Smart Agriculture for Sustainable Farming

PROCEEDINGS

34 th ANNUAL CONGRESS OF THE
POSTGRADUATE INSTITUTE OF AGRICULTURE

18 November 2022

Postgraduate Institute of Agriculture
University of Peradeniya

THIRTY-FOURTH ANNUAL CONGRESS

November 17-18, 2022

Postgraduate Institute of Agriculture

PROGRAMME

Inaugural Session

Chairperson: Prof. C.M.B. Dematawewa, Director, PGIA

8.30 a.m.	Registration
9.00 a.m.	National Anthem
9.10 a.m.	Welcome Address by **Prof. Lasantha Weerasinghe** Coordinator – PGIA Congress 2022
9.20 a.m.	Address by **Mr. Lahiru Chathuranga** President, Postgraduate Agriculture Students' Association
9.30 a.m.	Address by **Prof. S.S. Kodithuwakku** Dean, Faculty of Agriculture, University of Peradeniya
9.40 a.m.	Address by **Prof. C. M. B. Dematawewa** Director, Postgraduate Institute of Agriculture, University of Peradeniya
9.50 a.m.	Address by **Prof. M. D. Lamawansa** Vice Chancellor, University of Peradeniya
10.00 a.m.	Address by **HE Ms. Bonnie Horbach** Ambassador of the Kingdom of the Netherlands to Sri Lanka & Maldives
10.15 a.m.	Launching of the 1st Issue – 34th Volume of TAR Journal
10.20 a.m.	Keynote Address by **Prof. Owen Atkin** Director, Centre for Entrepreneurial Agricultural Technology, Australian National University
10.50 a.m.	Highlights of PGIA Annual Congress - 2022
11.00 a.m.	Commencement of Technical Sessions
1.00 p.m.	Lunch Break
1.30 p.m.	Invited Presentation by **Prof. Gordon A. Gow** Acting Director, Media & Technology Studies University of Alberta, Edmonton, Canada
2.10 p.m.	Poster Presentations
2.45 p.m.	Invited Presentation by **Prof. Emmanuel Frossard** Institute of Agricultural Science, Lindau, Switzerland

Closing Session

3.45 p.m.	Invited Presentation by **Dr. Gamini Samarasinghe** Distinguished PGIA Alumnus Additional Secretary (Agriculture Technology) Ministry of Agriculture
4.20 p.m.	Presentation of Awards
4.35 p.m.	Closing Remarks by Coordinator – PGIA Annual Congress
4.50 p.m.	Vote of Thanks by Secretary, PASA
5.00 p.m.	Closure of Programme

Technical Session I

Tools for Climate Resilient Agriculture

Chairperson: Prof. B. Marambe

Venue: Seminar Room A, PGIA

11.00 a.m. Development and Validation of a Model to Simulate Phenology, Canopy Growth and Yield of Maize, Mungbean and Tomato under Tropical Farming Systems
J.B.D.A.P. Kumara, L.D.B. Suriyagoda, W.A.J.M. De Costa, M.A.P.W.K. Malaviarachchi, K.M.R.D. Abhayapala1 and R.M.S. Fonseka

11.15 a.m. Selection of Model Homegarden: Does the District Heterogeneity Classify the Homegardens?
N. Kuruppuarachchi, L.D.B. Suriyagoda, D.K.N.G. Pushpakumara and G.L.L.P. Silva

11.30 a.m. Rainfall and Streamflow Trends in The Upper Maduru Oya Sub-watershed in Sri Lanka: A Comparative Study Among Different Statistical Methods
R.D.U.A. Ranasinghe, N.D.K. Dayawansa and R.P. De Silva

11.45 a.m. Vulnerability of Other Field Crop (OFC) Cultivating Farmers to Climatic Variability – A Study in Palugaswewa Cascade and Mahaweli System H in Anuradhapura, Sri Lanka.
S.D.N.M. Senadeera, N.D.K. Dayawansa, and R.P.De Silva

12.00 noon Shoot Cutting and Collecting Mechanisms of Different Motorized Tea Harvesters on Tea Yield and Yield Determining Physiological Parameters
S.R.W. Pathiranage, M.A. Wijeratne and W.A.J.M. De Costa

12.15 p.m. Determination of the Best Performing Sri Lankan Maize Accessions Based on the Photosynthetic, Biomass and Yield Traits
M.M.M. Mufeeth, A.N.M. Mubarak and A.D.N.T. Kumara

Technical Session II

Molecular Approaches for Improving Plant Performance

Chairperson: Prof. A.L.T. Perera

Venue: Seminar Room B, PGIA

11.00 a.m. Possibility of utilizing Inter Simple Sequence Repeat regions, bark powder morphology and floral morphometry to characterize the *Cinnamomum* species in Sri Lanka
H.A.B.M. Hathurusinghe, B. S. Bandusekara, D. K. N. G. Pushpakumara, R. A.A. K. Ranawaka, P. C. G. Bandaranayake

11.15 a.m. Impact of Support Type on Production of Terminal Shoot Cuttings of Black Pepper (*Piper nigrum* L.)
A.A.C.H. Dharmasena, H.M.P.A. Subasinghe, T.Sivananthaweral and K.W.L.K. Weerasinghe

11.30 a.m. Evaluation and Characterisation of *Saccharum* Germplasm for Sugarcane Breeding in Sri Lanka
A.M.M.S. Perera, A. Wijesuriya, A.N.W. Sumedha Thushari, D.P.S.T.G. Attanayaka and N.D. Wijesuriya

11.45 a.m. Exogenous Salicylic Acid Induced Drought Stress Tolerance in Immature Tea (*Camellia Sinensis* L.) Plants
M.M.N. Damayanthi, T.L. Wijeratne and J.W. Damunupola

12.00 noon Development of Liquid Culture System for Rapid Multiplication of *Gyrinops walla*
D.B.R.Kaushalya, J.P.Eeswara and L.Jayasinghe

12.15 p.m. Assessing the Impact of Elevational Variation on Health Related Properties in Green Leaves, Black Tea, Green Tea and Instant Tea Made Out of Selected Cultivar (TRI 2025) in Low, Mid and Up Country of Sri Lanka
K.A.P. Dalpathadu, P.M.H.D. Pathiraje, C.V.L. Jayasinghe, and S.P. Nissanka

Technical Session III

Curbing Losses in Production and Products

Chairperson: Prof. Devika De Costa

Venue: Seminar Room C, PGIA

11.00 a.m. Efficacy of Introduced Non-Chemical Methods to Control Wax Moth (*Galleria mellonella*) in Honeybees (*Apis cerana*)
S. A. D. Thakshila, U. G. A. I. Sirisena, N. Geekiyanage, S. Nanayakkara and V. A. T. Prabaswara

11.15 a.m. Solid Formulation of *Trichoderma virens* for the Management of Banana Anthracnose Caused by *Colletotrichum musae*
M. A. Madushani, T. D. C. Priyadarshani, K. W. A. Madhushan, G. D. N. Menike, P. A. Weerasinghe, U. G. A. I. Sirisena, H. R. G. Tharaka and D. M. D. Dissanayake

11.30 a.m. Insecticide Resistance, Resistance Mechanisms, and Phylogeny of Three *Myzus persicae* Populations in Cabbage from Three Agroclimatic Zones of Sri Lanka
J. P. Marasinghe, S. H.P.P. Karunaratne, S. N. Surendran, K. S. Hemachandra and L. Nugaliyadde

11.45 a.m. Comparison of High-Performance Liquid Chromatography (HPLC) Profiles and Antimicrobial Activity of Different *Cinnamomum* Species in Sri Lanka.
S. Bandusekara, D. K. N. G. Pushpakumara, P. C. G. Bandaranayake

12.00 noon *Allium cepa* L. (Onion) Storage Diseases and Effect of *Trichoderma asperellum* and *Trichoderma virens* Pre-harvest Treatments on Postharvest Quality
L.N.R.Gunaratna, N. Deshappriya, R.G.S.A.S.Rajapaksha and D.L.Jayaratne

12.15 p.m. Dynamics of Rice Brown Leaf Spot Disease (*Bipolaris oryzae*) Incidences due to Seasonal Weather Differences in the Dry Zone of Sri Lanka
W. M. D. M. Wickramasinghe, T. D. C. Priyadarshani, W. C. P. Egodawatta, D. I. D. S. Beneragama, G. D. N. Menike

Technical Session IV

Social Dimensions in Food and Environment

Chairperson: Prof. L.H.P. Gunarathne

Venue: Seminar Room D, PGIA

11.00 a.m. Scope of the Homegardens in Realizing Household Dietary Diversity: A Case Study in Selected Districts of Sri Lanka
W. A. M. Lowe, D. K. N. G. Pushpakumara, H. L. J. Weerahewa, W. A. U. Vitharana, B. Marambe, B. V. R. Punyawardena and G. L. L. P. Silva

11.15 a.m. Effectiveness of use of "WhatsApp" Messenger Mobile Application for an Extension Campaign and Advisory Forum for Tea Smallholders in Rathnapura District
S.P.A.P.K. Jayarathna, U.I. Dissanayake

11.30 a.m. Production Diversity, Seasonality and Dietary Diversity in Rural Agricultural Context in Sri Lanka: A Case of Mahakanumulla Village Tank Cascade System
N. Nayanathara and D. Hemachandra

11.45 a.m. Effect of Socio-Economic and Institutional Factors on the Choice of Food Production System Practiced in Home Gardens
P.S.H. Silva, S.A. Weerasooriya

12.00 noon A Geospatial and Socio-economic Assessment of Tree Density of Trees Outside Forests Sources in Agro-ecological Regions: Home gardens in Upper Mahaweli Catchment in Sri Lanka
H.M. Badra S. Hearath, D.K.N.G. Pushpakumara, P. Wickramagamage and Michael Hewson

12.15 p.m. Resource Recovery by Composting Municipal Waste: Successive Development in Sri Lanka
T. N. Rajapaksha, A. K. Karunarathna

Technical Session V

Soil and Water Resource Management

Chairperson: Prof. G.B.B. Herath

Venue: Seminar Room E, PGIA

11.00 a.m.	Variability of Soil pH and EC as Affected by Water Source, Cropping System, and Soil Order in Paddy Growing Soils of Sri Lanka ***K.H.B.H. Delgoda, N.A.S.A. Neththasinghe, E.D.C.T. Chandrasekara, D.M.S.B. Dissanayaka, M. Ariyarathne, B. Marambe, D.N. Sirisena, U. Rathnayake, H.K. Kadupitiya and L.D.B. Suriyagoda***
11.15 a.m.	Performance of Micro Irrigation Systems in Coconut Plantations: A Field Study ***B.H.R. Fernando, C.S. Ranasinghe, S. Pathmarajah and M.I.M. Mowjood***
11.30 a.m.	Tank Sedimentation and Soil Erosion Simulations of the Sub-catchments Under Present Land Use Scenario and Conservation Interventions in Palugaswewa Tank Cascade System, Sri Lanka ***P. Kowshayini, H.B. Nayakekorala and S. Pathmarajah***
11.45 a.m.	Estimation of Surface Runoff using SCS - CN Method: A Case Study of Kotagala Oya Watershed, Nuwara Eliya, Sri Lanka ***J.M.A.U.Jayasekara, N.D.K. Dayawansa and M.I.M.Mowjood***
12.00 noon	Characterization of Long-term Average Climate and Soil Water Deficit across an Altitudinal Gradient of Tropical Rainforests in Sri Lanka ***R.M.C. Madhumali, H.K. Nimalka Sanjeewani and W.A.J.M. De Costa***
12.15 p.m.	Comparative Assessment of Soil Chemical Characteristics in Two Contrasting Vegetable Cultivating Systems of Sri Lanka ***H. A. N. Upekshani, R. S. Dharmakeerthi, P. Weerasinghe and W. S. Dandeniya***

Lunch Break

01.00 p.m. – 01.30 p.m.

Invited Presentation I

Chairperson: Prof. W.A.D.P. Wanigasundara

Time: 01.30 p.m.

Agricultural Extension and Commercial Social Media: Is it Time to Diversify the Digital Habitat?

Prof. Gordon A. Gow
Acting Director, Media & Technology Studies,
University of Alberta, Edmonton, Canada

Display of Posters

2.10 p.m. – 3.00 p.m.

Invited Presentation II

Chairperson: Prof. Janaki Mohotti

Time: 03.00 p.m.

En-route for the Planet Mars: Recycling Nutrients from Organic Wastes for Growing Higher Plants during Long-term Manned Space Missions

Prof. Emmanuel Frossard
Institute of Agricultural Science, Lindau, Switzerland

Closing Session

Chairperson: Prof. C.M.B. Dematawewa, Director, PGIA

3.45 pm	Invited Presentation by **Dr. Gamini Samarasinghe** Distinguished PGIA Alumnus, Additional Secretary (Agriculture Technology) Ministry of Agriculture
4.20 pm	Presentation of Awards
4.35 pm	Closing Remarks by Coordinator – PGIA Annual Congress
4.50 pm	Vote of Thanks by Secretary, PASA
5.00 pm	Closure of Programme

November 17, 2022
Postgraduate Institute of Agriculture, Peradeniya

Poster Evaluation
PROGRAMME

Session I: Resource Management in Agriculture and Forestry
Venue: Seminar Room A, PGIA

10.00 a.m. Impact of Mild Water Stress During the Flowering Stage on Leaf Functional Traits and Yield of Selected Cowpea Varieties Grown in The Low Country Dry Zone of Sri Lanka
W.G.I.P. Wijayaraja, M. Piyarathne, L.K. Weerasinghe, M.A.P.W.K. Malaviarachchi, D.P. Kumarathunge, D.A.U.D. Devasinghe, S. Rathnayake, N. Geekiyanage

10.05 a.m. Assessment of Soil NPK and Rice Yield under Three Different Nutrient Management Systems in the Dry Zone Rice Farming
N.G.Sriyani, M.G.T.S.Amarasekara, D.M.S. Duminda, A.G.T. Herath and A.M.S.U.M.Attanayake

10.10 a.m. Spatial Variability of Selected Soil Physico-Chemical Properties in Tropical Rainforests of Sri Lanka across a Wide Altitudinal Gradient
H.K.N. Sanjeewani, W.A.J.M.De Costa and R.B Mapa

10.15 a.m. Impacts of Converting a Rubber Plantation into an Oil Palm Plantation on Selected Soil Properties: A Case Study from a Rubber - Oil Palm Plantation in Low Country Wet Zone of Sri Lanka
K.M. Kularathna, D.N. Vidana Gamage, R.S. Dharmakeerthi and R.C.W.M.R. A. Nugawela

10.20 a.m. Plant Diversity, Aboveground Biomass and Carbon Stock in an Isolated Tropical Sub Montane Forest in Sri Lanka
B. M. B. Weerakoon and S. P. Nissanka

10.25 a.m. Development of a Botanical Formulation Using *Cinnamomum verum* and *Pongamia pinnata* Leaves for Suppression of Nitrification in Soil
P.A.M. Dias and W.S. Dandeniya

10.30 a.m. Development of Local Breeding Lines for Rust-Resistance by Incorporation of Rust-Resistant Genes in Common Bean
H.M.P.S. Kumari, C.K. Weebadde, M. A. Pastor-Corrales, R.G.A.S. Rajapakshe, P.C.G. Bandaranayake

10.35 a.m. Influence of Geographical Aspect and Topography on Canopy Openness in Tropical Rainforests of Sri Lanka along an Altitudinal Gradient
R.M.C. Madhumali, W.M.P.S.B. Wahala, H.K. Nimalka Sanjeewani, D.P. Samarasinghe and W.A.J.M. De Costa

Session II - Society Attributes in Agriculture

Venue: Seminar Room B, PGIA

10.00 a.m. Household Food Waste Behaviour in the Western Province of Sri Lanka: A Preliminary Study
R. G. I. C. Waidyarathne, S. A. Weerasooriya, P. M. Korale-Gedara and T. Perera

10.05 a.m. Prerequisites for Operationalizing Co-management in Small-Scale Fisheries
R.A.D.S. Ranatunga, D.A.M. De Silva, Oscar Amarasinghe, and M.G. Kularatne

10.10 a.m. Overcoming the Digital Barrier among the Elderly Population for Mobile Banking Services in Sri Lanka
W. M. D. A. K. Wickramasinghe and S. A. Weerasooriya

10.15 a.m. Assessment of Virtual Water of Irrigated Agriculture, Imports, Exports and Water Footprint for Sri Lanka
W.C.S. Wanasinghe, E.R.N. Gunawardena and, M.I.M. Mowjood

10.20 a.m. A Case Study on the Impact of Newly Introduced Rubber Farming System on Livelihood of Smallholders in the Moneragala District
P.K.K.S. Gunarathne, T.M.S.P.K. Tennakoon and Jagath C. Edirisinghe

10.25 a.m. Has Collective Action Improved the Efficacy of Tea Smallholding Development Societies in Sri Lanka?
K. G. J. P. Mahindapala, M. W. A. P. Jayathilaka, L. N. A. C. Jayawardana and M. Wijerathna

Message from the Chief Guest

The world today is facing many challenges. One of the most urgent is the pending food crisis: How can we feed the growing world population with limited resources? What are the ways to increase food production while cutting down on resources? How can the agricultural sector be modernized to contribute to the climate change mitigation and adaptation? Is it realistic to make agriculture climate neutral? Sooner rather than later, we need to find answers to these questions. Education and research are the key to unlocking these answers. Together we can co-create innovative solutions to global environmental, societal and economic challenges.

Therefore it is important to have a thorough research and education system that prepares people for these questions. The Post Graduate Institute of Agriculture has served the country for over three decades. This post graduate institute of Sri Lanka has brought forth outstanding scientific researchers and experts ready and capable finding solutions needed to solve the challenges we are facing. The Annual Congress is an interesting forum for young graduates to share their research experiences with a wider group of researchers. The fact that students from several countries are participating in this Annual Congress, makes it a real regional knowledge hub. The theme this year 'Smart Agriculture for Sustainable Farming' is very relevant for the today's context making it a great opportunity to share knowledge and learn from each other: to ultimately co-create pioneering solutions to global challenges.

Sri Lankan and Dutch researchers have been cooperating and challenging each other to contribute to such solutions. The Dutch Embassy has and continues to supports relations between our institutes to facilitate knowledge and technology transfer in order to cocreate best solutions for local challenges. Together we have introduced better methods in sustainable farming. A few examples are:

- *the agroforestry project being implemented*
- *series of webinars on going organic*
- *sustainable livestock management activities*
- *sustainable protected horticulture management trainings*
- *Integrated Pest Management trainings*

These collaborative programs have created new knowledge in sustainable farming.
For these reasons, I am very sad I cannot join your conference today. I would like to extend my sincere best wishes to the PGIA for a successful and inspiring event leading to new sustainable solutions for urgent agricultural challenges.

HE Ms. Bonnie Horbach
Ambassador of the Kingdom of the Netherlands to Sri Lanka & Maldives

Message from the Director

It is with great pride and pleasure that I deliver this message on the occasion of successfully staging the Annual Congress of the PGIA for the 34th time consecutively. Since its establishment in 1976, the PGIA has enthusiastically taken up the national leadership role and responsibility in human resource development in terms of postgraduate education in Agriculture in Sri Lanka. With over 350 foreign qualified academics, researchers and other agriculture professionals serving in the teaching panel, PGIA has made a tremendous contribution to the nation producing over 5000 graduates over the years.

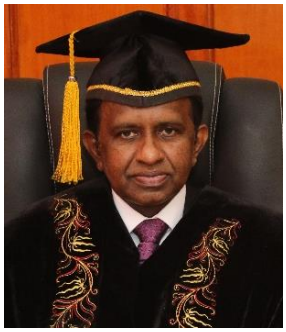
The Annual Congress was started by the PGIA in 1989 to provide a platform for postgraduate students local and overseas to present their findings in front of a highly learned audience of academics, researchers, and other stakeholders of agriculture and get the exposure to fruitful deliberations. Over the years Annual Congress has become the most glamorous scientific event of PGIA attracting elite professionals of all disciplines in Agriculture. The scientific sessions of PGIA Congress, adorned by keynote speeches of eminent international scientists, ensure comprehensive coverage of the latest scientific breakthroughs in Agriculture. The advanced research studies of the students, funded by local and international grants, are aimed at producing discoveries and innovative solutions in Agriculture to achieve the sustainable development goals local and overseas. Meticulous efforts of the Editorial Board ensure the articles submitted across the globe undergo a rigorous review process before selection for presentation at the Congress and subsequent publication in the Tropical Agricultural Research, the official journal of the PGIA.

The current economic crisis faced by the nation catalyzed by the Covid 19 pandemic and subsequent policy changes has significantly changed the PGIA Congress from its' famous on ground glamour to virtual mode with a much larger group of online audience. The hybrid mode adopted has enabled an Opening Ceremony on ground with Her Excellency Ms. Bonnie Horbach, the Ambassador of the Netherlands to Sri Lanka and Maldives (Chief Guest) and other invited dignitaries followed by a virtual interactive platform for all presenters with audience joining online, and finally an on-ground Awarding Ceremony with Dr. Gamini Samarasinghe, Additional Secretary, Ministry of Agriculture, Mahaweli, Irrigation and Rural Development (a former alumnus of the PGIA) appearing as the Chief Guest of the Closing Session.

The highly organized coordinator of the PGIA Annual Congress this year, Prof. Lasantha Weerasinghe was able to plan all activities well ahead of time during these difficult times and summon a large group of staff and student volunteers as the Organizing Committee. Sincere appreciations go to all those who have worked behind the scene over a year supporting in staging the 34th Annual Congress so professionally including the Organizing Committee, the Boards of Study, the chief editors and editorial board, reviewers, judges, academics, PGIA staff, students and well-wishers. I wish the 34 th Annual Congress a grand success.

Prof. C.M.B. Dematawewa
Director/ Postgraduate Institute of Agriculture

Message from the Vice-Chancellor



I am extremely happy to send this message in honor of the 34th Annual Congress of the University of Peradeniya's Postgraduate Institute of Agriculture (PGIA). Since its establishment in 1989, the PGIA Congress has been an annual event that draws specialists from all fields of agriculture and related sciences, both present and future.

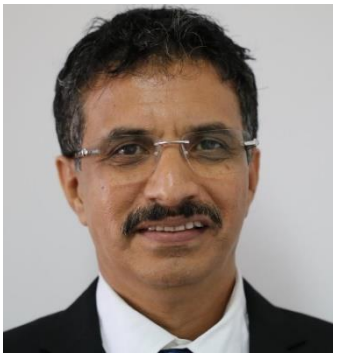
The conference's theme, "Smart Agriculture for Sustainable Farming," is incredibly pertinent given that, for a number of reasons, integrating the Internet of Things with agricultural-related activities is the way forward for sustainable farming. Adoption of information technology and communication helps low-input agriculture by lowering the need for energy, fertilizer and pesticides, enabling more accurate decision-making, minimizing negative externalities, increasing crop production, ensuring food safety, and enhancing the quality of life for farmers. In the current environment, all of these are crucial to our nation. Therefore, I am confident that the 34th Congress has the full potential to change agriculture policies and practices in our country.

I wish to express my appreciation to the coordinator and organizing committee of the PGIA's 34th Annual Congress for their efforts in bringing the Annual Congress-2022 to fruition.

I wish the PGIA congress-2022 all the very best!

Prof. M.D. Lamawansa
Vice Chancellor
University of Peradeniya

Message from the Dean



As Dean of the Faculty of Agriculture, University of Peradeniya, it is a privilege and pleasure to send this message to the 34th Annual Congress of the Postgraduate Institute of Agriculture (PGIA). During the last few decades, the PGIA and the Faculty of Agriculture have collaborated to achieve their primary objective of creating a knowledge society.

The Annual Congress brings together academics, scientists, policymakers, and other stakeholders from the private sector and non-governmental organizations (NGOs) in a common platform to discuss and debate issues and provide solutions to many real-life problems. In the process, it also aids in the capacity building of all its stakeholders.

I want to take this opportunity to thank the people who started this congress 33 years ago, and those who have been contributing to keeping it going every year since. With pride, I state that the members of the Faculty of Agriculture, University of Peradeniya, have significantly contributed to bringing this event to its current standards while keeping up with emerging global trends and challenges. I am optimistic that this year's Annual congress will also provide a forum for discussing cutting-edge science and technology among its multidisciplinary audience.

I congratulate the congress coordinator, the organizing committee and the Director PGIA for their tireless efforts to make the event a great success during this challenging period. On behalf of the Faculty of Agriculture, the University of Peradeniya, the primary partner of the PGIA in its academic and research endeavours. I wish the 34th PGIA Annual Congress every success.

Prof. S.S. Kodithuwakku
Dean/ Faculty of Agriculture
University of Peradeniya

Message from the President, Postgraduate Agriculture Students' Association

It is with great pleasure that I write this message as the President of the Postgraduate Agriculture Students' Association (PASA) on the occasion of the 34th Annual Congress of the Postgraduate Institute of Agriculture of the University of Peradeniya to be held from 17th – 18th November 2022.

The Annual congress PGIA is the most awaited and a prestigious event of the students of the PGIA and the students from all around the world which provides them the opportunity to present their findings to a wider audience. This event brings forth the platform for the students to deliver their findings to academics, scientists, policy makers and students while letting them to share, discuss and debate their research findings. These opportunities have contributed to taking the name of University of Peradeniya up to the heights of being among top 600 universities in the world.

The PGIA Congress is organized by the PGIA, University of Peradeniya is an utmost important event of the PGIA calendar for the staff and the students. So, the contribution of students in this regard should be tremendous because this is an event purely meant for students' benefits and it should be reaped by them.

I, on behalf of PASA, pay our gratitude to the Congress coordinator and the organizing committee for the immense effort in organizing and making this event a great success.

Mr. Lahiru Chathuranga
President, Postgraduate Agriculture Students' Association (PASA)
Postgraduate Institute of Agriculture
University of Peradeniya

Message from the Congress Coordinator
34th Annual Congress, Postgraduate Institute of Agriculture

The 34th PGIA Annual Congress continues the long tradition of providing an opportunity for postgraduate students, academia, and scientists from all over the world representing a broad spectrum of disciplines to gather around a common theme. The theme of the 34th annual congress is & quot;Smart Agriculture for Sustainable Farming,& quot; and it will be staged as a virtual event.

Over the years, the Annual Congress of the PGIA has become one of the most recognized scientific platforms in the country. The PGIA Congress particularly aims to disseminate key findings of the research in agriculture and allied sciences that have led or are leading to higher degrees of postgraduate students and young scientists from Sri Lanka and around the globe.

Findings of the research are presented in the Congress in oral and poster sessions and are published in abstract form in the Congress Proceedings. This year, we organized four pre-Congress workshops aiming the capacity development of young scientists in publishing and presenting scientific information. The outstanding studies presented at the Congress will be published as a full paper in one of the top-ranking indexed journals in the country, Tropical Agricultural Research (TAR), published by the PGIA.

This year, we received 49 full-length original research papers. After a rigorous peer-reviewing process, 46 papers were selected to be presented at the Congress. The eight technical sessions of the Congress are arranged to find common interests and create synergy among the different disciplines. The sessions will include oral and poster presentations, and the presenters exhibiting high standards of scientific excellence will be recognized through awards. I would like to thank the Chief Guest, HE Ms. Bonnie Horbach, Ambassador of the Kingdom of the Netherlands to Sri Lanka and the Maldives, and Prof. M.D. Lamawansa, the Vice- Chancellor, University of Peradeniya, for gracing the inaugural session. My sincere thanks are also extended to the keynote speaker, Prof. Owen Atkin, and the two invited speakers: Prof. Emmanuel Frossard and Prof. Gordon A. Gow, who will share their thoughts and visions at the 2022 PGIA Congress. I am grateful to the Editors-in-Chief and Editorial Board members of the journal, the authors and reviewers of papers, and the chairpersons and evaluators of the technical sessions for their invaluable contribution to making the 34th Annual Congress a success. Special tributes are due to the Director of the PGIA and his staff, the organizing committee of the Congress led by the abled chairpersons of four subcommittees, the generous sponsors, and everyone who encouraged and supported this event in numerous ways. It is indeed a pleasure to work with them.

I sincerely hope that the PGIA Congress 2022 will be an intellectually fruitful and emotionally fulfilling one. Let the scientific message of this symposium contribute to the national development of Sri Lanka.

Prof. K.W.L.K. Weerasinghe
Congress Coordinator, 2022

Past Directors of Postgraduate Institute of Agriculture University of Peradeniya

Prof. S. Samita	*July 2014 – September 2017*
Prof. B.C.N. Peiris	*October 2011 – June 2014*
Prof. A.L.T. Perera	*August 2006 - September 2011*
Prof. R.O. Thattil	*January 2002 – August 2006*
Prof. H.P.M. Gunasena	*March 1997 – January 2002*
Prof. Y.D.A. Senanayake	*January 1987 – March 1997*
Prof. T. Jogaratnam	*February 1978 – December 1986*
Prof. R.R. Appadurai	*June 1975 – February 1978*

Past Congress Coordinators

Prof. P.C.G. Bandaranayake	*2021*	*Prof. C.M.B. Dematawewa*	*2004*
Prof. R.S. Dharmakeerthi	*2020*	*Prof. (Ms.) S.P. Indraratne*	*2003*
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Prevalence of Bovine Tuberculosis among Cattle and Buffaloes in the Central Province of Sri Lanka

Oral Presentations:

- ***D. M. N. J. Kumari, J. Weerahewa and D. Hemachandra***
  Spatial Price Linkages of Regional Vegetable Markets of Sri Lanka: A Comparison of Pre- and Post-COVID-19 Periods

- ***K.A.P. Dalpathadu, H.U.K.D.Z. Rajapakse, C.V.L. Jayasinghe, S.P. Nissanka***
  Manufacturing of Low Haze Instant Tea Extracts Using Sri Lankan Broken Mixed Fannings (BMF) as Raw Materials

- ***P. A. C. T. Perera, C. M. B. Dematawewa, T. V. Sundarabarathy , Suranga P. Kodithuwakku, and U. Edirisinghe***
  Effects of Exotic Tilapia on Native Fish, Climbing Perch (*Anabas testudineus* Bloch, 1792): An Environmental Perspective

- ***Y.H.P.S.N. Kumara, A. Amarasinghe, P.G.A. Pushpakumara, H.M.S Wasana, W.M.T.D Rathnakumara, G. A. Gunawardana and B. Alexander***
  Prevalence of Bovine Tuberculosis among Cattle and Buffaloes in the Central Province of Sri Lanka

- ***N. M. K. C. Premarathne, Athula Senaratne , L. H. P. Gunaratne***
  Ex-post Study on Expected Utility of Weather Information: Quasi Experiment on Sri Lankan Paddy Farming

***Poster Presentations*:**

- ***M.R. Roshana and T. Mahendran***
  Assessment of Knowledge and Practices regarding Iron Deficiency Anemia among Pregnant Women in Kattankudy D.S. Division of the Batticaloa District

- ***A.V.C. Abhayagunasekara, G.D.S.N. Chandrasena, D.M.O.K.B. Dissanayake, J.M. Shyaman Madhawa Jayasundara, D.K.N.G. Pushpakumara, W.L.G. Samarasinghe, P.C.G. Bandaranayake***
  Wild Rice Species in Sri Lanka as Genetic Resources in Breeding for Brown Planthopper (*Nilaparvata lugens* (Stål) Resistance in Rice

- ***K. M. R. U. Gunarathne, J. M. N. Marikkar, E. Mendis, C. Yalegama, L. Jayasinghe and B. S. K. Ulpathakumbura***

  Mid-IR Spectral Characterization and Chemometric Evaluation of Different Solvent Extracts of Coconut Testa Flour

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Oral Sessions

SESSION I: Tools for Climate Resilient Agriculture
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Venue: Seminar Room B, PGIA

Chairperson	Prof. A.L.T. Perera
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SESSION III: Curbing Losses in Production and Products
Venue: Seminar Room C, PGIA

Chairperson	Prof. Devika De Costa
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SESSION IV: Social Dimensions in Food and Environment
Venue: Seminar Room D, PGIA

Chairperson	Prof. L.H.P. Gunarathne
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SESSION V: Soil and Water Resource Management
Venue: Seminar Room E, PGIA

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Poster Sessions

SESSION I: Resource Management in Agriculture and Forestry
Venue: Seminar Room A, PGIA

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Session Coordinator	Dr. Sewwandi Chandrasekara

SESSION II: Society Attributes in Agriculture
Venue: Seminar Room B

Judges	Prof. Anton Perera Dr. Sumali Nishantha Dissanayake Dr. T. Rathnayake Dr. A Kankanamge
Session Coordinator	Ms. Buddhika Bandara

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Keynote Address & Invited Presentations

Development and Validation of a Model to Simulate Phenology, Canopy Growth and Yield of Maize, Mungbean and Tomato under Tropical Farming Systems

J.B.D.A.P. Kumara[1,2*], L.D.B. Suriyagoda[3], W.A.J.M. De Costa[3], M.A.P.W.K. Malaviarachchi[1,4], K.M.R.D. Abhayapala[1] and R.M.S. Fonseka[3]

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A significant portion of crop production in the tropics occurs at subsistent level and with high vulnerability to climate change. Process-based crop simulation models are effective tools to predict environmental impacts including climate change effects and to make management decisions on crop production. The principal objective of this study was to develop crop-specific simulation models to predict phenology, canopy growth and yield performance of maize, mungbean and tomato crops grown in tropical farming conditions with special relevance to locally-adapted inbred germplasm. The developed models consisted of sub-models to simulate canopy growth, radiation interception and conversion and dry matter partitioning. All sub-models were parameterized by detailed measurements of leaf growth, dry matter accumulation and partitioning on locally-adapted varieties of maize, mungbean and tomato over two cropping seasons. The same crop varieties were established in a multi-locational field experiment spanning a sufficiently wide temperature gradient over four cropping seasons for model validation. Models were validated by comparing model predictions of phenological development and yield against field observations and secondary data from the literature. Overall, simulated phenological development (R^2 >0.5, RMSE <5 days for all three crops) and yield (R^2 >0.5, RMSE <68, 48 and 476 g/m^2 for maize, mungbean and tomato, respectively) of the three crops were in agreement with the observed data under a wide range of environmental conditions. These modelling approaches can be successfully applied to open-pollinated (maize) and inbred varieties (mungbean and tomato) grown in farmer fields in tropical South Asia.

Keywords: Local germplasm, Phenology, Simulation modelling, Sri Lanka, Thermal time

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Selection of Model Homegarden: Does the District Heterogeneity Classifies the Homegardens?

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Among numerous studies done with homegardens, few efforts have been drawn up to examine biodiversity, input availability and influence of complex environment of households and homegardens on its produces. Improving attempts of homegardens are generally managed at administrative level. The success of those attempts are required to be evaluated by appropriate tools which are not well defined. To address this research gap a study was formulated with an aim to group selected homegardens identifying the variables contributing in grouping those homegardens, and thereby to suggest the characteristics of a model homegarden. A homegardens survey was conducted focusing Ratnapura and Hambantota districts. Pooled and separated samples of two districts were employed in K-means cluster analysis and obtained groups were subjected to discriminant function analysis to derive the important variables in discriminating homegardens. Homegardens in Ratnapura were grouped into three and key variables contributing to differentiate those were annual expenditure for homegarden, labor usage/year, above ground biomass, availability of disease incidences, species density of tree/ha and tree density/ha. There were four groups of homegardens in Hambantota and key variables contributed for their differences were annual expenditure for homegarden, availability of pest incidences, annual income from homegarden, species density of tree/ha, share of produced in the homegarden to consumption, technical knowledge on farming and land extent. The results were similar in the case of pooled analysis. Accordingly, a homegarden requires to be comprised with income driven and diversity supporting components for it to be considered as a model homegarden with maximum productivity. However, due to the heterogeneity of homegardens, distinct groups within districts could not be identified, suggesting the inappropriateness of making administrative boundaries-based decisions regarding the interventions of homegardens.

Keywords: Cluster analysis, Discriminant variables, Homegarden, Model

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Rainfall and Streamflow Trends in the Upper *Maduru Oya* Sub-watershed in Sri Lanka: A Comparative Study Among Different Statistical Methods

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Analysis of historical data of rainfall and streamflow provides useful information for management of water resources in a river basin. The objective of this study was to assess the variations and analyze trends of rainfall and streamflow data in the upper Maduru Oya sub watershed in Sri Lanka during 30 year period (1989 October to 2019 September). Daily rainfall data from two gauging locations (Padiyathalawa and Bibile) and daily average streamflow data from one gauging location (Padiyathalawa) were used in the study. Descriptive statistics were used to assess the variations. Mann Kendal Trend Test (MK test) and Innovative Trend Analysis method (ITA) were used to analyze the trend and Sen's Slope Estimator to assess the magnitude of the trend. Based on the MK test, most of the rainfall trends obtained were increasing and streamflow trends were decreasing. Rainfall trends found in Padiyathalawa were not statistically significant. Annual, first inter-monsoon, March and May time scales of rainfall showed significant upward trends at Bibile (p <0.1) while streamflow in January, April and September showed significant negative trends (p <0.1) at Padiyathalawa. The results displayed by all three tests were in very good agreement for rainfall. ITA results showed similar trend types of 77%, 95% and 41% at Padiyathalawa and Bibile rainfall and streamflow, respectively. A strong positive (p <0.01) and low correlations between the trend value of ITA and Z value of MK test were found for rainfall and streamflow, respectively. Changes in rainfall were not sufficient to explain the observed trends in streamflow. Therefore, the future research should be directed at the causal aspects of streamflow change in this watershed.

Keywords: Innovative Trend Analysis method, Mann Kendal test, Rainfall, Sen's slope Estimator, Streamflow

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Vulnerability of Other Field Crop (OFC) Cultivating Farmers to Climatic Variability: A Study in Palugaswewa Cascade and Mahaweli System H in Anuradhapura, Sri Lanka.

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Frequently occurring extreme weather events have caused agricultural production losses in considerable amounts in the Dry zone of Sri Lanka. Hence, it is important to identify the systems and the farmer groups, which are highly vulnerable to climate change prior to propose remedial measures. Paddy is the main crop cultivated by the dry zone farmers in Sri Lanka. The majority of the farmers cultivate paddy during *Maha* season while Other Field Crops (OFC) are cultivated in *Yala* season in the same land due to water scarcity. This study developed a climate vulnerability index for OFC farmers and tested its applicability in major and minor irrigation systems. For this study, secondary data were collected from relevant government institutions and field-level organizations. Yield data, demographic data, socioeconomic data, and marketing data were collected through a questionnaire survey. Indicators were selected under three dimensions of vulnerability representing physical and environmental factors, socioeconomic factors and the factors related to external assistance. All indicators were calculated for major and minor irrigation system separately. The results revealed that, farmers in both irrigation systems are highly vulnerable to the external assistance index while low in the physical and environmental index and socio-economic index. The minor irrigation scheme has high external assistance to climate change compared to the major irrigation scheme. The results of overall vulnerability index indicated that, the climatic vulnerability of farmers in minor irrigation system is higher (61.6) than the major irrigation system (57.1). These indices are useful in assessing the status of the farmers to apply interventions to reduce their vulnerability to facilitate the livelihoods.

Keywords: Climate change, Irrigation systems, OFC farmers, Vulnerability index

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Shoot Cutting and Collecting Mechanisms of Different Motorized Tea Harvesters on Tea Yield and Yield Determining Physiological Parameters

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The impact of various cutting and collecting mechanisms of different non-selective tea harvesters on tea yield were studied compared to manual harvesting (control). Machines used were; battery-operated Forbes & Walker harvester with helically arranged picking arms (BatFW), battery-operated Kawasaki harvester with reciprocating blades (BatKW) and petrol-driven Kawasaki harvester with reciprocating blades (PetKW). Tea yield, coarse leaf content, operational time, shoot compositions in bush and harvest, branch girthing and root starch content were recorded for one year. Motorized harvesters reduced about 50 % of tea yield compared to control. Number of machines required (units/ha/day) was six, four and two, respectively for BatFW, BatKW and PetKW as against eight manual pluckers, and corresponding tea extents covered were 0.17, 0.25 and 0.47 ha/unit/day, respectively as against 0.13 ha/unit/day in manual. Manual harvesting and BatFW consumed high and comparable worker requirements compared to the other harvesting methods. Average shoot weight and total shoot density was least affected by BatFW. The highest *arimbu* removal was observed in PetKW, followed by BatKW, BatFW and the control. *Banji* accumulation in the plucking table was highest in BatFW, followed by PetKW, BatKW and control. Damage to *arimbu* in bushes was highest with PetKW followed by BatKW, BatFW and the control. Reciprocating blades were more productive in harvesting (700 g/cm/day) than picking arms (500 g/cm/day). All machines affected branch girthing and root starch reserves more than the manual harvesting. The mechanical impacts on yield determining physiological parameters *viz*., *arimbu* removal, accumulated *banji*, affected yield components, poor branch development and depleted root starch reserves collectively resulted in tea yield reduction.

Keywords: Cutting and collecting mechanisms, Motorized tea harvesters, Physiology, Tea yield decline

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Determination of the Best Performing Sri Lankan Maize Accessions Based on the Photosynthetic, Biomass and Yield Traits

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Maize (*Zea mays* L.) is one of the most widely cultivated cereal crops throughout the world including Sri Lanka. Though the information on the photosynthetic, biomass and grain yield of local maize accessions are useful for plant breeding programs, those information are lacking at present. Therefore, this study aimed to investigate the potentials of maize accession for their high photosynthetic, biomass, and grain yield production characteristics, and to select the best performers using the rank summation and selection index criteria. As the first step, the maize seeds derived from 14 maize landraces along with two varieties *viz*; *cv. Pacific-999* and *cv. Bhadra* (control) were field established. The leaf-level photosynthetic and chlorophyll fluorescence traits were assessed, while biomass and yield traits were determined at harvest, by employing standard techniques. Our findings revealed that traits related to growth, photosynthetic, and biomass had high variations. The landraces investigated varied in the number of days taken to 50 % flowering, photosynthetic, transpiration, water use efficiency, and maximum quantum yield traits. In addition, the fluctuation in biomass and final grain yield was also pronounced. According to rank summation index analysis, the maize landraces *SEU2*, *SEU15*, *SEU16*, *SEU9* and *SEU10* were identified as superior in terms of photosynthetic, biomass and yield compared to *cv. Bhadra*, exhibiting the lowest RSI values of 70, 96, 97, 98 and 113, respectively. Therefore, future crop development programs can potentially make use of these five maize landraces identified in the present study.

Keywords: Above ground biomass, Grain yield, Maize accession, Photosynthesis

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Possibility of Utilizing Inter Simple Sequence Repeat Regions, Bark Powder Morphology and Floral Morphometry to Characterize the *Cinnamomum* Species in Sri Lanka

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The genus *Cinnamomum* of the family Lauraceae consists of economically important evergreen aromatic trees and shrubs. The Ceylon cinnamon (*Cinnamomum verum* syn. *C. zeylanicum*) has an exceptional position in the global cinnamon market. In addition to the cultivated species, Sri Lanka is home to seven endemic wild *Cinnamomum* species, *Cinnamomum capparu-coronde, Cinnamomum citriodorum, Cinnamomum dubium, Cinnamomum litseifolium, Cinnamomum ovalifolium, Cinnamomum rivulorum,* and *Cinnamomum sinharajaense*. Nevertheless, the species delimitation has not been successful with some morphometric and molecular traits. Therefore, this study focused on molecular characterization with Inter Simple Sequence Repeats (ISSR) nuclear markers, floral morphometric characteristics, and microscopy of powered bark of *Cinnamomum* species reported in Sri Lanka. According to the results, four polymorphic ISSR regions resulted in an average of 83.7 % polymorphism among all collected species, suggesting considerable polymorphism. The bark fiber size of the cultivated species is different from the studied wild species and could be used as a key to identify adulterants during export. The cultivated cinnamon, *C. verum* and two wild species (*C. sinharajaense*, and *C. capparu-coronde*) have considerably larger flowers compared to other species. Moreover, some floral traits such as flower colour and shape could differentiate species such as *C. sinharajaense* and *C. capparu-coronde*. The Scanning Electron Microscopy (SCM) of available pollens showed that the pollen size, length of the spines, interspinal distance, and spine ornamentation significantly contribute to species variation and such variations need to be studied comprehensively. Nevertheless, the phylogeny of *Cinnamomum* species could not be completely resolved with ISSR regions, bark powder morphology, and floral morphological traits assessed, and suggest further studies.

Keywords: Species delimitation, *Cinnamomum verum*, Pollen morphology, ISSR

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Impact of Support Type on Production of Terminal Shoot Cuttings of Black Pepper (*Piper nigrum* L.)

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Terminal orthotropic branches used for propagation of black pepper (*Piper nigrum* L.) are the most vigorous shoot types of pepper vine, with an active terminal bud and few lateral shoots. Due to difficulties in finding a large number of terminal shoot cuttings from pepper fields, it is essential to maintain mother plants for commercial scale production. Thus, a split plot experiment was conducted to compare the production of terminal shoot cuttings of the black pepper variety "*Dingi Rala*" using *Gliricidia* and column type supports in an already established pepper mother plant garden. Results revealed no significant difference between *Gliricidia* supports and column type supports related to growth and terminal shoot cuttings production of black pepper. With increasing number of shoots produced per vine, the average length and the number of lateral branches of the orthotropic stems produced per vine decreased in *Gliricidia* supports, while the average number of lateral branches of the orthotropic stems decreased in column type supports. The average number of terminal shoot cuttings and single nodal cuttings produced per vine increased with increasing shoot number per vine (p <0.05). The mean number of terminal shoot cuttings produced with column and *Gliricidia* supports were 5.9 and 8.5 respectively, per vine (p>0.05). Collectively, results indicated the importance of maintaining more than seven shoots per vine until pruning of mother pepper vines when using column type supports; however, no such requirement was evident when using *Gliricidia* supports to produce terminal shoot cuttings. Training more than one pepper mother vine to a column type support is recommended to maximize terminal shoot cutting production in the pepper variety "*Dingi Rala*".

Keywords; Black pepper, Column type supports, *Gliricidia*, Mother plant garden, Terminal shoot cuttings

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Evaluation and Characterization of *Saccharum* Germplasm for Sugarcane Breeding in Sri Lanka

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Genetically-variable sugarcane progenies are generated through crossing of parents, and commercial varieties with high cane and sugar yields, moderate fibre, pest and disease resistance, and adaptability to growing conditions are potential future cultivars are selected from these progenies. This study was conducted to identify parents with high transferring ability of most of these characteristics into progenies for efficient variety selection. In this regard, 508 accessions from the *Saccharum* germplasm were assessed for their commercial attributes. Data on cane and sugar yield components were collected from each accession. Phenotypic correlations were estimated for each pair of characteristics. Principal component analysis was performed and subsequently, cluster analysis was done based on the first three principal components (PCs). Phenotypic relationships revealed that plot yield of an accession is mainly determined by number of stalks and stalk length suggesting the accessions with a higher number of stalks and higher stalk lengths can be taken as promising parents for breeding for cane yield. The strong positive relationships of brix to other components of sugar content prove that the parents with high sugar can be classified by hand brix. The selected PCs clustered the accessions into four groups. Group 1 comprised the parental core-collection for generating progenies with moderate cane yield, high sugar yield, and moderate fibre whilst accessions in group 3 can be used for breeding energy cane (*e*-cane). The accessions SLC 91 46 and S 2003-US-247 were identified as the most promising parents in the simultaneous improvement of cane and sugar yields with moderate fibre.

Keywords: Hierarchical clustering, Phenotypic correlations, Principal components

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Exogenous Salicylic Acid Induced Drought Stress Tolerance in Immature Tea (*Camellia Sinensis* L.) Plants

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Salicylic acid (SA) induces drought tolerance in many plants. Although a lot of work has been done on different crops to minimize the adverse effects of drought by exogenous application of SA, little information is available on tea. Therefore, potential of inducing drought tolerance on immature tea by exogenous application of SA was studied under glasshouse conditions at the Tea Research Institute, Talawakelle, Sri Lanka, using one-year-old potted tea cultivars of known drought tolerance based on the improvement of physiological (gas exchange and relative water content) and biochemical parameters. Plants were exposed to a drying cycle while they were foliar sprayed with SA in various concentrations [0 (Water spray -WS), 50, 100, 150 and 200 mg/L] along with well-watered (WW) and no-spray (NS) treatments. Data were collected at 18 hours, 14 and 21 days after spraying (DAS) and recovery after rewatering. Drought tolerance index was calculated for each and every parameter relatively to the corresponding data of WW. The effective concentration selected from the glasshouse study was tested under field conditions in Talawakelle using three-year-old tea plants. The experiment was arranged according to RCBD with 3 blocks with 75 plants per treatment. When plants achieved a moderate moisture stress, they were foliar sprayed with SA 150 mg/L along with WS and NS treatments. Data were collected at 7, 14 and 21 DAS and recovery after rain. Drought stress led to declining of gas exchange parameters, leaf relative water content and increasing accumulation of osmolytes. Exogenous application of 150 mg/L SA significantly improved physiological parameters such as leaf relative water content and gas exchange parameters, osmolyte accumulation and antioxidant activity and thereby become more effective in enhancing drought tolerance on immature tea.

Keywords: Antioxidant activity, Growth regulator, Osmolytes, Physiological responses

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Development of Liquid Culture System for Rapid Multiplication of *Gyrinops walla*

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Agarwood is an expensive resinous compound, produced by *Gyrinops walla* as defence response to external damages. Tissue culture technique is the best alternative for rapid multiplication and product synthesis. This study demonstrated an efficient method of rapid multiplication using liquid cultures for *G. walla.* MS medium supplemented with 1.0 mg/L BAP and 0.1 mg/L IBA, 100 mg/L Myoinositol and 30.0 g/L of sucrose and 3.0 g/L Phytagel was used as the control (T0). The effect of shoot growth on liquid culture on the same medium was investigated without inert support (T1) and was kept on a shaker, with the support of filter paper bridges (T2), with rigid support (T3), wet foam (T4) and as double layer of liquid and semi-solid medium (T5). At the end of the sixth week growth rates and cell doubling times were calculated. Results showed significant differences between treatments at α=0.05 probability level ($p < 0.0001$). All liquid cultures except T3 stimulated the biomass. The highest growth rate (0.38 g/week), lowest cell doubling time (1.82 weeks) and (11-13 shoots/shoot) of *G. walla* were resulted in T1 and at the same time hyperhydricity was observed and it was overcome by combining liquid cultures together with a flexible matrix or using double layer system. The nature of the matrix was found to be a vital factor to achieve the desired benefits of the liquid cultures. The necessity of a matrix can be skipped by practicing T5 while achieving desired benefits.

Key words: Agarwood, *Gyrinops walla*, Liquid cultures, Rapid multiplication

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Assessing the Impact of Elevational Variation on Health Related Properties in Green Leaves, Black Tea, Green Tea and Instant Tea Made Out of Selected Cultivar (TRI 2025) in Low, Mid and Up Country of Sri Lanka

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Health related properties of instant tea extracts produced from different raw materials that can be used to produce instant tea; BOP, BOPF, Dust 1, Broken Mixed Fannings (BMF), green tea (GT) Gun Powder (GP), GT dust, and GT BMF and fresh leaves were compared using the samples collected from estates in the up country (UC), mid country (MC), and low country (LC) of Sri Lanka. Results showed that Total Polyphenol Content (TPC) in fresh leaf samples collected from each estate were significantly higher (p <0.05) compared to manufactured black tea and green tea grades. The highest TPC in the fresh leaves was recorded from UC followed by LC and MC. Green tea had the highest overall polyphenol contents compared to black tea grades. The TPC percentages increased by 2-fold in instant tea powder compared to the contents in BMF. The Total Antioxidant Activity (TAOA) was lower (p <0.05) in UC fresh leaf compared to MC and LC. The GT dust has significantly higher TAOA, compared to BMF and GP. TAOA content of instant tea powder was three times higher than the values obtained for the raw materials. The mean caffeine contents of black tea grades were significantly higher in LC even though no variation was observed in GT grades. The concentrations of epigallocatechin, catechin, epicatechin and epigallocatechin gallate varied significantly among elevation categories. Between BMF and the instant tea manufactured from the same, there was a significant difference in epigallocatechin, catechin, epicatechin, and Total Catechin.

Keywords: Broken Mixed Fannings, Caffeine, Elevations, Total Antioxidant Activity, Total Poly Phenol Content

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Efficacy of Introduced Non-Chemical Methods to Control Wax Moth (*Galleria mellonella*) in Honeybees (*Apis cerana*)

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The greater wax moth (*Galleria mellonella* L.) is an extremely destructive pest that limits the rearing honeybees in Sri Lanka. This moth can destroy bee colonies in a very short period of time leading the colony to abscond. In the past, many beekeepers abandoned beekeeping due to this issue. Although some control methods are followed by beekeepers based on their experience, the efficacy of such treatments was not adequately investigated. This study was designed to investigate the appropriateness of introduced non-chemical strategies to control the wax moth problem. The treatments were fixed net trap, smoking with dried tobacco leaves and sugar feeding. The efficacy of the methods on controlling of wax moth was evaluated using the indices such as colony growth, colony performance, colony weight, comb area, and colony performance index (CPI). The lowest wax moth infestation was recorded in colonies treated with smoke of tobacco leaves and the highest wax moth infestation was found in untreated colonies: control (66.67 %), i.e., without any chemical treatment. The comb area was significantly (p <0.01) higher in tobacco leaf smoking and sugar fed treatments than others. The weight of the bee colonies was significantly (p <0.01) higher in sugar fed treatment and tobacco smoke applied treatment than the others. The least weight was recorded from the control. The CPI at 7:00 am was significantly different (p <0.05), and at 10:00 am and 3:00 pm, the CPI were not significantly different among the treatments suggesting that there is no effect on the CPI values from the introduced non-chemical methods. We recommend the application of tobacco leaf smoke to control wax moth infestation in *Apis cerana* colonies.

Keywords: Beekeeping**,** Infestation, Pest, Sri Lanka, Wax moth

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Solid Formulation of *Trichoderma virens* for the Management of Banana Anthracnose Caused by *Colletotrichum musae*

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Trichoderma spp. Are widely used as bio control agents for controlling a wide range of plant diseases. Banana anthracnose caused by *Colletotrichum musae* is a prominent, widely distributed postharvest disease. This study was carried out to assess the effectiveness of locally isolated *Trichoderma virens* against *C. musae* and the mass production of *T. virens* using locally available, low-cost solid substrates. *T. virens* was tested for the inhibition of *C. musae* isolate *in-vitro* and *in-vivo* by dual plating and inoculating into two varieties of ripened banana: Kolikuttu and Cavendish, respectively. For mass production, T. virens was inoculated into different solid substrates including scraped coconut waste, sawdust, tea waste, seeds from rice, finger millet, and maize, dried pieces of water hyacinth plant, paddy straw, and *Panicum* maximum leaves; spore counts (cfu/g) were regularly recorded and viability was checked by plating after 12 weeks of storage. The pathogen inhibition percentage by *T. virens* was 74.10 %. Disease severity was 0 % in *Kolikuttu* and 19 % in *Cavendish* after 5 days of *T. virens* spore application ($1x10^7$ spores/mL). Significantly higher ($p \leq 0.05$) mean spore production resulted in rice seeds ($9.345x10^9$ spores/g) compared to the other substrates and the least resulted in sawdust ($1.808x10^9$ spores/g) at the 8th week after *T. virens* inoculation. Spores of *T. virens* were viable in all the tested substrates throughout the study period. The results conclude that *T. virens* is capable of controlling banana anthracnose and can be efficiently mass-produced by using rice seeds, dried pieces of *P. maximum* leaves, and finger millet seeds as substrates.

Keywords: Banana anthracnose, Mass production, Spore count, Substrate, *Trichoderma virens*

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Insecticide Resistance, Resistance Mechanisms, and Phylogeny of Three *Myzus persicae* Populations in Cabbage from Three Agroclimatic Zones of Sri Lanka

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The aphid, *Myzus persicae* is an important pest that feeds on plant sap. Also it acts as a vector for plant viruses and secrets honey dew promoting sooty mold growth. Management of *M. persicae* is mainly by synthetic pesticides. The development of resistance against common pesticides has resulted in control failures of *M. persicae.* The objective of this study was to examine the status of pesticide resistance and the genetic structure of *M. persicae* populations. Samples were collected from cabbage cultivations in dry (Anuradhapura), wet (Kandy), and intermediate (Badulla) zones of Sri Lanka during 2017-2019. Bioassays were conducted against 5 insecticides using the leaf dip method. Biochemical assays examined the activity of insecticide detoxifying enzymes and the insensitivity of organophosphate/carbamate target site, acetylcholinesterases (AChEs) in Badulla and Kandy populations. A 636 bp mtCOI gene sequence was used to infer the phylogeny. The resistance spectrum of the populations was low to moderate; 17-25 % resistance to thiamethoxam, 11-15% to acetamiprid, 20-28 % to carbosulfan, 20-41 % to etofenprox, and 4-9 % to profenofos. Elevated activity of esterases (specific activities 0.91-1.11 µmol/min/mg protein) and glutathione S-transferases (1.27-1.82 µmol/min/mg protein) were observed for increased metabolism of pesticides. Monooxygenase-based detoxification was noticeable in neonicotinoid resistance. Insensitive AChEs contribute to organophosphate and carbamate resistance. Phylogenetic analysis revealed that two haplotypes of the studied mtCOI gene sequence are present in the three populations tested, indicating that environmental and biological pressure, including the pesticide selection pressure, may be contributing to the emergence of novel genotypes of *M. persicae*.

Keywords: Bioassays, Biochemical assays, Haplotypes, Pesticide resistance

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Comparison of High-Performance Liquid Chromatography (HPLC) Profiles and Antimicrobial Activity of Different *Cinnamomum* Species in Sri Lanka

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The demand for Ceylon cinnamon (*Cinnamomum zeylanicum* syn. *C. verum*) is consistent due to its superior characteristics in aroma, taste and flavour. Besides that, Sri Lanka is home to seven other wild species: *Cinnamomum capparu-coronde, Cinnamomum citriodorum, Cinnamomum dubium, Cinnamomum litseifolium, Cinnamomum ovalifolium, Cinnamomum rivulorum,* and *Cinnamomum sinharajaense.* Since the bark of cinnamon contains more than seventy bioactive compounds, it possesses various pharmacological and health benefits, including antimicrobial activity. Although there is some literature on the antimicrobial activity and chemical composition of *C. zeylanicum,* wild species have not been studied yet. The present study was conducted to evaluate the antimicrobial activity and biochemical compounds of different *Cinnamomum* species found in Sri Lanka. The bark methanol extract was prepared, and the crude trans-cinnamaldehyde, cinnamyl alcohol, cinnamyl acetate, coumaric acid, and coumarin were quantified using HPLC techniques. The antimicrobial properties were evaluated by disc diffusion assay against two standard pathogenic strains, *Escherichia coli* ATCC 25922 and *Pseudomonas aeruginosa* ATCC 27853. There was no detectable level of coumarin or coumaric acid in any of the species. The highest trans-cinnamaldehyde content and antimicrobial activity were observed for *C. zeylanicum,* followed by *C. sinharajaense* and *C. capparu-coronde.* Further, *C. ovalifolium, C. dubium*, and *C. rivulorum* did not show positive inhibition zones against the two pathogenic strains and detectable levels of trans-cinnamaldehyde. However, the results showed a strong positive correlation between antimicrobial activity and trans-cinnamaldehyde content in *Cinnamomum* species in Sri Lanka.

Keywords: *Cinnamomum verum*, Bark crude, Antimicrobial activity**.**

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Allium cepa L. (Onion) Storage Diseases and Effect of *Trichoderma asperellum* and *Trichoderma virens* Pre-harvest Treatments on Postharvest Quality

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Substantial yield losses are reported during the storage of *Allium cepa* L., with no successful methods to minimize postharvest losses. The objectives of this study were to study the effect of pre-treatment of *Allium cepa* L. seeds, seedlings and transplants with *Trichoderma asperellum* and *Trichoderma virens* on the post-harvest losses during storage and evaluate factors associated with storage losses. Storage behavior of *Allium cepa* L. bulbs after different field treatments with *Trichoderma* spp. were studied. A complete randomized design was used for the experiment. The common onion bulb diseases encountered during storage were basal rot and black mould diseases, while *Fusarium* sp., *Mucor* sp., *Penicillium* sp., *Aspergillus niger, Aspergillus flavus* were associated with diseased bulbs. Results of percent diseased bulbs revealed that there was no significant effect of pre-harvest treatments with *Trichoderma asperellum* and *Trichoderma virens* on the control of diseases during storage. Further, some storage losses of onions were due to sprouting, rooting and wilting. These deteriorations were enhanced by the prevalent temperature (~ 30-32 ˚C) and relative humidity (~77 - 79 %) during the storage period.

Keywords: *Aspergillus* spp., Deterioration, *Fusarium* sp., *Mucor* sp., Sprouting

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Dynamics of Rice Brown Leaf Spot Disease (*Bipolaris oryzae*) Incidences due to Seasonal Weather Differences in the Dry Zone of Sri Lanka

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Weather factors are key determinants in ecological disease management in sustainable agriculture, while judicious cropping systems deliver better control over rice diseases in tropical conditions. This study was designed to explore the effect of weather factors under different cropping system approaches and seasons on the incidence of Rice Brown Leaf Spot (RBLS) disease caused by *Bipolaris oryzae* in the tropical dry zone of Sri Lanka. The incidence of RBLS was recorded under 'Conventional', 'Reduced', and 'Organic' cropping systems commencing from the first occurrence of disease symptoms at three-day sampling intervals in the tropical dry zone during wet (*Maha*) 2018/19, 2019/20, dry (*Yala*) 2019 and 2020 seasons. Secondary data on weather parameters were collected from the regional weather station. RBSL incidences were highest in the wet season and were most abundant in rice plants at the reproductive stage. The disease incidence dynamics over the time were found to be similar among all the cropping systems in three out of four seasons. The cumulative amount of rainfall seven days before the disease observation (RF7), the day-RH (DRH), and the maximum (TMAX48) and average temperature (TAVG48) that were recorded 48 h before the disease observations were found to be significantly correlated with the disease incidence of three cropping systems in the wet season. DRH and minimum temperature (TMIN72) of 72 h before the disease observed in the wet season resulted in higher disease incidences. RBLS disease can be managed concerning the cropping systems under high DRH and TMIN (20-25 °C) in the wet season.

Keywords: Cropping systems, Dry season, Rice Brown Leaf Spot, Weather parameters, Wet season

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Scope of the Homegardens in Realizing Household Dietary Diversity: A Case Study in Selected Districts of Sri Lanka

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Homegardens are resourceful ecosystems that provide essential services to the environment and mankind. Their contribution to secure household food requirement is among the provisional services of contemporary relevance. A study was conducted in 429 homegardens in Jaffna, Matale, Ratnapura and Hambantota districts to assess the scope of utilizing homegarden resources on household food security. A questionnaire survey was conducted to gather information on the consumption frequency and the number of food categories that were purchased, produced and shared. The mean food consumption score (FCS) was 60±23, where 89 % of the study population had an acceptable level of FCS (FCS >35). As per the dietary diversity score (HDDS), an average household consumed at least eight food categories per day. Coconut was the most common food commodity produced in homegardens, followed by jackfruit and other fruits (mango, guava, soursop and pomegranate). Households rely on market-available foods as their primary food source. The study revealed that utilizing at least one food category produced within the homestead, could improve FCS and assist to fulfil the household food demand significantly. However, majority of the homestead food resources were identified as plant-based, except in Jaffna where the presence of livestock and poultry in homegarden was common. Many of the plant-based resources were from perennial fruit-bearing trees. Therefore, modifying the tree composition and utilizing viable crops can be considered a timely option to avert household food insecurity. Further, incorporating livestock components (dairy and poultry) as a part of homegardens is beneficial in fulfilling the animal protein demand of the household.

Keywords: dietary diversity, food security, homegarden, homestead resources, household, Sri Lanka

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Effectiveness of use of "WhatsApp" Messenger Mobile Application for an Extension Campaign and Advisory Forum for Tea Smallholders in Rathnapura District

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Tea smallholders play a vital role in Sri Lankan tea industry. Knowledge dissemination for this sector is very much important as there is a knowledge gap between the disseminators and smallholders. The current knowledge dissemination process has not been able to reduce this gap. Mobile-based messenger applications offer useful features, which enable them to use as extension tools. Therefore, this study was conducted to identify the possibility of using mobile-based messenger applications in conducting extension campaigns and advisory forum and evaluate the effectiveness and user acceptance. Tea smallholders in Rathnapura district were selected as the study community while 54 smallholders were randomly chosen to participate in the campaign. A short-term extension campaign and an advisory forum were planned and implemented on WhatsApp messenger as the main communication platform. Farmers were invited to exchange their ideas, experiences, queries, and comments related to tea cultivation. Farmers' knowledge gain was studied using a pre and post-test assessment. Farmers' reaction to the extension campaign was evaluated using a questionnaire. Data were collected using an online questionnaire, and telephone interviews. Results of the Wilcoxon sign rank test indicated that the knowledge gained from the extension campaign was positively (p <0.05). Sixty seven percent rated the extension campaign as very successful. Eighty three percent responded that organizing similar extension campaigns through WhatsApp chat in the future as very good. The study concludes that mobile platforms such as WhatsApp messenger are effective in implementing extension advisory campaigns to enhance awareness and educate farmers on basic tea management practices.

Keywords: Extension and advisory Campaign, Knowledge gain, Tea Smallholders, Technology dissemination, WhatsApp

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Production Diversity, Seasonality and Dietary Diversity in Rural Agricultural Context in Sri Lanka: A Case of *Mahakanumulla* Village Tank Cascade System

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Rural agricultural households are often identified as vulnerable to malnutrition and hence, often is the targeted beneficiary group in most nutrition and health development programmes. Dietary diversity is considered as a characteristic of a healthy diet. Improving production diversity is considered to increase dietary diversity in subsistence farming contexts, yet with the agricultural transformation, this association needs to be revisited. The objective of this study was to investigate the association between production diversity and dietary diversity in rural agricultural context in Sri Lanka taking the seasonality into account. The study site was *Mahakanumulla* Village Tank Cascade System in the Dry zone of Sri Lanka. Pooled Ordinary Least Squares regression and Random Effect panel data model were used in estimation. The results revealed that production diversity and dietary diversity are having a positive and statistically significant relationship. Education level of the household head, income and the household size are also identified as factors affecting the household dietary diversity. The households seem to smoothen dietary diversity level across months and hence there is no significant difference in dietary diversity between *Yala* and *Maha* seasons or pre-harvesting and post-harvesting time periods. Cultivating specific crop types such as cereals, involvement of livestock farming and the season affect the frequency of consumption of some food groups such as dairy and meat. This study concludes that increasing production diversity could improve the nutrition of the rural agricultural households in Sri Lanka. Hence, nutrition development programmes may benefit from encouraging production diversity in rural agricultural contexts.

Keywords: Agricultural, Dietary diversity, Production diversity, Seasonality, Sri Lanka

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Effect of Socio-Economic and Institutional Factors on the Choice of Food Production System Practiced in Home Gardens

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The global existence of small-scale food production at the household level has a wide range in terms of physical appearance and utilization. There are three fundamental food production systems based on a variety of type-specific and general features (i.e. household garden, market garden, and field garden). These three types of home food production systems can be identified in a village tank cascade system in the Dry zone of Sri Lanka. Socio-economic and institutional variables might have an impact on the household choice of the food production system practiced in their home gardens. This study analyzes the socio-economic and institutional factors affecting the choice of food production system practiced in home gardens based on random utility theory. A revealed preference approach was employed to identify the current home garden choice of households. A multinomial logit model was used to analyze the data which were collected from 102 households randomly within the hydrological boundary of the Mahakanumulla village tank cascade system. The decision to have a household garden is driven by socio-economic and institutional factors rather than market gardens and field gardens. The effect of these factors on the decision to have a field garden is comparatively less. Each type of food production system plays a different role in fulfilling a household's essential requirements. Using these results policymakers can predict farm management decisions of households and plan evidence-based strategic government intervention to meet the daily nutrient requirement, ensure food security and mitigate food scarcity.

Keywords: Choice Analysis, Revealed preference approach, Utility maximization, Village tank cascade system

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A Geospatial and Socio-economic Assessment of Tree Density Outside Forests Sources in Agro-ecological Regions: Home gardens in Upper Mahaweli Catchment in Sri Lanka

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Homegardens (HGs) as a Trees Outside Forest Sources (TOFS) play a vital role in offsetting tree cover loss due to large-scale deforestation in the Upper Mahaweli Catchment (UMC) over the past two centuries. The potential of HGs is determined by the extent and qualitative characteristics, which are governed by biophysical and socio-economic factors. Therefore, temporal and spatial distribution of HGs of UMC in relation to agro-ecological regions (IM_1, IM_3, IL_2, IU_2, IU_3 and WM_2), their tree density and factors effecting on tree density were assessed. A geospatial assessment was carried out using Landsat Images acquired from 1992 and 2017. Tree density of HGs was estimated using trees having dbh >10 cm of a random sample of HGs (n = 500) in UMC. Factors effecting on tree density were assessed using regression analysis. According to the spatial assessment, IM_{3a} covers the highest percentage of area (66.49 %) by HGs in UMC in 2017, whereas the highest incremental percentage area of HGs from 1992-2017 was recorded in IM_{1a} (22.84 %) and the lowest was in IL_2 (0.03 %). The highest tree density of HGs was observed in IU_2 (858.29 trees/ha) while the average was in WM_{2a} (505.45 trees/ha), and these values are comparable with the tree density of south-Asian tropical rain forests. However, there is a tendency of spreading exotic tree species rapidly in IU_2, WM_{2a} and IU_{3d}. According to the multiple linear regression model (p <0.01, R^2 - 58.62 %), variables such as the age of the HG, pepper cultivated area, distance to the road and institutional support were positively related, and vegetable cultivated area and population density were negatively related to the tree diversity. This study proposes to introduce a suitable inventive package to enhance the tree density of HGs as the major TOFS in the UMC along with the promotion native species to maintain ecological sustainability of the catchment.

Keywords: Geospatial assessment, Homegardens, Tree density, Trees outside forest sources, Upper Mahaweli Catchment

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Resource Recovery by Composting Municipal Waste: Successive Development in Sri Lanka

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This paper presents an outcome of a general review on Municipal Solid Waste (MSW) composting in Sri Lanka over the past-few decades. The review used an extensive amount of secondary data extracted from authorized publications and reliable sources. Preliminary analysis revealed that a considerable discrepancy exists among different data sources. Therefore, a detailed verification survey was conducted to verify and update the secondary data. Data analysis showed that MSW composting systems established in early 90's were self-initiates of local authorities with the intention of biodegradable waste resource recovery through centralized composting which were then expanded to a number of local authorities through a series of foreign donor projects in the 1990-2005 period. Interventions made by the Ministry of Environment through the *Pilisaru* national project in 2008, and public capital investments by other central and provincial government agencies brought up a rapid increase of composting facilities in the country from 2005 to 2015. The policy reforms and support from timely imposed regulations helped to effectively implement the goals of organic waste resource recovery through composting. This research estimated that 1130 metric tons of biodegradable waste, which was about 29% of estimated total MSW collection diverted to 156 centralized composting facilities in Sri Lanka. However, the amount of compost manufactured through centralized composting systems remained low at approximately 10 % of throughput. The quality assessment of MSW compost samples obtained from composting facilities owned by the local authorities revealed that 75-86 % of compost samples were compliance with the NPK requirement of SLS1634:2019 while 5 % of samples contained heavy metals (Ni, Cr, Pb) beyond the permissible limits. In conclusion, sustainability of composting as a mean of biodegradable waste management depends on the next level of technical and financial support to establish mechanisms to secure the disposal of residual waste, quality assurance of compost and marketing of MSW compost.

Keywords: Biodegradable waste, Chronological evolution, Compost quality, MSW

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Variability of Soil pH and EC as Affected by Water Source, Cropping System, and Soil Order in Paddy Growing Soils of Sri Lanka

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Soil reaction (pH) and electrical conductivity (EC) are considered as two major chemical properties which determine the soil nutrient availability and rice yield. Therefore, this study was conducted to study the variation of pH and EC in rice cultivated soils as affected by major water source used for rice cultivation, rice-based cropping system adopted and rice growing soil orders in different agro-climatic zones (ACZs) in Sri Lanka. A total of 1000 soil samples were collected from lowland paddy fields. Both pH and EC were measured in 1:5 soil: water extracts. The pH of the soil samples was in the range of 3.01-7.73 with a mean value of 4.98. Moreover, 77 % of the soil samples were below the optimum range of pH for rice cultivation (5.5-7). Values of pH observed in Dry Zone soils were higher (5.2) than that in Wet Zone (4.4) ($P<0.05$). Soil EC values were between 1.09 - 3,169 µS/cm with a mean value of 148.5 µS/cm. Up country Intermediate zone recorded the highest soil EC than that in other ACZs ($p<0.05$). Moreover, 82 %, 12 %, 3 % and 1.5 % of soil samples recorded EC values in the ranges of 0-200 (non-saline), 200-400 (slightly saline), 400-800 (moderately saline) and 800-1600 µS/cm (highly saline), respectively. Less than 1 % of soil samples reported EC values greater than the threshold level of soil salinity (3000 µS/cm). Appropriate agronomic management practices need to be adopted, particularly to improve soil pH, in order to improve rice crop productivity.

Keywords: Agro-climatic zones, Electrical conductivity, Paddy, Soil Reaction

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Performance of Micro Irrigation Systems in Coconut Plantations: A Field Study

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The majority of the coconut farmers in Sri Lanka are reluctant to adopt Micro-Irrigation Systems, complaining about the low performance. A field study was conducted to verify the claim. The performance was evaluated in two subunits at inlet and distal end of two micro-irrigation systems with drippers and mini sprayers. The subunit at inlet of the system with drippers showed a fair Emission Uniformity and all other tested subunits in both systems showed poor Emission Uniformity (<70 %). In the drip irrigation system, the increase of Emission Uniformity in subunit at the distal end was approximately 33 %. The increase of Emission Uniformity in all subunits of both systems was 4-6 % after replacing the emitters with new emitters. System with drippers showed severe clogging risk and the system with mini sprayers showed minor clogging risk. However, the percent weight reduction of a mini sprayer after washing due to removal of clogging substances was the highest (2 %) even though the water quality was in the low clogging risk category. The coefficient of manufacturer's variation of the new drippers was in the marginal category of the classification. The Emitter Flow Variation of all the subunits were unacceptable level (<25 %) with the existing drippers and mini sprayers. Only the subunit at the inlet of the drip irrigation system showed acceptable Emitter Flow Variation with new emitters. This study reveals that the low performance in both systems is due to emitter clogging and poor hydraulic design.

Keywords: Drip, Emission Uniformity, Emitter Clogging, Mini Sprayer

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Tank Sedimentation and Soil Erosion Simulations of the Sub-catchments Under Present Land Use Scenario and Conservation Interventions in Palugaswewa Tank Cascade System, Sri Lanka

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Agriculture in the dry zone of Sri Lanka sustained over two millennia by harvesting the rainwater using manmade village tanks arranged in a cascade system. Soil erosion threatens the Tank Cascade Systems (TCS) by causing a high level of sedimentation in tanks. There are no studies conducted in the country on spatial soil loss in TCS. Therefore, this study focuses on the sedimentation and spatial distribution of potential soil erosion rates in six selected sub-catchments in Palugaswewa TCS. The present volume of sedimentation of each tank was calculated using sediment depth contour maps. The spatial distribution of the potential average annual soil erosion rate of the sub-catchments of the Palugaswewa was assessed for the present land use scenario and some conservation intervention using revised universal soil loss equation (RUSLE) and geographic information system. The potential annual sediment yield was calculated using sediment delivery ratio and potential average annual soil erosion rate. At present, 40 % to 50 % of the tank storage capacity has been filled with sediments under existing land use. The potential average annual erosion rates of the sub-catchments of Palugaswewa TCS varied between 18.8 t/ha/yr and 44.3 t/ha/yr. The sediment delivery ratio varied from 0.18 to 0.9. This study suggests that adapting appropriate conservation measures such as cover cropping and soil contour bunding reduces the potential average annual erosion rates to between 8.9 t/ha/yr and 14.5 t/ha/yr in the Palugaswewa sub-catchments.

Keywords: RUSLE, Tank storage capacity, Village tank

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Estimation of Surface Runoff using SCS - CN Method: A Case Study of *Kotagala* Oya Watershed, Nuwara Eliya, Sri Lanka

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Effective watershed management and planning requires a solid understanding of hydrological behavior. The most important hydrological processes in evaluating water resources are rainfall and runoff. The estimation of runoff in a watershed is essential to effectively manage the limited water resources. However, due to the ungauged nature of the majority of watersheds in Sri Lanka, the measurement of runoff depth is a crucial factor for the development of hydrological projects. Models of rainfall-runoff have been used to predict surface runoff, which could be used to estimate water availability. There are many ways to calculate runoff from rainfall, but the SCS-CN approach is still the most well-known and often applied method because its key component, runoff curve number, depends on land use/land cover, soil type, and antecedent soil moisture. *Kotagala* wetland watershed located in the Nuwara Eliya District, Sri Lanka has been taken as a case study to estimate surface runoff by the SCS curve number method and GIS. Results show the average annual surface runoff depth for the catchment is about 2120.1 mm. The annual average volume of runoff for the 2002-2021 period was calculated as 2.7×10^7 m^3 which is 72 % of the total average annual rainfall in the watershed. The results were validated by other studies in the similar catchment. The soil conservation service - curve number and GIS can be used to compute runoff for ungauged watersheds in Sri Lanka and to support watershed management.

Key words: Arc GIS, Curve number, Land use, Surface runoff, Watershed

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Characterization of Long-term Average Climate and Soil Water Deficit across an Altitudinal Gradient of Tropical Rainforests in Sri Lanka

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Long-term average climate and its variability strongly influence the structure and dynamics of tropical rainforests of Sri Lanka (TRFSLs), a key ecosystem for environmental sustenance. The objectives of this work were to characterize the long-term average climate and soil water deficit (SWD) across the entire altitude range of TRFSLs and determine their within-year and inter-annual variability. Long-term (1990-2018) climatic data were obtained from WorldClim2 and CRU-TS-4.03 global databases for the areas containing ten permanent samplings plots within TRFSLs across an altitudinal range from 117 to 2132 m above sea level. Soil water deficit was computed, on a monthly (SWD) and cumulative (CSWD) basis, as the difference between rainfall and evapotranspiration. Long-term annual means of maximum (T_{max}), minimum (T_{min}) and mean (T_{mean}) temperatures decreased with increasing altitude while the diurnal temperature range (DTR) increased. Sensitivity to altitude was greater for T_{min} than for T_{max}. Within-year variation patterns of T_{max}, T_{min} and DTR were different, with peaks in March, April-May, and April respectively. Forests in higher altitudes experienced greater DTRs with greater within-year fluctuation than those in mid- and lower altitudes. Long-term annual rainfall and solar irradiance decreased while SWD and CSWD increased with increasing altitude. All altitudes showed peak SWD and CSWD in February-March. The higher altitudes showed an additional peak in June-July. Inter-annual variability, quantified in terms of the coefficient of variation, was greater for rainfall than temperature, while CSWD and SWD showed the highest variability. It is highlighted that the requirement of adaptive mechanisms for climate variability is greatest in montane forests at high altitudes.

Keywords: Climate variability, Diurnal temperature range, Maximum temperature, Minimum temperature, With-year variation

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Comparative Assessment of Soil Chemical Characteristics in Two Contrasting Vegetable Cultivating Systems of Sri Lanka

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Vegetable cultivation in Sri Lanka is characterized with intensive and commercialized agricultural systems with very high input of agro-chemicals. Diagnosing soil fertility levels in these systems is essential to supply plant nutrients in required quantities and balanced ratios to maximize productivity while minimizing environmental pollution. Objective of this study was to assess the current status of soil chemical characteristics in two intensive vegetable cultivating systems in the central highlands. Soils from randomly selected farmer fields (n = 100) in two contrasting vegetable cultivating systems; vegetable-potato-vegetable in Nuwara Eliya region (NE) and vegetable-paddy-vegetable in Marassana region (M), were collected and analyzed for various chemical properties. The pH buffer capacity, electrical conductivity, total carbon and nitrogen contents were significantly high in soils in NE (p <0.05). From the measured plant available nutrients, P, K, Mg, S, and Zn contents were significantly high in NE (p <0.05) but Cu availability was not significantly different between the two systems. All farmer fields in NE and about 90% and 100% in M, exceeded the optimum P and K levels for crop growth, respectively. About 88% of NE and 98% of M fields had higher Mg contents than the optimum but K:Mg ratios were within the optimum levels. Almost all fields in the two regions had lower than optimum S, Cu and Zn contents suggesting the need for their application for higher productivity levels. Review of literature suggested that available P content has been increased at an alarming rate (about 5 mg/kg/year), during the last four decades, and had already exceeded the agronomic threshold level (60 mg/kg) in most of the soils of NE (98%) and M (84%). Strong policy level interventions with site-specific integrated nutrient management strategies are essential for the sustenance of vegetable production in central highlands of Sri Lanka.

Key words: Chemical properties, Optimum levels, Vegetable cultivation.

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Impact of Mild Water Stress During the Flowering Stage on Leaf Functional Traits and Yield of Selected Cowpea Varieties Grown in The Low Country Dry Zone of Sri Lanka

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Cowpea (*Vigna unguiculata*) is one of the versatile and important legumes growing in tropical and subtropical regions of the world. Cowpea is grown in the Dry Zone of Sri Lanka as an inter-season crop between two major rice growing seasons: *Yala* and *Maha*. However, despite the short life cycle, it is highly likely that cowpea experiences mild soil moisture stress (around 70 % of field capacity) conditions at the flowering stage due to enhanced evapotranspiration in response to increasing air temperature. Therefore, in this study, five cowpea varieties were subjected to two soil moisture conditions; field capacity and mild water stress at the onset of flowering under a split-plot design for two consecutive inter-seasons. The effect of soil moisture stress on leaf functional traits and yield parameters was evaluated to investigate underlying relationships between yield reduction and leaf gas exchange traits. The yield reduction in the five varieties tested was associated with a reduction (p <0.05) in leaf net assimilation rate, number of pods/plants, and number of seeds/pods. Further, variety-dependent reductions in leaf functional traits in many varieties leading to a reduction in yield parameters (p <0.05) were obvious under mild water stress conditions. Despite the water stress variety, Waruni performed well in both moisture conditions. Therefore, it can be concluded that cowpea varieties for inter-season cultivation should be selected based on their ability to maintain yield under mild water stress conditions. A special emphasis should be placed on commencing cultivation as soon as the main crop is harvested in order to better utilize the residual moisture.

Keywords: Leaf functional traits, Mild water stress, Response of cowpea, Total yield

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Assessment of Soil NPK and Rice Yield under Three Different Nutrient Management Systems in the Dry Zone Rice Farming

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Experimenting alternative farming methods for rice crop (*Oryza sativa* L.) is urgently required for Sri Lanka to overcome the consequences of conventional chemical farming. Hence, this study was initiated during the *Maha* season 2018/19 with three treatments as Chemical Nutrient Management (CNM)-100% Department of Agriculture recommendation, Integrated Nutrient Management (INM)-50% of nitrogen (N) requirement supply with inorganic fertilizer and 25% N requirement supply with organic fertilizer and Organic Nutrient Management (ONM)-only 50% N requirement supply with organic fertilizers, to assess the performance of rice under three management systems. Soil samples collected from experimental plots were analyzed for total N, available phosphorous (P) and exchangeable potassium (K). Final grain yield was calculated in plot basis. Total N reported 30 % significant increment within ONM from *Maha* (2018/19) to *Maha* (2020/21). Available P of ONM increased from 4.7, 2.4, and 9.6 mg/kg to 16.5, 21.7, and 13.2 mg/kg at initial, 50% heading and harvesting stages, respectively from 2018/19 *Maha* to 2020/21 *Mah*a. Exchangeable K fluctuated without any significance between treatments as well as crop growth stages at the *Maha* 2020/21. Significantly greater yield was obtained in CNM as 3.4 t/ha while INM and ONM reported 3.1 and 1.7 t/ha respectively in the 2018/19 *Mah*a. However, no significant difference was observed in final grain yield in 2020/21 *Maha* season and it was reported as 4.2 t/ha (CNM), 4.8 t/ha (INM), and 4 t/ha (ONM). Overall, the study confirms that soil NPK developed at ONM system enriched the soil and gave a similar yield after three main seasons and INM as one of the best approaches to optimize the paddy yield while reducing the use of inorganic fertilizers.

Keywords: Crop stage, Nutrient management systems, Rice yield, Soil NPK

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Spatial Variability of Selected Soil Physico-Chemical Properties in Tropical Rainforests of Sri Lanka across a Wide Altitudinal Gradient

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Soil variations, composition and functioning of tropical rainforests (TRFs) have a dynamic two-way relationship. This work's objective was to characterize the variation of key physico-chemical properties of TRF soils with altitude in Sri Lanka. Nine soil variables, *viz.* pH, organic carbon (SOC), cation exchange capacity (CEC), percentages of sand, silt and clay, bulk density (BD), and soil water contents at suctions of 0.033 MPa (Field Capacity, FC) and 1.5 MPa (Wilting Point, WP) at five soil depths (0-5, 5-15, 15-30, 30-60 and 60-100 cm) were extracted from the national-level digital soil database for a series of permanent sampling plots in TRFs established from 117 to 2235 m above sea level. Soil pH peaked at mid-altitudes (5.7-5.8), decreased at both lower and higher altitudes, and was negatively correlated to SOC ($r = -0.350$, $p = 0.0087$). Soil CEC increased with altitude and maximum CEC was 17.44 cmol/kg recorded at 2080 m. Soil CEC was positively correlated to SOC ($r = 0.787$, $p < 0.001$) and silt % ($r = 0.806$, $p < 0.001$). Soil BD increased slightly from low to mid-altitudes, followed by substantial decreases up to higher altitudes, which were accompanied by increased silt% ($r = -0.623$, $p < 0.001$) and clay% ($r = -0.354$, $p = 0.0081$) and decreased sand % ($r = 0.645$, $p < 0.001$). Field capacity and available soil water (ASW) calculated as FC-WP, increased with altitude ($p < 0.05$). According to factor analysis, Factor 1, incorporating CEC, Silt %, FC, ASW, WP and BD, explained 74% of the observed soil variation. Factors 2 and 3, incorporating pH and clay % explained 13% and 12% variations, respectively. Soil variables of Factor 1 decreased with increasing long-term (1970-2018) annual means of temperature ($p < 0.0001$) and rainfall ($p < 0.0001$) but increased with diurnal temperature range ($p < 0.0001$) (DTR). Clay % (Factor 3) increased with decreasing DTR and rainfall ($p = 0.0183$) but pH (Factor 2) was climate-insensitive. The relationships between the composite factors incorporating soil physico-chemical properties and long-term climate are important to predict how the soil properties are likely to vary with future climate change and how such soil variations could influence the forest ecosystem. Overall, results of this study demonstrate the complex interactions between soil properties and climate in the tropical rainforest ecosystems in Sri Lanka.

Keywords: Cation exchange capacity, Climate sensitivity, pH, Soil organic carbon, Soil texture

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Investigating Selected Soil Properties of Young Oil Palm and Rubber Plantation in the Low Country Wet Zone of Sri Lanka

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Oil palm has been introduced as an alternative crop due to low productivity and low prices for rubber in Sri Lanka. There have been concerns raised about the negative effects of oil palm cultivation on soil properties. The study examined selected soil properties of an eight-year-old oil palm and rubber plantations that had previously been under continuous rubber cultivation at the Eladuwa estate, Mathugama, Sri Lanka. A total of 16 samples of intact, minimally disturbed soil were collected within one-meter radius of four oil palm trees and rubber trees in each field with a flat terrain (slope < 2%). Soil properties such as bulk density, saturated hydraulic conductivity, soil organic carbon, dry and wet aggregate stability, texture, gravel percentage, soil thermal properties, and pH were determined. Neither oil palm cultivated soil nor rubber cultivated soil showed significant differences in the bulk density of surface soil (0-15 cm). In contrast, rubber cultivated sub-surface soil (15-30 m) had significantly higher bulk density than oil palm (15-30 cm) cultivated soil. Due to the presence of loose gravels, oil palm cultivated soil had significantly higher surface and subsurface hydraulic conductivity than rubber cultivated soil. No significant differences were found between oil palm and rubber cultivated soils in terms of soil organic carbon, mean weight diameter, and water stable aggregate percentage. Due to its high water retention capacity and slightly higher organic carbon content, rubber cultivated soil had significantly higher volumetric heat capacity than oil palm cultivated soil. This study showed that oil palm establishment has not resulted in significantly altered soil organic carbon content, soil erosion susceptibility to wind and water, or soil reaction when compared to rubber cultivation after eight years. Additional studies are needed to confirm the results across a broader range of soils and age categories for oil palm and rubber plantations.

Keywords: low country wet zone, Oil palm, Rubber, Soil properties,

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Plant Diversity, Aboveground Biomass and Carbon Stock in an Isolated Tropical Sub Montane Forest in Sri Lanka

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This study was conducted at Rilagala conservation forest, Nawalapitiya to assess and compare the plant diversity, above ground biomass and carbon (C) stock in periphery and interior of an isolated sub montane forest in Sri Lanka. All trees above 5 cm Diameter at Breast Height (DBH) in eleven randomly demarcated 25 m × 25 m plots were recorded. Distance up to 100 m from forest boundary considered as the periphery (8 plots) and over 200 m as the core (3 plots). A total of 1,583 trees belonged to 29 species were recorded and aboveground biomass (AGB) and C stocks were calculated using allometric equations. Tree diversity of each plot was calculated using the Shannon diversity index (H'). The species richness and H' were highest at periphery (n = 23, H' = 2.55) while lowest at forest interior (n=11, H'=1.97). The highest tree density was recorded at periphery (2,992 trees/ha) and it decreased to 1,408 trees/ha towards the core. The average DBH was 8.5 ± 3.33 cm and it increased towards the forest interior (9.7 ± 4.51 cm) from periphery (7.2 ± 3.74 cm). Estimated aboveground biomass was ranged from 63.99 - 108.13 Mg/ha with a mean of 82.53 ± 14.39 Mg/ha. The above ground C stock was estimated from 31.99 - 54.07 Mg/ha with a mean of 41.26 ± 7.2 Mg/ha. However, there was no significant difference between forest periphery and core in variables, except species richness (p <0.05). The study revealed that the diversity and density of trees decreased towards the forest interior and vice versa recorded for DBH, AGB and C stock. The study highlight the importance of conserving isolated tropical sub montane forest patches for C sequestration.

Keywords: Allometric equations, Forest conservation, Forest regeneration, Vegetation structure

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Development of a Botanical Formulation Using *Cinnamomum verum* and *Pongamia pinnata* Leaves for Suppression of Nitrification in Soil

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There is a growing interest of controlling nitrification by using botanical nitrification inhibitors to enhance the nitrogen fertilizer use efficiency. The main objective of this study is to develop a botanical formulation (BF) with *Cinnamomum verum* (cinnamon) and *Pongamia pinnata* (karanda) leaves to suppress the nitrification rate of two soils (Red Yellow Podzolic (RYP) and Reddish-Brown Earth (RBE)) commonly used for vegetable cultivation in Sri Lanka. A BF was prepared manually using dried and powdered leaves of cinnamon and karanda, biochar and cornflour. The two soils were treated with BF at three application rates (0 %, 5 % and 10 %, w/w) and potential nitrification rate (PNR) was determined using shaken slurry method in a laboratory incubation. The obtained data were analysed by Statistical Analysis Software (SAS). The BF application significantly delayed (p <0.05) nitrate formation in both soils. The RBE soil had significantly less (p <0.05) PNR compared to RYP soil. The application of 5% and 10 % BF, significantly reduced PNR in both soils at 4 hours of incubation. However, only 10 % BF application rate remained effective in suppressing PNR at 21 hours of incubation. Therefore, results indicate the possibility of using dried, powdered leaves of cinnamon and karanda for suppressing the rate of nitrification in soil. Incorporation of these crops which are capable of inhibiting nitrification or delaying the conversion of NH_4^+ into NO_3^- into vegetable cultivations in the country may help to retain N in these soil systems. Further studies are required to investigate the effect of developed BF on soil biological properties and its impact under field conditions.

Keywords; Botanical formulation, *Cinnamomum verum*, nitrification inhibition, *Pongamia pinnata*, Potential Nitrification Rate

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Development of Local Breeding Lines for Rust-Resistance by Incorporation of Rust-Resistant Genes in Common Bean

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Bean rust is one of the major diseases of common bean reported globally and in Sri Lanka. This study describes the research conducted for the development of rust-resistant snap bean breeding lines using gene pyramiding assisted by molecular markers. The rust-resistant genes *Ur-3* and *Ur-11* derived from resistant sources PI 181996, BelMiNeb-RMR-8, BelDakMi-RMR-19, which, were crossed with local popular varieties Kappetipola nil and Galpalama Kalu (Capri) to obtain F_1, F_2 and Backcross (BC) generations. Resistant progenies identified with standard phenotypic disease screening method were tested with sequence characterized amplified region (SCAR) markers linked to two rust-resistant genes; SK 14 (linked to *Ur-3*) and GT-2 (linked to *Ur-11*). The plants presented preferred agronomic characteristics similar to locally demanded plant types with rust-resistant genes were used to obtain the next generations in each cross combination beyond F_2 and BC_1F_1. Molecular marker, GT-2 showed higher reproducibility with F_1, F_2, and BC_1 50 % to 80 %. Four resistant lines obtained from the crosses (Kappetipila nil x BelDakMi-RMR-19, Galpalam Kalu x BelMiNeb RMR -8, Kappetipolanil x PI 181996, and Kappetipila nil x BelMiNeb RMR -8) with the 2 resistant genes (*Ur-3* and *Ur-11*) were selected from field trials. Evaluations under field conditions showed that the selected lines were productive as other locally improved varieties and are considered as locally developed gene pyramided advanced lines. A vast range of genotypes produced through this research with introgression of rust-resistant genes. These genotypes will be important as the base population for future rust disease-resistant breeding programs in Sri Lanka.

Keywords: Gene pyramiding, Introgression, Molecular markers, Resistant breeding

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Influence of Geographical Aspect and Topography on Canopy Openness in Tropical Rainforests of Sri Lanka along an Altitudinal Gradient

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Solar radiation energy is a limiting factor for forest growth in humid tropical environments. Radiation incident on a forest canopy varies with azimuth angle of incident radiation and aspect of the forest terrain. The objective of this work was to determine the influence of the geographical aspect and azimuth of incident radiation on the canopy structure of tropical rainforests of Sri Lanka (TRFSL). Hemispherical photography was used to capture canopy images of TRFSLs in ten permanent sampling plots across an altitudinal range from 117 m to 2132 m above mean sea level. Fraction of visible sky (V_{sky}) in 144 sectors of the canopy hemisphere, defined by 18 zenith angle (ZnA) x 8 azimuth angle (AzA) segments, was determined using image analysis. Canopy openness, quantified as V_{sky} of the overall hemisphere, increased with increasing altitude. Canopy leaf area index, decreased linearly with altitude and had a negative relationship with V_{sky}. Canopy openness of the top one-third (ZnA = 0^o–30^o) of the hemisphere ($V_{sky(0-30)}$) was significantly (p <0.05) lower on the east (AzA = 90^o) than on the west (AzA = 270^o) in a majority of plots. Similarly, $V_{sky(0-30)}$ was lower on the northern (AzA = 0^o) than the southern (AzA = 180^o) canopy segment. These patterns were altered in plots where nearby mountains and slope aspect of the plot influenced incident radiation. These observations support the hypothesis that canopies of TRFSL are structured to maximize radiation capture by allocating more leaf area, and therefore having lower canopy openness, on sides of the canopy, which face directions of greater radiation receipt.

Keywords: Visible sky fraction, Canopy hemisphere, Zenith angle, Azimuth angle

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Household Food Waste Behaviour in the Western Province of Sri Lanka: A Preliminary Study

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Each year over 1.6 million tons of food are wasted by Sri Lankan households. This research assesses the food waste behaviour of households and the effect of behavioural patterns of food purchase and preparation and attitude towards food waste on household food waste. The study focused on households in the Western province and data were collected through an online survey (n = 145). Data were analyzed using both descriptive analyses and Structural Equation Modelling (SEM). The SEM was utilized to determine the impact of households' intentions to waste food, food purchasing behaviour and food-making behaviour on food waste. The results indicated that on average, there is a weekly wastage of 3 – 5 % of food in a household, while cooked rice and raw vegetables are the mostly wasted commodities. Leftovers are the largest contributor to household food waste. The study revealed that bulk and low-quality food purchasing strategies to save money ended up in more food waste. Food-making behaviours such as using everything feasible from raw foods while cooking and attempting to recover as much as possible when a food item begins to spoil contributed to reducing food waste. The attitudes and subjective norms of a household have a negative impact on its intent to waste food. However, contrary to popular belief, intentions to waste food had no effect on food waste, demonstrating that food waste is not a planned behaviour. Consequently, the results allow us to conclude that food waste is not caused by a single component but rather by the combinations of behaviour and attitude variables. In conclusion, the campaign to alter household food purchasing and preparation could help to reduce food wastage.

Keywords: Food waste behaviour, Household food waste, Structural equation model

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Prerequisites for Operationalizing Co-management in Small-scale Fisheries

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It is widely recognized that the contribution of small-scale fisheries (SSF) to nutrition, food security, employment generation and poverty alleviation in the developing world is immense. Nevertheless, the sustainable development of SSF remains a considerable challenge due to sector's increased dependence on ecosystem services, economic globalization and climate change. Co-management is established as a mainstream approach to addressing major issues in SSF. In this study, we employed a multi-step procedure through a literature survey and a systematic selection of case studies to review the issues and problems in the SSF and to examine how co-management has intervened to resolve major SSF issues. Finally, it is attempted to explore the prerequisites for operationalizing co-management. The paper builds on lessons learned from case studies from Uruguay, Zambia, Timor Leste and Sri Lanka, where SSF plays a significant role in fisheries. The paper emphasizes the role of Ostrom's modified principles, which demonstrates the ability of common pool resource users such as small-scale fishers to manage their resources sustainably. We take the position that the existence of Ostrom's modified design principles is a significant prerequisite to operationalizing co-management. The presence of strong, committed and respected local leaders, unity and cohesion of community networks, availability of strong local organizations and enforcement of indirect regulations such as community-based protected areas and closed seasons, and strong local knowledge base on ecological systems are recognized as important prerequisites for operationalizing co-management. The results also show that robust socio-economic conditions and appropriate ecological settings enhance the drive for co-management.

Keywords: Community participation, Fisheries management, Sustainable development

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Overcoming the Digital Barrier among the Elderly Population for Mobile Banking Services in Sri Lanka

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In the present dynamic business environment, banking institutions are always searching for innovative and creative digital solutions to remain one step ahead of their rivals and to be the first choice for their customers. Not all groups of society adopt or use mobile banking at the same pace. The elderly, disabled, and low-income are lagging in adopting and using mobile banking services. In contrast, few scientific studies have focused on the elderly and mobile banking. This study focuses on comprehending the present level of knowledge on the drivers and obstacles of mobile banking and social networking among seniors by conducting a comprehensive review of existing literature and conducting primary data analysis on the issue. The sample size for the study is 100 adults over 50, including both commercial banking customers and non-customers. Relevant data was collected by distributing a survey questionnaire to targeted respondents. A total of six factors are examined in this study: perceived usefulness, perceived ease of use; trust; security; perceived cost; and technological competence to determine the influence of these variables on the behavioral intention of seniors to use mobile banking services. A significant positive relationship was found between the intention to use mobile banking and perceived usefulness, ease of use, trust, security, and technical competency. A significant negative relationship was found between perceived cost and intention to use mobile banking. The study's findings have important implications for banking institutions that want to enhance mobile banking usage among the elderly to ensure their long-term viability.

Keywords: Intention to use, Elderly Population, Mobile Banking, Technological Acceptance Model

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Assessment of Virtual Water of Irrigated Agriculture, Imports, Exports and Water Footprint for Sri Lanka

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Since irrigated agriculture is considered as the highest water user in Sri Lanka, there is a demand for reallocation of water for other sectors such as drinking, industries etc. However, this needs to be done while ensuring the food security of the nation using the virtual water concept, which is defined as the embedded water in a product. Therefore, this study was conducted with the objective of assessing (i) virtual water of agricultural production, (ii) virtual water of food imports and exports, (iii) virtual water trade and (iv) water footprint of the nation. The data on crop water requirement, extent cultivated, imported and exported agricultural products were collected from secondary sources and the analysis was made according to the globally accepted methodology. The annual virtual water value of domestic production was 8.13 Gm^3 from which paddy contributes to 54.7 %. The average virtual water value of paddy in *Maha* season is less than the *Yala* season whilst the virtual water value of paddy in minor schemes are higher than that of major schemes in both seasons implying that more water is required to produce 1 kg of paddy in minor schemes. The net imports of virtual water is 3.4 Gm^3/year. The water footprint of Sri Lanka is 11.59 Gm^3/year with a per capita water footprint of 535.22 m^3/year. The net virtual water imports to the country are about 29.8 % of its food requirement and could be easily met by the available water resources.

Key words: Food security, Virtual water value, Virtual water trade, Water footprint

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A Case Study on the Impact of Newly Introduced Rubber Farming System on Livelihood of Smallholders in the Moneragala District

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The main objective of this study is to examine the livelihood impact on smallholders due to introduction of rubber farming system into Moneragala District. The Multi-dimensional model to Assess the Livelihood Impact of Rubber farming at Household level (MALIRH) was constructed to assess the impact of rubber farming on livelihood development at household level through the following steps; Identification of domain for the construct, item generation, categorization of items into determinants, initial data collection and purification through expert validation, pilot testing, scale modification, refinement and finalization. Finally, seventeen items were selected to develop and measure the livelihood impact of rubber farming with the use of MALIRH. Two hundred and fifty six rubber smallholders were selected from 256 households and asked to mark their opinion on the items based on a five-point ordinal scale in the questionnaire based on the previous five year reference period. The respondents were separated into three categories according to the impact namely high, moderate and low, based on their total livelihood impact by rubber farming. Socio-economic characteristics of rubber smallholders and item-wise impact was evaluated by using descriptive statistical methods and were analyzed by STATA 14. Sixty-four percent of rubber smallholders in this study area consider rubber farming to exert a high impact on the development of five livelihood capital assets at household level. While, 28% of rubber smallholders consider it to wield a moderate impact, 8 % of rubber smallholders consider it a low impact. The assessment shows that the mean score of overall impact of rubber farming on the livelihood capital asset development at household level is 3.67. The highest mean score (3.75) was recorded from physical capital assets and the lowest (3.52) was recorded from human capital assets. The mean scores of natural, social and financial capital assets were 3.59, 3.73 and 3.75, respectively. There is a positive impact of rubber farming on the development of livelihoods at the household level in the study area. Therefore, rubber farming can be expanded into non-traditional areas in the country as a livelihood strategy to enhance the development of livelihoods.

Keywords: Impact of rubber farming, Livelihood

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Has Collective Action Improved the Efficacy of Tea Smallholding Development Societies in Sri Lanka?

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Farmers' Organisations (FO) have evolved to address the major constraints faced by smallholder farmers. They need to address the diverse concerns of members. Collective action (CA) of members has the potential to influence FOs' effectiveness. Tea Smallholding Development Societies (TSDS) were established through a legislative act and are expected to serve tea growers on resource and market-related issues. However, currently, the sub-sector seems stagnant as per some key indicators and that question the interventions made by TSDSs to the lives of farmers. This study sought to explore the efficacy of TSDSs and investigate their relationship with CA status. Data were collected from 120 TSDSs covering major tea growing areas using structured questionnaires. Results revealed that only 25 % of TSDSs offer multipurpose services at varying rates. The majority of TSDS acts only as an intermediary agency linking farmers with government agencies for various forms of assistance. Market-oriented activities were minimal. Policy dialogue is often lacking within organisations, which can block opportunities to develop a collective consciousness among the membership. Overall observations can be classified into four clusters based on the level of multitasking service provision. Significant correlations are revealed between the efficacy of TSDSs and the status of collective action. Correlation is stronger when collective actions take place on a voluntary basis than when a third party intervenes, raising the question of dependency. The results, supported by the literature, revealed that CA and efficacy function as interdependent variables. Thus, these two factors have the potential to behave in a vicious circle.

Keywords: Collective action, Correlation, Efficacy, Multipurpose activity, Tea Smallholding Development societies.

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Keynote Address & Invited Presentations

KEYNOTE ADDRESS

Using Advances in Technology to Develop Climate-Ready Crops for the Future

Prof. Owen Atkin

Centre for Entreprenurial Agri-Technology
Australian National University
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INVITED PRESENTATION I

Agricultural Extension and Commercial Social Media: Is it Time to Diversify the Digital Habitat?

Prof. Gordon A. Gow

Sociology/Media & Technology Studies
University of Alberta
Canada

INVITED PRESENTATION II

En-route for the Planet Mars: Recycling Nutrients from Organic Wastes for Growing Higher Plants during Long-term Manned Space Missions

Prof. Emmanuel Frossard

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Using Advances in Technology to Develop Climate-Ready Crops for the Future

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To keep pace with increasing global demand for food and to minimize the demand for arable land, grain yields per hectare need to increase by 2-2.5% each year. Yet, the actual annual increases delivered by crop breeding programs around the world fall markedly short of this figure, with recent increases in grain yields often being 0.5-1.5 % per year. Reliance on business as usual crop breeding – with new varieties taking over a decade to develop - are unlikely, therefore, to deliver the increases needed. Contributing to the challenge of achieving global food security are the negative effects of climate change on crop yields, with rising day and night temperatures resulting in reduced yields of rice, wheat and other crops. In this seminar, I will outline the importance of high throughput phenotyping of genetically diverse germplasm – and applications of machine learning methods - to accelerate the breeding of climate-ready crops for the future. As a case example, I will outline work being done to improve the efficiency with which light energy is converted into plant biomass. While the Green Revolution and more recent breeding has near maximized the harvest index and efficiency of light capture by crops, breeding has not maximized the efficiency with which solar radiation is converted into biomass. Two processes are crucial in determining the efficiency of biomass production from light: photosynthesis and respiration. The seminar will outline work being done to improve these processes, including work to identify genetic variants with reduced rates of respiratory carbon release per unit photosynthetic carbon uptake, and how we are screening for heat tolerance of these processes.

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Agricultural Extension and Commercial Social Media: Is it Time to Diversify the Digital Habitat?

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A survey of the literature confirms that the agricultural sector is increasingly reliant on commercial social media for all aspects of communication and information sharing. Within the context of agricultural extension and rural development, social media is particularly important in supporting social learning through communities of practice. However, there are growing concerns about the propagation of misinformation on social media as well as questions about the collection and monetization of user data on these platforms.

In this presentation, I will make a case that those involved in agricultural extension and rural development should begin to consider an ICT diversification strategy by introducing non-commercial social media platforms and tools into their mix of communication channels. Non-commercial social media provides a means to combat misinformation and retain local ownership over data that is generated through the use of these platforms. I will briefly introduce one possible pathway forward with non-commercial social media known as the 'Fediverse' and present some examples of how it is being used to foster communities of practice in organic farming, home gardening, and plant identification.

Extension services will have challenges in implementing this approach and will need to consider research alliances, infrastructure and service resources, as well as digital skills training. I will discuss some steps to be considered going forward. This presentation is based on a growing body of knowledge about the long-term path dependent consequences of commercial social media use, as well as emerging opportunities for creating diverse digital habitats that will better serve the current and future needs of stakeholders in the agriculture sector.

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En-route for the Planet Mars: Recycling Nutrients from Organic Wastes for Growing Higher Plants during Long-term Manned Space Missions

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Long-term manned space missions to Moon and Mars will be soon reality. Shipping food, water and O_2 from Earth will be very costly because of the huge masses to be transported. The crew will therefore need to rely on a life support system allowing the recycling of wastes to produce the necessary food, oxygen, and clean water for the crew while removing CO_2 from the atmosphere of the spaceship. The European Space Agency plans to achieve this goal with the Micro Ecological Life Support System Alternative (MELiSSA) loop which includes five compartments. All wastes produced by the crew (compartment V), except urine which will be collected separately, will be transferred to compartment I, where they will be anaerobically digested. The products resulting from this digestion will be metabolized by photoheterotrophic bacteria located in compartment II. The minerals released from compartment II, together with the urine will be forwarded to compartment III where ammonium will be nitrified. Nutrients will then be transported to compartment IV, in which higher plants growing in a hydroponic system will produce food, O2, and water for the astronauts while removing CO_2 from the atmosphere. Most of the work done up to date on the MELiSSA loop has focused on O_2, CO_2, carbon (C), and nitrogen (N) fluxes, while other plant nutrients have been very little studied. It is currently assumed that the loop will provide all nutrients in the appropriate forms and concentrations and at the proper time to the higher plant compartment.

We review in this paper what should be considered so that higher plants grown in the MELiSSA loop, could indeed receive and use all nutrients they need in available forms and appropriate concentrations to allow optimal growth. Our review shows that to reach that goal new data will need to be collected, new methods will need to be developed, and technological progresses will be needed. Among the new data to be collected we will need full input and output element balances for each step implemented in the MELiSSA loop to assess whether all elements are recycled. These mass balances will have to be calculated for nutrients as well as toxic elements. It will be also necessary to analyze the forms of elements and, if necessary, to implement additional processes to transform nutrients into forms that are available to plants growing under hydroponic conditions. We will also need to quantify the impact of various plant nutritional regimes on CO_2 uptake, O_2, water, and biomass production under closed conditions. Among the new methods to be developed, the most urgent one would be to remove Na from urine as soon as it is collected without removing any plant nutrients. Finally, it will be important to develop ion-sensitive electrodes that can be used in the long term for each element of interest, and a method to treat data collected by these electrodes in real-time so that plants can always be fed with the nutrients they need. We hypothesize that these developments will not only profit long-term manned space missions but also the development of sustainable plant production systems on Earth.

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- *Chief Guest, HE, Ms. Bonnie Horbach, Ambassador of the Kingdom of the Netherlands to Sri Lanka and the Maldives*
- *Keynote speaker, Prof. Owen Atkin, Director, Centre for Entrepreneurial Agri-Technology, Australian National University, Canberra, Australia*
- *Invited speakers, Prof. Gordon A Gow, Acting Director, Media & Technology Studies, University of Alberta, Edmonton, Canada and Prof. Emmanuel Frossard, Institute of Agricultural Sciences, Switzerland*
- *Invited Alumni speaker, Dr. Gamini Samarasinghe, Additional Secretary to the Ministry of Agriculture*
- *Prof. M.D. Lamawansa, the Vice Chancellor of the University of Peradeniya*
- *Prof. K.A.S.S. Kodithuwakku, the Dean of the Faculty of Agriculture, University of Peradeniya*
- *Academic staff members of the Faculty of Agriculture, University of Peradeniya*
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- *Deputy Registrar, Senior Assistant Bursar and the staff of the PGIA*
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- *Authors of papers*
- *Panel of reviewers*
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