBD Priyantha, VAN Wickramasingha, HMU Abeywardhana and WMS Wijayatunga

Project C/PATH. Services of Plant Pathology Division

Six black tea samples were analyzed for microbial contaminations.

GD Sinniah, M Niranjan and DGNP Karunajeewa

Project C/ENTO. Services of Entomalogy Divison

Field inspection was made in Field No. 12, St. Coombs Estate to investigate the tea tortrix infestation and recommendations were given.

PD Senanayake

Project C/NEM. Services of Nematology Division

Nematology laboratories at Talawakele, Hantane and Ratnapura 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.

PGDS Amarasena, UB Herath, BMGK Godavita and B Jananey

Project C/PHYS. Services of Plant Physiology Division

Twenty-three sets of root samples were received to identify their suitability for pruning. Twelve samples were analyzed for starch reserves and other samples were rejected while advising on proper root sampling procedure. Iodine solution was provided to five estates and Advisory and Extension Division of the TRI while advising them on how to perform the root starch test. The root sampling procedure was resubmitted to the Director's approval which is to be published as a guideline on the official website of the TRI.

TL Wijeratne, DMS Navaratne, V Sidhakaran, ADIU Jayawardhana and NM Vithanage

Project C/TECH. Services of Technoloyg Division

Ongoing Activities

- Staff extended advisory services on various aspects of tea manufacture to 102 tea factories.
- Staff calibrated 14 moisture meters received from tea factories and submitted reports.
- Staff calibrated 05 Microwave ovens for determination of moisture content in withered leaves.
- Staff determined moisture content in 422 tea samples received from tea factories and submitted reports.
- Staff tested 12 made tea sample received from a tea factory for chemical parameters and submitted report.
- Staff participated in a 3-day workshop on minimization of deficiencies and delays in TEC and Procurement committee reporting.
- Staff conducted lectures on tea manufacture for NDPM (National Diploma in Plantation Management) students organized by NIPM.
- Staff participated in the discussion with TSHDA officials for their 2022 Action Plan

K Raveendran, MA Chamindra, WMS Weerawardena, SH Priyanthie and L Jayasinghe

Project C/MECH. Service by Mechanical Workshop

General Mechanics completed 09 jobs on vehicle repair, 24 jobs on factory machinery repairs for institute factories and 58 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

Updating TRI Website

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

Content	Updated/uploaded Location
News items of Launching of Technology Transfer Office of TRISL Helpdesk Contact Details to facilitate Stakeholders Guidelines for Production and Usage of Compost Fertilizer No. 01/2021 (Sinhala version) Guidelines for Tea Coconut Intercropping No. 02/2021 (English version) Industry Guidelines for Copper Alloy Cast Components in Rotovanes No. 03/2021 (English version) Hand Book on Tea (Reprint 2019) Postponement of Tender closing/ Pre-bid meeting dates for Repairing of Tea Factory Machineries	”What’s New” section of the Homepage
Graphical banners of Launching of Technology Transfer Office of TRISLDevelopment and Introduction of a Motorized Selective Tea Harvester for Tea Lands in Sri Lanka Value added tea products under “Products Diversification”	“Slide Show” section of the Homepage
Details of Carbonated tea as a Value added tea product	Research Highlights area of Homepage
Photographs of Director, Acting Additional Director, Deputy Director Research (Production) & Deputy Director (Administration)	Senior Management page under About TRI
Descriptive details & Photographs relevant to Value Added Tea Products	Value Added Tea Products under Products Diversification

Content	Updated/uploaded Location
Development and Introduction of a Motorized Selective Tea Harvester	Research & Development
English version of Guidelines of 02/2021 and 03/2021 Sinhala version of Guideline of 01/202 with downloading facility	Recommendations under Technology Dissemination
Tae Thathu Vol. 16 No. 1 & 2 with downloading facility	Publications & Videos under Technology Dissemination
Pages of Description of Technology Transfer Office, Technologies available for licensing,Innovations of TRI,Documents with downloading facility and Contact Details of TTO	Technology Transfer Office
Vacancy advertisements for recruitment of following positions of Senior Research Officer, Senior Advisory Officer, Senior Accountant, Research Officer, Engineering Assistant (Mechanical), Engineering Assistant (Electrical), Experimental Officer, Extension Officer, Management Assistant (Store Keeping, Technical Officer (Civil), Technical Officer (Workshop), Estate Medical Practitioner, Clerk and Junior Assistant Clerk	Vacancies under Advertisements
Call for EOIs of Development and Introduction of a Motorized Selective Tea Harvester for Tea Lands in Sri Lanka Design, Development or Import, Modify and Introduction of Trenching Machines for Burying of Tea Prunings (Pruned Branches)	Call for Expression of Interest under Advertisements
Tender Invitations of Purchase of Inductively Couples Plasma Analyzer, Provision of Security Services for TRI, Purchase of Vehicle for Mobile Lab, Insurance Coverage for Year 2022, Amended tender opening dates, Repairing of St. Joachim Factory and Postponement of Tender closing dates/ Pre-bid meeting dates for Repairing of Tea Factory Machineries	Procurement Notices under Advertisements

Development of Management Information System (MIS)

As a crucial part of decision making of TRISL management, it is essential to manage necessary data/ information more efficiently and accurately. The proposed MIS shall be fully integrated system interconnecting Divisions/ Units/ Offices and also regional and extension centers. This system will satisfy necessary operational requirements and also provide analytical tool for the purpose of information analysis. This system will provide a platform with a modular architecture where it has highest level of flexibility to changes and capable of adding new services and features. Selected software development team, 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 Management, Payroll, Procurement, Finance & Accounting, Inventory, Staff Transport Management and Expenses Reimbursement modules was completed by the developer and relevant insertions are done by responsible officers attached to respective Divisions.

Infrastructure Development and Maintenance

- Relocation of server room with state of the art technologies and fiber optic connectivity in-between new server room and Administration building was successfully completed.
- Eight laptop computers, ten desktop computers, one 3KVA online UPS system, one 1200VA UPS system and 15 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 adhering to their requirements.
- 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®) was also upgraded and renewed in order to manage and control internet bandwidth, usage and also to protect TRI intranet from outside threats coming through the internet.
- 45 major jobs under the activity of installation & troubleshooting of computers, computer accessories and LAN were completed/ carried out.

Other Services

Information & Communication Technology (ICT) unit rendered following ICT related services also to other Divisions, Units, Regional and Extension Centers and to the 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 of new accounting software for St. Coombs Estate

- Facilitated establishing the software based Call Center at Mid Country Regional Center
- Obtained 2 Mbps VPN Facility from M/s Sri Lanka Telecom PLC to access Tea Land Registration Database of Sri Lanka Tea Board and facilitated to access and download data for institutional requirement
- Facilitated to arrange/host/connect 105 Online Video conference meetings as and when required for the management & staff members using meet.gov.lk, Zoom, Microsoft Teams, Google Meet, Skype, *etc* technologies
- Maintenance of CCTV Surveillance Camera System
- 15 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
- Assist staff members to prepare various reports, presentations, documents and graphic designs, *etc*;

Mr. U D Alagiyawadu continued his services on the following;

- 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 ICTU section of Annual Report 2019 to Sinhala language

Special Activities

Outsource duties of Technical Officer (ICT Hardware)

M/s Lanka Communication Services (Private) Limited continued its operation up to 05th August to cover-up the duties of Technical Officer (ICT Hardware). Accordingly, an officer is posted at the ICT unit to render related services.

Human Resource Development and Capacity Building

Mr U D Alagiyawadu successfully completed a Certificate in Dynamic Web Application Development with PHP & MySQL course conducted by the University of Colombo School of Computing (UCSC).

Staff Movements

Mr. U D Alagiyawadu continued covering up duties of Network Administrator up to 02nd May.

Mr. A A Upendra started duties in ICT Unit as Network Administrator with effect from 03rd May and resigned from the service with effect from 27th August.

Mr. U D Alagiyawadu was re-appointed to covering up duties of Network Administrator with effect from 28th August and continued the services up to end of the year.

Trainees

Ms. H M S N Wijayarathna, who is following Information and Communication Technology Technician (NVQ Level 4) training programme at the National Apprentice and Industrial Training Authority (NAITA), Hatton, commenced her practical training since 15th November at ICT unit for a period of six months.

LIBRARY

Main function of the library is the collection and dissemination of information on the requirements of TRI scientist 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

Two new books acquired free of charge were added to the current collection of 4790 books. The Library procured 82 journals/serials through subscription, gift and exchange. Subscriptions renewed for the year for ITC (International Tea Committee, UK) Monthly Statistical Summary and ITC Annual Bulletin of Statistics. Hundred and Eleven library materials (books and other) were borrowed from the library by TRI scientific staff.

Services

During the year, 359 news paper articles were added to the news clippings collection. 821 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 fuctions held at the institute and captured 979 digital photographs.

During the year seven events have been covered and provided photographs for Publications and publicity unit for the update of TRI website.

PUBLICATIONS AND PUBLICITY UNIT

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. The Covid-19 pandemic situation affects the operations of the unit during the 2nd and 3rd Quarters of the year. Due to the isolation of the St. Coombs Grama Niladhari Division, the institute also temporarily closed with effect from 07 May 2021. However, with alternative work arrangements such as "Work from Home", scheduled works have been carried out. Following the guidelines on prevention strategies of the Covid-19 pandemic in the workplace, the unit was re-opened on 14 June 2021, and from 01 July 2021 onwards operations were continued adapting to the new normal situation.

Planned works for the year 2021 were postponed due to the effects of the pandemic situation, especially the printing works of Annual Reports, Sri Lanka Journal of Tea Science, Tea Bulletin and Newsletters of 2020/2021. However, unit provided assistance to carry out the operations related to information dissemination to the stakeholders through 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. 41,645.00 within the year. Advisory Circulars, Guidelines, Budget of TRISL, Research Publications related to fertilizer, pesticides, *etc*. for the year 2021 were the main documents printed.

Further, the Publication unit has served other Divisions/Units, and Staff members, in making photocopies at the main photocopying service of TRI. Total recovery made through photocopy Services was Rs.23,477.00, while the personal base recovery was Rs.2,714.00. Total of 20,763.00 photocopies were provided.

Sales of Publications

Sales of TRI Publications are the major operation carried out by the Unit. With compared to the last year's total sales volume and the earnings from the sales is less due to the unexpected situation that arose with the Covid-19 pandemic situation. Sales worth of the publications of the year reported Rs. 167,525.00. Summary of the sales given in Table 8. Compared to the year 2020, sales were increased during the year 2021, adapting to the new normal situation with the Covid-19 pandemic situation.

Table 8. Summary of sales value (Rupees): 2019-2021

	English (Rs.)	Sinhala Value (Rs.)	Tamil Value (Rs.)	AV materials Value (Rs.)	Total Value (Rs.)
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

Table 9-12 indicates the sales value of the English, Sinhala and Tamil publications and AV materials during the year 2021.

Table 9. Sales of publications - Year 2021 - English

English Publications

No	Description	Price (Rs)	Quantity	Amount (Rs)
1	Advisory Circular Folders	600.00	34	20,400.00
2	Chemical Control of Tea Pests	150.00	20	3,000.00
3	Labour Economics in Tea	150.00	2	300.00
4	Correction of nutrient deficiency symptoms in tea Poster	15.00	5	75.00
5	Proceedings of Regional Scientific Committee -1988	250.00	1	250.00
6	Nuwara Eliya District Tea Development Plan	150.00	1	150.00
7	Shoot growth and harvesting of tea	100.00	14	1,400.00
8	Monograph No.4 - Tea Manufacture in Ceylon, EL Keegal	750.00	13	9,750.00
9	Monograph No.5 - One day course in tea manufacture, EL Keegal	350.00	9	3,150.00
10	Monograph No.6 - Insect and mite pests of tea in Ceylon, JE Cranham	100.00	3	300.00
11	Monograph No.7 - Facets of the tea research in practice, RL Wickremasinghe	100.00	65	6,500.00
12	Cost of tea Cultivation from nursery to the field	400.00	6	2,400.00
13	Tea and Health	750.00	2	1,500.00
14	Tea for Health	100.00	4	400.00
15	Weeds of Tea lands in Sri Lanka	200.00	13	2,600.00
16	Twentieth Century tea research in Sri Lanka	2,000.00	1	2,000.00
17	Poster on Soil conservation with vetiver grass	30.00	3	90.00
18	Wall chart on Major pests of tea in Sri Lanka	100.00	9	900.00
19	Handbook on Tea-1st Edition	1,750.00	2	3,500.00
20	Handbook on Tea- Reprinted 2019 (Issued to TRI Officers with Discount)	1,500.00	2	3,000.00

Table 9. Sales of publications - Year 2021 - English Cont.,

No	Description	Price (Rs)	Quantity	Amount (Rs)
21	Handbook on Tea- Reprinted 2019	2,000.00	47	94,000.00
22	Integrated Soil Fertility Management	500.00	5	2,500.00
23	Soil Conservation in Tea Lands	20.00	15	300.00
24	Common Diseases on Tea Cultivation Poster	100.00	10	1,000.00
			Sub-total	159,465.00

Table 10. Sales of publications - 2021 – Sinhala

No.	Description	Price (Rs.)	Quantity	Amount (Rs.)
1	උපදෙස් චක්‍රලේඛ ගොනුව	500.00	6	3,000.00
2	සැවැන්දරා වගා කර පස සුරකිමු (පෝස්ටරය)	30.00	1	30.00
3	සුව රැකුමට තේ	125.00	4	500.00
4	ශ්‍රී ලංකාවේ තේ කර්මාන්තය සහ තේ පර්යේෂණ ආයතනය	10.00	7	70.00
5	තේ වගාවට සරු පසක්	50.00	15	750.00
6	තේ ඉඩම්වල පස සංරක්ෂණය	20.00	13	260.00
7	තේ වගාවේ ප්‍රධාන රෝග හඳුනා ගනිමු (පෝස්ටරය)	100.00	2	200.00
8	තේ තවාන් පාලනය (පෝස්ටරය)	100.00	12	1,200.00
			Sub-total	6,010.00

Table 11. Sales of publications - Year 2021 - Tamil

No.	Description	Price (Rs.)	Quantity	Amount (Rs.)
1	Advisory Circular Folders	500.00	1	500.00
2	Correction of nutrient deficiency symptoms in tea Poster (Tamil)	15.00	7	105.00
3	Field Guidebook (Tamil)	125.00	5	625.00
4	Soil productivity poster (Tamil)	50.00	7	350.00
5	Poster on Soil conservation with vetiver grass (Tamil)	30.00	6	180.00
6	Tea Industry and TRISL of Sri Lanka (Tamil)	10.00	4	40.00
			Sub-total	Rs.1,800.00

Tanble 12. Sales of publications – Year 2021 - Audio-visual materials

No.	Description	Price (Rs.)	Quantity	Amount (Rs.)
1	Plucking and Pruning CD	Rs.100.00	2	Rs.200.00
2	Soil Conservation CD	Rs.50	1	Rs.50.00
			Sub-total	Rs.250.00
	Total			Rs.167,525.00

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 13).

Table 13. Summary of the publications distributed through regional centers

No	Regional Center	Annual Publications	Circular Folders	Books	Posters	AV Materials
1	Low-country	18		55	25	30
2	Mid-country	10	10	65		
3	Kalutara	03	20	40	20	
4	Galle	04	10	45	10	
5	Deniyaya	03				
6	Uva	03	10	25	10	
	Total	41	50	230	65	30

In addition, TRI recommendations and TRI publications were issued to the RPC sector, TSHDA and to the individual personnel/organizations (around 30) via post.

1. Annual Reports (English, Sinhala, and Tamil)

Printing process of Annual Report of the institute for the year 2019 was delayed due to the pandemic situation. However, the print ready version was available during the 4th Quarter of the year. Annual Report 2020 is subjected to the Ministry of Plantation Industry approval is pending and Translations of Sinhala and Tamil Reports have been completed. Distribution of Annual Report 2018 to the stakeholders was completed.

2. Sri Lanka Journal of Tea Science Review

The Sri Lanka Journal of Tea Science (SLJTS) publishesthe current research in tea covering all aspects of Tea Science in Sri Lanka. The articles in 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.

Nine articles have been received for Volume 83 (Part 1 and II) of SLJTS and were reviewed by fourteen external subject specialists. Only five articles have been selected for publication.

Volume 84 (Part 1 and II) and Volume 85 (Part I and II) printing process initiated and selected articles of 7th Plantations Crop Research Symposium were reproduced with the permission of the Symposium secretariat.

For upcoming volumes of SLJTS, 10 articles were received and peer reviewing process was completed for 08 articles. Two articles have been subjected to internal reviewing process.

3. TRI Update (English) and *Tae Thathu (Sinhala)* News Letters

TRI update and *Tae Thathu* are published twice a year in June and in December. Those were the two newsletter type magazines in English and Sinhala that provided updated information on the tea industry, TRISL research, innovations and knowledge dissemination, *etc.*

"TRI update" Volume 17 and Volume 18 (Part I and II) have been published and circulated among stakeholders.

Further, *Tae Thathu* Volume 16 (I and II) and Volume 17 (Issue I) were published and circulated among the Tea smallholders.

Coordinators of both newsletters have been continued their works on publishing upcoming volumes.

4. Tea Bulletin

Tea Bulletin is an annual publication of TRISL which provides current updates on technology dissemination with 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 is in the process of printing.

The Coordinator for Tea Bulletin is engaged with reviewing articles for the upcoming volume.

5. TRI Guidelines

Four new guidelines were issued and distributed to the stakeholders.

- මාර්ගෝපදේශ අංකඃ 01/2021 - තේ ඉඩම් සඳහා කොම්පෝස්ට් නිපදවීම සහ භාවිතා කිරීම (ජූනි 2021)
- Guideline No. 02/2021 – Guidelines for Tea and Coconut Intercropping (August, 2021)
- Guideline No. 03/2021 – Industry Guidelines for Copper Alloy cast components in Rotovanes (August, 2021)
- Guideline No. 04/2021 – Guidelines on strategic cost component management in tea cultivation with special reference to rational use of plant nutrients and tea manufacturer (December, 2021)

Reprinting of Publications

Re-printing of 1500 Nos. Hand Book on Tea completed and made available for the stakeholders.

Due to the Covid-19 situation and due to lack of resource persons for reading the proof document of Tea and Health Book, the works related to the re-printing have not continued during this year.

Two scientists of the Agronomy Division updated the 1st edition of the book on "Guide to Identification of Weeds in Tea Lands in Sri Lanka" reviewed by an external subject specialist and is subject to amendments.

New edition of the "Field Guide Book" (English) printing process initiated and placed with the selected supplier for page setup.

New Publications

Advisory and Extension Division developed the "Compost Preparation Guide", tri-language booklet and Sticker on the same theme. Publications and Publicity Unit provides assistance in the printing process of the booklet and State Printing Cooperation has been selected as the supplier.

Online login was created with National Library and Documentation Centre website to facilitate the process of obtaining ISBN numbers for the institutional publications.

Initiation of the MIS for operations

With the initiation of the MIS for the TRI operations, it has been proposed to automate the major operations of the Publications and Publicity Unit such as inventory management activities, stock of the publications and the sales of the unit. MIS related to the identified specific operations have been developed by the service provider. Two training sessions were held to introduce the operational aspects of MIS and data entering into the application and is in progressing.

Special Events covered during the year and updates of the website / Facebook page

With the support of photography and ICT unit, publications and Publicity unit covered the following events and updated the official website:

1. Visit of H.E. the Ambassador of Viet Nam to Sri Lanka Ho Thi Thanh Truc to the TRISL, Talawakelle on 23rd October, 2021
2. Visit of the Counsellor (Political and Trade) of High Commission of Canada to the TRISL, Talawakelle on 08th December, 2021

TRI Call Centre provides advisory facilities to the tea growers with current problems/ issues and 08 messages uploaded to the FB page make aware the farmers through the social media platform.

Other assignments

Publications/ Publicity Officer served as a member of Technical Evaluation Committees for the Selection of Supplier for printing annual publications, stationeries for stationery stores, the printing of "Field Guide Book" of Advisory and Extension Division.

TECHNOLOGY TRANSFER OFFICE (TTO)

The Technology Transfer Office of TRI was established in 2020 with the objective of managing all Intellectual Property (IP) associated work of the institute. TTO is entrusted to assist innovators in IP related activities, identify innovations with commercial potential, licensing of such and establishment of the communication channel with prospective clients to elevate those innovations to an industrial level. The office is being continued to operate on a virtual platform where Dr. M A B Ranatunga, Head, Plant Breeding Division work as the TTO Manager and A R M A M Rathnayake, Advisory Officer, Advisory and Extension Division work as TTO Assistant.

During the year 2021, one patent application titled "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" was submitted. This invention was an outcome of the collaborative research project conducted by the Tea Research Institute and the Synkromax Biotech Pvt Ltd. In addition, amendments were submitted to two previously filed patent applications namely "Mathematical model-based control system for trough withering of tea", and "Spicy Tea Sauce and Method of Preparation".

The third round of remote mentoring program organized under the Enabling Innovation Environment Program organized by the World Intellectual Property Organization (WIPO) which commenced on the 4th November 2020 continued till 3rd May 2021. Two technologies were discussed under the mentoring program namely "Mathematical model-based control system for trough withering of tea" and "Process control system for drying orthodox – rotorvane teas in Fluid Bed Dryer". Existing issues and steps to overcome such issues in relation to both technologies were discussed with the WIPO mentor Mr. Cengiz Tarhan during the mentoring programme. Similarly, the fourth round of the remote mentoring programme was started on 27th October 2021 with the mentorship of the same mentor Mr. Cengiz Tarhan and one technology was selected for the program titled "Spicy Tea Sauce and Method of Preparation".

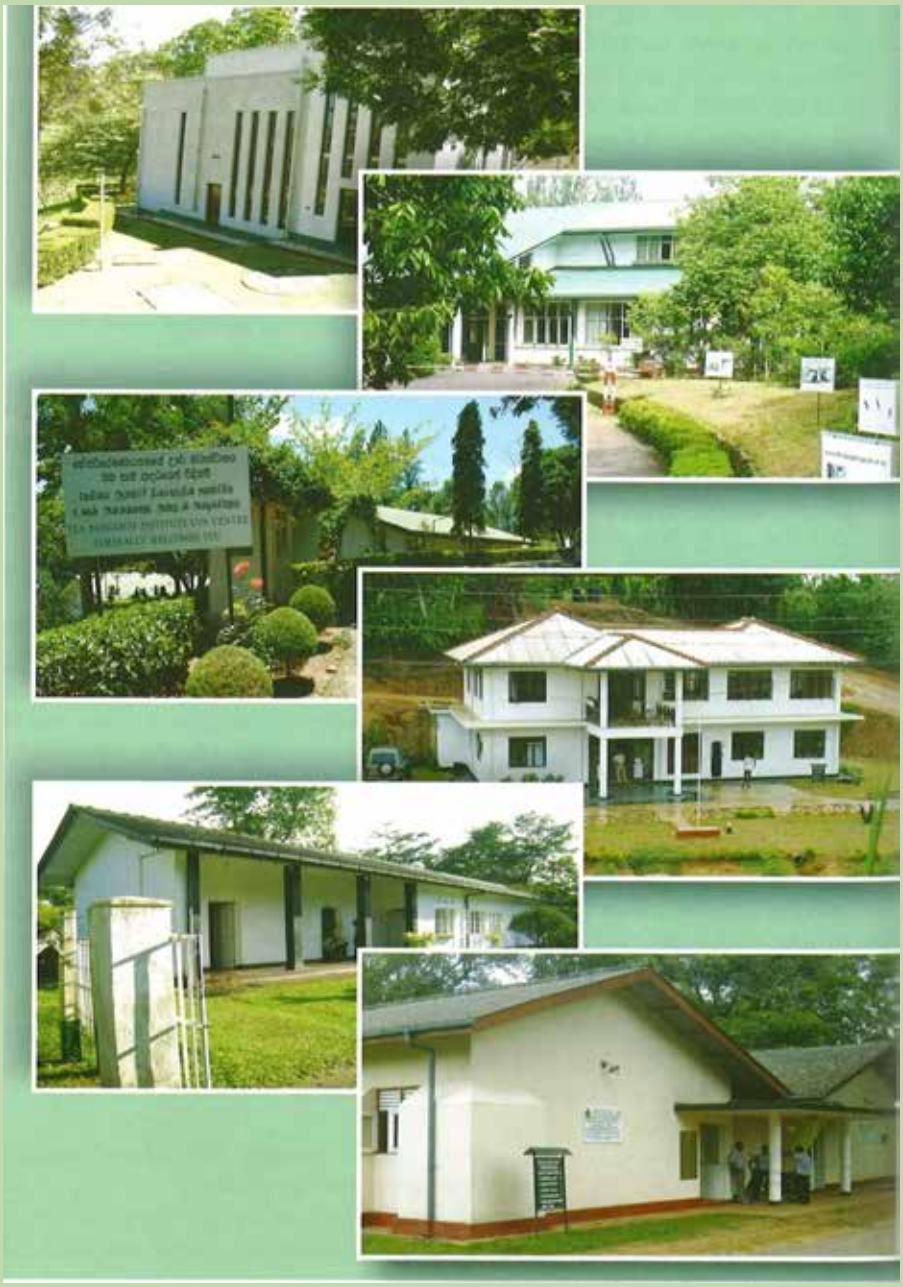
The institutional IP Policy was drafted and submitted to the Tea Research Board for approval. The IP Policy establishes the protocols applicable to all IP related rights arising from the research carried out at the Institute and it describes the requirements for the effective management, protection, and commercialization of intellectual property of the Institute.

In view of strengthening the knowledge and enhancing competencies of the staff in relation to Intellectual Property aspects, officers from TTO along with other scientists participated in the following study courses:

1. Certificate course in Intellectual Property Law conducted by the Bar Association of Sri Lanka
2. Certificate course in IP Studies conducted by the Osaka Institute of Technology, Japan organized by WIPO

Furthermore, a separate web page dedicated to the Technology Transfer Office was created in the TRI Official website to conveniently showcase available technologies and all related information.

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

All staff of the TRI Low Country Research, Advisory and Extension Centre (LCRAEC) was vaccinated against Covid-19 on 15th and 21st July and 21st August, 2021. Prof Ben Basnayake visited St. Joachim factory and worked with staff of the Technology Division for producing biochar using the drier furnace. IFAD mission visited TRI Low-country Center on December 15, 2021 for progress evaluation of the STaRR project.

Some officers from Head office, Talawakelle and Low-country Center went through Covid-19 quarantine at the hostel.

Staff movement

Mr S S Sunil, Driver retired from the services of TRI with effect from June 18, 2021. Mr K A Karunatilaka and Mr T Rajendran (General Workers) also retired from the TRI service with effect from May 22 and June 19, 2021 respectively. Mr J M R K Bandara (Electrician) was transferred to TRI Mid-Country Center and in his place, Mr S H P Dayaratne (Engineering Assistant-Electrical) was transferred from head office, to TRI Low-country Center with immediate effect in October 2021. Ms B Jananey, Technical Officer, Entomology Division and Mr Malith Maduranga, General Worker were transferred from TRI Talawakelle to Low-country Center with effect from February 17 and March 10, 2021 respectively.

Research, Advisory and extension activities

Agronomy, Plant Breeding, Entomology and Process Technology Divisions continued their field and laboratory experiments. Details of the experiments are given under the respective research projects. Although, research, advisory and extension activities were disturbed by the Covid-19 pandemic and lock down situation in the country, staff of the Center continued most of the activities using ICTs and following health guidelines.

The Advisory and Extension Officers have done 28 Advisory and extension visits and 7 training programmes following health guidelines. The advisory and extension staff also monitored progress of adaptive trials in the region and visited 17 farmer centered bio-organic trials. They have entertained more than 152 visitors to the Center. Staff of Process Technology Division provided solutions for tea manufacture and machinery related problems by visiting 39 tea factories and also 26 factories received advices through telephone conversations. The Division also conducted a training programme for estate Managers and Factory Officers of Kahawatte Plantation. Staff of Agronomy Division conducted a field demonstration and training on the use of selective tea harvesters at Bio tea garden, Idalgasheenna.

Several awareness programme-cum-discussions were held for the tea smallholders of Rawanakande, Wathukarakande, Udakande and Thorawelkande with special reference to bush debilitation due to nematode infestation. Staff of Advisory and Extension Division and Nematology Division analyzed soil and root samples from 56 holdings in this region and found that the majority of the sampled lands (>90%) have nematode infestation. In addition, tea bushes have been debilitated due to shot-hole borer damage and canker. Dr M A Wijeratne participated in two "Subarathi" radio programmes broadcasted on 16th October and 6th November 2021. He also addressed Area Scientific Conference of the Karnataka Planter's Association, India on October 5, 2021 on Climate change impacts on tea and adaptation strategies *via* virtual plat form. .

Analytical and other services

Staff attached to the STaRR project and Agronomy Division has analyzed more than 1400 soil samples from smallholdings in Ratnapura, Matara and Galle Districts and provided Soil Quality Index (SQI) reports. Entomology and Nematology Division has analysed 317 samples for nematodes. The soil analytical laboratory of SPND has analysed 1551 soil samples, 160 chemical fertilizer samples and 82 organic manure/bio-fertilizer samples during the year. Process Technology Division has undertaken moisture meter calibration tests and miniature manufacturing of tea samples from experiments.

Human resource development/ Training

Senior Advisory Officer, Mr K G J P Mahindapala continued his postgraduate study programme in PGIA, Peradeniya.

Miscellaneous activities

A workshop-cum-field demonstration on mechanization/automation of field and factory operations was held at TRI LCRC on January 22 for the members of IESL. Rs 35 million was approved by the Treasury for a three year project proposal prepared by the Agronomy Division on Development and introduction of a motorized selective tea harvester suitable for tea lands in Sri Lanka (2021-2023). Several workshops-cum-field demonstrations and virtual meetings were held at the Center to educate applicants of the special project on appropriate mechanization of harvesting. The prototypes developed by the selected applicants were evaluated by the project advisory and monitoring committee chaired by Dr M A Wijeratne. Special Treasury fund of Rs 50 mn was allocated to the Process Technology Division to develop St. Joachim tea factory as an experimental process technology development factory.

A meeting to discuss the progress of STaRR project was held with the participation of STaRR officials at TRI LCRC on 29th September 2021. Senior staff of the Center participated in in-house TECs appointed for procuring of laboratory equipment, tea factory machineries and general goods and services and also for procurement for other tea related organizations. With the financial assistance of STaRR project, Agronomy Division maintained 2ha block of CO3 grass planted on the St. Joachim Estate and issued cuttings to the smallholders/beneficiaries of STaRR project.

Plant Breeding Division has completed planting of mother bushes of new TRI cultivars (TRI 5000 and 4000 series) in 2.3 ha of St. Joachim estate and undertaken land preparation of 10 new seed gardens in the low-country region. Seven hectares of mother bushes of new cultivars have also been established in collaboration with Advisory and Extension Division, TSHDA and corporate sector estates. In addition, they have issued improved seeds and planting materials of new cultivars for establishing demonstration blocks and mother bushes in corporate sector estates and on smallholdings.

Dr M A Wijeratne continued his duties as Head, Agronomy Division, TRI in addition to those of the Head of the Center. Being the Convener/Secretary of CCR, he also convened four CCR meetings in 2021 in consultation with the Chairman, TRB and the Director, TRI. Representing the TRI, Dr M A Wijeratne attended the District Co-ordination Committee (DCC) meetings organized by the District Secretariat, Ratnapura. Being a member of the expert committee, Dr M A Wijeratne shared his expertise for revising the National Land Use Policy in Sri Lanka.

Infrastructure developments

Buildings and lay-out

Internal and External colour washing of Bungalows No. B7 and C14 were attended. Swing, badminton court and other recreation items of the Sport club were painted. Repairs to roof, gutters, down pipes, ceiling and valance board of B1 and C8 bungalows, roof, gutters and ceiling of Plant Breeding Field Office damaged due to a fallen tree and minor repairs of roof and cupboards of library were completed. New set of bathroom fittings was fixed to room No 4 of the guesthouse. The Buddhist Shrine of the Center was repaired and painted. Repairs to TRI LCRC Sports club building, ceiling of C7 quarters and roof of the stores for disposable items were attended. Termite infested wall and the display board with TRI publications fixed at the office entrance were repaired. Due to termite attack, number of books kept in the display board was completely damaged. A new water supply line was provided to the Entomology laboratory. A new security hut was fabricated and established near St. Joachim factory for providing security to TRI staff quarters.

Under the government's special road development programme, asphalt carpet laying of access road to the office, circuit bungalow and sport club/staff quarters was completed under the supervision of Road Development Authority, Ratnapura. In addition, internal roads of the Low-country Regional Center were also repaired using tar mixture prepared at the Center. Other routine repairs, cleaning and maintenance work of the TRI LCRC buildings and lay-out were satisfactorily attended.

Electrical maintenance

Electrical repairs and maintenance of Agronomy, Entomology, Technology and Plant Breeding Divisions, staff quarters B1, B2, B4, C 1, C4, C18, D 1, D3, D5 and D 6, guesthouse, hostel, security mess and other TRI buildings were satisfactorily attended. Three batteries and PC card of PABX machine were replaced repairs to telephone connections were also satisfactorily done. Batteries of the Seminar hall generator were also replaced. Two unserviceable Air Conditioners in Lecture room were replaced with new ones and other Air Conditioners were serviced. In addition, four new ACs were fixed for the seminar hall and one for the Chairman's room in the guesthouse. Repairs to Buddhist Shrine's electrical fittings were attended before painting.

Services of the Electrician were rendered for routine electrical repairs of St. Joachim factory, electricity generator and staff quarters. Electrician of the Center also attended electricity supply-related work of the new SQI laboratory at Walahanduwa. In addition, fixing of electrical components and electricity supply for the newly installed Colour Sorter of St. Joachim factory and supply of electricity connection to St. Joachim estate's compost bay were done.

Transport

General maintenance, running repairs and servicing of the vehicles of the Low-country Center were carried out satisfactorily.

Security service

The Golden Heart Security Service has provided their services satisfactorily until September 2021. However, number of guards on duty was less than the agreement on some days. With effect from 1st October, 2021, Ms J and T Security and Investigation Services took over the security service of the Center.

Weather

A total rainfall of 4792.5 mm was recorded during the year under reference. It was 1183.7mm more than the last year and also higher than that of the decennial mean *i.e*. 3808.8mm. The total number of wet days was 194. The month of February recorded less rainfall (*i.e.* 41.8mm) than that of the decennial mean. In contrary, January, March, May, June, July and November (six months) received heavy rainfall quantities that are higher than their respective decennial means. Although there was no marked deviation in the pattern of variation at the beginning of the year, mean temperature in December was about 1.2 ^{o}C warmer than that of the decennial mean and in contrast, the opposite was true for the month of November. Further, February and September recorded higher temperatures than the decennial means.

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

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

General

The TRI Mid-Country Research Advisory and Extension Centre, Hantane, Kandy is established for implementing the research, advisory and extension programme of the Tea Research Institute for mid elevation tea plantations located in Kandy, Matale Districts and some part of Nuwara Eliya District. This center serves for 37 Government Sector Estates, 23 Regional Plantation Company sector estates, about 250 medium scale estates and about 33000 smallholders. This center is extending its research and extension activities under the disciplines of Soils and Plant Nutrition, Agronomy, Entomology and Nematology along with Advisory Extension Division. A unit of Agricultural Economics is also established at the center. A tea field and a nursery are also maintained at the center for issuing planting materials, conducting research experiments, demonstrations and training purposes. The center had planned many research and extension programmes for its stakeholders throughout the year 2020. However, the annual programme was affected by the situation encountered due to Covid-19 after the first quarter.

Table 1. Land utilization of the centre - 2021

Land Use Pattern	Extent (ha)
Seedling tea	2.00
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	1.00
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) Mrs. B K S Herath, Account Clerk retired from the TRI service with effect from 28th February 2021
2) Mr.J M R K Bandara, Electrician was transferred to the Mid-Country Research Advisory and Extension centre, from Low-Country Research Advisory and Extension Centre, with effect from 03rd November 2021.
3) Ms. H M C G Pilapitiya, Research Officer was on study leave with effect from 19th September 2018.

Advisory and Extension Programmes

The center conducted several awareness programmes on different themes for tea growers of corporate and smallholding sectors and higher education students mainly in the first quarter. Few Training programmes on compost preparation and application was conducted by the Advisory and Extension Division in collaboration with Sri Lanka Tea Board. Special nursery training programmes were conducted at the centre for executives and field staff in estates of Elkaduwa Plantations Limited and State Plantation Corporation. The Advisory Officer involved in training programs and made presentations for ten programmes on Mechanization conducted at Rathnasiri Wickramanayake Training Centre, organized by TSHDA for selected group of young entrepreneurs from tea smallholders. In addition, another few training programmes specially for small holders were conducted with restricted numbers of participants under Covid-19 prevention guidelines.

The Short Message Service (SMS) gateway of the TRI for educating the tea growers, was continued and technical content editing of *Govimithuru* Mobile Voice message service was also attended by the divisional staff. The MOU between the TRI and Dialog Axiata company on sharing advisory and technical content in order to disseminate electronically, was signed and a function was held for exchanging of documents of the MOU on December 9th, 2021at the centre. The TRI Call Centre (TRI Technical Information and Advisory Service) was established in the Centre in first quarter of the year and it was in operation for public from June 2021. The staff of the division involved in site selection and data collection of Farmer Centered Organic Fertilizer Trials initiated by the TSHDA. The staff of the Division also involved in Establishment of Mechanized Tea Gardens Demonstration Project of the Tea Board and the Farmer Field School programme of FAO/RDAL projects.

A demonstration plot of 0.7ac was established in the centre for demonstrating the effect of burring of pruning under the project of GL 386.

All the above programmes were coordinated and conducted by the Advisory and Extension staff with the assistance of respective research staff while attending to many routine services like advisory visits to estates and small holdings of the region on cultivation issues.

Agronomy Division

A new trial was started under project A 24.1 to screen new post emergent herbicide, Avenger AG Burndown LC d-Limomene fatty acid (55% w/w EC) in Nayapana estate. Rehabilitation grasses testing trial at the centre was continued and lopping weights and soil parameters were recorded. These particular blocks were planted with TRI 4042 cultivar.

Evaluation of growth performances of new shade tree species was carried out at Elkaduwa Estate under A34.2. Under the shade tree experiment at Elkaduwa Estate, Elkaduwa, new shade tree varieties *Derris microphylla , Derris robusta,* and *Cassia nodosa* were planted.

Further, the recording of metrological observatory data at the center was carried out by the Divisional staff.

Entomology/Nematology Division

For screening lines for resistance/tolerance to the root lesion and burrowing nematodes for Mid-Country region, six accessions and four cultivars were put out against *Radopholus similis* at the centre. CO3, *Packchong* and *Lomendra* grasses were tested for screening new grass species against *Radopholus similis.*

Twenty-two soil and root samples of tea growers and 26 experimental samples were tested for nematodes in the year. In addition, 62 soil and root samples were also tested for the STaRR project.

Under the project D/Ento - spray volume trials for nursery plants, following chemical and plant protections were Tested with Lime / Sulpher and Fipronil 50EC.

Soils and Plant Nutrition Division

The experiments, conducted under Project A 15.3 on development of methods for formulation of bio-organic and mineral or compound fertilizers suitable for tea at Elkaduwa Estate, Elkaduwa, Rathwatte Estate, Ukuwela, Midland Estate, Rattota, New Peacock Estate, ussellawa and Loolecondera Estate, Hewaheta were terminated. A new 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. Isolation, purification and maintenance of N_2 fixing and phosphate solubilizing bacteria from the collected low-country soil samples were continued.

Trials were continued to measure the pH buffering activity of different soil series in Opalgalla Estate, Panvilla and Craighead Estate Dolosbage. A trial to investigate the use of different micronutrients was continued at Werapitya Private Estate.

Infrastructure Development

Renovation work of the laboratory and the office roof was started after completing the procurement procedures.

Colour washing and necessary maintenance work of quarters, office buildings and repairs of vehicle fleet were also attended. Repair work of roads which was damaged due to heavy rains, was started. Under G L340 project on Mother Bush Establishment of TRI 5000 series cultivars, 0.5 ha block was planted with TRI 5000 series cultivar and 0.1 ha was planted with TRI 3000 and TRI4000 series cultivars.

Miscellaneous Activities

Mr. K.R.W.B. Kahandawa, Advisory Officer/ OIC continued to represent the TRI in the expert group of Farmer Field Group Component of Rehabilitation of Degraded Agricultural Lands Project of FAO.

The Head of the Divisions meeting of the TRI was held at TRI Mid- Country Research Advisory and Extension centre on 23.04.2021 with the participation of Chairman of the TRB, Director of TRI and all the Heads of the Divisions and OICs of TRI Regional Research Advisory and Extension centres.

Crop

The Green leaf (kg) harvested during the year 2021 is given in Table 2.

Table 2. Crop - Green leaf harvested (kg) - 2021

Month	Crop harvested / sold (kg)	Rate (Rs) per kg	Income received (Rs)
January	1209	84.00	101,556.00
February	1126	84.00	94,584.00
March	1204	86.03	103,580.12
April	1731	77.00	133,287.00
May	2001	77.00	154,077.00
June	1768	70.00	123,760.00
July	1277	70.00	89,390.00
August	1132	70.00	79,240.00
September	1108	68.00	75,344.00
October	1205	72.00	86,760.00
November	740	74.28	54,967.20
December	724	74.00	53,576.00
Total	15,225		1,150,121.32

Income

Income generated by the center and visitors to the center during the year are given in Table 3 and Table 4 respectively.

Table 3. Income of the centre - 2021

Description		Income (Rs.)
Income received from sale of VP cuttings (499,250**)**	-	748,875.00
Income received from sale of VP Plants (20,842**)**	-	625,260.00
Income received from sale of Green Leaf (15,225 kg)	-	1,150,121.32
Guest House accommodation charges (Rs.)	-	19,150.00
Income received from Soil pH and Fertilizer Testing Charges (Rs.)	-	131,845.00
Sale of TRI Publication (Rs.)	-	65,235.00
Miscellaneous (Rs.)	-	25,000.00
Total	-	2,765,486.32

Visitors to the Station

Table 4. Visitors to the MCRAEC - 2021

Category	No. of visitors
Tea Growers	452
Students (higher education)	27
General visitors	28
Total	507

TRI ADVISORY AND EXTENSION CENTRE - PASSARA

A Abeysooriya
B Sc Agric (Peradeniya, Sri Lanka)
Officer in Charge

General

The Uva Advisory and Extension Center was the first regional center established by the TRI in 1931 to undertake research on prevalence of the Nettle Grubs infestation in the region. At present, it provides services for about 30,000 ha in 62 RPC estates, 60 private estates, and 29,000 tea 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 station is given in Table 01

Table 1. Land utilization of the center - 2021

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

No staff transfers / retirements during the year 2021.

Advisory and Extension Programmes / Training

In 2021, 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 servicers to both cooperate and smallholdings by conducting advisory and extension visits, training programs, and seminars.

One Regional Technical and Extension Forum (RTEF) meeting was held for the officials of TSHDA. The subjects presented by the research and extension staff in the meetings were, “Liquid fertilizer use for Tea cultivation” and “Use of Velam (Fluopyram) as a nematicide in tea cultivation”.

Different programs conducted for the Uva region include a seminar on "Sustainable tea cultivation" for the bought leaf collectors of the Uva region in January and a field day for the field staff of Baganila Estate on "Tea nursery management". Also, four field programs were conducted for the estate executives and field staff of Madulsima and Hapugasthenna Plantations on "Compost preparation and soil fertility management". Two training programs were held for the executives and field staff of Balangoda Plantations (Uva) on "Forking and Tea disease management". Another two training programs were conducted by the center for the estate managers of Madulsima plantations on "Integrated pest management (IPM), land selection and new clearing management". Two training programs on plucking of tea were conducted for the field staff of Balangoda and Madulsima plantations in the Uva region with the support of Advisory and Extension Division, Talawakelle, and one training program on "safe use of pesticide" was conducted for the sprayer gangs of Maskeliya plantations.

TOT program on "Compost preparation" was conducted for the TSHDA officials and two method demonstrations on Vermicompost preparation were conducted via online flatform for the tea smallholders of the Uva region.

Table 2. Summary of the advisory and extension activities - 2021

Description		Number of Activities
Advisory visits made to estates and smallholdings in Uva	-	83
Advisory Letters issued	-	81
Seminars/ Field days/ Training programs	-	16
Regional seminars held in the area	-	01
Meetings / seminars attended	-	28
Soil samples tested for pH	-	1,402
Soil samples tested for organic carbon content	-	927
VP cuttings issued	-	652,850
VP plants sold	-	5,925
No. of a publication sold	-	40
Commercial nursery inspections	-	118

Human Resource Development Programs / Training

A Abeysooriya, Officer – In – Charge / Extension Officer, participated online seminar on "Modern agriculture development and agriculture park construction in Sri Lanka" organized by the International Exchange Center Yangling Agricultural Industries Demonstration Zone, Shaanxi Province, China.

Research Programmes/ Trials/Adaptive Trials

Following field trials were continued at the center with the supervision of relevant divisions from the head office

- Up keep of Germplasm in Field No. 03
- Up keep of PPPB UVP 11 trial Field No. 02

- Up keep of PPPB UVP 12 and UVP 13 trials in Field No. 03
- Up keep of the root study trial of TRI 5000 series cultivars by Physiology Division in Field No. 03
- Up keep of PPPB UVP 14 trial in Field No. 02
- Up keep of Polyclonal seed garden at the field no. 04
- Up keep of Rehabilitation grass trial by Agronomy Division in Field No. 05
- Up keep of trial on evaluation of tea cultivars amenable for mechanical harvesting conducted by Agronomy Division in Field No. 2 evaluation.
- Initiation of safe duplication of core collection of germplasm in field no. 05

Participatory observations were made on TRI 5000 series commercial level adaptive trials established by the Plant Breeding Division at Haputale Estate, Craige Estate, Glenalpine Estate and smallholder tea land in Kandegedara. 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 in the region with the collaboration of TSHDA.

ADB mother bush project

Out of the targeted 400,000 number of cuttings, uva extension center was able to issue 652,850 cuttings from the Mother Bush site at the center.

Infrastructure development and maintenance

- Mother bushes (TRI 5000 series mother bush project) were planted in 1.5-hectare during the year 2021.
- Vermicompost and Vermi wash units were constructed.

Region specific issues/Miscellaneous activities

- Officer-In-Charge/EO and Extension officer have collected leaf and soils samples for the analysis from farmer-centered organic trials in the region.
- Officer-In-Charge/EO and Extension officer have inspected 118 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 tea growers in the Uva region.
- Officer-In-Charge has participated in Planters Association (Uva) meetings.

Crop and Income

Crop and income generated from the center is given in Table 3 and income generated from other sources is given in Table 4.

Table 3. Crop and income - 2021

Month	Green Leaf (Kg)	Price	Amount (Rs.)
January	1761	78.67	138,537.87
February	1699	79.37	134,849.63
March	3409	81.92	279,265.28
April	3963	81.17	321,676.71
May	3346	77.41	259,013.86
June	3177	68.2	216,671.40
July	2115	68.35	144,560.25
August	2267	66.18	150,030.06
September	1904	64.14	122,122.56
October	1738	67.2	116,793.60
November	2091	72.9	152,433.90
December	1463	80.93	118,400.59
Total	28,933		2,154,355.71

Income

Table 4. Income earned during the year - 2021

Description		Income (Rs.)
Sale of the Green leaf (28,933 kg)	-	2,154,355.71
Sale of VP cuttings	-	991,275.00
Sale of VP plants	-	177,750.00
Soil analytical charges	-	375,320.00
Sale of publications	-	13,505.00
Guesthouse accommodation charges	-	14,150.00
Sale of firewood	-	5,400.00
Total income	-	3,731,755.71

Visitors to the station

Details of visitors to the center are given in Table 5.

Table 5. Visitors to the center - 2021

Category		No. of Visitors
RPC personnel	-	75
Smallholders	-	180
Others	-	120
Students	-	28
TRI Officers	-	65
Total	-	468

TRI ADVISORY AND EXTENSION CENTRE - KOTTAWA

P D De Alwis
B Sc Agric (Sp) Hons. (Ruhuna, Sri Lanka)
Extension Officer / Officer-in-Charge

General

The TRI Galle Advisory and 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 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 was as follows (Table 1).

Table 1. Land utilization patter of the centre - 2021

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
CO - 3 (new rehabilitation grass spp.)	0.40
Tea Seed Garden	0.83
Unproductive areas for rehabilitation	1.00
Coconut and other crops	1.52
Marshy Land	1.22
Forestry	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. Necessary documents were submitted to the Divisional secretariat, Yakkalamulla. Accordingly, total land extent was reduced from 31.73ha to 28.96 ha.

In consultation with the heads of Divisions at TRI head office, the extension centre carried out research and extension activities for the corporate, proprietary estates and small holdings in the region.

Adequate numbers of training and awareness programmes could not be organized due to Covid-19 pandemic situation. Requests came from the growers for those activities were also very few.

The important extension activities carried out in 2021 by the advisory staff of the centre are mentioned below:

- A seminar was coordinated on Soil Quality Index (SQI) and new rehabilitation grass, CO-03, under the STaRR project in the region. The TOT programme was conducted by TRI Agronomy officials for TSHDA officials.
- A seminar was conducted on soil pH sampling and soil fertility management for tea small holders at proposed model plantation village, Kadurugashena in collaboration with the Department of Export Agriculture officials.
- An awareness programme was conducted on tea cultivation for small holders at proposed model plantation village, Kadurugashena.
- A ToT program was conducted on Agro-chemical usage for the officials of Agstar PLC.
- Awareness programmes were conducted on plot demarcation, sampling and fertilizer application for small holders whom lands were selected for Bio-fertilizer trials.
- Training/ awareness programmes were conducted on mechanical tipping in the lands under the Model Tea Farm project of Sri Lanka Tea Board.
- Training and awareness programme on compost production and operation of new pH meters for TSHDA officials (TOT) in Galle and Matara districts were conducted in collaboration with SPND officials at Walahanduwa.
- A training program was conducted on compost production, for a proprietary estate at Elpitiya.

Advisory and Extension activities

Table 2. Summary of Advisory and Extension activities - 2021

Item	Number
Visitors to the centre (Estates/Small holders/Students/Foreigners/Others)	548
Advisory correspondence with Estate/Small holders	149
Advisory Visits (on call and routine) to Corporate sector and Small holding sector	67
Training programmes/ Seminars/Group discussions/Field Days/ Demonstrations	14
Educational/Familiarization and Meetings	21
Issue of Publications/Leaflets/Pamphlets (free issues were not included)	88
V.P. Cuttings sold	647,625
V.P. Plants sold	6,993
Soil Samples tested for pH	107
Visits/Involvements in Experiments (Adaptive Trials)	03

Staff movements

Mr.P K Jayawickrama, Experimental Officer was transferred to the Soils and Plant Nutrition Laboratory Complex, Walahanduwa due to exigencies of services with effect from 3rd February 2021.

Research trials

Following trials have been carried out by the respective Research Divisions in collaboration with the centre.

Plant Breeding Division:

TRI 5000 series observation/ multiplication plots in Field No. 02

Four potential TRI 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 other plots are in plucking.

Agronomy Division

Evaluation of the performance of different grass species for soil rehabilitation in Field No.02 was terminated.

Mother Bush Project

A total of 647,625 cuttings belong to TRI 4000 series cultivars were issued from approximately 1.4 ha of mother bush area. Some plucking fields have been converted into mother bushes to cater for high demand of shoots. This was one of the major services offered by the Centre to the growers in the region for popularizing TRI 4000 series cultivars tolerant to regional specific pests, diseases and drought conditions.

Moreover, 43,650 nursery plants were raised in the VP tea nursery. While 6,993 plants were sold to the tea growers and approximately 23,987 plants were used for replanting and infilling programme of the centre.

Visitors

The number of visitors received by the centre was 548 and its breakdown given in Table 3.

Table 3. Visitors to the centre - 2021

Category	Number
Corporate Sector, Private Estates and Small Holders	495
University/Diploma Students and Others	53
Total	548

Infrastructure Developments and Maintenance

- Reconstruction of the access road from the main entrance to the guest house was in progress.
- Interlocking of guest house portico was completed.
- Construction of a retaining wall for labour cottage No. 19 was completed.

Field Development Activities

- Approximately 22,000 plants of TRI 5000 series cultivars were established in Filed No.01, 02,03 and 05 as mother bushes (vote: GL-340)
- A tube well for sprinkler irrigation system was established for irrigating mother bush new clearings (2 ha).
- Construction of leader drains in field No. 4 was completed.
- Land preparation was completed in field No. 6 to set up a new nursery for raising 100,000 plants to be distributed under the subsidy scheme of Sri Lanka Tea Board.
- 0.5ha land preparation was completed for the establishment of tea seed garden (vote: GL-390)
- Under the special project 2021, vote: GL 386, burying of pruning for improving soil organic matter as a climate change mitigation measure –was completed in Field No. 06 (01Acre)
- Compost production unit was established in field No. 01. A chopping machine for compost production was also received.
- Approximately 1987 plants were infilled in the field No. 01, 02.

Special Events

- Attended the ceremonies on opening of the composting centre at TSHDA and releasing of VP nursery plants under 500 nursery project at Walahanduwa and Karapitiya. The honorable minister of Plantation was the chief guest in the event. The programmes were organized by TSHDA in July.
- An observational visit was made to "Model Plantation Village"- Kadurugashena, with the Director TRI. The Secretary to the Ministry of Plantation was the chief guest and all the officials of the higher positions in related institutes, departments and authorities, participated in the event.
- Reconstruction of the access road from the main entrance to the guest house was undertaken and approximately 92% of the project was completed.

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 - 2021

Month	Green Leaf (kg)	Price (Rs)	Amount (Rs)
January	2,547.5	108.00	275,130.00
February	1,708.5	108.00	184,518.00
March	2,218	110.00	243,980.00
April	1,419	102.29	145,150.93
May	1,818	102.00	185,436.00
June	1,669	102.00	170,238.00
July	1,871.5	100.60	188,272.90
August	1,628.5	104.00	169,364.00
September	2,031	103.00	209,193.00
October	2,113	102.00	215,526.00
November	2,010	107.00	215,070.00
December	1,780	102.00	181,560.00
Total	22,814		2,383,438.83

Income

The income of the Centre with its activities and the income breakdown given in Table 5.

Table 5. Income earned during the year 2021

Activity	Income (Rs)
Sale of Green leaf	2,383,438.83
Sale of VP Cuttings	971,437.50
Sale of VP Plants	215,790.00
Soil Analytical Charges	10,355.00
Sale of Publications	15,740.00
Guest House accommodation charges	6,950.00
Miscellaneous income	12,500.00
Total income	3,616,211.33

Annual Weather

The annual precipitation was 3648.4 mm and it was 19.6% increase when compared with the 10 years average (from 2011 to 2020). But the monthly rainfall distribution was uneven. The mean minimum temperature was 23.2 ^{0}C and there was no clear change when compare with the mean minimum temperature during past ten years. The mean maximum temperature was 31.1 ^{0}C and it was 0.48% decrease when compared with the 10 years average. There was no clear change with the mean sunshine hours when compared with the last 10 years average.

TRI ADVISORY AND EXTENSION CENTRE - DENIYAYA

C E Munasinghe
B.Sc. Agric. (Wayamba, Sri Lanka) M Phill (University of Peradeniya)
Head

General

The TRI Deniyaya Advisory and Extension Centre, Ratnapura Road, Deniyaya is primarily an Advisory and Extension center occupying a total of 2.0 ha (5.0 acres) in extent and equipped with a small-scale laboratory for soil pH and Carbon analysis. The land use pattern of the Centre is given in Table 1.

Table 1. Land use pattern of the center - 2021

Land use pattern	Extent (ha)
Mature tea	0.12
Experimental trials	0.16
New clearing (TRI 3000/4000 series)	0.40
New clearing (TRI 5000 series mother bushes)	0.40
Buildings, Gardens, Roads, Nursery, *etc.*,	0.92
Total extent	2.00

TRI Center, in consultation with the Heads of Divisions at the Head office, conduct 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.

Human Resource of the Center

1. Staff as at 31 December 2021

- Mr. C E Munasinghe - Advisory Officer / Head - Grade II
  B.Sc. Agric. (Wayamba, Sri Lanka),
  M Phil (University of Peradeniya, Sri Lanka)
- Ms. H B Tharangika - Extension Officer - Grade III
  B.Sc. Food Production and Tec. Mgt.
  (University of Wayamba, Sri Lanka)
- Ms. W S T Wijesinghe - Management Assistant - Grade III
- Mr. M D Chandana - Driver - Grade V1

2. Labor force

Number of check-roll workers as at 31st December 2021 - 05

Advisory and Extension programs - 2021

1. Advisory and Extension Activities

Amidst the Covid-19 pandemic situation, The Center conducted following advisory / extension and stake holder interactive activities in the year 2021 (Table 2).

Table 2. Advisory and Extension Activities 2021

	Item		Number
1	Visitors to the station (*from Estates/Students/Foreigners/ Smallholders/Others)*		782
2	Correspondence (Advisory, Extension and Administrative)		539
3	Advisory and Extension visits (on call and routine) to corporate sector and small holder sector		93
4	Training programs/ Seminars/ Group Discussions /Field days/ Demonstrations/ Educational/ Familiarizations and Meetings		22
5	Issue of Publications / Leaflets / Pamphlets	Free issue	20
		On cash	19
6	Soil Samples tested for pH		372
7	Soil Samples tested for Carbon		01
8	Soil Samples handed over for testing for Nematodes		59
9	VP Cuttings issued		46,902
11	Commercial Nursery Inspections		50
12	Exhibitions / Mobile Services		01
13	Visits/Involvements in experiments (Adaptive/Research Trials and Mother Bush sites)		67
14	VP Plants issued		8460

2. Key Technology Dissemination/ Stakeholder Service/ Public Relation Activities

- The Head and the staff, in collaboration with STaRR project officers of Matara district conducted a series of field day programs on production and use of compost in tea lands for selected tea smallholder groups.
- The Head and the staff, in collaboration with SPND, TRI and TSHDA, Matara involved in maintaining seven (07) Farmer Centered Bio Fertilizer trials (trial designing, sampling, treatment application and monitoring) of Matara district.
- The Head and the staff conducted a series of field day programs on managing tea bush debilitation for the tea smallholders of Deniyaya, Kolawenigama and Kolonna tea inspector regions of Matara and Ratnapura districts.
- The Head attended "*Gama Samaga Pilisandarak*" program (ගම සමඟ පිළිසඳරක් වැඩසටහන - මාතර දිස්ත්‍රික්කය) chaired by His Excellency the President on 27th March 2021 in Derangala, Matara district.

- The Head participated in a series of online meetings (via Zoom) organized by the Low-Country Tea Planters Association and educated proprietary tea growers on seasonal issues on tea cultivation.
- The Head attended a special meeting organized by the District Secretariat, Matara and delivered a lecture on TRI guidelines on use of organic fertilizer for tea on 15th June 2021.
- The Head visited tea nurseries of Matara district initiated under the special tea nursery project of Sri Lanka Tea Bord and provided with necessary technical advices.
- The Head involved in establishing a model tea garden at Berubeula estate in Urubokka under the special project of the Ministry of Plantations on "Improving soil Carbon to Mitigate Effect of Climate Change on Tea".

1. Research trials

Following trials are being carried out in the region in collaboration with the respective Research Divisions.

- Entomology and Nematology Division
  Two (02) trials on screening of TRI 5000 series cultivars for Nematodes and Shot Hole Borer were initiated at the premises in collaboration with the Entomology and Nematology division.
- Plant Breeding Division
  i. TRI 5000 Series: Four LVP phase iii trials are being monitored at the premises and Indola, Kiruwanaganga and Deniyaya Estates.
  ii. Two improved seed gardens are being monitored at Kiruwanaganga Estate
  iii. One seedling evaluation trial is 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 is being monitored in Smallholder lands in Morawaka and Akuressa of Matara District in collaboration with the Plant Breeding Division, TRI and TSHDA.
- One Adaptive trial on foliar application for tea is in progress at Deniyaya Estate in collaboration with SPND.
- One adaptive trial on use of wood ash for tea at Kiruwanaganga Estate, in collaboration with SPND.
- Seven (07) Farmer Centered Bio Fertilizer trials established at tea smallholder lands of Matara district are being monitored in collaboration with Tea Smallholdings Development Authority, Matara.
- Two model tea lands demonstrating the TRI recommendations on management of tea bush debilitation problem were established in Pallegama and Beverley regions of Deniyaya and are successfully being monitored.

3. **TRI 5000 Series Mother Bush Project**
    - 3682 plants of Accession No. 84 and 23/5 of TRI 5000 series are being maintained successfully at TRI Deniyaya premises in collaboration with Mother Bush Coordinator and Plant Breeding Division, TRI.
    - 2035 plants of TRI 5000 series were raised at TRI Deniyaya nursery and delivered to TRI 5000 series mother bush sites earmarked in Kotapola and Eramudugoda of Matara district for planting.
    - The Center regularly inspected six (06) TRI 5000 series mother bush sites at Kiruwanaganga estate, Diyadawa, Kotapola, Eramudugoda, Alapaladeniya and Mawarala regions in Matara district in collaboration with Mother Bush Coordinator and Plant Breeding Division, TRI.

4. **Improved Seedling Project**
    - Three Isolated seed gardens established at Kiruwanaganga, Lankaberiya and Wilpita estates are being monitored in collaboration with Plant Breeding Division, TRI.
    - 1170 plants of TRI 2016, TRI 3055, TRI 2043, TRI 2027, S 106 and KP 204 cultivars were raised at the nursery for planting in isolated seed gardens in year 2022.

Constructions/ Infrastructure Developments and Maintenance

- Concreting the internal road to the "C" and "D" type quarters in the premises was successfully completed under the supervision of Engineering Division, TRI.
- A special project funded by the Ministry of Plantations on "Improving soil Carbon to Mitigate Effect of Climate Change on Tea" was initiated in a plot of land (0.6 acres) at the premises.
- In comply with the government policy on Green Agriculture, an organic fertilizer unit consisting of wormy composting unit, chopping machine and compost demonstration area was established at the premises with the purpose of educating tea growers of Matara district on the production and use of organic fertilizers in tea.

Special issues encountered in the region

Bush debilitation incidences were reported in few tea smallholder lands in Kiriweldola, Pallegama and Kolawenigama regions in Deniyaya. All the debilitated tea lands were inspected and major pest attacks, aging of tea bushes and poor adoption of Good Agricultural Practices were identified as major causes behind the bush debilitation. Followed by 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

Monthly harvested crop, price offered by the factory and the monthly income are given in Table 3.

Table 3. Crop and Income - 2021

Month	Green Leaf (kg)	Price (Rs)	Amount (Rs)
January	318	113.00	35,934.00
February	288	114.00	32,832.00
March	390	116.70	45,513.00
April	337	112.00	37,744.00
May	549	112.87	61,965.63
June	364	111.35	40,531.40
July	441	119.35	52,633.35
August	412	119.21	49,114.52
September	476	116.24	55,330.24
October	455	118.33	53,840.15
November	566	116.38	65,871.08
December	424	124.22	52,669.28
Total	5020		583,978.65

Total income of the center with its activities and the income component breakdown is given in Table 4.

Table 4. Annual Income of the Center - 2021

SN	Item	Quantity/No.	Income (Rs.)
1	Sales of Green Leaf	5020 kg	583,978.65
2	Sales of Publications	19	9,240.00
3	Sales of cuttings	46,902	46,088.00
4	Sales of plants	8460	253,800.00
5	Soil Analysis	373	35,595.00
6	Guest House accommodation	92	21,350.00
	Total Income		950,051.65

Visitors to the center

Number of visitors to the center in year 2021 is given in Table 5.

Table 5. Visitors to the center - 2021

Category	No. of visitors
Planters from RPC sector	07
Proprietary planters	41
Smallholders	305
Officers from other institutes	99
Students / School Children	80
Others	250
Total	782

Weather data 2021

The annual rainfall of year 2021 was recorded as 4452.2 mm which is approximately a rise of 21% compared to that of the previous year (3664.4 mm). The highest rainfall was recorded in May (808.5 mm) and the minimum was in August (203.2 mm). The number of annual wet days was 182 which is nearly a rise of 25% compared to the previous year (146 days). Accordingly, the rainfall and its distribution throughout the year was more favorable for the growth of tea than that of the previous year. Meanwhile the average temperature of the year was recorded around 26 ^{0}C.

Miscellaneous Activities

Special Presentations

- The Head delivered a presentation on the the Role of the TRI Advisory and Extension center, Deniyaya for a group of newly recruited SLAS trainee officers (November 2021).

TRI ADVISORY AND EXTENSION CENTRE MATUGAMA

Haran Jayaweera
MBA (Malaysia) CMI (UK) MCPM (Sri Lanka)
Officer-in-Charge

General

The TRI Kalutara Advisory and Extension Centre, Niwithigalakelle, Mathugama 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.

The Advisory and Extension Centre carried out a large number of field investigations in the low grown plantations situated in Kalutara, Gampaha, and Colombo Districts. The Advisory and 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 Smallholder Sector in the region. Tea productivity improvement through Good Agriculture Practices (GAPs) with special attention to Soil Rehabilitation, Soil Conservation, Shade Management, Pest and Disease Management, Mechanization, Weed Management, and proper harvesting of tea were the themes that received high priority.

The outbreak of Coronavirus disease (Covid-19) in 2021 was a significant impediment to the provision of services and development to stakeholders in the region. The island-wide lockdown from mid-May to mid-June and August to October severely affected many activities. Despite the fact that the Covid-19 pandemic has severely affected, the officer in charge and the staff have taken all possible necessary actions to provide advisory services to stakeholders in the region via traditional channels and direct messaging applications (WhatsApp).

Staff Movements

Mr. A A H Chinthaka, Management Assistant was transferred from the Administration Division, TRI, Talawakelle and assumed duties on November 1, 2021

Advisory and Extension Programs

Regional Technical and Extension Forum (RTEF)

Amidst the outbreak of the Covid-19 epidemic, One Regional, Technical and Extension Forum (RTEF) was held via online for the Smallholder sector of all tea growing regions with the participation of TRI, TSHDA, SLTB officials, and the members of Tea Development Societies. The subject discussed was "Preparation and establishment of tea fields in view of mechanizing field practices in the future"

Training Programs /Field days

- The staff of the Advisory and Extension Centre 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 Advisory and Extension Centre conducted plucking and mechanization training programs for the proprietary estates
- The Officer-in-Charge participated for the awareness programs conducted by TSHDA, SLTB and District Secretariat Office

Advisory and Extension Activities

Table 1. Advisory and extension activities - 2021

Description	No. of Activities
Advisory visits made to Corporate sector, Proprietary estates and Smallholding sector	137
Advisory correspondences	67
Training programs/Seminars/ Field days/ Group Discussions/ Crop clinics/ Demonstrations	4
Issue of publications/ leaflets/ pamphlets	12
Soil samples tested for pH	73
TRI 5000 series mother bush sites visits	13
Visits/Involvements in Experiments (Adaptive Trials)	35
Meetings Attended	36
Other visits	2
Total	379

Adaptive Trials and new initiatives

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, TRI and the TSHDA and progress was periodically monitored by the staff of the Centre.

Field Experiments

I. In collaboration with Agronomy Division, new trial on mechanical harvesting at Soyza Estate, Lihiniyawa was commenced.

II. Investigation on nematode attack of tea land in Mahakalupahana in collaboration with Entomology division Talawakelle and Ratnapura.

III. With the assistance of the project coordinator and the Head, Advisory and Extension Division, the Officer In-Charge has established a demonstration site at Rayigam estate with the main objective to demonstrate the benefits of burying of prunings, shade tree loppings, green manure, and compost to improve soil health as mitigation measures for to address climate change.

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 to tea growers is one of the most important services for the tea industry. With the help of the mother bush coordinator and plant Breeding Division, Officer In-charge has taken action to initiate a TRI 5000 series mother bush area and nursery at Vogan Estate
- 2900 tea plants of TRI 5000 series cultivars (12/11, 23/5 accessions) and TRI 4049 on 0.82 ha was planted to establish in mother bush block in RRI, Niwithigalakale premises, with the help of the Mother Bush project coordinator and the Plant Breeding Division, TRI.

Seed garden Project

- Two lands have been selected to establish seed gardens in Vogan Estate and Raigam Estate with the help of the Plant Breeding Division, TRI.

Special Events/ Meetings

- The Officer-in-Charge participated in District Agriculture Committee and District Development Committee meetings held at the District Secretariat Office, Kalutara
- The Officer-in-Charge participated in the Kalutara District Covid-19 control committee and organic fertilizer meetings.
- The Officer-in-charge has appointed as the chairman of tea development council of Kalutara, which was established by the Secretary of Ministry of Plantation.

Human Resource Development/Training

- Mr. H. Jayaweera, Officer in charge attended an online Training course on tea production technology and tea industry promotion for Sri Lanka on at 27 October to 15 November, 2021 organized by the Zhangzhou College of science and technology Fujian, China

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

Miscellaneous Activities

- The officer-in-charge and Extension officer of the center participated to establish and monitor Organic Fertilizer trial in Meegahathenna, which was initiated by the Tea Small Holding Authority
- The Organic Fertilizer demonstration unit was completed by the staff of the Centre to educate the stake holders and general public
- The Officer-in-Charge actively participated in the meeting at Ministry of Plantation

The Officer-in-Charge and Extension officer participated in the workshop on call center management and operation conducted by National Agriculture Information and Communication Centre (NAICC), Gannoruwa.

Income

Total income of the Centre with its activities and the income component breakdown is as follows. (Table 2)

Table 2. Income of the Centre - 2021

Activity	Income (Rs.)
Sale of Publication	4,715.00
Soil Analysis for pH	6,935.00
Suppliers registration fees	3,000.00
Sale of Tea Green leaf	1,150.00
Total	15,800.00

Visitors to the station

A Total of 90 personnel visited the Kalutara Advisory and Extension Centre (Table 3).

Table 3. Visitors to the Centre- 2021

Category of Visitors	No. of Visitors
Corporate Sector Estates	15
Small holders	65
University Students	2
Agriculture School Students	1
TRI Officers	7
Total	90

AWARDS, GRANTS, STUDY PROGRAMMES, PUBLICATIONS AND SPECIAL PRESENTATIONS

ADVISORY AND EXTENSION DIVISION

Study Programmes

Mr. K G J P Mahindapala, Senior Advisory Officer continued his 3-year postgraduate study (PhD) which was commenced on 26th March 2019 in PGIA, University of Peradeniya utilizing TRI funds with the research component titled "Developing a Model to Improve the Efficacy of Tea Grower Societies for Technology Transfer and Transform Farmer Behavior".

Mr. S P Rathnayake, Senior Advisory Officer continued his 3-year postgraduate study (PhD) which was commenced on 2nd July 2019 in PGIA, University of Peradeniya utilizing TRI funds with the research component titled "Private-Public Partnership (PPP): Intervention in Technology Dissemination, Input Facilitation and Marketing Raw Material (Green Leaf) of Tea Small Holders in Sri Lanka".

Mr. C J Liyanaarachchi, Advisory Officer continued his 3-year postgraduate study (PhD) in University of the Philippines, Los Banos, Laguna, Philippines which was commenced on 6th August 2018 utilizing SLCARP funds with the research component titled "Social Media Integration into Technology Dissemination System for Corporate Sector Tea Plantations in Sri Lanka".

Mr. T G N Mahinda, Senior Advisory Officer was granted full-time study leave for postgraduate program leading to PhD, for 3-year period with effect from 11th October 2021 in PGIA, University of Sabaragamuwa utilizing TRI funds with the research component titled "Adoption of Mechanization Technologies in Corporate Sector Tea Plantations in Sri Lanka".

Mr. A L R U Kumara, Advisory Officer was granted full -time study leave (PhD in Sekolah Pengajian Siswazah School of Graduate Studies, University of Putra, Malaysia with effect from 30th November utilizing SLCARP funds with the research component titled "Community Development Agribusiness Based Extension Model for the Sustainability of Medium Scale Tea Estates in Sri Lanka".

Mr. K R W B Kahandawa, Mr. C E Munasinghe, Mr. H Jayaweera, Mr. G S Pradeep, Mr. S P A P K Jayarathne, Mr. P D De Alwis, attended online training course on "Tea Production Technology and Promotion of Tea Industry for Sri Lanka" organized by Zhangzhou College of Science and Technology, Fujian, China.

Mr. A Abeysooriya, Extension Officer attended an online seminar on "Modern Agriculture Development and Agriculture Park Construction in Sri Lanka" organized by the International Exchange Center Yangling Agricultural Industries Demonstration Zone, Shaanxi Province, China.

Dr. V S Sidhakaran, Head Advisory and Extension Division and Mrs. M A H Nishanthi, Advisory Officer attended an online workshop on "How to Minimize Weaknesses and Delays of Technical Evaluation Committees and Procurement Committees" organized by National Institute of Plantation Management, Sri Lanka.

Publications

Sidhakaran V S, Wijerathne M A, Shyamalie H W, Pradeep G S, Lakmali K G, Muralithasan R. 2021. "Evidence based analysis of National Tea Production Decline Since 2013".

Miscellaneous Activities

Dr. V S Sidhakaran, Head Advisory and Extension Division continued to serve as the Convenor / Secretary of Consultative Committee on Estates forum.

Dr. V S Sidhakaran, Head Advisory and Extension Division continued to be the coordinator of Research-Extension Linkage Forum.

Mr. A L R U Kumara, Advisory Officer continued to serve as the coordinator of ADB Mother Bush project and the coordinator for TRI 5000 series mother bush project up to 30th November 2021.

Mr. K R W B Kahandawa, Advisory Officer continued to serve as the Convenor / Secretary of Advisory and Extension forum.

Mrs. M A H Nishanthi, Advisory Officer continued to serve as the coordinator for the "*Tae Thathu*" newsletter of the TRI.

Mrs. M A H Nishanthi, Advisory Officer coordinated and assisted in updating the "Field Guide Book" of the TRI.

Mr. S P A P K Jayarathne, Extension Officer continued to serve as the coordinator of the Extension and Experimental forum for the Small Holder Sector.

AGRICULTURAL ECONOMICS DIVISION

Study Programmes

H M C G Pilapitiya, Research Officer continued her PhD program at Saga University, Japan on "Impact of Product Innovation and Diversification towards Firm Performance and Growth in Tea Industry with special reference to Sri Lanka and Japan" (from October, 2018 - March, 2022)

Publications

Shyamalie H W, Nadeeshani K W N and Rathnayake R M A T. 2021. Exploring Adoption of the Range Alternative Worker Deployment Models by the Tea Sector in Sri Lanka. Submitted for publishing in Sri lanka Journal of Tea Science.

Pilapitiya H M C G and Silva S D. 2021. Innovative Value Addition in Tea (*Camellia sinensis*): A Comparative Analysis between Sri Lanka and Japan. International Journal of Innovative Approaches in Agricultural Research, 5(1), 17-36. DOI: https: //doi.org/ 10.29329 /ijiaar.2021.339.2

Presentations

Dr. H W Shyamalie delivered the Guest speech on overview of tea industry for under graduate students in Agricultural Economics and Business Management, Faculty of Agriculture, University of Peradeniyaon 7th July 2021.

Dr. H W Shyamalie delivered a lecture on Cost of tea production and labor use economics in tea for Technology Module for National Diploma in Plantation Management on 22nd September 2022.

Dr. H W Shyamalie presented progress on Investigating the social and economic impacts of alternative worker deployment models (AWDMs) in large scale tea plantations in Sri Lanka for the collaborative research team from Michigan State University on 6th October 2021.

Dr. H W Shyamalie contributed as a resource person for the radio program broadcasted on 23rd October 2021 on "කුඩා තේ වතු හිමියන්ගේ ජීවන තත්ත්වය නගා සිටුවීම, කුඩා තේ ඉඩම්වල ආදායම් මට්ටම ඉහළ නැංවීම සහ වියදම අවම කිරීම".

Dr. H W Shyamalie contributed as a resource person for the radio program broadcasted on 30th October 2021 on "තේ වගා සහනාධාර සහ වගා ණය යෝජනා ක්‍රම සඳහා තේ පර්යේෂණ ආයතනයේ දායකත්වය".

Dr. H.W. Shyamaliecontributed as a resource person for the radio program broadcasted on 20th November 2021 on "තේ කර්මාන්තයේ වෘත්තීය සුරක්ෂිතතාව සහ සෞඛ්‍යය".

Dr. H W Shyamalie presented two Concept papers on (1) offering incentive scheme to attract bought leaf suppliers to St. Coombs and (2) Tea sales center using a container at the 84th Consultative Committee Meeting on Estates held on13th December 2021 at, Sri Lanka Tea BoardAuditorium, Colombo.

Dr. H W Shyamalie presented on "Update on Cost of Production and profitability of tea during the last five years" at the TRI Annual Technical Briefing on some key industry issues held on 30th December 2021 at Ruby Hall, Marino Beach Hotel, Kollupitya.

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 member of committee appointed for preparing report on St. Joachim estate and tea factory

Dr. H W Shyamalie served as a member of committee appointed for preparing report on Evidence based analysis on yield decline.

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 contact person for Media and update of tea database, Ministry of Plantation.

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.

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 member of committee appointed for preparing report on St. Joachim estate and tea factory.

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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 and National Research, Development and Innovation Survey -2020 conducted by the NASTEC.

Dr. H W Shyamalie served as a contact person for Media and update of tea database, Ministry of Plantation.

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

Business plan for St. Joachim estate and this was submitted to Consultative Committee on Estate Report on suitable crops for intercropping/mixed cropping in tea.

Report on Contribution of tea to Sri Lankan economy.

Concept paper on offering incentive scheme to attract bought leaf suppliers to St. Coombs Estate, Talawakelle.

Concept paper on Tea sales center using a container/vessel.

Summary report on fertiliser recommendations.

Reports on valuation of tea bushes (2reportsfor Meddakande estate, Nuwara Eliya estate, smallholdings sector in Nawalapitiya, Palmgarden Estate).

Report on "ව්‍යවස්ථාපිත ආයතන සහ අනුබද්ධ ආයතනවල ප්‍රගතිය සමාලෝචනය (2021 ජූලි 31 වන දින දක්වා)".

Interim Guidelines on Strategic Cost Components Management in Tea Plantations (1st draft).

Benefit cost analysis of tea cultivation for the committee on oil palm cultivation.

Progress report on investigating the social and economic impacts of alternative worker deployment models (AWDMs) in large scale tea plantations in Sri Lanka.

Database

National Research, Development and Innovation Survey -2020 in National Science Foundation

National Research, Development and Innovation Survey -2020 in NASTEC

Meetings/Forums attended

Dr. H W Shyamalie attended the *Validation Workshop on Five Year Strategic Plan for the Tea sector in Sri Lanka 2021-2025"* on 08th January 2021.

Dr. H W Shyamalie attended the Intensive Course on Agricultural Policy Analysis Evaluation of the Programme held on 17th, 18th, 19th, 26th, 27th and 28th of February 2021 at Oakray Regency hotel, Peradeniya.

Dr. H W Shyamalie attended 187th HOD meeting held on 23rdApril 2021 at Mid-Country Regional Center, Kandy

Dr. H W Shyamalie attended the virtual Awareness Session for Staff of the Tea Research Institute on Preparation of Road Map for the Substitution of Organic Fertilizer in place of Inorganic fertilizer for cultivation of Tea as mandated by the GOSL on 20th May 2021.

Dr. H W Shyamalie attended Dr. H.W.Shyamalie served as a contact person of TRI for the virtual meeting on National Tea Introduction Decline - Evidence based Analysis held on 8th July 2021.

Dr. H W Shyamalie attended the General Meeting on Creation of a Green Socio-Economy with Sustainable Solutions for Climate Changes: TRISL Action/Activity Plans on Projects 2021 – 2023 - Briefing held on 14th July 2021.

Dr. H W Shyamalie attended the Virtual Session on Gender Responsive Budgeting (GRB) on 30th July 2021.

Dr. H W Shyamalie attended the Planning Meeting on Monitoring and Evaluation of Demonstration Sites Treated with Bio-fertilizers In Different Tea Growing Regions held on 4th August 2021.

Dr. H W Shyamalie attended the meeting held for the Visit by The Research Institue of Orgnaic Agriculture (FiBL) and School of Agricultural, Forest and Food Science (HAFL) Switzerland Experts to TRI on 9th August 2021.

Dr. H W Shyamalie attended the Ministerial Steering Committee on Organic Plantation held on 26th October 2021(a virtual meeting).

Dr. H W Shyamalie attended the CCR special virtual meeting to discuss progress of evidence based analysis on yield decline held on 14th November 2021.

Dr. H W Shyamalie attended the Golden Share Holder Meeting (virtual) held on 23rd, 25th, 26th November and 3rd December 2021.

Dr. H W Shyamalie attended the Awareness program of Agriculture Sector- New base year 2015 of Gross Domestic Product (GDP) on 24th November 2021.

Dr. H W Shyamalie attended a virtual meeting on Department of Census and Statistics plan to share the new improvement made in the agriculture sector on 24th November 2021.

Dr. H W Shyamalie attended the meeting on update tea database at Ministry of Plantation on 30th November 2021.

Dr. H W Shyamalie attended the virtual meeting on Oil Palm Cultivation on 2nd December 2021

Dr. H W Shyamalie attended the Consultative Committee on estates held on 13th December 2021at the auditorium of Sri Lanka Tea Board, Colombo.

Dr. H W Shyamalie attended the virtual meeting on Oil Palm held on Dec 14, 2021.

Dr. H W Shyamalie attended the Research allowance Subcommittee meeting on 20 Dec 2021 held at council for Agricultural Research Policy, Colombo.

Dr. H W Shyamalie attended to the meeting on Distribution of fertilizer held at auditorium of Ministry of Plantation on 28th December 2021.

Dr. H W Shyamalie attended the Special Discussion to develop a Short term/ Long Term Strategic Plan- Elkaduwa Plantations LTD held at the Ministry of Plantation on 28th December 2021.

Dr. H W Shyamalie attended the TRI Annual Technical Briefing on some key industry issues held at Ruby Hall, Marino Beach Hotel, Kollupitiya on 30thDecember 2021.

Student supervision
Mr. P M S L Wimalathunga, a student of Hardy Advanced Technological Institute Ampara conducted his industrial training in Agricultural Economics Division from 10th May 2021 to 10th November 2021 under the supervision of Dr. H W Shyamalie.

AGRONOMY DIVISION

Study programmes
Ms Samanthi Jayasinghe continued her research component of the postgraduate programme leading to PhD at the University of Philippines, Los Banos (UPLB).

Publications/Reports
Field inspections Report on "Soil Rehabilitation on Hybrid Napier - CO3 at Galle and Matara Districts (STaRR project)", January 2021 (Dr N P S N Bandara & M G S Liyanage).

Field Inspection Reports on "Soil Rehabilitation with Hybrid Napier-CO3 Cultivation in Badulla District (STaRR project)" July/August/September 2021 (NPSN Bandara and MGS Liyanage)

Report on soil quality status on Bandunkanda Estate, Baddegama, 2021 October (NPSN Bandara)

Special Presentations

Dr M A Wijeratne addressed Area Scientific Conference of the Karnataka Planter's Association, India on Climate change impacts on tea and adaptation strategies on 5th October, 2021.

Dr M A Wijeratne and Dr S R W Pathiranage conducted a field demonstration-cum training on use of TRI selective tea harvesters at Biotea Garden, Idalgashinna on 18th January, 2021.

Dr M A Wijeratne and Dr S R W Pathiranage conducted a workshop-cum-field demonstration on mechanization of tea field operations at TRI LCRC on 22nd January for the members of IESL.

Dr. N P S N Bandara addressed officials of the STaRR Project on Soil Quality Index (පාංශු තත්ව දර්ශකය සහ එහි භාවිතය) at Galle and Matara Districts (2 Seminars).

Dr. N P S N Bandara made presentations on tea micro irrigation for the Tea Estate Owners Association, at Suriyakanda and TSHDA officials of Ratnapura District. He also made online presentations on micro irrigation in tea for TSHDA officials and tea smallholders in October and December respectively.

Dr. N P S N Bandara made presentations at Inter-Monsoon and Monsoon Forums in May and October 2021.

Dr. S R W Pathiranage made presentations at TSHDA workshops conducted for smallholders on the "Use of machines in tea fields" at the Training Centre, Hantana.

Mr. M G S Liyanage made presentations on CO3 grass planting at Badulla, Ratnapura, Galle, Matara and Nuwara Eliya Districts for the Small Tea & Rubber Revitalization Project (STaRR Project) in February/March 2021.

Dr. NPSN Bandara delivered following presentations at the forums/ seminars/ workshops held during the year 2021.

- Presentations on CO3 grass planting at Badulla, Ratnapura, Galle and Matara, STaRR Project February 2021
- තේ වගාව සඳහා ක්ෂුද්‍ර ජල සම්පාදන ක්‍රමවේදයන් : වර්තමාන භාවිතය, Tea Estate Owners Association, Suriyakanda, February 2021
- පාංශු තත්ව දර්ශකය සහ එහි භාවිතය, Small Tea and Rubber Revitalization Project Officials, Galle and Matara Districts (2 Seminars), February 2021
- තේ වගාව සඳහා ක්ෂුද්‍ර ජල සම්පාදන ක්‍රමවේදයන් : නිර්මාණය සහ නඩත්තුව, for TSHDA Officials, Ratnapura District, March 2021
- 2020/21 North East Monsoon and 2021 1st Inter Monsoon, 24th Monsoon Forum, May 2021
- 2021 South West Monsoon, 25th Monsoon Forum, October 2021

- තේ වගාව සඳහා ක්ෂුද්‍ර ජල සම්පාදන භාවිතය - Online seminar to TSHDA Officials, October 2021 and December, 2021

Miscellaneous activities

Field Inspections and Reports

Field inspections on Soil Rehabilitation on Hybrid Napier CO3 under STaRR project at Galle and Matara District, January 2021.

Presentations on CO3 grass planting at Nuwara Eliya district, STaRR project March 2021

Field inspections and report was prepared on "Soil Rehabilitation with Hybrid Napier CO3 Cultivation in Badulla District" – N P S N Bandara and M G S Liyanage, July/August 2021

Field inspections and report was prepared on "Soil Rehabilitation with Hybrid Napier CO3 Cultivation in Badulla District" – N P S N Bandara and M G S Liyanage, August/September 2021

Report on soil quality status for Bandunkanda Estate, Baddegama by N P S N Bandara – October, 2021.

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/Agronomy Division, TRI. He also involved in the development activities of STaRR Project.

Dr. M A Wijeratne participated in two "*Subarathi*" radio programmes broadcasted on 16th October and 6th November 2021.

Being a member of the expert committee, Dr M A Wijeratne shared his expertise for revising the National Land Use Policy of Sri Lanka.

Dr. M A Wijeratne and Dr S R W Pathiranage engaged in a three-year special project on development and introduction of a motorized selective tea harvester suitable for tea lands in Sri Lanka.

Dr. M A Wijeratne attended the District Co-ordination Committee meetings and other special meetings on "*Gama Samaga Pilisandara*" programme organized by the District Secretariat, Ratnapura.

Dr. M A Wijeratne also served as a member of the Faculty Board of Agriculture, University of Ruhuna.

Dr. S R W Patthiranage, served as a committee member/resource person of the two special projects on Burying of tea pruning as a climate change mitigation strategy in tea lands and Development and introduction of trenching machines. He also engaged in the TRISL and TSHDA technical evaluation/procurement committees.

Dr. S R W Pathiranage served as a resource person in the introductory program; "Future Prospectus for Agriculture Graduates" conducted for fresh student intake of Faculty of Agriculture, University of Runuha.

BIOCHEMISTRY DIVISION

Study programmes/Training programmes/Workshops

K G N P Piyasena successfully completed FAO/IAEA Virtual Training course on "Use of Stable Isotope and Trace Element Profiling to Determine Food Origin and Verify Food Authenticity" organized by the IAEA, Vienna from 11th to 22nd October 2021.

K G N P Piyasena successfully completed Virtual Training course on "Certificate course in intellectual property law" organized by the Bar Association of Sri Lanka, from April to July 2021.

Publications

Jayawardhane S A D P S, Edirisinghe E N U, Fernando M S C, Tharangika H B, 2021. Development and Validation of a HPLC based analytical method, towards the determination of sugar concentration in processed black tea.Technicum BiochemMed, 2(1),1-11.

Arunodi R H C S, Perera G A A R, Piyasena K G N P and Edirisinghe E N U. 2021. Evaluation of Changes in Theaflavin, Thearubigins, Caffeine and Alcohol Content during Tea Wine Fermentation. Proceedings of International Research Conference of Uva Wellassa University (IRCUWU). pp.224.

Nisansala H M S Perera G A A R Piyasena K G N P and Edirisinghe E N U 2021. Evaluation of Changes in Polyphenol, Amino Acid and Catechins Content during Tea Wine Fermentation. Proceedings of International Research Conference of Uva Wellassa University (IRCUWU). pp.222.

Miscellaneous Activities

Trainees

Ms. S Nisansala Herath, final year student from Department of Export Agriculture, Faculty of Animal Science and Export Agriculture, Uva Wellassa University completed her final year research project at Biochemistry Division (January to April 2021).

Ms. R H C S Arunodi, final year student from Department of Export Agriculture, Faculty of Animal Science and Export Agriculture, Uva Wellassa University completed her final year research project at Biochemistry Division (January to April 2021).

ENTOMOLOGY AND NEMATOLOGY DIVISION

Study Programmes/ Training and Workshops

Mrs. A M P Sammani participated in the online course of Applied Statistics and Research Methods conducted by Institute of Mathematics and Management, Sri Lanka.

Publications

Sinniah G D, Senanayake P D, 2021. Microbial Technologies in Pest and Disease Management of Tea (*Camellia sinensis* (L.) O. Kuntze). In: Bhatt P, Gangola S, Udayanga D, Kumar G. (Eds.). Microbial Technology for Sustainable Environment. Springer Nature Singapore Pte Ltd., Singapore, pp. 325-345.

Presentations/Awareness programmes

An undergraduate student of Faculty of Agriculture, University of Wayamba was trained at TRI, Ratnapura.

PLANT BREEDING DIVISION

MOUs, Grants, Special funding, Progress reviews and Collaborative research

Memorandum of Understanding (MoU) signed between the Tea Research Institute of Sri Lanka (TRISL), and Council of Scientific and Industrial Research - Institute of Himalayan Bio-resource Technology (CSIR-IHBT), India in February, 2021 to carry out a research project on "High throughput genotyping to expedite genetic characterization and dissection of important agronomic traits of tea".

Study programmes/Training programmes/Workshops

K K Ranaweera completed bench work of the postgraduate programme leading to PhD at the PGIA and resumed duties on 5th August, 2021 after completing the study leave period. Thesis is being prepared.

J D Kottawa Arachchi, continued his post graduate programme leading to PhD at the Himachal Pradesh Agricultural University, Palampur, India.

M A S Kelum Pemarathne, Research Assistant (Contractual basis) commenced his postgraduate programme leading to MPhil at the PGIA, Peradeniya.

M A B Ranatunga participated at the workshop on "How to minimize weaknesses and delays of Technical Evaluation Committees and Procurement Committees" organized by the NIPM in November 2021.

M A B Ranatunga participated at the workshop on "Seminar on Agricultural Biotechnology for Developing Countries" organized by the Hubei Vocational College of Biotechnology, China from 18th November to 01st December 2021.

M A B Ranatunga successfully completed FAO/IAEA Virtual Training course on "Use of Stable Isotope and Trace Element Profiling to Determine Food Origin and Verify Food Authenticity" organized by the IAEA, Vienna from 11th to 22nd October 2021.

M A B Ranatunga successfully completed a short course on "Industrial Mathematics" organized by the Institute of Mathematics and Management, Sri Lanka in May 2021.

Publications

Ranaweera K K, Ranatunga M A B, Eeswara J P, Thilakarathne S and Kadono H. 2021. Regeneration Plantlets of Tea [*Camellia sinensis* (L.) O Kuntze] cv. TRI 5001 through Somatic Embryogenesis in Liquid Dynamic Medium. Proceedings of the Thirty-Third Annual Congress of the PGIA, Peradeniya.

Kottawa-Arachchi J D, Ekanayake G, Ranatunga M A B, Amarakoon A M T, Gunasekare M T K, Sharma R K and Attanayake R N. 2021. Variation of biochemical compounds in a bi-parental progeny of tea [*Camellia sinensis* (L.) O. Kuntze]. Proceedings of Peradeniya University International Research Sessions 2021, Sri Lanka, Vol. 23, 11th and 12th November 2021.

Kottawa-Arachchi J D, Ranatunga M A B, Sharma R K, Amarakoon A M T, Gunasekare M T K, Chaudhary H K and Attanayake R N 2021. Molecular characterization of Sri Lankan tea [*Camellia sinensis* (L.) O. Kuntze] genotypes with diverse origins using SSR markers for future breeding programmes. International Conference on Applied and Pure Sciences, 2021 Faculty of Science, University of Kelaniya, Sri Lanka.

Ranatunga M A B, Uwadaira Y, Ikehata A and Ito H. 2021. NIR Spectroscopic Determination of Polyphenol Content in Teas and Tea Extract at 2142 nm. *Sensors and Materials*, Vol.33, No. 12. 4135-4145

Wijewardhana M P H M, Jayawardana N U, Niranjan M and Ranatunga M A B. 2021 Selection and Optimization of qPCR Primers for Expression Analysis of Four Catechin Biosynthesis Genes in Tea (*Camellia sinensis* (L.) O. Kuntze). *In*: Proceedings of the Faculty of Agriculture Undergraduate Research Symposium 2021, University of Peradeniya, Sri Lanka. pp.106

Pallewaththa P G S, Ranatunga M A B and Jinendra B M S. 2021. Non destructive estimation of total polyphenol content in fresh tea leaves (*Camellia sinensis* L O Kuntze) by Near Infra-red spectroscopy. *In:* Proceedings of Undergraduate Research Symposium on Agricultural Engineering and Environment Technology, University of Ruhuna, Sri Lanka. pp 28.

Following 4 extended abstracts were presented for the International Tea Conference and 3rd Global Forum for Directors of Tea Research Institutes, held on-line hosted by China Tea Science Society (CTSS) and Tea Research Institute, Chinese Academy of Agricultural Sciences (TRI CAAS) – Proceedings is in Print.

Ranaweera K K, Ranatunga M A B , Eeswara J P , Thilakarathne S. and Kadono H. 2021. Optimum light conditions for Photoautotrophic micro propagation of tea (*Camellia sinensis* (L.) O. Kuntze) on liquid cultures.

Kottawa-Arachchi J D, Ranatunga M A B, Sharma R K, Parmar R, Amarakoon A M T, Gunasekare M T K, Chaudhary H K, Attanayake R N. 2021. Molecular characterization of Sri Lankan tea [*Camellia sinensis* (L.) O. Kuntze] genotypes using functionally relevant SSR markers

Piyasundara J H N, Wickramasinghe I P, Gunesekara M T K , Wijeratne M A, Perera S A C N, Ranatunga M A B and Mudalige A K. 2021. Reproductive Phenology and Floral Biology of the parental genotypes of Tea (*Camellia sinensis*) Seed Gardens.

Ratiyalage C J, Jayaratna M, Kottawa-Arachchi J D, Ranaeera K K, Ranatunga M A B. 2021. Optimization of medium for in *vitro* pollen germination of tea (*Camellia sinensis* (L.) O. Kuntze)

Presentations

KK Ranaweera, made a presentation at the 33rd Annual post graduate congress of the PGIA held 16th and 17th November, 2021.

KK Ranaweera, JD Kottawa-Arachchi, JHN Piyasundara and CJ Ratiyalage made four presentations at International Tea Conference and 3rd Global Forum for Directors of Tea Research Institutes, held on line hosted by China Tea Science Society (CTSS) and Tea Research Institute, Chinese Academy of Agricultural Sciences (TRI CAAS), month

Services

M A B Ranatunga continued to serve as the Chairman of the Publication and Presentation Panel (PPP) of TRI.

M A B Ranatunga continued to serve as the Manager of the Technology Transfer Office (TTO) of TRI.

J H N Piyasundara continued to serve as the coordinator of TRI Update.

Trainees
Three under-graduate students completed their research projects / in plant training at the division. One under-graduate student commenced her research projects / in plant training.

New Recruitments, Promotions, Resignations and Retirements
MASK Pemarathne, was recruited as a Research Assistant (Contractual basis) under a special project funded by National Research Council (NRC 20 – 123) with effect from 18th January, 2021

PLANT PATHOLOGY DIVISION

Postgraduate study
M Niranjan, Research Officer, commenced a postgraduate study program leading to PhD at Graduate School of Environmental and Life Sciences, Okayama University, Japan in October 2021 (MEXT awarded scholarship).

Seminars/Presentations/lectures made
Conducted a virtual awareness program on rational use of pesticides for Kelani Valley plantations PLC.

Short courses/ Trainings
G D Sinniah followed the Certificate Course in Intellectual Property Law (online) organized by Bar Association of Sri Lanka from April 30 to July 16, 2021.

G D Sinniah attended virtual training course on Tea Production Technology and Tea Industry Promotion for Sri Lanka organized by Zhangzhou College of Science and Technology, China from Oct 26th to Nov 15th, 2021

GD Sinniah attended virtual Seminar on Agricultural Biotechnology for Developing Countries organized by Hubei Vocational College of Bio-Technology, China from Nov. 18- Dec. 1, 2021

Publications
Sinniah G D, Senanayake P D. 2021. Microbial Technologies in Pest and Disease Management of Tea (*Camellia sinensis* (L.) O. Kuntze). In: Microbial Technology for Sustainable Environment (Eds) Pankaj Bhatt, Saurabh Gangola, Dhanushka Udayanga, Govind Kumar. Springer Nature Singapore Pte Ltd., Singapore, pp 325-345.

Pandey A K, Sinniah G D, Babu A, and Tanti A. 2021. How the Global Tea Industry Copes up with Fungal Diseases-Challenges and Opportunities. Plant Disease 105, 1868-1879. https://doi.org/10.1094/PDIS-09-20-1945-FE

Wijewardhana M P H M, Jayawardana N U, Niranjan M and Ranatunga M A B. 2021. Selection and optimization of qPCR primers for expression analysis of four catechin biosynthesis genes in Tea (*Camellia sinensis* (L.) O. Kuntze). Proceedings of the Faculty of Agriculture Undergraduate Research Symposium, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka. p.106.

PLANT PHYSIOLOGY DIVISION

Study Programmes

Ms. M M N Damayanthi continued her postgraduate programme leading to a PhD degree at the Postgraduate Institute of Science, University of Peradeniya, Sri Lanka.

Publications

Wijeratne T L. 2018. Review on research carried out by the Tea Research Institute of Sri Lanka on Climate change impacts and the need of implementing good agricultural practices. Sri Lanka Journal of Tea Science, 83 (Part1 and 2) (in press).

Jayawardhana A D I U, Widulanka A K A K S, Wijeratne T L, Mohotti A J, Nissanka S P and Mohotti K M. 2021. Some selected biochemical and physiological responses in organically and conventionally grown tea (*Camellia sinensis* (L.) O. Kuntze) to increased ambient temperature. International Journal of Agriculture, Forestry and Plantation, Vol. 11 (June). ISSN: 2462-1757. 78-84.

Jayawardhana A D I U, Widulanka A K A K S, Wijeratne T L, Mohotti A J, Nissanka S P and Mohotti K M. 2021. Some selected biochemical and physiological responses in organically and conventionally grown tea (*Camellia sinensis* (L.) O. Kuntze) to increased ambient temperature. In Proceedings of the 2nd International Plantation Conference (IPC 2021), "A sustainable approach for diversifying livelihood and environment in plantation industry" organized by the Faculty of Plantation and Agrotechnology, University of Teknologi, Malaysia held online from 9th - 10th March 2021. pp. 25.

Special Presentations

Dr. T L Wijeratne participated at the Subharathi live radio programme as a resource person to discuss on "Impacts of climate change on tea industry in Sri Lanka and adaptation measures".

SOILS AND PLANT NUTRITION DIVISION

Study Programmes

L R M C Liyanage (SRO), resumed duties in the SPND on 31st December 2021 after completion of postgraduate studies at University Putra in Malaysia.

S Raguraj (RO) and R K A Amali (RO) are continuing their postgraduate study programmes at University Putra Malaysia.

Publications

Liyanage L R M C, Sulaiman M F, Ismail R, Gunaratne G P, Dharmakeerthi R S, Rupasinghe M G N, Mayakaduwa A P and Hanafi M M. 2021. Carbon mineralization dynamics of organic materials and their usage in the restoration of degraded tropical tea-growing soil. Agronomy, 11(6), 1191.https://doi.org/https://doi.org/10.3390/ agronomy11061191

Amali R K A, Lim H N, Ibrahim I, Huang N M, Zainal Z, Ahmad S A A. 2021. Significance of nanomaterials in electrochemical sensors for nitrate detection A review, Trends in electrochemical analytical chemistry (31) e00135

Tennakoon P L K, Rajapaksha R M C P and Hettiarachchi L S K. 2021. Indigeneous PGPR consortia greatly reduces fertilizer need for tea nurseries. Published in Sri Lanka Journal of Food and Agriculture in June 2021 issue.

Special Presentation

W M S Wijayatunga, S K Weeratunga conducted training and awareness programme on the "Use of portable pH meters and compost making methods" to the Tea Inspectors of TSHDA in Nuwaraeliya and Uva regions at TRI, Talawakelle on 06th October 2021.

JRY Abeywardana conducted training programme on the "Use of portable pH meters" to the Tea Inspectors of TSHDA in Galle and Matara regions at Walahanduwa Analytical Laboratory, Galle on 06th October 2021.

W M S Wijayatunga, O G K Gunaratna conducted training and awareness programme on the "Use of portable pH meters and compost making methods" to the Tea Inspectors of TSHDA in Ratnapura and Kalutara regions at TRI, Ratnapura on 08th October 2021.

W M S Wijayatunga, conducted training and awareness programme on the "Use of portable pH meters and compost making methods" to the Tea Inspectors of TSHDA in Kandy and Kegalle regions at TRI, Hantane on 11th October 2021.

W M S Wijayatunge delivered online lecture on "Impotence of organic tea farming for tea plantation", for Tea Inspectors of Tea Small Holding Authority, organized by NIPM on 22nd November 2021.

S K Weeratunga conducted a training programme on "Use of Bench top and portable pH meters" to the Young Tea Farmers in Nuwaraeliya and Uva regions at TRI, Talawakelle on 15th December 2021.

O G K Gunaratna conducted training programme on the "Use of Bench top and portable pH meters" to the Young Tea Farmers in Ratnapura, Kegalle and Kalutara regions at Walahanduwa Analytical Laboratory, Galle on 16th December 2021.

JRY Abeywardana conducted training programme on the "Use of Bench top and portable pH meters" to the Young Tea Farmers in Galle and Matara regions at Walahanduwa Analytical Laboratory, Galle on 20th December 2021.

Miscellaneous activities:
Two Agriculture diploma students completed their in-plant training at the Division.

New Recruitments, Promotions, Resignations and Retirements
V A N Wickramasingha and H M U Abeywardhana resigned from the TRI service in August 2021.

PROCESS TECHNOLOGY DIVISION

Publications
Edirisinghe E A N K, Raveendran K, Koneswaramoorthy S, Senanayaka V, Jayasinghe L, Chamindra M A. 2021. Development of wood chips feeding system to be retrofitted to conventional furnace/air heater-drier system for tea drying, Proceedings of the National Engineering Research Symposium: 97-104.

ST. COOMBS ESTATE - TALAWAKELLE

M K D Priyantha
Superintendent

Clerical Staff	Mr. K A Manoj 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 Sarath Kumar	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	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 & 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 30th December 2021.

Hectare Statement as at 31st December 2021

Table 1. Hectare Statement as at 31st December 2021

	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

Table 1. Hectare Statement as at 31st December 2021 (Cont.,)

	St.Coombs	Lamiliere	Total
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 (Table 2) were pruned during the season in year 2021.

Table 2. Pruned fields – 2021

Division	Field Nos	Extent (ha)
Upper	1B, 3A,	9.6
Lower	10, 13D	6.7
Lamiliere	8A, 9A, 12	10.0

- All field works were done as per the estimates following TRI guidelines.
- Fertilizer application was based on TRI recommendation.

ADB Mother Bush Project

- 250,150 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 – 2021/2022

Crop and Yield	2021		2020	
	Crop	Yield	Crop	Yield
St. Coombs	165,180	1940	160,630	1830
Lamiliere	74,815	1581	69,792	1450
Total	239,995	1811	230,422	1695
Bought Leaf	24,153		80,212	
Grand Total	264,148		310,634	

A Yield of 1,811 kg/ha was recorded in the year 2021.

Factory and Manufacture

Gross sale average for 2021 was Rs 655.50 which is Rs.35.17 above the Western High Grown Elevation average.

Weather Conditions

Rainfall of 3,706 mm was recorded on 182 wet days in year 2021.

Working Results

The Estate Loss of Rs.53,365,554.00 for the season.

Factory

Mr.S Sivan, Factory Mechanic retired from the service w.e.f. 6th September 2021

Driver

Mr.T Ramanathan, Driver retired from the service w.e.f. 09th January 2021

ST. JOACHIM ESTATE - RATNAPURA

D C C Jayasekera
Superintendent

Executive	Mr. D C C Jayasekera	Superintendent
Office	Mrs. N Koralage	Chief Clerk
	Mrs. K M G Lankika Dias	Senior Assistant Clerk
	Miss. W K Prasanika	Junior Assistant Clerk
	Miss. S Sudharshini	Junior Assistant Clerk
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. The following development works were carried out in the St. Joachim Factory.

- Repairs to Middleton Extractor.
- Re-tabling Roller No. 09 and 01
- Purchased a New Colour Separator in October 2021 – "MEYER Multi Scheme Tea Colour separator Machine'' -
  Model: 6CSX – 300TS, HS Code: 838.80.20 in October 2021.
  Manufacturer: HEFEI MEYER OPTOELECTRONIC TECHNOLOGY INC.



Figure 1. Multi Scheme Tea Colour separator Machine at St. Joachim Estate, Ratnapura

Land Utilization

Table 1. Land use as at 31st December 2021

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	6.06 ha
Total effective hectarage	24.96 ha

Crop

The tea production of St. Joachim Estate in 2021, compared to the previous year is given in Table 3.

A) TEA (made tea kg)

Table 3. Tea Crop - 2021

Year	Estate Crop (kg)	Bought Leaf Crop (kg)
2021	18,765	224,457
2020	16,064	135,405
Variance	+2701	+89,052

The Estate crop, 2701 kgs has increased compared to the last year.
The Bought Leaf quantity also has increased by 89,052 kgs as against last year.

Field Wise Yield Details - 2021

Table 4. Field wise yield details - 2021

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	932	348	847
Factory Block		0.08	0	0	0
1A	0.8	0.15	178	223	1187
1B	0.8	0.50	872	1090	1744
2A	0.93	0.58	829	891	1429
2F	4	0.87	1210	303	1391
3	3	0.86	702	234	816
3A	1	1	725	725	725
3B	0.5	0.5	434	868	868
3C	1	1	678	678	678
4	4.85	1.38	1162	240	842
5	0.6	0.12	315	525	2625
6C	2	0.23	44	22	191
8A	3	0.1	25	8	250
8C	1	1	1602	1602	1602

Table 4. Field wise yield details – 2021. Cont.,

Field No.	Extent (ha)	Effective (ha)	Total Made Tea (units)	Y.P.H (Based on Actual ha)	Y.P.H (Based on Effective Extent)
8E	0.5	0.5	1139	2278	2278
8F	3	2.5	2071	690	828
ADB					
1	3.46	0	0	0	0
3	1.2	0.4		0	0
4	1.62	1.62	516	319	319
5	0.94	0.94	1014	1079	1079
8	4	2.87	1558	390	543
10	0.6	0.6	370	617	617
TRI Fields					
2	3.52	3.52	601	171	171
3A	1.34	1.34	12	9	9
1A	1.2	1.2	1776	1480	1480
Total	**47.54**	**24.96**	**18765**	395	752

B) RUBBER

Table 5. Rubber Crop - 2021

Year	Estate Crop (kg)	Yield
2021	2510	304
2020	1896	241

Cultural Operations

The normal GAPs were undertaken in the estate.

Nursery plants

A total of 100,050 nursery plants were sold to small holders and issued to TRI 5000 Series Mother Bush Project during the year.

Table 6. Nursery plants - 2021

Description	Number of plants
Plants issued to TRI (5000 Series) from GL 340 Nursery	1350
Plants issued to GL 340 Field Cultivation (GL 340 Nursery -3720) (2020-2021 Estate Nursery 330) (2019-2020 Estate Nursery 4450)	8500
Plants issued to GL 340 Project from Estate Nursery for outside Field	6650
Plants issued to small holders from estate nursery	29507
Plants issued to small holders from contract nursery	54043
Total number of plants	100,050

ADB mother bush project
A total of 2200 shoots were issued to smallholders.

Tea manufacture
NSA of Rs. 609.99 was achieved in the year 2021 and it was Rs. 623.35 in 2020.

There was a progress in increasing tea prices in the month of December after purchasing the New Colour Separator.NSA was Rs. 646.07 for December 2021.

Total production (Made Tea)
Quantity of leaf manufactured at St. Joachim Tea Factory showed an increase of 91,753 Kg in 2021 as against the previous year.

Weather and Rainfall
Rainfall of 4,553.70 mm was recorded for 184 wet days, as against 3,141.90 mm and 147 wet days in 2020.

Trading Results
St. Joachim Estate and Factory Trading results as at 31st December 2021 are as follows (Table 7).

Table 7. Trading results - 2021

Description	2021 (Rs.) Actual	2020 (Rs.) Actual
Total Loss including Depreciation	(11,028,234/=)	(5,528,337/=)
Depreciation	10,907,571/=	10,420,115/=
Total Profit/Loss without Depreciation (With differed income approx.)	(120,663/=)	4,891,778/=

Staff Appointments
Mr. H E G Dilan Isuru appointed as Superintendent‘s Driver Since 21st March 2021.

ADMINISTRATION AND FINANCE

Special highlights

1. Human Resource Development and Capacity Building

(a) Staff strengthening and motivation

Staff Recruitments

Name	Designation	Date
Mr K A M Chaturanga	Administrative Officer (Chief Clerk)	01.02.2021
Mr A A Upendra	Network Administrator	03.05.2021
Mr H E G D Isuru	Driver, St. Joachim Estate	22.05.2021
Mr D T Gunawardane	Engineering Assistant (Mechanical)	14.06.2021
Mr S S P Dayaratne	Engineering Assistant (Electrical) St. Coombs Estate	01.07.2021

Resignations

Name	Designation	Date
Ms H M U I Abewardhana	Technical Officer (R and D)	02.08.2021
Mr V E Kumara	Management Assistant (Accounting)	18.08.2021
Mr A A Upendra	Network Administrator	27.08.2021
Ms V A N Wickramasinghe	Technical Officer (R and D)	05.09.2021

Retirements

Name	Designation	Date
Ms B K S Herath	Accounts Clerk	28.02.2021
Mr N Navaratne	Experimental Officer	09.02.2021
Mr S Koneshvaramoorthy	Senior Research Officer	12.04.2021
Mr K A Karunathilake	General Worker	22.05.2021
Mr T Rajendran	General Worker	19.06.2021

Retirements

Name	Designation	Date
Mr T Rajendran	General Worker	19.06.2021
Mr W G Senaviratne	Driver	01.06.2021
Mr S S Sunil	Driver	18.06.2021
Ms S H P Waduge	Experimental Officer	19.07.2021
Mr R Robert Sagayam	General Worker	23.08.2021
Ms W M S R Wanasinghe	Management Assistant (Clerical)	08.11.2021
Mr R M B D Ratnayake	Circuit Bungalow Keeper	11.11.2021

Demise

Name	Designation	Date
Mr. P Vijayakumar	General Worker	15.06.2021
Mr M Murugesu	Driver	27.06.2021

Transfers

Name of Officer	Designation	Place of Transfer	Date
Mr P K Jayawickrama	Experimental Officer	Walahanduwa	26.01.2021
Ms B Janeny	Technical Officer (R and D)	Ratnapura	18.05.2021
Ms S D K Nadeeshani	Management Assistant	Finance	08.09.2021
Mr S S P Dayaratne	Engineering Assistant (Elec)	Ratnapura	27.10.2021
Mr J M R K Bandara	Electrician	Hantane	27.10.2021
Mr A A A H Chinthaka	Management Assistant	Mutugama	01.11.2021

(b) Overseas Training/ Seminars/Conferences

Due to the Covid-19 pandemic situation, study period of following officers were extended:

Mrs L A S P Jayasinghe, Research Officer, Agronomy Division, TRI from 31st July 2021 to 30th April 2022 at the University of The Philippines, Los Banos.

Mr C J Liyanaarachchi, Advisory Officer, Advisory and Extension Division, TRI from 06th Aug to 5th November 2021.

Mr L M R C Liyanage, Research Officer, Soils and Plant Nutrition Division, TRI from 4th Sep 2021 to 31st December 2021 at the University Putra, Malaysia.

(c) Local Training/ Seminars/ Workshops

Dr M A B Ranatunga, Head, Plant Breeding Division and Dr G D Sinniah, Head, Plant Pathology participated at the seminar on "Agricultural Biotechnology for Developing Countries" conducted by Department of External Resources, Sri Lanka

Ms A R M A M Ratnayake, Advisory Officer, Mr H I G S Piyaruwan, Advisory Officer, Mr G S Pradeep, Extension Officer and Ms L G L Koswatte, Extension Officer, Advisory and Extension Division participated at training on "Information Technology and Digital Management School" conducted by Miloda from 20th to 23rd September 2021.

Dr M A B Ranatunga, Head, Plant Breeding Division participated at one- day workshop on "Basic of Intellectual Property Rights" conducted by Sri Lanka Council for Agricultural Research Policy on 30th Sep 2021.

Mr. M Neranjan, Research Officer, Plant Pathology Division, TRI participated 18 months Postgraduate study at the "Okayama University, Japan from 1st October 2021.

Dr K G N P Piyasena, Head (Attending duties), Biochemistry Division, Dr G D Sinniah, Head, Plant Pathology Division, Ms A R M A M Ratnayake, Advisory Officer, Advisory and Extension Division, Ms A M P Sammani, Research Officer, Entomology Division, Ms K G L Koswatte, Extension Officer and Ms K G M J W Gunapala, Extension Officer, Advisory and Extension Division participated at one day certificate course on "Applied Statistics and Research Methods Intake I" conducted by Institute of Mathematics and Management on 7th Oct 2021

Mr. T G N Mahinda, Senior Advisory Officer, Advisory and Extension Division, TRI commenced his three year postgraduate study at the Sabaragamuwa University on 11th October 2021.

Mr Rohitha U Kumara, Advisory Officer, Advisory and Extension Division, TRI commenced his three year postgraduate study at the University of Putra, Malaysia on 30th November 2021.

Mr M V Mohan, Accountant and Mr W A Nishantha, Accounting Officer, Finance Division participated at the training on "Reporting Financial Progress" conducted by Ministry of Plantation.

Ms K P K A Sewwandi, Senior Administrative Officer, Administration Division, Mr C J B Abeykoon, Engineering Assistant (Civil) and Mr G S Ariyaratne, Public Relation/Welfare Officer, Administration Division participated at EPTRI-eITEC-Civilian training programme on " Soil Waste Management" conducted by Indian Technical and Economic Cooperation from 8th to 22nd December 2021.

Infrastructure Developments and maintenance

Maintenance Work (Special Project)
Completed construction of retaining wall TRI Mid Country Station, Hanthana. Completed construction of culvert, Paving inter lock blocks, repairing drains, pavements and renovation works of internal road up to circuit bungalow, ceiling and roof renovation works of "C" 03 Bungalow at TRI Advisory and Extension Center Kottawa. Completed works of repairing "D" type Quarters Road. Construction of Roof renovation works and replacing timber floor of St. Joachim Tea factory, Ratnapura is in progress.

Maintenance Work (Capital Budget)
Completed the following works:

- Concreting internal road at Advisory and Extension Centre Deniyaya,
- Renovation of vehicle park roof, TRI Talawakelle.
- Roof repairing works Agriculture Economics unit, TRI, Talawakelle and Aluminium partition works at Finance Division.

Constructions related to laboratory up gradation at TRI Mid Country Station, Hantane, Bath room renovation works at TRI Low Country Station, Ratnapura and retaining wall near workers quarters at TRI Advisory and Extension Centre, Kottawa, are in progress.

Maintenance Work
160 Nos. of maintenance jobs were completed by the Engineering Division during the year 2021. All colour washing works and repair works (carpentry, masonry, roof repairing and plumbing) have been carried out under the color washing program) "A" type bungalows- 12,13 "B" type bungalows -4,7,10 "C" type bungalows – 10, 11, 22, 54, 24, 13, 21, 32, 04, 17, Chief Clerk quarters at St. Coombs "D" Type quarters – 49, 32, 53, 29 and "E" Type quarters 13,07,02,03.

Additional Painting Works
Completed internal colour washing and polishing of "Camellia Hostel" Room Nos. 39,40,20,02,07,11,21., "Junior Ladies Hostel" and "Senior Gents Hostel" Room No. 01.

internal Colour washing Plant Breeding Division (PCR Machinery room), Accounts Lower Division, internal touchup painting works after the partition works at Accounts Upper Division, Internal touchup painting works at Resident Engineer's office, Internal Colour washing partition room at SPN Division, Cleaning and Polishing works at TRI Guest House before Minister's visit, Cleaning and polishing and waxing "A" 5 and 3 bungalows and Advisory and Extension Division, Internal Colour washing and polishing at Montessori building, Internal colour washing renovated room at IT Unit, Internal colour washing 1st floor area at Administration building, cleaning and painting works TRI name boards, Cleaning and polishing works at Director's office, Internal colour washing and polishing at Senior Accountant's Office room, Painting Iron trusses in renovated experimental room at Pathology Division.

Water Supply

118 Nos. of jobs were completed during the year. Cleaning works at storage tanks, sedimentation tanks and all the water tanks in the premises of TRI has been attended.

Electrical Unit

150 Nos. of jobs were completed by the Electrical Unit during the year. Maintenance works of 99 TRI staff bungalows and quarters were completed (A type - 10, B type -04, C type -23, D type - 09 and E type -01).

Following Maintenance work were completed:
Electrical works at Hostels and Guest Houses - 31 jobs- Offices, Laboratories and St. Coombs Estate -72 jobs. Upgrade 3 phase main panel board wiring and arrange to control water pressure pump automatically in TRI Guest House.

Nematology Division net house new single-phase supplies and wiring.

Arranged new power supply for each newly renovated partition rooms and 80% of light system converted into energy saving LED lights in Upper and Low Finance Division.

Installed newly designed colour Separator and 3 phase wiring at St. Joachim Estate Factory at Ratnapura.

Generator services, new modular controller fixing, C type and B type electrical repairs at TRI Mid Country Station.

Soils and Plant Nutrient Division lighting system convert into energy saving LED light 60% (according to the standard) and installation successfully completed.

Soils and Plant Nutrient Division new lab room wiring, UPS power supply arrangements, Fume cupboard 3 phase motor rewinding and fixing.

TRI Mid Country Station overhead lines clearance and repairing Street lights repairing successfully completed. Agronomy, Entomology and Nematology, Plant Pathology Divisions lighting system convert into energy saving LED lights 40% (according to the standard) installation successfully completed. 80% of Camellia Hostel and Senior Staff Gents Hostel lights converted into energy saving LED lights. Rearranged network cable system in Finance Division. Fifty percent of the work of three-phase wiring of new lab in Plant Pathology Division completed. Electrical wiring and repairs in staff bungalows of A type 2 and 12, B type 7, C type 22, 12, 13, and D type 39, 33 and 44 were totally completed. Completed 500Kva Generator service and Radiator cleaning successfully (This was delayed on the part of supplier due to Covid-19 pandemic. However, this will be completed in Jan 2022).

St. Coombs Estate Bungalow, Factory, all pump Houses and overhead lines have been maintained

Maintained Street lights, Security post lights and arranged power supply to the Weather Station.

Telephone Exchange

Following maintenance work were also done during the year 2021.

1) Maintenance completed for 08 Nos. of job cards.
2) 263 jobs related to repair of telephone line and services works have been completed

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 for hardware and electrical items, Fire wood and fertilizer *etc*. and ???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 done during the year 2021.

No. of total services of vehicle	- 27 Nos.
No. of total repairs (Major)	- 04 Nos.
No. of total repairs (Minor)	- 68 Nos.
Tyre Change	- 26 Nos.
Visit Arrangements	- 1158 Nos.

TRI Legal Matters, Bond and Agreements

Appeared for nine Courts Cases, sixteen LT Cases and Nine Consultations. Nine Bond and Agreements have been signed.

FINANCIAL STATEMENTS

TEA RESEARCH BOARD
STATEMENT OF FINANCIAL POSITION AS AT 31st DECEMBER 2021

	Note	SLPSAS 2021 Rs. '000	SLPSAS 2021 Rs. '000	SLPSAS 2020 Rs. '000
ASSETS				
Current Assets				
Cash and Cash Equivalents	07		85,113	37,037
Short-term Investments			81,980	80,679
Trade and Other Receivables	08	54,598		55,788
Less:- Provision for Bad Debts		189		243
			54,409	55,545
			221,502	173,260
Inventories/Stocks	09	86,330		72,874
Deposits and Prepayments	10	3,420		4,444
Excess & Shortages	11	11		11
			89,761	77,330
Total Current Assets			311,264	250,590
Non-Current Assets				
Capital work-in-progress	12		6,600	13,177
Property, Plant & Equipment	13	2,957,672		2,873,116
Less:- Accumulated Depreciation		811,831		720,325
			2,145,841	2,152,791
Intangible Assets	14		-	2,382
			2,145,841	2,155,173
Total Non-Current Assets			2,152,440	2,168,350
Total Assets			**2,463,704**	**2,418,940**
LIABILITIES				
Current Liabilities				
Creditors and Payables	15	33,515		31,007
Accrued Expenses	16	23,761		26,430
Short-term Borrowings	17	28,448		39,568
Short-term Provisions	18	10,869		9,662
Employee Benefits	19	4,866		4,473
			101,459	111,140
Non-Current Liabilities				
On Going Projects	20	95,616		38,296
Provision for Gratuity	21	265,474		230,491
Petrol Deposit Refundable	22	11		13
Long Term Borrowings	23	16,947		18,749
			378,049	287,548
Total Liabilities			479,509	398,688
Total Net Assets			**1,984,196**	**2,020,252**
NET ASSETS/EQUITY				
Grants & Reserves	24		423,508	382,566
Tea Research Fund			(186,265)	(108,787)
Revaluation Reserve			1,746,953	1,746,473
Total Net Assets/Equity			**1,984,196**	**2,020,252**

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 (Acting)

TEA RESEARCH BOARD

STATEMENT OF FINANCIAL PERFORMANCE FOR THE YEAR ENDED 31ST DECEMBER 2021

	Note	SLPSAS 2021 Rs. '000	SLPSAS 2020 Rs. '000
Revenue			
Government Funds (Recurreent)	} 25	383,500	387,680
Deferred Income (Capital)		83,898	79,187
Other Income	26	23,037	29,235
		490,436	**496,102**
Add: P/L from Two Estates	27	(52,662)	(18,370)
		437,774	**477,732**
Expenses	28		
Personal Emoluments		292,067	309,479
Travelling		2,450	3,105
Supplies and Consumables		12,747	14,314
Repairs & Maintenance		24,524	24,429
Contractual Services, Transport, Utility & Services		49,893	49,192
Electricity & Heating		12,862	14,571
Communications		5,665	4,857
Research and Development		32,375	33,744
Depreciation		71,449	69,803
Other Expenses		3,613	1,934
Finance Cost		335	362
Total Expenses		507,980	**525,791**
Surplus/(Deficit) before Adjustments		(70,206)	(48,059)
Prior Year Adjustments		(7,272)	1,689
Net surplus/(Deficit) for the period		(77,478)	(46,370)

TEA RESEARCH BOARD
CONSOLIDATED CASH FOLW STATEMENT FOR THE YEAR ENDED 31ST DECEMBER 2021

	2021 Rs. '000	2021 Rs. '000	2020 Rs. '000
Cash Inflow / (Out Flow) from Operating Activities			
Net Surplus / Deficit for the year		(70,206)	(48,059)
Adjustment for			
Provision for Bad Debts	(54)		46.68
Prior year Adjustment	(7,272)		1,689
Provision for Gratuity	54,194		26,105
Depreciation	91,755		89,645
Increase Accumulated Depreciation	(248)		148
Interest Income on Investment	1,019		(6,750)
Decrese Fixed Assets adjustment	(478)		1,594
Asset Revaluation adjustment	480		(4,632)
Decrease in Intangible Assets			23
Deferred Income (Recurrent & Capital)	(467,947)		(468,554)
		(328,551)	(360,685)
Operating Cash Inflow / (Out Flow) befroe Changes inWorking Capital		**(398,757)**	**(408,744)**
Changes in Working Capital			
Increase / Decrease in Inventories	(13,456)		(7,250)
Increase / Decrease in Trade & Other Receivables	1,190		3,450
Increase / Decrease in Excess & Shortage	-		9
Increase / Decrease in Creditors & Other Payables	2,508		1,521
Increase / Decrease in Refundable Deposit	(2)		(1)
Increase / Decrease in Deposits & Prepayments	1,024		(1,362)
Increase / Decrease in Accrued Expenses	(2,669)		1,097
Increase / Decrease in Short Term Provisions	1,207		489
Increase / Decrease in Employee Benefits	393		1,110
		(9,804)	(937)
		(408,561)	(409,681)
Less: Gratuity Paid	19,211		(22,348)
Interest Received	1,019		6,750
		20,230	(15,599)
Net Cash Inflow / (Out Flow) from Operating Activities		**(428,791)**	**(425,280)**
Cash Inflow /(Out Flow) from Investing Activates			
Intangible Assets	2,382		-
Investing Activities	(1,302)		(2,080)
Purchase of Fixed Assets	(84,078)		(149,191)
Decrease in WIP	6,578		7,281
Increase in On-going Projects	57,321		10,945
Net Cash Inflow / (Out Flow) from Investing Activites		(19,100)	(133,045)
Net Cash Inflow / (Out Flow) from Operating & Investing Activites		(447,891)	**(558,325)**
Cash Inflow / (Out Flow) from Financing Activites			
Grants Received from Treasury	508,888		589,627
Loan Obtained	40,650		45,500
Loan Repaid	(53,571)		(42,446)
Brokers Advance	12,000		-
Brokers Advance Repaid	(12,000)		-
Net Cash Inflow / (Out Flow) from Financing Activites		495,967	592,681
Net Increase / (Decrease) in Cash and Cash Equivalents		**48,076**	**34,356**
Cash & Cash Equivalents at beginning of the year		**37,037**	**2,681**
Cash & Cash Equivalents at end of the year		**85,113**	**37,037**

TEA RESEARCH BOARD
STATEMENT OF CHANGES IN EQUITY FOR THE YEAR ENDED 31ST DECEMBER 2021

Rs'000

	Tea Research Fund	Revaluation Reserves	Grants & Reserves	Total Equity
Balance as at 01/01/2021	(108,787)	1,746,473	382,566	2,020,252
Prior year adjustment	(7,272)	-	-	(7,272)
Amounts received to Grant & Reserves	-	-	508,888	508,888
Amount transferred to Deffered Income	-	-	(467,947)	(467,947)
Revaluation Profit /(Loss)	-	480	-	480
Surplus / (Deficits) for the year	(70,206)	-	-	(70,206)
Balance as at 31/12/2021	(186,265)	1,746,953	423,508	1,984,196

Schedule A

TEA RESEARCH BOARD
ST.COOMBS & LAMILIERE ESTATES WORKING ACCOUNT
FOR THE PERIOD FROM 1ST JANUARY TO 31ST DECEMBER 2021

2020 Rs. Cts	2020 Kg's			2021 Kg's	2021 Rs. Cts	2021 Rs. Cts
		REVENUE				
		Tea sales Gross Proceeds				
131,575,860	206,494	Tea Sales Ex. Brokers(Gross)		204,718	133,446,907	
52,574,301	107,487	Tea sales Local & Graties		61,023	34,587,956	
-	-	Green Leaf Sales		5,844	1,992,429	
184,150,161	**313,980**			**271,584**		**170,027,291.26**
		Cost of Sales				
20,344,358	36,947	Opening Stock 01/01/2021		33,601	21,525,424	**21,525,423.70**
		Add				
204,163,313	310,634	Cost of Manufacturing	***Sch A. (1)***	264,149	214,444,901	
224,507,672	**347,581**			**297,750**	**235,970,324**	
		Less				
21,525,424	33,601	Closing Stock 31/12/2021		26,165	17,716,734	
202,982,248	**313,980**	**Cost of Sales**		**271,584**		**218,253,589.98**
(18,832,087)		**Gross Profit**				**(48,226,298.72)**
	-					
		Add				
593,635		ADB Profit / Loss (Sales of VP Cuttings)			18,175.78	
2,118,700		Local Tea Centre Profit/Loss			1,477,001.97	
8,107,229		Miscellaneous Income			8,789,295.08	
504,430		Deferred Income			442,876.36	
11,323,994		**Total Income**				**10,727,349.19**
(7,508,093)						**(37,498,949.53)**
		Administration & Finances				
2,866,080		Bank Loan & Brocker Advance Interest			1,817,758.54	
2,866,080						**1,817,758.54**
		Sales Tax & Disribution Expenses				
1,919,902		Brokerage,Handling charges & Sales Expenses			1,735,506.55	
1,919,902						**1,735,506.55**
4,785,983		**Total Expenditure**				**3,553,265.09**
(12,294,075)		**Profit /(Loss) For the Year**				**(41,052,214.62)**
		Schedule A. (1)				
		Cost of Manufacturing				
51,061,586		General Charges				77,562,333.85
21,045,644		Field Work & Cultivation				18,689,148.40
76,201,207		Production				93,240,228.75
10,127,823		Depreciation				9,402,948.52
45,727,055		Bought Leaf				15,550,241.21
204,163,313						**214,444,900.73**

Schedule B

TEA RESEARCH BOARD
ST.JOACHIM ESTATE WORKING ACCOUNT
FOR THE PERIOD FROM 1ST JANUARY TO 31ST DECEMBER 2021

2020 Rs. Cts	2020 Kg's			2021 Kg's	2021 Rs. Cts	2021 Rs. Cts
		REVENUE				
		Tea sales Gross Proceeds				
87,981,330.10	138,781	Tea Sales Ex. Brokers(Gross)		222,550	139,782,935.00	
7,298,111.98	15,996	Tea sales Local & Graties		15,074	7,708,782.00	
95,279,442.08	**154,777**			**237,624**		**147,491,717.00**
		Cost of Sales				
16,214,766.81	30,354	Opening Stock 01/01/2021		27,047	16,879,065.25	
		Add				
112,647,286.92	151,469	Manufacturing	*Sch B. (1)*	243,222	171,509,710.35	
	181,823			**270,269**	**188,388,775.60**	
		Less				
16,879,065.25	27,047	Closing Stock 31/12/2021		32,645	19,959,260.53	
111,982,988.48	**154,777**	Cost of Sales		**237,624**		168,429,515.07
(16,703,546.40)		Gross Profit				**(20,937,798.07)**
		Add				
1,807,006.57		Tea Center Profit			1,472,156.62	
580,791.00		Profit/Loss from Nursery			69,299.59	
5,759,645.57		Sale of Green Leaf			6,836,810.05	
7,385,776.62		Miscellaneous Income			5,339,222.40	
19,040.00		Income From Rubber			17,500.00	
(547,414.02)		Profit/Loss from ADB Shoots			(734,199.29)	
855,720.00		Deferred Income			855,719.52	
15,860,565.74						13,856,508.89
(842,980.66)		**Total Income**				**(7,081,289.18)**
		Administration & Finances				
3,861,268.65		Bank Loan & Broker Advance Interest			2,320,261.79	
						2,320,261.79
		Sales Tax & Disribution Expenses				
1,371,470.99		Brokerage, Handling charges & Sales Expenses			2,207,926.36	
5,232,739.64						**2,207,926.36**
5,232,739.64		**Total Expenditure**				**4,528,188.15**
(6,075,720.30)		**Profit /(Loss) For the Year**				**(11,609,477.33)**

Schedule B. (1)
Cost of Manufacturing

3,297,089.90	General Charges	1,911,320.27
1,123,721.19	Field Work & Cultivation	1,724,707.48
3,111,527.59	Production	4,325,619.00
57,162.25	Expenditure on Rubber	230,845.11
10,420,115.73	Depriciation	10,903,206.34
94,637,670.26	Bought Leaf A/C	152,414,012.15
112,647,286.92		**171,509,710.35**

TEA RESEARCH BOARD
NOTES TO THE ACCOUNTS AS AT 31ST DECEMBER 2021

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 utilized 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 has been 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 31st December 2021 are 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 the principal possessor of 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) and has 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 loss 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 of Tea Harvesting among the Tea Small Holders to overcome the labour shortage with the collaboration of Tea Small Holders' Development Authority (TSHDA) and Sri Lanka Tea Board (SLTB). Sum of Rs. 48 Mn has 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 (Treasury) in 2018. The amount is appearing in the books of accounts as at 31st December 2021 and will be adjusted in 2022 accordingly.

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.	Machinery and Equipments	20%	
IV.	Laboratory Equipment	20%	
V.	Library Books	20%	
VI.	Water Supply	10%	
VII.	Furniture	10%	
VIII.	Office Equipment	10%	
IX.	Electricity Installation	10%	
X.	Telephone	10%	
XI.	Water Supply Equipment	10%	
XII.	Capital Replanting	3%	
XIII.	Computers and Software	25%	
XIV.	Roads	5%	w.e.f Year 2018

e) Produce Stock/Inventories

i. **Stocks -** Stocks are measured at the lower of cost and net realizable value in accordance with SLPSAS 09 except the biological asset/produce stocks arisen from the agricultural activities which are measured accordance with well-established practices in the plantation industries.

ii. **Reclaimable Tea -** A new terminology was introduced by 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.

Year's Transaction

Income

Estate	Quantity Sold (kg)	Avg at (Rs)	Value (Rs)
St. Coombs Estate	35,390	233.38	8,259,228
St. Joachim Estate	24,065	156.55	3,767,512

Stock Valuation

Estate	Quantity Sold (kg)	Valued at (Rs)	Valuation (Rs)
St. Coombs Estate	8,224	220.00	1,809,280/-
St. Joachim Estate	4,153	165.00	685,245/-

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

i. 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 Gratuity Provision is based on Half Month Salary "x" No. of Service Years or last 14 Days Salary "x" No of Service Years.

ii. Adjustment of under provision due to the estate labour wage increment has been recognized as an expense in the current year ended 31st December 2021 on the following segments.

TRI Lent Labours - Rs. 7,534,800/-
St. Coombs Estate - Rs. 24,238,455/-
St. Joachim Estate - Rs. 4,548,550/-

i) Provision for Holiday Pay and Bonus
The basis of calculation is as follows:

$$\frac{\text{Total earnings for the year "x" Number of Entitled days}}{\text{Total days worked for the year (Per Employee)}}$$

j) Green Leaf
The 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
i. The comparative information in respect of the previous year is re-classified wherever necessary to comply with the current year's classification in order to provide a better presentation as per SLPSAS 01.
ii. Stock classifications (opening and closing stocks) and Cost of Sales are presented in the Financial Statements with effect from year 2018 separately.

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/- for 04 ex-officers employed by TRI as of end 2021. 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 is totally beyond the control of the entity.

b) Outstanding and Pending Court Cases
Three court cases, One LT case and One pending case are in progress as at 31st December 2021 and will be confirmed only by the occurrence or non-occurrence of one or more uncertain future events (decision of courts) which is totally beyond 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: In this case, the asset will be recognized in the period when the change in status occurs.***

b) Financial Fraud in St Coombs Estate

Domestic inquiries are in progress 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 2021.

Note 05 - Biological Assets

There are 5,654 numbers of valuable trees identified and marked in the premises of Talawakelle, Ratnapura, Hantane, Passara and Kottawa of the Board. However, the above numbers of trees have not been valued and taken into the accounts.

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 will be disclosed in the 2022 financial statements accordingly.

b) Tea Research Fund

Tea Research Fund has been decreased and recorded negative balance since 2019. 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 2021 to 31st December 2021.

	2021 Rs. Cts	2020 Rs. Cts
Note 07		
Cash and Cash Equivalents		
Cash and Bank Balance		
Tea Research Institute		
Bank of Ceylon, Talawakelle	5,101,304.13	4,903,172.64
Bank of Ceylon, Corporate Branch	19,931,249.54	(16,352,742.44)
Bank of Ceylon, Working Account (St. Coombs)	(14,224,870.16)	(14,259,220.20)
Bank of Ceylon, Savings Account (St. Coombs)	147,280.03	142,932.70
Bank of Ceylon, Working Account (St. Joachim)	98,000.00	278,722.27
Bank of Ceylon, Savings Account (St. Joachim)	247,002.50	83,075.06
Cash - TRI Talawakelle	245,215.35	326,845.96
Cash - Imprest - TRI Ratnapura	198,512.65	191,970.43
Cash - Imprest - TRI Hantana	53,883.36	155,080.00
Cash - Imprest - TRI Kottawa	14,640.28	22,080.78
Cash - Imprest - TRI Passara	57,562.53	75,457.00
Cash - Imprest - TRI Deniyaya	23,328.82	102,677.38
Cash - Imprest - TRI Walahanduwa	8,147.33	9,185.08
Cash - Imprest - TRI Mathugama	2,280.00	44,836.95
Stamps Imprest - TRI Talawakelle	3,835.00	930.00
Stamps Imprest - TRI Ratnapura	1,185.00	1,570.00
Stamps Imprest - TRI Hantana	585.00	705.00
Stamps Imprest - TRI Kottawa	1,110.00	975.00
Stamps Imprest - TRI Passara	560.00	-
Stamps Imprest - TRI Walahanduwa	392.00	332.00
Stamps Imprest - TRI Deniyaya	-	75.00
Stamps Imprest - TRI Matugama	120.00	360.00
Postal Franker - TRI Talawakelle	73,975.90	63,120.90
Postal Franker - TRI Ratnapura	3,249.45	3,514.45
	11,988,548.71	(24,204,344.04)
St. Coombs Estate		
Cash in Hand	105,412.76	4,560.51
Cash at Bank	141,143.11	1,539,121.81
Stamps	480.00	250.00
	247,035.87	1,543,932.32
St. Joachim Estate		
Cash in Hand	61,856.55	754.18
Cash at Bank	5,000.00	163,274.48
Stamps	1,015.00	740.00
	67,871.55	164,768.66
Short Term Investments		
Call Deposits - BOC (Corporate Barnch)	72,809,911.44	59,532,449.16
Total Cash & Cash Equivalents	**85,113,367.57**	**37,036,806.10**

	2021 Rs. Cts.	2020 Rs. Cts.
Note 08		
Trade and Other Receivables (Current)		
Debtors and Other Debit Balances		
Tea Research Institute		
TSHDA		
Sundry Debtors	3,437,252.80	3,832,764.87
Debtor- Income Utilization	152,950.00	-
Mechanization of Tea Harvesting	110,224.14	110,224.14
Recovery A/c (Staff Debtors)	240,919.18	240,551.44
Trade Debtors	472,825.97	714,589.09
Analytical Charges Due	346,320.00	1,033,905.00
Insurance Claim Due	336,239.01	454,289.01
Accrued Interest (BOC)	1,191,513.70	1,280,714.01
	6,288,244.80	7,667,037.56
St. Coombs Estate		
Check Roll Debtors	1,977,731.26	1,862,128.47
Sundry Debtors	999,406.38	441,992.64
Cash Not Deposited 2017/2018	3,217,245.27	3,217,245.27
Tea Center Debtors	6,078,407.12	6,067,209.62
Refuse Tea Debtors	308,346.00	308,346.00
Debtors - Mr. R.A.D.Kalum	672,630.14	672,630.14
Debtors - Mr. E M Dayaratne	-	3,985.99
Debtors - Mr. M M L Jayathilake	30,751.84	30,751.84
Electricity Recovery Lamillier	1,691.69	650.00
Sri Lanka Tea board & TSHDA	1,930,330.77	1,960,497.77
ADB Debtors	553,250.00	397,250.00
Labour Jurking Recovery	267,304.09	185,329.09
Staff Debtors	113,711.17	113,400.88
	16,150,805.73	15,261,417.71
St. Joachim Estate		
Agency Post Office	-	6,500.00
Check Roll Debts	23,515.86	23,683.73
Sundry Debtors	406,331.06	346,698.50
GL 340	654,143.28	507,117.73
GL 371/ Star project	-	204,678.91
M.P.C.S.Ltd Ratnapura	16,173.42	7,269.87
Staff Debtors	4,322.37	14,850.77
DCC Jayasekara WP KS 9386	-	5,780.00
Bought Leaf Debts	216,614.19	251,099.54
Kiriporuwa Estate	139,475.00	74,000.00
Harshani Water Supply Project	-	-
	1,460,575.18	1,441,679.05
Loans and Advances		
Tea Research Institute		
Staff Loans	21,136,572.50	20,740,254.04
Labour Loans - TRI Hantana	29,077.00	51,630.00
Labour Loans - TRI Kottawa	52,000.00	53,000.00
Labour Loans - TRI Passara	94,000.00	103,000.00
Labour Loans - TRI Deniyaya	5,000.00	6,000.00
Labour Loans - Walahanduwa	4,000.00	4,000.00
Labour Loans Skilled Workers	10,250.00	9,000.00
	21,330,899.50	20,966,884.04

Cont'd….

	2021 Rs. Cts.	2020 Rs. Cts.
St. Coombs Estate		
Festival Loan - Workers	4,112,535.00	3,969,435.00
Labour Advance	2,127,118.05	2,388,418.05
Cash Advance	92,200.00	926,668.00
Staff Loan	1,424,084.91	1,436,063.00
Special Loans	609,492.61	609,492.61
	8,365,430.57	9,330,076.66
St. Joachim Estate		
Staff Loan	67,509.84	92,510.50
Deepavali Festival Advance	726,624.94	821,124.94
X'mas Festival Advances	50,000.00	50,000.00
Sinhala New Year Festival Advance	157,850.00	157,350.00
	1,001,984.78	1,120,985.44
Total Trade & Other Receivables	**54,597,940.56**	**55,788,080.46**

Note 09
Inventories/Stocks

Tea Research Institute		
General Stocks	4,905,450.41	6,404,963.09
Electrical Stocks	899,934.08	1,239,860.23
Stocks at TRI Ratnapura	1,184,867.21	1,064,279.44
Stocks at TRI Hantana	478,893.53	466,742.30
Stocks at TRI Kottawa	99,116.35	149,730.16
Stocks at TRI Passara	137,672.32	106,099.50
Stocks at TRI Walahanduwa	44,820.00	47,720.00
Drugs Stocks	210,407.95	210,407.95
Motor Spare Parts Stocks	1,765,798.55	1,926,324.02
Stationery Stocks	803,391.79	1,154,288.09
Stationery Stocks-Walahanduwa	19,229.36	23,657.86
Tea Stock TRI Talawakelle	257,443.75	332,758.75
Milk & Sugar Stock Talawakelle	187,213.86	141,874.14
Tea Stock - TRI Ratnapura	-	11,950.20
Publication Stocks (Hand book on Tea)	1,864,258.00	31,925.00
Field Guide Book	4,950.00	6,022.50
Labour Economic on Tea	900.00	1,200.00
Timber Stocks A/c - TRI Kottawa	9,271.97	9,375.30
Timber Stocks A/c - TRI Hantane	6,016.67	6,016.67
	12,879,635.80	13,335,195.20

Cont'd….

	2021 Rs. Cts.	2020 Rs. Cts.
Goods-in-Transit A/c	22,486,867.15	10,631,656.12
Timber Stocks A/c - TRI Passara	4,873.88	1,828.88
V.P Plants Stocks -Hantane	1,357,410.03	1,202,013.18
V.P Plants Stocks -Kottawa	1,179,722.23	1,069,171.54
V.P Plants Stocks - Passara	314,911.52	207,195.27
V.P Plants Stocks -Deniyaya	471,028.15	420,797.89
Water Treatment Chemical Stocks	239,971.90	238,065.70
Stock of Fuel in Vehicles	251,294.90	249,697.45
Offset Paper Stocks	303,800.00	22,678.00
	26,609,879.76	14,043,104.03
St. Coombs Estate		
Rice & Food stuff	134,521.34	260,729.89
General Stock	6,363,025.98	3,755,897.90
Shade Nursery	-	55,168.23
Made Tea Stock	17,863,421.80	21,712,531.20
Nursery Stock 2019/2020	180,566.85	662,830.99
	24,541,535.97	26,447,158.21
St. Joachim Estate		
General Stock	1,181,018.08	871,477.35
Nursery Stock 2019/2020	40,273.00	326,276.05
Nursery Stock 2020/2021	935,150.85	772,497.14
Nursery Stock 2022/2023	9,100.00	-
Made Tea Stock	20,133,807.35	17,078,521.95
	22,299,349.28	19,048,772.49
Total Inventories/Stocks	86,330,400.81	72,874,229.93

Note 10
Deposits and Prepayments

Deposits
Tea Research Institute

Advance A/c	236,988.65	1,509,722.54
Deposits A/c	1,559,600.00	1,569,600.00
Deferred Revenue Expenditure TRI Hantane	32,878.42	100,850.16
Empty Cylinder Deposits A/c	625,107.60	625,107.60
	2,454,574.67	3,805,280.30

Cont'd….

	2021 Rs. Cts	2020 Rs. Cts
St. Coombs Estate		
New Crech Lamilier	-	(175.00)
TRI Staff Co-operative Stores	400.00	400.00
Empty Gas Cylinder Deposit	30,467.00	30,467.00
	30,867.00	30,692.00
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		-
	25,250.00	25,250.00
Pre Payments		
Tea Research Institute		
Pre Payments	908,991.49	582,863.73
	908,991.49	582,863.73
Total Deposits & Prepayments	3,419,683.16	4,444,086.03
Note 11		
Excess and Shortage		
Opening Balance as at 01/01/21	11,209.65	20,674.71
Fuel Adjustment	-	(9,465.06)
Closing Balance as at 31/12/2021	**11,209.65**	**11,209.65**
Note 12		
Capital Working Progress		
TRI Work-in-Progress	2,730,109.00	4,196,763.36
LTP Project	-	4,142,173.22
St. Coombs Estate Work-in-Progress	3,235,874.47	2,621,162.71
St. Joachim Estate Work-in-Progress	444,080.19	444,080.19
ISO Certificates WIP St.Coombs	189,479.00	189,479.00
Save the Childrens Project St.Coombs	-	1,583,507.90
Total Capital Working Progress	**6,599,542.66**	**13,177,166.38**

Note 13
Fixed Assets as at 31/12/2021

Item	Cost as at 01.01.2021	Addition Adjustments 2021	Disposal Adjustments 2021	Accounting Adjustments 2021	Balance as at 31.12.2021	Depreciation as at 01.01.2021	Depreciation for the year 2021	Disposal Adjustments 2021	Accounting Adjustment 2021	Accumulated Depreciation 31.12.2021	Net Book Value as at 31.12.2021
T.R.I											
Lands	**244,656,124**	-			**244,656,124.31**	-	-	-	-	-	**244,656,124.31**
Building	**948,014,592**	9,780,837			**957,795,428.34**	98,186,581	19,069,193			117,255,775	**840,539,653.67**
Internal Roads	**6,209,498**	873,900			**7,083,398.00**	1,235,677	332,354			1,568,030	**5,515,367.75**
Machinery & Equipments	**363,930,774**	46,632,640			**410,563,413.64**	**266,459,446**	41,062,381			307,521,827	**103,041,586.61**
Furniture	**47,759,956**	691,471			**48,451,427.27**	**24,580,518**	4,791,599			29,372,117	**19,079,309.87**
Utility Services	**23,424,714**	5,520,432			**28,945,145.85**	**5,443,228**	2,491,999			7,935,227	**21,009,918.73**
Vehicles	**111,014,686**	1,723,250		480,172	**113,218,108.68**	**106,069,349**	2,184,383		(248,002)	108,005,730	**5,212,378.42**
Other Fixed Assets	**3,956,716**	285,000			**4,241,715.62**	**508,813**	394,460			903,273	**3,338,443.06**
Library Books	**59,681,099**	136,665		(1,935)	**59,815,828.95**	**58,289,584**	776,425			59,066,008	**749,820.64**
Re- Planting Mature	**10,384,315**	755,073			**11,139,387.73**	**7,084,921**	345,832			7,430,753	**3,708,634.98**
Re- Planting Immature	**2,742,503**	(755,073)			**1,987,429.36**	-				-	**1,987,429.36**
Total	**1,821,774,976**	**65,644,195**	-	**478,237**	**1,887,897,408**	**567,858,117**	**71,448,625**	-	**(248,002)**	**639,058,740**	**1,248,838,667**
St.Coombs/St.Joachim											
Lands	**543,278,379**				**543,278,379**	-				-	**543,278,379**
Buildings	**219,648,177**	1,000,000			**220,648,177**	**24,953,805**	4,530,556			29,484,361	**191,163,816**
Machinery & Equipments	**91,508,823**	15,280,095			**106,788,918**	**49,044,071**	9,503,518			58,547,590	**48,241,328**
Furniture	**508,198**				**508,198**	**219,372**	50,819			270,191	**238,007**
Utility Services	-	791,326			**791,326**	-				-	**791,326**
Vehicles	**26,097,023**				**26,097,023**	**21,299,050**	1,508,394			22,807,444	**3,289,579**
Other Fixed Assets	**382,700**	1,362,217			**1,744,917**	**76,797**	54,755			131,552	**1,613,365**
Total Estates	**881,423,300**	**18,433,637**	-	-	**899,856,937**	**95,593,095**	**15,648,042**	-	-	**111,241,137**	**788,615,800**
Total TRI & Estates	**2,703,198,276**	**84,077,832**	-	**478,237**	**2,787,754,345**	**663,451,212**	**87,096,667**	-	**(248,002)**	**750,299,877**	**2,037,454,468**
Capital Re Planting Development											
Programme											
St.Coombs Estate Mature	**64,651,098**	72,670			**64,723,768**	**23,236,255**	2,909,299			26,145,555	**38,578,213**
St.Coombs Estate Immature	**195,584**	(72,670)			**122,914**	-				-	**122,914**
St.Joachim Estate Mature	**102,785,802**	1,325,706			**104,111,508**	**33,637,059**	1,748,814			35,385,873	**68,725,635**
St.Joachim Estate Immature	**2,285,263**	(1,325,706)			**959,557**	-				-	**959,557**
Total Replanting	**169,917,747**				**169,917,747**	**56,873,315**	**4,658,113**	-	-	61,531,428	**108,386,319**
Total Fixed Assets	**2,873,116,023**	**84,077,832**	-	**478,237**	**2,957,672,092**	**720,324,527**	**91,754,780**	-	**(248,002)**	**811,831,305**	**2,145,840,787**

	2021 Rs. Cts	2020 Rs. Cts
Note 14		
Intangible Assets		
St. Coombs ISO Certificate	-	2,381,613.30
	-	2,381,613.30
Note 15		
Creditors & Payables		
Payables		
Tea Research Institute		
Retention Money Payable	7,374,457.90	7,852,275.93
Tender Deposits Refundable	333,130.63	947,662.75
Security Deposits Refundable	366,605.41	358,084.94
Security Servises Bond	-	-
	8,074,193.94	9,158,023.62
St. Coombs Estate		
Pushpa Trading Corporation	504.00	504.00
Death Donation A/C Lamiliere	3,028.00	17,128.00
Death Donation A/C St.Coombs & TRI	53,413.50	93,363.50
Estate Staff Medical Scheme	1,136,965.94	1,067,206.87
TRI Buddhist Association	3,100.00	3,400.00
Insurance Premium of Cash Transport	-	47,034.03
TRI Sports Club	2,510.00	5,010.00
Temple Committee - St. Coombs	132,657.34	526,754.70
Temple Committee - Lamiliere	65,445.75	305,384.15
One Day Wages Recovery	482,000.00	242,502.70
Check off	187,016.00	221,188.89
Check Roll Recovery	794,777.93	893,355.94
Diyanillakelle Estate (B/L Supply)	-	931,060.30
Sutton Estate, Hatton	77,677.32	-
Smart Business LTD	(1,000.00)	106,560.00
Mr.D.C.C. Jayasekara (Actg. Superintend)	97,214.25	97,214.25
Mr.Buddhi Jayathilake (Asst. Superintend)	34,440.53	105,132.57
Mr.M K D Priyantha (Superintendent)	72,852.56	51,757.62
Mr. Udeni Wanigathunga (Actg.Superintendent)	-	62,323.71
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	523.38
Odinton Estate (B/L Supplier)	-	-
Security Fund - Lamilier	4,950.00	5,200.00
	3,149,966.11	4,784,494.22

	2,021 Rs. Cts	2,020 Rs. Cts
PHDT Housing Loan Recovery	845.44	845.44
Bank of Ceylon (Recovery)	414,210.00	679,260.00
NHDA	23,148.90	23,148.90
Chapel A/C -St Anthony Church	40,400.00	57,350.00
Staff Welfare	116,815.00	304,415.00
Iona Estate, Agarapatane	188,099.68	499,351.80
National Security A/C	750.00	750.00
Made up Cents	2,459.88	282.66
Inland Revenue Department	7,695.33	23,195.33
Creche Childrens Mid - Day Meals	-	7,450.00
Macduf Estate (B/L Supply)	0.10	0.10
Lion Press A/C	2,458.00	2,458.00
Stock Suppliers A/C	6,826,218.98	6,558,738.43
Melton Estate (B/L Supply)	1,006,857.78	-
Tea Small Holder (B/L Supply)	43,610.26	-
Green Leaf Overkg 2021 Balance	1,110,880.00	-
Other Accured Expenditure	993,267.75	650,772.72
	10,777,717.10	8,808,018.38
St. Joachim Estate		
Unclaimed Bought Leaf	280,640.69	268,666.10
Check off	15,986.00	16,736.00
Fine A/C	47,624.42	-
Bought Leaf Suppliers A/c	7,199,532.54	5,257,885.47
Insurance Premium (Recovery)	205.49	205.49
Pay Card recovery	1,292.00	776.00
Bank Loan Recovery	99,200.00	56,050.00
Kovil Rcovery	2,928.63	3,377.15
Stamp Duty	8,400.00	4,575.00
Labour Welfare	12,953.32	12,953.32
Unclaimed wages	56,253.37	66,674.59
Estate Staff Medical Scheme	3,026,315.81	2,461,955.10
Staff Recovery	2,100.00	2,100.00
Cash in Transits A/C	105,741.43	-
Death Donation A/c	7,400.00	8,600.00
Staff Welfare/EWHCS A/C	-	47,624.42
Harshani Water Supply Project	14,503.88	14,503.88
PHDT Housing Society	51,840.00	34,020.00
DCC Jayasekara WP KS 9386	45,160.00	
Contract Nursery	534,976.00	
	11,513,053.58	8,256,702.52
Total Creditors & Payables	33,514,930.73	31,007,238.74

Note 16 Accured Expenses	2021 Rs. Cts	2020 Rs. Cts
Creditors and Credit Balances		
Sundry Creditors	3,742,384.11	13,564,516.68
TSHDA Advance	480,000.00	480,000.00
Advance Receipts (Analytical Work)	1,543,530.00	686,960.00
Hantana Labour Wages	783,868.95	709,740.74
Kottawa Labour Wages	468,038.61	326,838.67
Passara Labour Wages	492,901.02	330,119.93
Deniyaya Laour Wages	108,454.42	56,626.17
Walahanduwa Labour Wages	53,200.00	33,910.00
Treasury Payable A/C	699,717.00	699,717.00
Stamp Duty	-	-
Skilled Workers Wages	26,609.12	26,900.11
Accrued Expenses	1,496,880.00	
	9,895,583.23	16,915,329.30
St Coombs Estate		
Provisions & Accrued Expenditure		
Check Roll	6,863,710.00	5,417,780.77
Sundry Creditors	383,491.14	183,431.09
ADB Payement	318,923.00	268,298.00
	7,566,124.14	5,869,509.86
St Joachim Estate		
Provisions & Accrued Expenditure		
Check Roll	2,610,620.00	1,922,032.02
Sundry Creditors	3,688,821.85	1,722,924.94
	6,299,441.85	3,644,956.96
Total Accrued Expenses	**23,761,149.22**	**26,429,796.12**
Note 17		
Short-term Borrowings		
Tea Research Institute		
Loan against FD - St. Coombs Estate	9,620,968.69	9,767,803.43
Loan against FD - St. Joachim Estate	18,827,192.77	29,800,238.90
	28,448,161.46	39,568,042.33

Cont'd….

	2021 Rs. Cts	2020 Rs. Cts
St. Coombs Estate		
Brokers Advanecs (Forbes & Walker)	-	-
	-	-
St. Joachim Estate		
Brokers Advanecs (Forbes & Walker)	-	-
Total Short-trem Borrowings	**28,448,161.46**	**39,568,042.33**
Note 18		
Short-term Provisions		
Tea Research Institute		
Provision for Audit Fees	1,356,000.00	1,725,000.00
Provision Holiday Pay/Bonus	981,872.60	814,542.54
	2,337,872.60	2,539,542.54
St. Coombs Estate		
Provision for Holiday Pay	4,866,870.00	3,909,120.00
Provision for Attendance Bonus	325,500.00	317,500.00
Incentive Provision (2016)	382,335.63	382,335.63
Incentive Provision (2017)	906,670.16	906,670.16
	6,481,375.79	5,515,625.79
St. Joachim Estate		
Provision for Holiday Pay	1,973,675.92	1,519,794.85
Provision for Attendance Bonus	76,250.00	86,750.00
	2,049,925.92	1,606,544.85
Total Short-term Provisions	**10,869,174.31**	**9,661,713.18**
Note 19		
Employee Benefits		
St.Coombs Estate		
Employees' Provident Fund	3,439,230.53	3,152,244.76
Employees' Trust Fund	449,745.37	558,389.59
	3,888,975.90	3,710,634.35
St. Joachim Estate		
Employees' Provident Fund	868,591.54	679,048.82
Employees' Trust Fund	108,510.00	83,360.00
	977,101.54	762,408.82
Total Employee Benefits	**4,866,077.44**	**4,473,043.17**

	2021 Rs. Cts.	2020 Rs. Cts.
Note 20		
On-Going Projects		
MPI Special Project Plant Breeding	(5,589,976.42)	138,829.01
MPI Special Project Physiology	3,454,049.82	3,454,049.82
MPI Special Project Engineering	3,989,301.25	3,188,255.50
CARP Special Project Entomology	1,621,651.06	1,621,651.06
MPI Special Project Engineering C Type Bungalow	10,676,236.44	10,676,236.44
ACMSC	2,783,806.08	2,669,794.18
Indo Sri Lanka Joint Research Project	416,339.86	(140,765.50)
FAO Passara	192,419.71	160,483.78
Synkromax Biotech Project	(285,265.97)	(805,125.97)
MPI Special Project 19 Eng 18Mn	48,906.72	48,906.72
MPI Special Project 19 Cap Equip 46	1,541,700.73	1,567,426.23
JIFF Products (Plant Breeding)	84,620.70	191,543.03
Michigen	688,600.00	688,600.00
JAT Agri	228,429.95	274,448.14
StaRR Project	(4,355,801.98)	114,718.61
CIC & TRI Tyara Project	838,186.40	850,000.00
Zagro Singapore Testing of Green Tea	110,643.75	116,881.36
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	3,078,873.34	13,228,483.24
Chopping & Trenching Machine (Advisory)	13,857,882.88	-
Mobile Laboratory (Advisory)	14,522,403.69	-
Experimental Tea Factory (Technology)	30,572,165.99	-
Automated Tea Harvester (Agronomy)	7,530,313.63	-
Seed Garden Establishment P/ Breeding	6,844,989.37	-
Promotion of Bio Petside P / Breeding	2,514,674.78	-
		-
Total On-going Projects	**95,616,432.90**	**38,295,696.77**
Note 21		
Provision for Gratuity		
Tea Research Institute		
Opening Balance as at 01/01/21	140,884,785.25	136,783,766.15
Add : Provision for the year	17,624,291.60	19,896,566.60
Under Provision	390,990.00	1,942,665.00
	158,900,066.85	158,622,997.75
Less : Paid During the year	13,774,785.00	17,603,812.50
Over Provision	37,125.00	134,400.00
Closing balance as at 31/12/21	**145,088,156.85**	**140,884,785.25**
St.Coombs Estate		
Opening Balance as at 01/01/21	69,330,847.75	69,291,531.75
Add : Provision for the year	5,919,000.05	4,464,460.00
Under Provision	24,238,454.70	-
	99,488,302.50	73,755,991.75
Less : Paid During the year	3,661,233.75	3,186,427.50
Over Provision	-	1,238,716.50
Closing balance as at 31/12/21	**95,827,068.75**	**69,330,847.75**
St. Joachim Estate		
Opening Balance as at 01/01/21	20,275,286.00	20,658,704.63
Add : Provision for the year	1,517,735.00	1,381,648.38
Under Provision	4,548,550.00	
	26,341,571.00	22,040,353.01
Less : Paid During the year	1,775,000.00	1,558,200.00
Over Provision	7,511.00	206,866.63
Closing balance as at 31/12/21	**24,559,060.00**	**20,275,286.38**
Total Provision for Gratuity	**265,474,285.60**	**230,490,919.38**

	2021 Rs. Cts.	2020 Rs. Cts.
Note 22		
Petrol Deposit Refundable		
Opnenig Balance as at 01/01/2021	12,800.00	14,000.00
Add:- Additions during the year 2021	250.00	1,000.00
	13,050.00	15,000.00
Less:- Refunds during the year 2021	2,050.00	2,200.00
Closing Balance as at 31/12/2021	11,000.00	12,800.00
Note 23		
Long-term Borrowings		
Tea Research Institute		
Loan against FD - St. Coombs Estate	6,861,666.90	8,521,666.84
Loan against FD - St. Joachim Estate	10,085,645.44	10,226,942.61
	16,947,312.34	18,748,609.45
Note 24		
Grants and Reserves		
Tea Research Institute		
Government Grants	163,986,495.91	138,102,145.04
Treasury Grant Duke's Bungalow	28,000.00	31,500.00
Treasury Grant for Motor Vehicles	-	82,800.55
Capital Reserve - National Scientific	566,305.09	1,751,705.09
Capital Reserve - ADB	73,516,253.25	76,470,000.25
Capital Reserve - ARP	5,602,653.79	5,859,520.41
Capital Replanting - SLTB	1,109,975.00	359,975.00
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 Childrens (St.Coombs) 2017	1,600,000.00	1,600,000.00
Capital Reserve 30mn Special Project - 2017	6,709,620.48	12,842,846.32
Capital Reserve 30mn Special Project - 2016	1,755,104.65	6,847,760.71
Capital Reserve Indo Sri Lanka Joint Reserch Project	625,810.75	962,598.25
Capital Reserve Special Project Physiology	44,235.62	67,235.62
Capital Reserve Special Project Plant Breeding	1,881,678.62	2,166,299.37
Capital Reserve Special Project ACMSC Unipower Project	40,745.21	62,745.21
Capital Reserve Special Project 2019	35,018,177.73	42,422,514.44
Capital Reserve Special Project 2018 - 99Mm	75,579,855.16	77,260,330.91
Capital Reserve Tresuary Special Project - Bio Chemistry	513,847.74	2,779,567.39
Capital Reserve Michigen	122,340.05	136,480.05
Capital Reserve STaRR Project	11,659,432.80	7,508,281.27
Capital Reserve MPI Spaicial Project 2020	18,723,924.27	-
Capital Reserve Experiment Tea Factory	13,936,679.29	-
Capital Reserve Supporting Genetic Imrpvement of P/Breeding	5,295,798.93	-
	421,286,173.82	380,283,545.36
St. Coombs Estate		
PHDT Grant	2,221,336.95	2,282,890.68
	2,221,336.95	**2,282,890.68**
Total Grants & Reserves	**423,507,510.77**	**382,566,436.04**

Note 25	2021 Rs. Cts	2020 Rs. Cts
Government Funds (Recurrent)		
Government Grants Received for Recurrent Expenditure	383,500,000.00	387,680,000.00
Total Government Funds (Recurrent)	**383,500,000.00**	**387,680,000.00**
Deferred Income (Capital)		
Deferred Income from Government Grants Received for R & D	53,008,867.38	33,743,846.00
Deferred Income from Government Grants Received Capital Assets	-	20,970,108.70
Deferred Income from other Grants	30,889,572.39	24,472,845.03
Total Deferred Income (Capital)	**83,898,439.77**	**79,186,799.73**

Note 26 Other Income		
Sales of Colonal Cuttings		
TRI Hantane	763,650.00	759,337.50
TRI Kottawa	967,127.50	684,712.50
TRI Passara	966,675.00	798,225.00
TRI Deniyaya	44,063.00	60,187.50
	2,741,515.50	2,302,462.50
Sales of Green Leaf		
TRI Talawakelle	298,920.75	192,824.36
TRI Hantane	1,893,202.32	1,591,241.65
TRI Kottawa	2,383,438.83	2,869,612.00
TRI Passara	2,162,091.61	2,622,229.76
TRI Mathugama	-	-
TRI Deniyaya	583,978.65	261,959.96
	7,321,632.16	7,537,867.73
Net Sales of VP Plant		
TRI Hantane	(132,346.70)	7,226.14
TRI Kottawa	60,559.38	87,884.83
TRI Deniyaya	29,104.00	2,091.60
TRI Passara	22,312.75	100,936.75
TRI Ratnapura	-	-
	(20,370.57)	198,139.32

	2021 Rs. Cts	2020 Rs. Cts
Miscellaneous		
Sales of Publication	148,300.00	197,014.50
Interest & Rental	1,018,864.48	912,981.19
Analyticle Services	5,337,115.00	8,840,735.50
Miscellaneous	1,777,466.34	2,496,052.17
	8,281,745.82	12,446,783.36
Interest on Investment	4,712,672.30	6,749,688.05
	4,712,672.30	6,749,688.05
Total Other Income	**23,037,195.21**	**29,234,940.96**

Note 27
P/L from Two Estates

Net Profit from St. Coombs Estate ***(Scheduel - A)***	(41,052,214.62)	(12,294,075.49)
Net Loss from St. Joachim Estate ***(Scheduel - B)***	(11,609,477.33)	(6,075,720.30)
Net Profit / (Loss) From Estates	**(52,661,691.95)**	**(18,369,795.79)**

Note 28
Expenses

	EXPENDITURE	Administration Finance and Common Service	Advisory, Extensions & Publicity	Substation Ratnapura Hantane	Research	2021 Rs. Cts Total	2020 Rs. Cts Total
01	Personnel Emoluments	79,027,683.89	34,003,320.15	34,996,363.88	87,569,468.22	235,596,836.14	246,779,378.22
08	Pensions and Retirement Benefits	10,330,834.07	5,167,943.78	3,833,906.68	12,393,181.49	31,725,866.02	33,988,728.97
08	Gratuity Provision	17,980,744.10	-	-	-	17,980,744.10	21,704,831.60
02	Travelling	995,669.34	642,127.50	290,422.75	521,602.75	2,449,822.34	3,104,949.81
03	Supplies and Requisites	6,076,382.64	1,429,317.15	1,342,180.15	3,898,862.42	12,746,742.36	14,314,227.76
04	Repairs and Maintenance of Capital Assets	16,804,114.39	1,616,199.34	3,699,478.38	2,404,463.72	24,524,255.83	24,428,674.36
04	Depreciation of Fixed Assets	71,448,625.04	-	-	-	71,448,625.04	69,802,920.94
05	Security Services	11,842,978.75	5,659,440.53	7,822,700.11	1,335,222.00	26,660,341.39	23,896,677.40
05	Electricity and Heating	8,290,815.36	614,629.85	3,840,295.44	116,654.70	12,862,395.35	14,571,161.76
05	Communication	3,450,464.17	588,922.80	864,780.21	761,228.68	5,665,395.86	4,857,304.08
05	Transportation, Utility & Other Service	18,505,923.82	2,060,773.30	2,192,173.77	59,665.24	22,818,536.13	24,555,696.61
07	Contributions Grants & Subsidies	5,524,196.36	358,219.57	322,582.08	558,427.93	6,763,425.94	7,005,797.37
10	Media, Advertising, Publicity and Gifts	289,581.69	345,397.03	104,009.57	10,032.00	749,020.29	1,102,025.59
12	Miscellaneous -Other	3,385,992.53	38,950.75	21,338.00	157,737.00	3,604,018.28	1,934,450.79
	Research and Development	-	-	-	-	-	-
13.03	Chemical and Glasswares (Local & Foreign)	122,454.40	326,571.65	47,724.59	9,582,231.31	10,078,981.95	15,293,491.93
13.01	Cultivation and Field Trials	-	9,436,331.21	3,425,292.30	8,518,034.53	21,379,658.04	17,883,692.40
13.05	Nursery Expenditure - TRI	-	-	-	434,393.53	434,393.53	255,056.94
14.01	Training - Local	137,600.00	101,500.00	10,000.00	97,600.00	346,700.00	181,950.00
14.02	Training - Overseas	-	-	-	135,198.00	135,198.00	129,654.72
15	Special Project - TTO Project	-	-	-	9,200.00	9,200.00	-
15	Special Project - Plant Breeding	-	-	-	-	-	-
	Total Expenditure	**254,214,060.55**	**62,389,644.61**	**62,813,247.91**	**128,563,203.52**	**507,980,156.59**	**525,790,671.25**

METEOROLOGICAL OBSERVATIONS

St. Coombs, Talawakelle
(Lat. 6.54'N; Long. 80.42E; 1394 amsl)

Month	Mean Temperature (^{0}C)		Soil Temp. (°C) 20 cm		Relative Humidity (%)		Sun Shine hrs (hrs/month)	Total Evaporation (mm)	Total Rainfall (mm/month)	Wet Days (No./Month)	Wind Velocity Mean (km/hr)
	Max.	Min.	8.30 am	3.30 pm	8.30 am	3.30 pm					
January	-	12.3	-	-	89	78	4.4	48.60	132.1	11	1.6
February	25.9	10.2	22.5	23.2	78	65	7.9	73.20	32.6	3	2.3
March	26.0	13.3	22.4	23.0	72	67	6.5	76.50	143.5	6	2.1
April	26.5	13.6	23.3	24.3	79	74	7.6	73.50	190.9	6	1.8
May	24.6	16.2	23.4	23.8	88	86	4.0	42.60	365.3	15	2.1
June	23.9	15.5	22.8	23.8	87	81	5.0	47.50	160.0	7	2.1
July	23.4	16.2	22.3	22.7	91	85	3.4	41.20	289.5	16	2.7
August	22.7	16.1	22.3	23.1	93	86	2.7	35.6	181.8	15	2.0
September	23.5	16.0	22.5	23.0	92	87	2.8	36.6	192.8	12	1.8
October	23.9	15.7	22.4	22.9	90	88	3.6	31.3	382.1	19	2.8
November	22.9	15.1	22.0	22.5	90	80	2.7	38.1	303.9	21	1.6
December	25.6	13.0	22.4	23.7	78	73	6.1	64.4	49.1	6	1.9
Total								**609.1**	**2423.6**	**137**	**24.8**
Mean	**24.4**	**14.4**	**20.7**	**21.3**	**85.6**	**79.2**	**4.7**	**50.8**	**202.0**		**2.1**

TRI Low-Country Research, Advisory and Extension Centre, Ratnapura
(Lat. 6° 43´ N; Long. 80° 21' E; 29 m amsl)

Month	Mean Temperature (^{0}C)		Relative Humidity (%)		Mean Sun shin	Total Rainfall (mm)	Wet days (No/Month)	Total Evaporation (mm)	Wind Velocity Mean (km/hr)
	Min.	Max.	8.30 hrs	3.30 hrs	(hrs/day)				
January	23.1	32.2	86.5	69.3	3.1	220.1	9	66.6	0.6
February	22.4	34.6	86.5	53.1	5.8	41.8	6	109.9	1.0
March	23.3	34.2	85.3	68.3	4.8	301.2	15	117.1	0.8
April	23.9	34.6	87.0	71.6	5.9	316.4	14	107.3	1.4
May	24.2	33.1	86.2	78.5	3.4	788.4	23	67.7	1.3
June	24.0	32.3	85.1	73.8	4.4	545.4	17	103.6	1.9
July	24.5	32.0	87.2	77.5	3.9	399.2	18	89.2	2.3
August	24.0	31.2	85.3	72.4	3.1	377.6	15	96.3	1.9
September	24.2	31.7	87.4	76.8	2.6	451.6	23	90.9	1.7
October	23.7	32.1	85.9	77.4	3.4	528.8	21	70.0	1.4
November	23.2	31.2	87.8	80.7	2.2	576.5	23	61.7	1.7
December	23.0	34.1	83.6	73.3	5.6	245.4	10	103.3	0.5
Total						**4792.40**	**194.0**	**1083.6**	**16.50**
Mean	**23.6**	**32.8**	**86.2**	**72.7**	**4.0**	**399.37**		**90.30**	**1.4**

TRI, Mid-Country Research, Advisory and Extension Centre, Kandy
(Lat. 7.26' N; Long. 80.63 E; Elevation 762 m amsl)

Month	Mean Temperature (^{0}C)		Soil Temp. (°C) 20cm		Relative Humidity (%)		Mean Sun Shine	Total Evaporation	Total Rainfall	Wet days (No./Month)
	Max.	Min.	8.30 am	3.30 pm	8.30 am	3.30 pm	(hrs/day)	(mm)	(mm)	
January	26.4	19.2	23.4	24.7	87.8	83.2	4.0	45.92	162.3	10
February	26.7	19.0	24.5	26.8	87.8	69.6	6.9	89.02	7.5	2
March	29.9	19.6	26.3	29.0	83.2	74.2	6.4	94.60	106.3	3
April	29.8	19.8	26.1	29.3	86.8	76.1	7.1	72.34	273.2	7
May	27.8	20.7	25.1	27.1	88.6	81.6	3.6	45.37	346.8	15
June	27.7	20.5	25.0	27.6	85.9	78.9	5.1	62.94	117.3	10
July	26.5	20.6	24.7	26.8	88.5	87.1	3.9	42.16	224.5	11
August	26.3	20.3	24.5	26.2	90.0	84.1	3.9	41.72	178.7	11
September	26.9	20.3	24.4	27.2	86.4	83.7	4.3	41.33	148.6	10
October	26.4	20.0	24.0	25.8	87.0	85.4	3.5	46.78	441.9	18
November	25.9	19.6	23.4	24.6	92.0	87.1	2.2	26.08	448.7	21
December	26.9	19.3	23.9	26.2	86.1	80.7	6.2	54.56	95.3	8
Total								**662.8**	**2551.1**	**126**
Mean	**27.3**	**19.9**	**24.6**	**26.8**	**87.5**	**81.0**	**4.8**	**55.2**	**212.6**	**10.5**

TRI, Advisory and Extension Centre, Passara
(Lat. 6.57'N; Long. 81.07 E; 1120amsl)

Month	Mean Temperature (^{0}C)		Relative Humidity (%)		Mean sunshine (hrs/day)	Total Rainfall (mm)	Total Evaporation (mm)
	Max.	Min.	8.30 hrs	3.30 hrs			
January	23.9	16.5	93	91.8	2.7	245.8	1.9
February	24	16.4	80.8	80.6	5.3	74.3	3.24
March	25.8	17.3	74.8	77	3.3	191.4	1.84
April	26.9	18.2	74.3	74.7	4.8	233.7	2.56
May	26.3	18.1	84	78	3.9	132.3	2.33
June	27.7	18.7	72	69	4	81.7	2.2
July	26.2	18.4	79	80	3.9	46.3	2.21
August	26.7	18.3	83	81	3.8	82.7	2.22
September	26.7	18.6	78	78	2.6	41.2	1.59
October	25.9	17.6	82	81	2.9	239.5	1.28
November	24.9	17.6	85	87	2.3	187.2	1.12
December	25	16.9	79	79	4.5	165.3	2.36
Total						**1721.4**	
Mean	**25.83**	**17.72**	**80.41**	**79.76**	**3.67**	**143.45**	**2.07**

TRI, Advisory and Extension Centre, Kottawa
(Lat. 6.05'N; Long. 80 E; 30 m amsl)

Month	Mean Temperature (^{0}C)		Soil Temp. (°C) 20 cm		Relative Humidity		Sun Shine hrs	Total Evaporation (mm)	Total Rainfall	Wet Days	Wind Velocity Mean (km/hr)
	Max.	Min.	8.30 am	3.30 pm	8.30 am	3.30 pm	hrs/month		(mm/month)	(No./Month)	
January	30.8	22.6	28.1	29.8	92	78	4.1	1.55	203.8	13	0.84
February	32.3	21.8	28.4	30.7	87	70	7.4	2.86	41.7	09	1.19
March	32.9	22.4	28.9	31.1	85	72	6.5	2.25	171.1	13	1.24
April	32.2	23.1	29.5	30.5	87	72	7.3	2.23	297.1	15	1.45
May	31.2	23.6	28.9	30.6	88	76	5.9	-	455.3	24	1.96
June	31.1	23.7	28.8	30.2	91	84	5.9	1.51	349.3	23	2.04
July	30.6	24.1	28.2	30.1	88	76	5.4	1.71	311.4	23	2.69
August	30.1	24.0	28.2	29.8	89	77	6.1	1.89	175.8	17	2.41
September	30.4	23.8	28.6	29.9	88	73	5.9	2.20	279.6	22	2.19
October	30.5	23.8	28.3	29.6	88	78	5.5	1.75	472.5	23	1.84
November	29.8	22.9	27.5	29.3	89	80	4.5	1.37	560.4	22	1.55
December	31.7	23.3	28.2	29.3	86	74	6.9	1.93	330.4	15	1.07
Total									**3648.4**	**219**	
Mean	**31.1**	**23.3**	**28.5**	**30.1**	**88**	**76**	**5.95**	**1.77**			**1.71**

TRI, Advisory and Extension Centre, Deniyaya
(Lat. 6.43'N; Long. 80 E; 33.3 250m amsl)

Month	Mean Temperature (^{0}C)		Relative Humidity (%)		Mean sunshine	Total Rainfall	Wet Days (No./Month)	Total Evaporation
	Max	Min	8.30 hrs	3.30 hrs	(hrs/day)	(mm)		(mm)
January	28.7	20.1	81	74	5.2	205.9	51.9	12
February	30.3	19.1	79	73	7.4	147.0	76.1	6
March	30.2	19.8	80	79	7.0	377.1	93.1	12
April	30.6	21.1	84	84	7.7	390.9	74.0	16
May	30.1	22.0	80	79	6.1	808.5	77.2	21
June	29.1	22.5	78	71	7.8	365.6	88.2	11
July	28.4	21.3	78	75	6.3	303.3	78.0	15
August	28.3	22.3	78	74	6.3	203.2	75.5	12
September	28.8	22.3	81	75	6.1	367.5	64.4	19
October	28.9	21.7	80	78	6.1	391.9	63.8	19
November	28.7	21.6	80	78	5.2	420.0	67.0	19
December	29.8	20.6	78	76	6.6	404.6	68.4	15
Total					**77.8**	**4385.5**	**877.6**	
Mean	**29.3**	**21.2**	**79.8**	**76.3**	**6.5**	**365.5**		**14.7**

REPORT OF THE AUDITOR GENERAL

PAL/D/TRB/FS/2021/29 11 October 2022

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 2021 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 2021 comprising the statement of financial position as at 31 December 2021 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 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 2021 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) Although the 92 vehicles belonging to the Tea Research Board with a fully depreciated cost of Rs.101,864,100, ten vehicles belonging to St. Joachim Estate with the revalued amount of Rs. 12,168,584, eight vehicles belonging to St. Coombs Estate cost at Rs. 7,094,000 and machinery and equipment cost at Rs. 31,792,070 were further being used at the end of the year under review, actions had not been taken to disclose with regard to that in accordance with Paragraph 92 (b) of Public Sector Accounting Standards No. 07 and actions had not been taken to revise and re-state the estimated error on these assets

in the financial statements in accordance with Sri Lanka Public Sector Accounting Standard No. 03.

(b) In calculating the net cash flows generated/used from operating and investing activities in the statement of cash flows values of Rs. 3,340,023 and Rs. 3,683,396 respectively had been adjusted incorrectly and interest expense paid amounting to Rs.4,123,220 and interest income received amounting to Rs. 4,518,953 had not been properly separately disclosed in the cash flow statement. Due to this, it was observed during the audit that the cash flow statement presented with the financial statements was not prepared according to the terms of Sri Lanka Public Sector Accounting Standard No. 02 .

(c) Although the value of biological assets should be assessed and accounted for, in accordance with Paragraph 16 of the Public Sector Accounting Standards 18 of Sri Lanka, a number of 5,654 valuable tall shade plants trees in Thalawakele, Ratnapura, Hanthana, Passara and Kottawa Regional Offices had not been so estimated and stated in the financial statements.

(d) Even though 03 vehicles which were given by Sri Lanka Tea Board had been revalued to Rs. 7,413, 550 and shown in the financial statements, the ownership of the vehicles had not been taken over by the Tea Research Board. Likewise, this had not been revealed even in the Notes to the financial statements.

(e) The income tax amounting to Rs. 1,131,041 to be paid on investment interest income of Rs. 4,712,672 in the year 2021 had not been accounted for.

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 2021 of the Board

The other information comprises the information included in the Annual Report 2021 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.

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 mis-stated, I need to report that fact. I have nothing to report in this regard.

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 (a) 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)	Even though the retention from the contracts from the year 2015 to the year 2019 the amounting to Rs. 3,551,559 had remained for more than 02 years, actions had not been taken to settle.
	(ii) F. R. 756 (9)	Although the Board should forward the Boards of Survey Report for the year 2021 to the Auditor General before June 15 of the next financial year, it had not been so done even by the date of audit on 31 July 2022 .
(b)	Section 13. 3 of Chapter II of Establishments Code of the Democratic Socialist Republic of Sri Lanka	Although an acting appointment should be made on a temporary basis until a permanent appointment is made, the appointment of posts of Additional Director, post of Senior Accountant, 01 post of Engineer, 04 Heads of Divisions, 04 more posts of the Board had made on acting basis without making regular appointment from year 01 to year 09 and a sum of Rs. 1,508,773 had been paid as acting allowances during the year under review.
(c)	Public Enterprises Circular No. PED / 12 of 02 June 2003 and Section 11 of the Finance Act No. 38 of 1971	Although the concurrence of the Minister of Finance and the relevant Minister should be obtained in investing money, such an approval had not been obtained when investing Rs. 81,980,000 in short-term deposits the Board as at 31 December 2021 .
(d)	Section 9.14 of Public Enterprises Circular No. PED / 12 of 02 June 2003	Although a procedural manual for the formulation of rules and regulations for the Human Resource Management should be prepared and the approval of the Secretary to the Treasury should be obtained, actions had not been so taken by the Board accordingly.

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) There were 101 ongoing research projects as indicated in the Action Plan of the Board during the year under review. Out of the research projects that were commenced from the year 2013 to the year under review, 07 research projects due to the shortage of skilled human resources in the tea sector by the year 2021 and 26 research projects which were spent Rs. 40,498,203 due to various reasons had been postponed or abandoned as per the information submitted to the audit. Likewise, 03 research projects identified to be carried out in 2014 and 2015 were stopped in the halfway without commencing due to lack of financial and labour resources and out of the allocation of for the year under review to conduct publications, exhibitions and symposiums on research amounting to Rs. 2,500,000 a per cent of 89 had not been utilized and symposiums had not been held in the last 02-03 years.

(b) The Staff Provident Fund of the Tea Research Board had been certified by the Labour Commissioner on 30 October 2014 as an approved provident fund with effect from 01 June 1959 under Section 27 (1) of the Employees Provident Fund Act No. 15 of 1958. According to Section 4 (I) of the Management Law Code of this Provident Fund, the Board of Trustees of the Fund should consist of 07 members including the Director of the Tea Research Institute (Chairman of the Board of Trustees), 02 directors and two members of the Fund and two officers who are not members of the Fund nominated by the Sri Lanka Tea Board, in contrary to that, actions had not been taken to include the two members of the Tea Board so far in this Committee indicating that there is no need for two external members due to the reasons such as unnecessary time spent in obtaining loans or cancelling of the membership of a member, misplacement of documents and problems of the organization being transferred to an external party, etc. It was observed that the Board was continuing the activities of the Provident Fund without taking any effective steps to solve this problem.

(c) Even though the buildings had been constructed at Walahanduwa, Deniyaya and Kottawa Divisional Offices by incurring a sum of Rs. 72,031,804 before the year 2010 and the ownership of those lands is owned by the State Plantation Corporation, Talawakele Plantation Company and the Government respectively, arrangements had notbeen

made to take over the ownership of those lands to the Board even by the year under review .

(d) Although the value lost due to the financial fraud of the year 2017 amounting to Rs. 10,276,628 as a result of the internal controll weaknesses of the St. Coombs Estate had remained in the debtor balance, it was observed that the failure to recover damages or take disciplinary action to finalize the examinations by the end of the year under review and recover the loss or to take deciplinary actions as a controversial issue .

(e) It was observed that the St. Joachim Estate, which has a total factory capacity of 1,020,000 kg of finished tea annually, was operating at an under capacity of 72 to 85 per cent of that capacity in the previous year and the year under review. It is observed that the lack of attention of the institution for replanting had caused this underutilization situation.

(f) Even though four years had elapsed for an equipment (Walk in Type Environmental Facility) which was purchased from India incurring a sum of Rs. 12,554,583 on 24 November 2017 for special projects, it could not be used for researches due to lack of expected functional level as a result of failure of installation and fixing the equipment properly. Actions had not been taken against the Procurement and Technical Committees related to this purchase and the balance of Rs.3,454,050 after incurring these expenses from the money received from the Ministry for this Project, had been shown under the projects- in -progress in the financial statements.

(g) As a result of breeching of the agreements which had entered into in the years 2005 and 2009 with the Board by the 04 officers who had obtained foreign study leave with full pay and not reported back to service after being abroad and left the service before completion of compulsory service after returning to service, it had been impossible to recover the value of the relevant Bond amounting to Rs. 15,054,891 by the end of the year 2021 . Even though the Board had filed legal cases, 02 cases were shelved by the court since 2011 because the accused could not be found.

(h) The estate has been continuously making losses since 2018 as per the working account of St. Coombs and Lamilia Estate and it was observed a 234 per cent increase in loss to a loss of Rs.41,052,214 in the year under review as compared to previous year. Further, in comparing of Net Sales Average (NSA) per 01 kg of tea and Cost of Production (COP) per 01 kg of tea shows a continuous rise in production cost after

2018 and it was further observed that the loss of 01 kg of tea was recorded as high as Rs.222 in the year under review.

(i) The domestic tea sales revenue of the St. Coombs and Lamilia Estate for the preceding year amounting to Rs. 52,574,301 had become Rs.34,587,956 in the year under review and it was observed that the decrease it by Rs. 17,986,345 i.e. 34 per cent as compared to the previous year and decrease of the profit of the mother cultivation project under the Asian Development Bank assistance and the profit of the Tea Centre by Rs. 1,217,158 had directly affected for the high loss situation that occurred in the year under review .

(j) Even though there were 36 Senior Managerial Posts within the approved cadre of the Board, 26 posts out of that were in vacant during the year under review. Within those vacancies 04 Divisional Head posts, 13 Chief Research Officer posts and 05 Chief Counselling Officer posts were in vacant to be filled by internal promotions and as a result of non-availability of qualified officers, the vacancies had remained for more than 02 years. Similarly, there were 52 per cent of operational and instructional officer positions and 63 per cent of technical and non-technical management assistant positions in vacant.

W.P.C. Wickramarathne
Auditor General.