



Proceedings of the

10th Annual Research Symposium 2018

“Seeding a Greener Future”

**Organized by the
Faculty of Agriculture
Rajarata University of Sri Lanka**

**Co-organized by
Ministry of Science, Technology, Research, Skills Development &
Vocational Training and Kandyan Heritage
Sri Lanka**

Proceedings of the 10th Annual Research Symposium 2018

Faculty of Agriculture, Rajarata University of Sri Lanka

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FOREWORD

It is with great pleasure I convey this foreword on the occasion of the 10th Annual Research Symposium, 2018, of the Faculty of Agriculture, Rajarata University of Sri Lanka.



This symposium proceeding consists of 90 abstracts of the research conducted by the final year agriculture students with the supervision of academic staff and external supervisors. The research abstracts have been compiled into eight disciplines namely Agricultural Engineering, Agricultural Systems and Management, Agricultural Economics and Extension, Animal Production and Technology, Crop Science, Agricultural Biology, Environmental Soil Management and Food and Postharvest Technology. The quality of the symposium proceedings has reached a commendable level due to the generous commitments of the various contributors. The success of the proceedings is an indication of outstanding effort and energy of reviewers, members of the editorial board and the symposium proceeding committee. I wish to take this opportunity to thank Vice Chancellor, Prof. Ranjith Wijayawardane, Dean of the Faculty, Dr. A.M.J.B. Adikari and Symposium Coordinator, Dr. W.A.D. Nayananjalie for their tremendous support. I wish to extend my thanks to coordinators of each department, for their untiring effort in collecting abstracts and distributing among reviewers on time to make reviewing process success. I take this opportunity to thank Mr. P.D. Kahandage and members of the publication committee for their time consuming effort in compiling proceedings. Finally, on behalf of the editorial board, I would like to thank to all who contributed numerous ways to complete this task successfully.

Dr. M.G.T.S. Amarasekara
Editor in- Chief
10th Annual Research Symposium, 2018
Faculty of Agriculture
Rajarata University of Sri Lanka

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MESSAGE FROM THE VICE CHANCELLOR

It is with great pleasure I send this message to congratulate 10th Annual Research Symposium 2018 organized by the Faculty of Agriculture, Rajarata University of Sri Lanka. This symposium would provide a forum to present and publish research work carried out



by final year students under the guidance of academic staff and the outside subject experts. Most of the research conducted are applied research that address the issues directly relevant to the agriculture development of the country. During the past decade, the quality of the research and the symposium proceedings have reached a commendable level showing the commitment of the academics staff and the students to develop research culture in the faculty.

I wish to convey my gratitude to Dr. A.M.J. B. Adikara, Dean, Faculty of Agriculture, Dr. W.A.D. Nayananjalie, Coordinator 10th Annual research Symposium- 2018 and all academic and non academic staff for their excellent work and untiring effort to organize this event in successful manner. Finally I wish all the best to all students who present their research findings at the annual research symposium.

Snr. Prof. Ranjith Wijayawardana,
Vice Chancellor

MESSAGE FROM THE DEAN

It gives me great pleasure to issue this message on the occasion of 10th Annual Research Symposium, 2018 of the Faculty of Agriculture, Rajarata University of Sri Lanka. Annual Research Symposium of the faculty has been a great success in last several years with high quality presentations and participation of academics, industry personnel, undergraduates and scientists from different research institutions.



The Annual Research Symposium of the year 2018 has a great importance to the faculty because research outcomes of the graduating students are staged and published. I sincerely believe that the experience students gain and the partnership strengthen in participating the research session will brighten their path to the challenging future. The proceedings of this year symposium consists of research abstracts presented by 90 graduating students of the faculty. The quality of the abstracts has been maintained by reviewing thoroughly and assessed by a panel of experienced editorial board.

I would like to thank Dr. (Mrs.) W.A.D. Nayananjalie, Coordinator and Dr. M.G.T.S. Amarasekara, Editor-in-Chief of the 10th Annual Research Symposium and their team mates for the tremendous effort for the success of the symposium. As the Dean of the faculty, I wish to convey my sincere gratitude for the academic and non-academic staff of the Faculty of Agriculture for extending their fullest support and corporation to show up the Annual Research Symposium - 2018 for 10th consecutive time. I also congratulate the graduating students and would like to place a special thank to Senior Prof. K.H.R. Wijayawardana, Vice Chancellor of the University for his moral support and inspirations to complete the event successfully. I also would like to express my sincere gratitude to the university, sponsors and contributors for giving financial assistance to meet the expenses of the symposium.

I wish 10th Annual Research Symposium - 2018 a great success.

Dr. A.M.J.B. Adikari
Dean/Faculty of Agriculture
Rajarata University of Sri Lanka

MESSAGE FROM THE COORDINATOR

On behalf of the organizing committee, I warmly welcome your participation in the 10th Annual Research Symposium, Faculty of Agriculture, Rajarata University of Sri Lanka on 5th of September, 2018. The Annual Research Symposium is the premier for dissemination of research outcomes, problem solutions, and insights on new challenges facing in the field of agriculture and these findings have always been significant in the agricultural sector. The keynote speech, followed by ninety (90) oral presentations of eight parallel tracks will be presented at the symposium. For the first time in the Faculty of Agriculture, RUSL, there is a three minutes thesis (3MT) competition to enhance students' presentation skills, shaping up professional leaders of tomorrow.



Further, I take this opportunity to extend my profound gratitude to Prof. Ranjith Wijewardana, Vice Chancellor, Rajarata University of Sri Lanka and Dr. A.M.J.B. Adikari, Dean, Faculty of Agriculture for extending their fullest support and guidance to this event. I also express my sincere thank to keynote speaker, Dr. Herath Manthrithilake, Head, Sri Lanka Development Initiative International Water Management Institute for accepting our invitation to deliver the keynote speech. The conference would not have been possible without the enthusiastic and the hard work of number of personnel. Therefore, my heart-full thank also goes to all my colleagues in the academic staff, the administrative staff and the non-academic staff in the faculty who worked with me extending their fullest cooperation to this event. I thank all authors and presenters at the 10th Annual Research Symposium who are the major contributors of this event. I also extend my sincere thank to the members in the editorial committee and the reviewers for their valuable comments and all the panelists for sharing their views on current research topics. I acknowledge Dr. M.G.T.S. Amarasekara, the Editor-in-Chief of the symposium for his significant contribution and Mr. P.D. Kahandage, for his valuable time spent on bringing this publication to the present format within a short time period.

Financial assistance to this event came through many generous contributors and I am grateful to all the sponsors for their generous support. Special thank goes to the Ministry of Science, Technology, Research, Skills Development & Vocational Training and Kandyan Heritage who co-sponsored this event.

I look forward to an exciting day with insightful presentations, discussions, and sharing of technical ideas. I would like to congratulate all the final year undergraduates who graduated today and wish all the best in their future endeavors. Finally, I wish a successful symposium.

Dr. (Mrs.). W.A.D. Nayananjalie
Faculty of Agriculture
Rajarata University of Sri Lanka.

KEYNOTE ADDRESS

Greening the Future

Greening (disambiguation) is the process of transforming living environments and also artifacts such as space, a lifestyle or a brand image, into a more environmentally friendly version (i.e. 'greening your home' or 'greening your office'). The act of greening generally involves incorporating more environmentally friendly systems into one's environment, such as the home, work place and generally lifestyle (Wikipedia).

Greening is also a general term for the appropriate selection and planting of plants on, in or next to buildings and in public parks. The goal of greening is usually a combination of environmental benefits and improving the visual design of surfaces, a green wall or green roof, as well as the creation of green spaces. This usually requires technical measures such as earthworks or supporting climbing plants. Greening – the process of becoming more active about protecting the environment.

Our natural environment is one of our most precious inheritance. We in Sri Lanka are blessed with a wonderful variety of natural landscapes and habitats. Environment is – at its roots – another word for nature, for the planet that sustains us, the life on earth that inspires wonder and reverence, the places dear to us we wish to protect and preserve. We value those landscapes and coastlines as goods in themselves, places of beauty that nurture and support all forms of wildlife.

Nevertheless, we also draw from the planet all the raw materials we need to live – food, water, air and energy for growth. Therefore, protecting and enhancing the environment – '*Greening for the Future*', is about more than respecting nature. It is critical if the next generation is to flourish, with abundant natural resources to draw on, that we look after our and their inheritance wisely.

Respecting nature's intrinsic value, and the value of all life, is critical to our mission. Our duty is protecting and enhancing them all and handing over to the next generation. For the reasons mentioned above, we safeguard cherished landscapes from economic exploitation, protect the welfare of sentient animals and strive to preserve endangered woodland and plant life, not to mention the greening of our urban environments.

In that sense, **our goals** should be simple: cleaner air and water; plants and animals that are thriving; and a cleaner, greener country for all of us.

We have already taken huge strides to improve environmental protections, declaring forests and habitats as reserves, identifying endemic and endangered flora and fauna; controlling Ag chemicals coming into the country, plant and animal quarantine; banning non-decaying polythene; enacting EIA / EPL procedures and improving the quality of the air we breathe by vehicle emission certificates, improving fuel standards, etc.

We have done a lot, but **needs to do much more** to save our existing environment. We should sets out the further action we will take. Connecting more people with the environment will promote greater well-being. By using our land more sustainably and creating new habitats for wildlife, improving land use by planning and implementing stricture rules and regulations, we can arrest the decline in native species and improve our bio diversity. By tackling the scourge of waste and plastics, we can make our surrounding land, coast and ocean cleaner and healthier. Moreover, by making the most of emerging technologies, we can build a cleaner, greener country and reap the economic rewards of the green growth revolution. Sri Lanka can be the champion for the protection of our planet.

We have 46 ag-ecological zones. You know the uniqueness of those zones. Each of them deserve a **specific plan of action**, with national ambitions and targets. As well as, setting an example for others to follow in our treatment of the countryside, rivers, lakes and wetlands, land and topography, coastlines, flora and fauna.

We should strive to replenish depleted soil, plant trees, support wetlands, rid water bodies and rivers of rubbish, reduce greenhouse gas emissions, cleanse the air of pollutants, develop cleaner, sustainable energy and protect threatened species and habitats, while producing more.

We should also cherish our international clout as a 'biodiversity hot spot' to influence and bear, in pursuit of a cleaner and greener country. We should use opportunities to strengthen and enhance the protections our countryside, rivers, coastline and wildlife habitats; enjoy, and develop new methods of agricultural and fisheries support, which put the environment first.

- ✓ Population growth and economic development will mean more demand for **housing and other gray infrastructure** that spoils the nature. However, we need to ensure that we support development and the environment by embedding the principle that new development should result in net environmental gain – with neglected or degraded land returned to health and habitats for wildlife restored or created. All communities are now aware of the need for ensuring a healthy environment. It is time to capitalize on the initiatives such as 'green buildings', low-energy construction and management of carbon footprint in the urban environment.
- ✓ We must tread more lightly on our land, using resources more wisely and radically reducing the **waste we generate**. Waste is choking our water bodies and streams and despoiling our landscapes as well as contributing to greenhouse gas emissions and scarring habitats. Time to develop proper management practices for all aspects of handling, storage, and disposal of waste (toxic and other types) which is generated. Environmentally sound and safe management of chemicals and waste is important and plays a crucial role in preserving our environment. We should have a plan outlining ways to reduce the use of plastics that contribute to pollution, and broader steps to encourage recycling and the more thoughtful use of resources.
- ✓ We need to do have a plan not only to protect but also to harness the value of our **flora and fauna**. We should not forget that other animals and plants born and bred in this country are our “fellow citizens”. We cannot have more rights than them to live and flourish!
- ✓ On our coastlines, we must do more to **protect the beaches and marine wildlife** around us from pollution. We should develop a fishing policy that ensures seas return to health and fish stocks are replenished. We should also extend the marine protected areas around our coasts so that these stretches of environmentally precious maritime heritage have the best possible protection.
- ✓ We need to do what is necessary to adapt to the **effects of a changing climate**, improving the resilience of our infrastructure, housing and natural environment. We also should set out how we will tackle the effects of climate change – still perhaps the most serious long-term risk to the environment given higher land and sea temperatures, rising sea levels, extreme weather patterns and ocean acidification, which harms marine species.

We need to work with nature to protect communities from flooding, slowing rivers, drying lands, depleting groundwater, creating, and sustaining more wetlands to reduce flood and drought risks and offer valuable habitats.

Sri Lanka's biggest climate issue is with water. As the drought illustrated, there is little of the precious liquid and it needs to be conserved. The changing climate, with ever-increasing temperatures, means that it is becoming increasingly difficult for communities to continue with business as usual. This means all sorts of changes in how humanity works, from farmers changing how they irrigate to villages sharing resources to grow sustainably. This calls to look at communities that are thinking out of the box in ensuring their own survival.

The new system of **support that we should develop for farmers** – true friends of the earth, who recognize that a care for land is crucial to future rural prosperity – should have environmental enhancement at its heart. We should support farmers to intensify sustainably their production process, without expanding to fields rich in herbs and wildflowers; plant more trees, restore habitats for endangered species, recover soil fertility and attract wildlife back. We should ensure broader landscapes are transformed by connecting habitats into larger corridors for wildlife. Planting more trees provides not just new habitats for wildlife – it also helps reduce carbon dioxide levels and can reduce flood risk.

We can also **set standards** in protecting and growing natural capital – leading the world in using this approach as a tool in decision-making. We should take into account the often hidden additional benefits in every aspect of the environment for national wellbeing, health and economic prosperity, with scientific and economic evidence to the fore.

To **ensure strong governance**, we should consult on plans to set up a leading **environmental watchdog**, an independent, statutory body, to hold Government to account for upholding environmental standards. We should regularly update these plans to reflect the changing nature of the environment. In areas, where environmental conservation policy is devolved and responsibility rests with the provincial and local bodies, need to involve more broadly, work with the ***Devolved Administrations*** to uphold environmental standards and go further to protect our shared natural heritage. In working with the Devolved Administrations on areas where common frameworks need to be retained.

They seek to improve **social justice** by tackling the pollution suffered by **those living in less favourable areas**, and by opening up the mental and physical health benefits of the natural world to people from the widest possible range of ages and backgrounds.

We can show leadership on conservation, climate change, land use, sustainable global food supplies and marine health. The current generation of leaders and decision makers are handing over polluted world with rising carbon levels. This is both a challenge and an opportunity for **youth**, who need to stand up and become the climate leaders of tomorrow. **Women** play a crucial in addressing some of the challenges in the environment, and are often underrepresented in organizations and projects relating to the environment. This must be recognized and support women become more resilient, and play more of a role in shaping their own, sustainable, future.

We should **champion sustainable development**, lead in environmental science, innovate to achieve clean green growth and increase resource efficiency to provide benefits to both our environment and economy, and keep our pledge to hand over our planet to the next generation in a better condition than when we inherited it.

Finally, we should be aware of the payback period for each technology. “Quick return” is defined as those that pay back costs in two to three years, which is rare in conservation. “**Investment decisions**” are those that need special management consideration because the payback is not three to five years. “Strategic assets” refer to technologies that pay for themselves over their lifetime. Of course, the numbers will not be identical for all aspects of environment. That said, these estimates do provide a sense of direction and scale.

If you look for, most of the **technologies** are already available for our purpose. The challenge for us is to figure out which ones to use and /or how to put them into practice, and how to renew them so that they continue to work year in and year out. There are **Five Principles** that can help to make sense of what technologies to use and how to put them into long-term practice. I strongly feel these are equally good for organizations as well as for individuals to adopt. Those principles (adopted from Makenzie Consultants) are:

Think lean: Building a *resource-productivity strategy*. Lean thinking and green thinking are based on the same fundamentals and work together well. This will minimize the waste.

Think limits: Use the *theoretical limit concept*—an analysis that identifies the lowest amount of energy required for a given process—to set ambitious but realistic goals.

Think Efficiency: Review the full return(output equation) when making changes. Evaluate tradeoffs such as throughput, yield, energy, and the environment as a whole—changes in one will likely affect the others. Output should be the main factor in making final decisions.

Think holistic: Making and sustaining change is not only a matter of technical improvements; it also means changing mind-sets, behaviors, and the management system throughout the organization and every individual.

Think circular: Consider your outputs/product as a future resource that can be used repeatedly, moving from the usual linear supply chain toward supply circles.

These five principles would help us foster the kind of creative thinking that can deliver substantial resource productivity improvements, which is the basis for 'greening our future'. These actions will, I hope, ensure that this country is recognized as the leading global champion of a greener, healthier, more sustainable future for the next generation.

Do not forget, we hold our natural environment in trust for the next generation. By implementing rigorous measures in protecting environment, ours can become the first generation to leave that environment in a better state than we found it, and pass on to the next generation a natural environment protected and enhanced for the future.

An irrigated field is contrasted next to a plowed field on a farm on the outskirts of Mudgee, Australia on July 18, 2018.

— David Gray / Reuters

Greening (disambiguation) is the process of transforming living environments, and also artifacts such as space, a lifestyle or a brand image, into a more environmentally friendly version (i.e. 'greening your home' or 'greening your office'). The act of greening generally involves incorporating more environmentally friendly systems into one's environment, such as the home work place, and generally lifestyle.

Greening is also a general term for the appropriate selection and planting of plants on, in, or next to buildings, for example, and in public parks. The goal of greening is usually a combination of environmental benefits and improving the visual design of surfaces, a green wall or green roof, as well as the creation of green spaces. This usually requires technical measures such as earthworks or supporting climbing plants. Furthermore, permanent care and irrigation is usually necessary to maintain the greened environment, in some areas there are normative requirements for the planning and execution of the greening, for example roadsides greening. In soil bioengineering, plants with technical functions may be needed.

The greening of deserts is a particularly difficult task. If it is sustainable, it is the most effective measure for the economic development of arid areas, decreases global warming, and improves the local climate.

These “green” qualities include, but not limited to reduced toxicity, re-usability, energy efficiency, responsible packaging and labeling, recycled content, intelligent design, responsible manufacturing techniques, reduction of personal environmental hazards, alleviate heat island effects.

- The process of making somewhere greener by planting grass, trees and concern about ugly effects of industrialization has led to the greening of many of our cities.

ABSTRACT INDEX

SESSION 01 – AGRICULTURAL ENGINEERING

Comparative Study to Improve the Quality of Reverse Osmosis Concentrate using Phytoremediation Techniques

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SESSION 01



AGRICULTURAL ENGINEERING



COMPARATIVE STUDY TO IMPROVE THE QUALITY OF REVERSE OSMOSIS CONCENTRATE USING PHYTOREMEDIATION TECHNIQUES

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Reverse Osmosis (RO) plants have been introduced by many organizations to Chronic Kidney Disease of Unidentified Etiology (CKDu) affected areas as an effective drinking water treatment method. Reverse Osmosis concentrate is normally released to the environment without any treatment. This study was conducted to identify the possibility of improving the quality of RO concentrates using phytoremediation techniques. Four plant species; Vetiver (*Vertiveria zizanioides*), Cattail (*Typha augustifolia*), Cannas (*Canna indica*) and Bulrush (*Scirpus californicus*) were planted in plastic containers (60 x 30 x 30 cm) and soil without amendments was served as the control. The experimental units were treated with concentrates obtained from RO plant installed in girls' hostel, Faculty of Agriculture at a rate of 2.3 mls⁻¹ for two months. The hydraulic retention time was 3h. Water samples were collected from inlets and outlets of the each experimental unit by two weeks interval and analyzed for pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), concentration of Na⁺, K⁺, Ca²⁺, Mg²⁺, NO₃⁻-N, PO₄³⁻-P and NH₄⁺-N. The experiments were conducted in a Completely Randomized Design with three replicates. The results revealed that Removal Efficiencies (RE) of all pollutants were increasing with time. Cattail and Bulrush plants showed significantly ($p < 0.05$) higher RE for EC, TDS, NO₃⁻-N and NH₄⁺-N by 9.6%, 10%, 8.2% and 16% respectively. Cannas showed significantly ($p < 0.05$) higher RE for EC and TDS by 9.6% and 10% respectively. Also the RE of PO₄³⁻-P was significantly ($p < 0.05$) higher in Cattail (12%). Sodium Adsorption Ratio of all treatment plants were under the low sodium (0-10) water quality class. Therefore, it can be concluded that the quality of RO concentrate can be improved using phytoremediation techniques. However, further studies are vital to identify the most effective plant species.

Keywords: CKDu, Phytoremediation, Removal efficiency, Reverse osmosis, RO concentrate

EVALUATION OF THE PERFORMANCE AND PROCESSING COST OF NEWLY DEVELOPED LOOSE LEAF BARN METHOD FOR CURING OF TOBACCO LEAVES

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Tobacco is the most widely grown non-food crop in the world. Traditional tobacco curing encounters a vast postharvest loss and it requires more labour. As a solution, Brazil introduced a Loose Leaf Barn (LLB) curing technology and Ceylon Tobacco Company (CTC) attempted to adapt it locally. This research was designed to evaluate the performance of newly developed LLB method and to compare it against standard values of traditional local curing method to validate the expected benefit realization. Research was carried out at CTC, Galewela. Newly designed LLB was operated four times to collect qualitative and quantitative data such as weight of the green leaves (kg) and cured leaves (kg), required man days for an operation, amount of consumed paddy husk (kg), and consumed units of electricity (kWh) on curing process. Data were analyzed to determine standard indices such as cost of processing (LKR.kg⁻¹), average price of cured leaves (LKR.kg⁻¹), ratio of the green leaves to cured leaves, green leaf handling efficiency and the amount of paddy husk required to produce 1 kg of cured leaves and compared them with the standard values. According to the results, the amount of paddy husk required to produce 1 kg of cured leaves by LLB was significantly ($p < 0.05$) lower (53.2%) than the traditional method and the other indices did not show any significant difference between the two methods. However, the profit gained by the new method is significantly lower than the traditional method ($p > 0.05$). Therefore, it is recommended to improve the performance of LLB by engaging skilled labour to make the leaf handling operation more efficient and standardization of quality of green leaves to increase average price above the standard. Further, the new model should be modified to make it more viable to local conditions before commercialization of the product.

Keywords: Curing, Green leaf, Loose leaf barn, Tobacco

DEVELOPMENT OF AN INFRARED-ASSISTED DRIED AIR DRYER FOR DRYING OF FRESH PEPPER

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Dried black pepper (*Piper nigrum* L.) is the fourth most exported agricultural produce in Sri Lanka. It's contribution to the economy of the country is significant. There are no proper dryers developed to dry fresh berries at small and medium scale level. Presently, drying yards and mats are extensively used for drying fresh berries and as a result, dried black pepper contains dust, fecal matters and impurities. This low quality and unhygienic dried products receive low demand at export markets. Therefore improving drying method of fresh berries is important. The main objective of this study was to develop an infrared assisted air dryer for drying fresh berries with high quality, cost effective manner. Newly developed dryer consists of, refrigerated air dryer, infrared heaters and cabinet type dryer. Refrigerated air dryer reduces moisture content and temperature of air up to 24% and 25°C respectively. This refrigerated air is sent through infrared heaters of 3x1000 W. The heated air at 42°C enters to the cabinet type dryer which comprises of three trays with the capacity of 1kg of flesh berries. The evaluation of developed dryer was done in terms of moisture content, time taken to drying and quality. Dryer reduced the moisture content from 70.1% to 12% and took 6 hours for drying up to 12% moisture content, where sun drying of same fresh berries took 30 hours. Dried pepper was brown to black in color, 0.04% extraneous matter, zero mouldy berries, 7.3% light berries, 0.7% pin heads at 12% moisture content. Results shows that dried product could be categorized at 2nd grade as per the ISO 105, due to high amount of light berries. This could be overcome by harvesting at correct maturity. Hence, it can be concluded that developed dryer is highly suitable for drying pepper.

Keywords: Black pepper, Drying, Infrared heating

A FEASIBILITY ANALYSIS OF THE CONSTRUCTED WETLAND UNIT FOR DOMESTIC GREYWATER TREATMENT

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Constructed Wetlands(CW) are considered as a low-cost and eco-friendly wastewater treatment technology, which can be extended even up to the domestic level. This study was designed to assess the feasibility of pilot scale CW units on greywater treatment at domestic level. The CW units were constructed using plastic containers planted with three selected wetland plants; Vetiver (*Vetiveria zizanioides*), Water spinach/*Kangkung* (*Ipomoea aquatic* L.), Lasia/*Kohila* (*Lasia spinosa* L.) and soil without amendments was served as a control. The experiment was conducted in greenhouse conditions. Synthesized domestic wastewater was fed into the CW units during 02 months of period at the rate of 2.025 mLs⁻¹. The Hydraulic Retention Time (HRT) was 4 hours. Biological Oxygen Demand (BOD₅), Total Dissolve Solids (TDS), pH, Electrical Conductivity (EC), PO₄⁻³-P, NO₃⁻-N, NH₄⁺-N, Cd, As and Pb were monitored in both influent and effluent in two weeks interval during eight weeks. The experiments were conducted in a Completely Randomized Design (CRD) with three replicates. According to the results, each wetland plant recorded an increasing pollutant (BOD₅, TDS, pH, EC, PO₄⁻³-P, NO₃⁻-N, NH₄⁺-N, and heavy metals) Removal Efficiencies (RE) throughout the monitoring period. Vetiver showed significantly ($p < 0.05$) higher RE for BOD₅, PO₄⁻³-P, NO₃⁻-N, NH₄⁺-N by 46%, 71%, 83% and 89% respectively. However, Water spinach and Lasia showed significantly ($p < 0.05$) higher RE for NO₃⁻-N and PO₄⁻³-P by 77% and 68% respectively. Hence, it can be concluded that the pilot scale CW units are feasible technology for greywater treatment at domestic level with the combination of Vetiver, Water spinach and Lasia. However, it can be recommended to continue this study to obtain a firm conclusion.

Keywords: Constructed wetlands, Greywater treatment, Removal efficiencies, Wetland plants

IMPROVED SOLAR WATER DISTILLATION UNIT FOR DRINKING WATER PRODUCTION FROM HARDWATER

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Water distillation is one of the deionization processes which evaporates water using heat energy. Although, several solar water distillation systems are being introduced, they are not in use due to numerous reasons. Therefore, this study aimed to introduce an efficient solar water distillation unit to produce distilled water. Major components of this unit were water basin, water circulation system and pre-heating system. After series of preliminary trails a prototype unit with 0.5m² water basin was fabricated. The performance of the distillation unit was tested with five treatments namely; a black painted basin/ control (T1), a basin with pre-heater (T2), a basin with a sand layer (T3), a basin with sponge cubes (T4) and a basin with all components together (T5). Temperatures of the basin water, basin air and ambient air, wind velocity, solar radiation and volume of distilled water were measured in 30 minute intervals for 12 hours (6.00 am to 6.00 pm) for each treatment in three days as replicates. Data of each treatment were statistically analyzed using ANOVA. Results revealed that T5 has performed significantly better than other treatments ($p < 0.05$) in all aspects. Maximum temperature of basin water and air was observed as 59°C and 65°C respectively in T5. Results showed that pre-heater elevates the temperature of basin air and water which increased the distilled volume by 72.9% over the control. Applying a sand layer has contributed to increase distilled volume by 19.9% retaining the heat after 12.00 pm. Sponge cubes have increased the volume by 48.2% providing higher surface area. Maximum total capacity within 12 hours was given by T5 and it was observed as 2,256 mL. Thus, it can be concluded that, all the new features introduced have significantly contributed to increase the performance of a solar distillation system.

Keywords: Distilled volume, Distilled water, Pre heater, Solar distillation

AN APPLICATION OF RUSLE MODEL TO PRIORITIZE EROSION CONTROL IN KELANI RIVER BASIN IN SRI LANKA

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Soil erosion is the process of removal and transport of soil materials by the activity of erosive agents such as water, wind, ice, snow, animals and human activities. It is one of the serious environmental and ecological issues in Sri Lanka which lead to decrease in biological diversity, ecosystem stability and agricultural land productivity. Hence, it is important to prioritize areas especially in river basins to implement conservation measures. In this study, soil erosion was evaluated and hazard map of the soil erosion was created for the *Kelani* river basin using Revised Universal Soil Loss Equation (RUSLE) model in Arc GIS (version 10.2). Digital Elevation Model (15 x15 m), historical twenty years rainfall data of 14 rain gauge stations, land use and soil map were used to derive RUSLE factors. Soil map for the basin was digitized using soils of the wet zone of Sri Lanka map and land use map was extracted from the Survey Departments map. Raster calculator in GIS was used to estimate the average annual soil erosion of the river basin. The average annual soil loss in Kelani river basin varied from 0 to 103.7 $\text{tha}^{-1}\text{year}^{-1}$ with mean annual soil loss of 10.9 $\text{tha}^{-1}\text{year}^{-1}$. The basin was categorized into five different erosion hazard classes; low, moderate, high, very high, and extremely high. About 70% of the area in the river basin comes under low to moderate erosion hazard class ($< 12 \text{tha}^{-1}\text{year}^{-1}$). The developed erosion hazard map indicates majority of extremely vulnerable soil erosion areas ($> 60 \text{tha}^{-1}\text{year}^{-1}$) are located around Kithulgala and Ampana areas in Kegalla district and Laxapana area in Nuwaraeliya district. It further help to identify the critical erosion prone areas to adopt appropriate soil prevention and control measures in the Kelani river basin.

Keywords: Kelani river basin, Revised Universal Soil Loss Equation, Soil erosion, Soil erosion hazard map.

**ASSESSMENT OF WATER QUALITY IN DIFFERENT INLET AND
OUTLET CANNALS OF NUWARAWEWA TANK IN ANURADHAPURA,
SRI LANKA**

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Nuwarawewa tank is one of the major drinking water supplying reservoirs in the city of Anuradhapura, Sri Lanka. Assessment of water quality is vital for the sustainable management of drinking water resources. This study was conducted to evaluate temporal variability of water quality in different inlets and outlet canals of Nuwarawewa tank. Seven major inlets and one outlet canals connected to Nuwarawewa tank were identified and one sampling location was selected from each of these canals. Water samples were collected from each selected location in one-month interval for three months period. Soil samples (0-30 cm) were collected from each location at second time point. Simultaneously, reference soil samples were collected from the nearby locations which have no influence by canal hydrology. Water quality parameters such as pH, EC, DO, TDS, NO_3^- -N, NH_4^+ -N, Available Phosphorus (Av.P), alkalinity and heavy metals (Cd and As) concentrations were determined in each water sample. Soil samples were analyzed for pH, EC, NO_3^- -N, NH_4^+ -N, Av.P, total Cd and total As. The results of this study showed that pH, DO, NH_4^+ -N, and Av.P of some of the water samples tested were higher and other water quality parameters were within permissible levels according to WHO drinking water standards. Higher Av.N and Av.P were observed in all soil samples compared to the reference values in literature. Soil As level was ranged from 0.027 to 0.089 ppm and it was within the permissible levels according to European Regulatory Standards for soils and Cd were not detected. A temporal variation of water quality parameters was observed in the inlet and outlet canals during the study period. The results conclude that, impacts of surrounding land use on water pollution in inlet water canals connected to Nuwarawewa tank are higher and implementation of pollution management plan is required to prevent further pollution by conducting future researches.

Keywords: Land use, Nuwarawewa, Water pollution, Water quality

TREND ANALYSIS OF RAINFALL OVER SRI LANKA; APPLICATION OF INNOVATIVE TREND ANALYSIS METHODOLOGY

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Rainfall trend analysis provides useful information for effective planning, designing and management of water resources and gives insight to the climate change of a region. This study investigates the trends in annual and seasonal rainfall at 30 rainfall stations from 1987 to 2017 period over Sri Lanka using an Innovative Trend Analysis (ITA) and Mann Kendall test (MK) with Sen's slope estimator. The relationships between trends in ITA and MK were studied by correlation analysis. According to the MK test, annual rainfall at 19 stations showed increasing trends and only trends at Potuwil, Anuradhapura, Battcaloa and Bakamoona stations were significant. Annual rainfall at 11 locations showed decreasing trend, but none of their trends were significant ($p < 0.05$). ITA results for annual rainfall showed increasing trend at 70% stations while 30% stations showed decreasing trend. Furthermore, MK test results for seasonal rainfall indicated increasing trend at 77, 53 and 27% of stations during First Inter Monsoon (FIM), Second Inter Monsoon (SIM) and South West Monsoon (SWM) seasons respectively. All tested stations showed increasing rainfall trend during North East Monsoon seasons (NEM) for MK test analysis. According to ITA results for seasonal rainfall, 90% stations showed increasing trend during FIM and 77% stations showed increasing trend for both SIM and NEM seasons. ITA and MK tests exhibit similar trend results for 80% of the stations (24 stations) except Kurunagalla, Mahailukpallama, Puttalam, Thissamaharama, Colombo and Higurakgoda. Moreover, Spearman's rho correlation coefficient between ITA and MK test trends showed significant ($p < 0.05$) positive strong correlation (0.87). In general, the eastern, southern, northern and north central regions of the country showed increasing rainfall trend over the last 30 years while north western, western, sabaragamuwa regions and central hills of the country indicated a decreasing rainfall trend during the period 1987 to 2017.

Keywords: Innovative trend analysis, Mann Kendall test, Rainfall, Sri Lanka

SESSION 02



ENVIRONMENTAL SOIL MANAGEMENT



ROLE OF DEVELOPED MICROBIAL BIOFILMS ON GROWTH AND YIELD OF RICE

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Biofilms are aggregates of multiple microbial communities, attached to each other or to a surface. *In vitro* developed beneficial biofilms can be used as biofertilizers, which are then called biofilm biofertilizers (BFBF). Pseudonodules like structures produced by BFBF on rice roots increase available nutrients and hormones in rhizosphere resulting reduced usage of chemical fertilizers. Therefore, this study was conducted to evaluate the effect of BFBF on growth and yield of rice, when applied with new fertilizer recommendation introduced in 2013 by Department of Agriculture. A field experiment was conducted at the Rice Research and Development Institute at Bathalagoda. Five treatments were tested with a control. Treatments consisted of different levels of chemical fertilizers alone and their combined application with BFBF. The experiment was arranged in Randomized Complete Block Design (RCBD) with three replicates to each treatment. Plant, soil and nutritional parameters were recorded and analysed to find out the relationship between grain yield and the measured parameters. The results revealed that shoot endophytic bacterial communities affect panicle formation of rice plants. There was a significant positive relationship ($p < 0.05$) between the count of shoot endophytic bacterial community and panicle formation, which was positively related to grain yield. Similarly, rhizosphere organic matter content showed a significant positive relationship ($p < 0.05$) with spikelet formation and grain yield. Treatments with the application of BFBF showed increasing trend of organic matter, grain filling, panicle formation and root growth, probably due to increased microbial functions in the rhizosphere. However, further studies under the same field conditions are required to confirm the best combination of BFBF with newly introduced chemical fertilizer recommendation, for the optimum growth and yield of rice.

Keywords: Biofilm biofertilizer, Endophytic bacteria, Microbial functions, Rice yield

CHARACTERIZATION OF SOIL CHEMICAL AND PHYSICAL PROPERTIES SUPPORTING TO FOREST RESTORATION IN ENDANA TEA ESTATE, KAHAWATHTHA, SRI LANKA

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Spatial characterization of soil properties is an initial step in forest restoration process. This study was conducted to explore soil spatial variability in a forest restoration site of Endana Estate, Kahawaththa, Sri Lanka. The land use map and digital elevation models of the study area were developed based on Google Earth satellite images. Sixty seven soil samples (0-30 cm) were randomly collected spatially representing different land uses of the study field and analysed to determine pH, EC, Total N, Available P, Exchangeable K, Organic Carbon (OC) and Bulk Density (BD). Ordinary Kriging procedure was implemented to prepare maps of different soil properties. Higher (Coefficient of Variation (CV) > 60%) spatial variability was recorded in EC and total N. Soil OC, K, P, and BD showed moderate (12% < CV < 60%) spatial variability. Lower (12% > CV) spatial variability was recorded in pH. Strong (Relative Nugget Effect (RNE) < 25%) structured spatial variability were recorded in EC, K, N, P, and BD. Moderate (25% < RNE < 75%) structured variability was recorded in pH and OC. An elevation gradient (276 – 402 m) was observed from northern to southern direction in the study area. The same pattern was observed in spatial variability maps of pH and OC. Higher N, P, K, and EC values were observed in the middle part of the study field probably due to fertilizer application. Moreover, higher N and P values were shown in the northern area of the respective maps due to fertilizer application. High BD values were shown in the southern area of the respective map probably due to being compacted by animals and roots activities. Maps showed high (N, BD, EC, and P) to moderate accuracy (K, OC, and pH) based on leave-one-out cross validation technique. The results suggest suitable land use specific soil management approaches for forest restoration in the study site.

Keywords: Land uses, Soil mapping, Soil spatial variability

PHYTOEXTRACTION OF NUTRIENTS AND HEAVY METALS BY THE MONOCOT PLANTS IN THAULLA AREA OF ULANKULAMA TANK, ANURADHAPURA, SRI LANKA

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Thaulla is the upper peripheral region of small tanks in the dry zone of Sri Lanka. This study aimed to investigate the phytoextraction behavior of monocot plants in *thaulla* area of Ulankulama tank located in Anuradhapura. *Atora* (*Panicum repens*) and *Thunessa* (*Cyperus iria*) were selected as those were abundance in *thaulla* area. The accumulation of total N, P, K, Ca, Mg, Cd, Pb and As were assessed by getting both plant and soil samples from 20 sampling points in *thaulla* area. Another seven samples both plant and soil from adjacent areas of the *thaulla* were taken as reference samples and nutrient and heavy metal values of *thaulla* area were compared with those of reference using two sample t- test. Standard analytical methods were followed for all the analysis. The results indicated significantly ($p < 0.05$) higher shoot and root nitrogen content of plant samples obtained from *thaulla* area when compared to those of reference plant. P, K and Cd content in both shoot and root in plant samples taken from *thaulla* area showed non-significant higher values than those of reference plants. However, K, Ca, Mg and Pb concentration of soil samples were significantly higher ($p < 0.05$) in *thaulla* than those of reference soil samples. According to the ratio of Shoot : Root, the study showed higher accumulation of both nutrient and heavy metals in shoot than those of roots and this ratio was higher in *thaulla* area plants than those of reference plants. This is further confirmed by the higher ratio of Shoot : Soil than the ratio of Root : Soil for both nutrients and heavy metals. Overall, this study showed the higher nutrient and heavy metal accumulation in *thaulla* soil and higher extraction of nutrients and heavy metals by the selected monocot plants in *thaulla* area than those of same plants in adjacent reference area.

Keywords: Heavy metals, Nutrients, Phytoextraction, *Thaulla*, Small tank

**SOIL PROPERTIES OF CONVENTIONAL AND ORGANICALLY
MANAGED PEPPER CULTIVATIONS IN MID COUNTRY
INTERMEDIATE ZONE IN SRI LANKA**

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The present demand for organic products in the world market is growing rapidly. In parallel to global market, demand for organically grown black pepper (*Piper nigrum* L.) also expanding annually. As a result, more cropping lands are being certified as organic. Soil physical and chemical parameters are the effective tools to evaluate long term effects of conventional and organic farming systems as a consequence of different agronomic management practices. The aim of this study was to compare soil fertility status of conventional and organically managed pepper cultivations in Mid Country Intermediate Zone (IM₁) in Sri Lanka. Three pairs of conventional and organically managed pepper cultivations in three different locations in Mid Country Intermediate Zone were selected. Soil samples were drawn from top (0 - 20 cm) and subsoil (20 - 40 cm) were analyzed for different soil parameters. Data analysis was done by two factor factorial model using Statistical Analysis System. Results revealed that no significant difference ($p > 0.05$) in soil pH, Electrical Conductivity (EC), Cation Exchange Capacity (CEC), total N, available P, exchangeable Mg, Ca and tested micronutrients in both conventional and organically managed systems in all three locations. Exchangeable soil K was significantly higher ($p < 0.05$) in organic plantations compared to that of conventional plantations in both top and sub soil. Organic carbon also showed significantly higher ($p < 0.05$) level in organic fields but only in the topsoil. Soil bulk density and porosity in both top and subsoils of conventional and organically managed cultivations in all three locations were not significantly different ($p > 0.05$). The results of the study do not show remarkable effect of organic farming on tested soil chemical and physical properties in pepper cultivations. However, further studies are needed to assess biological soil properties of both farming systems.

Keywords: Conventional farming, Organic farming, Pepper cultivation, Soil fertility parameters

PERFORMANCE OF BIOFILM-ENRICHED EPPAWALA ROCK PHOSPHATE AS AN ALTERNATIVE FOR TRIPLE SUPER PHOSPHATE IN RICE CULTIVATION

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Eppawala Rock Phosphates (ERP) has a greater potential to be used as an alternate for Triple Super Phosphate (TSP) if phosphorous (P) biosolubility is increased. A certain biofilm (BF3) has been identified as the most efficient P biosolubilizer for ERP. Thus, this study was designed to test the potential of biofilm-enriched ERP to replace the TSP in rice cultivation. Two experiments were conducted; soil leaching tube and pot experiments under controlled conditions. A modified chemical fertilizer (CF_M) mixture was developed by replacing TSP from ERP in the existing chemical fertilizer (CF_E) mixture for rice recommended by the Department of Agriculture (DOA). However, nitrogen (N) and potassium (K), levels were maintained according to DOA recommendation. Eleven treatments were used with all possible combinations of CF_E and CF_M at rates of 50% or 100% alone or together with the BF3. Soil alone was used as the control. Treatment of 50% CF_M + BF3 was denoted as biofilm-enriched ERP. The experiments were conducted in a Completely Randomized Design (CRD) with three replicates. Biofilm enriched ERP showed no added advantage over the CF_E , with lower cumulative solubilized P in leachates. At the end of the pot experiment; biofilm-enriched ERP showed significantly ($p < 0.05$) higher P retention in soil and significantly ($p < 0.05$) lower grain yield comparison to the CF_E . However, biofilm-enriched ERP showed no any significant ($p > 0.05$) difference in plant P uptake. The overall results conclude that the biofilm-enriched ERP performed poorly in comparison to the DOA recommended TSP dosage. Thus, further studies are required to enhance the performance of biofilm-enriched ERP to use as an alternate for TSP in rice cultivation.

Keywords: Biofilm, Eppawala rock phosphate, Rice cultivation, Triple super phosphate

CALIBRATION AND VALIDATION OF SWAT MODEL FOR THE STREAMFLOW OF KIRINDI OYA RIVER BASIN IN SRI LANKA

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Hydrological modelling is performed widely to study the dynamics of movement of water and sediment and their impact on the river basins health. Soil and Water Assessment Tool (SWAT) was set up to Kirindi Oya river basin for hydrologic modeling. SWAT-CUP (SWAT-Calibration and Uncertainty Program) was used for model sensitivity, calibration and validation, following the Sequential Uncertainty Fitting technique. The model calibration was performed for 10 years and validated for the subsequent 6 years. To assess the competence of model calibration and uncertainty, two indices; 'p-factor' and 'r-factor' were taken into account. The goodness of fit was further assessed through the use of the coefficient of determination (R^2) and the Nash–Sutcliffe efficiency (NS) between the observed and the final simulated values. The Kirindi Oya river basin was delineated and sub divided into 18 sub basins and 350 hydrological response units during setting the model. Calibration and validation of SWAT model for streamflow at two stations resulted in 'p- factor' in the range of 0.29 to 0.39 and 0.24 to 0.29 during calibration and validation respectively. The 'r-factor' varied from 0.91 to 1.61 and 1.04 to 1.68 during calibration and validation periods respectively. Further statistics during the calibration period (NS = -0.53 to 0.14, R^2 = 0.06 to 0.17) and the validation period (NS = -0.61 to - 0.68, R^2 = 0.02 to 0.04) were not so satisfactory. The reasons for poor performance may be because that this study did not consider the hydrology of tanks and paddy fields in the basin due to non-availability of data and poor quality streamflow data. Therefore, it is suggested to setup the model for the upstream area of the basin where there are no considerable number of tanks and also use quality set of streamflow data for calibration and validation.

Keywords: Soil and Water Assessment Tool, SWAT-Calibration and Uncertainty Program, Kirindi Oya river basin

SOLUBILIZATION OF PHOSPHORUS FROM DIFFERENT PHOSPHORUS SOURCES BY USING PHOSPHORUS SOLUBILIZING BACTERIA ASSOCIATED WITH RUBBER

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Phosphorus (P) is a vital macro nutrient in rubber (*Hevea brasiliensis* L.) plant for its optimum growth and yield. Even though, there is high amount of P in soil of the most rubber plantations, this element is un available form to plants due to formation of insoluble complexes of P with Al or Fe. Hence, use of phosphate solubilizing microorganisms (PSM) has become very interesting option to improve P availability of soil leading for reduction of application of phosphate chemical fertilizer. Therefore, this study was conducted to isolate the phosphorus solubilizing bacteria (PSB) associated with rubber rhizosphere. The isolated bacteria were enumerated on Pikovskayas (PVK) medium and evaluated for their effectiveness on solubilization of insoluble inorganic compounds, Calcium Hydrogen Phosphate (CaHPO_4) and Tri Calcium Phosphate ($\text{Ca}_3(\text{PO}_4)_2$) in solid and liquid media. The solubilizing ability was measured in the solid media by using Solubilization Index (SI). In the liquid media soluble P and pH were measured in 3rd and 7th day after inoculation. Out of isolated 24 bacterial strains, eleven isolates were selected on the basis of effectively appearing the halo zone in CaHPO_4 solid medium and subsequently introduced into the liquid medium. The medium with $\text{Ca}_3(\text{PO}_4)_2$ showed less halo appearing compared to CaHPO_4 . All bacteria showed improvement of soluble P in the liquid medium compared to the solid medium. In CaHPO_4 medium, a negative correlation could be observed in between pH value and soluble P with the time. However, this pattern could not be observed with $\text{Ca}_3(\text{PO}_4)_2$ medium. CaHPO_4 liquid medium showed a significant P solubilization ($P < 0.005$) than $\text{Ca}_3(\text{PO}_4)_2$ on 3rd and 7th day respectively. PSB3 was the most effective P solubilizer in the CaHPO_4 ($P < 0.005$). Hence, more studies are required prior to come up with concrete conclusion on PSB on solubilization of P.

Keywords: Phosphorus solubilizing bacteria, Phosphorus solubilization, Rubber plantation, Tri calcium phosphate

HEAVY METAL ACCUMULATION IN RICE GRAINS AND RICE GROWING SOILS IN KALUTARA SEGMENT, SRI LANKA

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Assessment of environmental risk associated with the pollution of heavy metals is important for proper management of paddy soils. A study was conducted to determine concentration of heavy metals in rice grains and rice growing soils in Kalutara segment in western province, Sri Lanka. Soil and grain samples were collected from randomly selected rice growing fields in different locations. Soil and grain samples were analyzed for As, Cd, Ni, Pb, and Hg using Inductively Coupled Plasma Optical Emission Spectrophotometer. The mean concentration of As, Cd, Ni and Pb in the soil were 1.5, 0.49, 8.2 and 35.8 mgkg⁻¹ respectively. Mercury was not detected in any soil sample. According to geoaccumulation index (I_{geo}) most of the tested rice growing soils can be classified as uncontaminated with respect to As and Ni, uncontaminated and uncontaminated to moderately contaminated in Cd, moderately and moderately to highly polluted in Pb. Heavy metals were detected in 36% out of 83 grain samples. The range of mean concentration of As, Cd and Pb observed in grain samples were 0.03-0.08, 0.01-0.04 and 0.21-0.27 mgkg⁻¹ respectively. Mercury and Ni were not detected in any grain sample. According to permissible level recommended by FAO/WHO Joint CODEX Alimentarius, accumulation of Pb in 16% of the total grain samples were higher than the permissible level. However, there was no any relationship observed between heavy metal content in grain samples and soil samples. The study reveals that there is a potential to accumulate a few heavy metals in rice grain above permissible level. Therefore, further studies are needed to determine mobility and bioavailability of heavy metals in paddy soils in order to recommend remedial measures.

Keywords: Geoaccumulation index, Heavy metals, Paddy soils, Permissible level of heavy metals

ASSESSMENT OF SOIL EROSION IN DIFFERENT LAND USES AND ITS RELATIONSHIP WITH SOIL CHEMICAL PROPERTIES IN KURUWITA AND RANDENIGALA CATCHMENTS

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Accurate assessment of soil erosion is very important for sustainable land management. Fallout Radio Nucleotide (FRN) technique is widely used for estimation of soil erosion. However, applicability of this technique for Sri Lanka was rarely investigated. This study was conducted to quantify the rate of soil erosion using FRN technique in Kuruwita (WL1a) and Randenigala catchments (IM1b) of Sri Lanka. The study further investigated the relationship between soil chemical properties and soil erosion in the selected catchments. Four land uses were identified in Kuruwita (Natural Forest, Tea, Rubber and Paddy) and Randenigala (Natural forest, Plantation forest, shifting cultivation and Home garden). Nine soil samples (0 – 40 cm) were collected from each land use in three parallel transects and analyzed for both radio-isotopes of ¹³⁷Cs and ²¹⁰Pb activities using Gamma detector. Radioactivity values were converted to soil erosion/deposition values using mass balance II model. Soil samples were also tested for chemical properties such as pH, EC, available P, exchangeable K and organic matter. Post-hoc mean separation procedure was implemented to identify the differences ($p < 0.05$) in soil erosion estimates and chemical properties among catchments, slope positions and land uses. The highest soil erosion was observed in tea lands ($10.64 \text{ tha}^{-1}\text{yr}^{-1}$) in Kuruwita site and sediment deposition was observed in paddy soils. In Randenigala catchment, shifting cultivation fields recorded the highest soil erosion ($50.58 \text{ tha}^{-1}\text{yr}^{-1}$). Conversely, the lowest soil erosion and optimum nutrients availability were observed in natural forests in both Randenigala and Kuruwita catchments. The nutrient availability showed a negative relationship with soil erosion in land uses unaffected by chemical fertilization. The study revealed that soil erosion of a given land is highly dependent on rainfall, land use type and the slope. Results conclude the occurrence of higher rate of soil erosion in shifting cultivated and tea lands among the tested land uses which have been highly influenced by human activities in both kuruwita and Randenigla catchments.

Keywords: Fallout radionuclides technology, Nutrients availability, Soil erosion

COMPARISON OF SOIL PROPERTIES BETWEEN ORGANIC AND CONVENTIONAL RICE FARMING SYSTEMS IN SRI LANKA

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Organic farming is a production system that sustains the health of soil. However, some studies revealed that in practice this is not always true. This study was conducted to compare soil properties between organic and conventional rice farming systems in Sri Lanka. Soil samples were collected from rice farming fields located in Rice Research and Development Institute Batalagoda and two farmer fields at Rambawa and Eppawala where both organic and conventional systems are practiced in same *yaya* area. All three locations have more than five years of farming history with totally organic inputs. Soil samples drawn from 0 - 15 cm depth of organic and conventional rice fields were analyzed for chemical, physical and biological properties. Data analysis was done by two factor factorial model using Statistical Analysis System. Results revealed that soil pH, available NO₃⁻-N and exchangeable K were significantly lower ($p < 0.05$) in organic fields compared to conventional fields. However, organic fields showed significantly higher ($p < 0.05$) soil organic matter, NH₄-N and Cation Exchange Capacity (CEC) levels. Higher soil organic matter content may be the reason for increased CEC level and hence high retention of NH₄-N found in the soils of organic fields. Soil EC, available P and total N levels were not significantly different between ($p > 0.05$) organic and conventional fields. Heavy metals (As and Cd) were not detected in both organic and conventional fields. Soil bulk density, biomass C and microbial activity were also not significantly different ($p > 0.05$) between two farming systems. The results of the study conclude that increased soil organic matter content reported in organically managed rice fields enhances soil fertility by improving CEC of the soil.

Keywords: Conventional agriculture, Organic farming, Rice farming in Sri Lanka, Soil chemical properties

CONSTRUCTED WETLAND SYSTEM FOR TREATMENT OF GREYWATER USING BULRUSH PLANTS

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Constructed wetlands (CWs) are a reliable technology for the treatment of greywater especially in tropical countries. Wetland plants are capable of treating the wastewater by adsorbing and absorbing various pollutants through their roots. Therefore, this study aimed to evaluate the performance of greywater treatment by Free Water Surface flow constructed wetland located in Faculty of Agriculture , Rajarata University of Sri Lanka. The CW system was planted with bulrush (*Scirpus californicus*) which has been selected after a series of pilot studies. The greywater discharged from a student hostel complex was directed in to the wetland at the rate of $0.75\text{m}^3\text{h}^{-1}$. The hydraulic retention time was 45h. Water quality parameters of the influent and effluent were monitored for a period of two months by analyzing Biological Oxygen Demand (BOD), Total Dissolved Solid (TDS), Dissolved Oxygen (DO), pH, Electrical Conductivity (EC), NO_3^- -N, NH_4^+ -N, PO_4^{3-} -P and heavy metals. According to the results, the system reduced the concentration of contaminants with the increasing Removal Efficiencies (RE) throughout the monitoring period. The average RE of BOD_5 , NO_3^- -N, NH_4^+ -N, PO_4^{3-} -P were 68.8%, 28.6%, 2.3%, 69.0% respectively. The pH and the TDS level were also within the permissible level following the wastewater discharge standards given by Central Environmental Authority of Sri Lanka. Hence, it can be concluded that the bulrush plant is efficient in removing BOD_5 (RE 45%), PO_4^{3-} -P (RE 69%) from greywater. However, the selected plant poorly performed in removal of NO_3^- -N, NH_4^+ -N during the study period with lowest REs. This can be due to the perennial nature of the bulrush plant and further studies are recommended to enhance the efficiency of CW system.

Keywords: Phytoremediation, Pollutant removal efficiency, Wastewater treatment.

SESSION 03



AGRICULTURAL ECONOMICS & EXTENSION

**ADAPTABILITY AND EFFECTIVENESS OF SUSTAINABLE
CERTIFICATION SCHEMES IN LOW COUNTRY TEA SECTOR, SRI
LANKA: A CASE STUDY IN DENIYAYA**

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Tea sector contributes immensely to the economy and Gross Domestic Production of Sri Lanka. Though, Ceylon tea has remarked its position among tea exporters, sustainability of Ceylon tea industry is threatened due to various environmental, economic and social factors. In order to mitigate these problems, sustainable certification schemes were introduced. The study was carried out to assess the adaptability and effectiveness of these certification schemes since no study was done in Sri Lanka previously. Primary data were collected from 400 random sample of tea smallholders in three divisional secretarial divisions using pre-tested and structured questionnaire. Non adapters of the scheme were 75% of the respondents while the rest were practicing organic and rainforest alliance certification schemes. Factors affecting adaptability were identified by fitting binary logistic regression model. Difference of yield and income of adapters and non adapters were compared by pooled t-test. Logistic regression results revealed that, adaptability to sustainable certification increase with tea income (OR:1.10), level of education (OR:17.34), gender (OR:1.83) and number of family labours (OR:1.64) while, adaptability decrease with age (OR:0.93) and yield (OR:0.99). Results of pooled t-test indicated that monthly yield (382 kg) and income (LKR 42,453) of adapters significantly higher ($p < 0.05$) than non adapters (yield =347 kg and income =LKR 31,989). In conclusion, sustainable certification schemes ensure higher yield and income of tea farmers. Higher fixed price levels for certified green leaf would encourage tea small holders to adapt and continue sustainable certification schemes. Recommendation of simple, convenient and non labour intensive practices will ensure the adaption of sustainable certification schemes. Nevertheless, well planed awareness programs are essential to enhance the farmer participation.

Keywords: Binary logistic regression, Rainforest alliance, Sustainable certification schemes, Tea smallholders

FACTORS AFFECTING EFFICIENCY IN POTATO PRODUCTION IN NUWARA ELIYA DISTRICT

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Potato is an important food crop, which plays a vital role in the world economy as well as in Sri Lankan economy. However, prevailing high cost of production and low productivity have reduced the total production efficiency in Sri Lanka's potato sector, and little attention has been paid to conduct studies to estimate production efficiency in potato production. Therefore, this study attributed to reveal the level and determinants in production efficiency of potato production in Nuwara Eliya district. Using multi stage random sampling technique, a sample of 107 commercial level potato farmers were selected and a Cobb Douglas Stochastic Frontier Production function was estimated using survey data. The results revealed that, levels of technical efficiency were between 10% and 96% with a mean of 56%, showing that the production can be increased by 44% or cost can be reduced by 44% by adopting the best farming practices. Land and fertilizer were statistically significant and positively related with total production, whilst farm power was negatively significantly related. Elasticity of land extent was the largest (0.902), whilst elasticity of cost of agrochemicals was the lowest (-0.202). The inefficiency effect model revealed that, farmer's experience, prevalence of membership in farmer organization and credit amount have impacted positive effect on technical efficiency whilst, the farmer's age has a negative effect on technical efficiency. Allocative efficiency analysis showed that the land, fertilizer, agrochemicals and labor were underutilized as the marginal productivity to factor cost ratio was greater than one. This indicates that profitability can be increased by increasing land extent, fertilizer, agrochemicals and labor, whilst decreasing seeds. Seeds were over utilized as the ratio is less than one. Therefore, it is recommended that the government should take effective steps to control the prices of inputs and should enhance the knowledge of the farmers in order to increase production efficiency.

Keywords: Cobb Douglas Stochastic Frontier, Efficiency, Potato

**FACTORS AFFECTING LOW PRODUCTIVITY OF PADDY LANDS:
CASE STUDY IN GAMPAHA DISTRICT, SRI LANKA**

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Paddy (*Oryza sativa*) plays a significant role in the Sri Lankan economy in terms of food security, livelihood, imports and exports, and gross domestic production. Recently, a yield gap has been observed between actual (2.8 tha⁻¹) and potential (6-7 tha⁻¹) paddy productivity in Gampaha district. Since technical factors have already been identified by previous studies, main emphasis was given on identifying socio-economic and demographic factors affecting low productivity of paddy lands. A pre-tested structured questionnaire survey was carried out with randomly selected 90 paddy farmers. Collected data were analyzed using descriptive statistics and a multiple linear regression model. Accordingly, majority of the respondents were more than 50 years of age plus have more than 30 years of experience in commercial paddy farming. Average cultivated land size was 2 acres with an average yield of 3.12 tha⁻¹. The results of the regression analysis revealed that type of fertilizer ($p=0.03$), purpose of cultivation ($p=0.007$), cultivation extent ($p=0.04$) had a significantly positive relationship ($p<0.05$) while labor availability ($p=0.088$) had a significantly negative relationship with land productivity ($p<0.1$). Land productivity was significantly higher in paddy lands, where respondents use both organic and inorganic fertilizer. However, years of experience in paddy farming ($p=0.391$), access to credit ($p=0.566$), and access to extension ($p=0.963$) did not have any significant impact on land productivity ($p<0.05$). Major constraints identified by respondents for poor land productivity were flooding condition, access to water sources during dry periods and insufficient fertilizer subsidies. According to the findings of this study, it is recommended to adapt risk mitigating strategies such as adjusting cultivation according to rainy seasons, use of flood tolerant and high yielding varieties and practicing crop diversification to increase paddy productivity. Moreover, actions need to be taken to minimize flooding condition in the area through proper land management practices.

Keywords: Land productivity, Paddy farming, Socio-economic factors

**IMPACT OF CHRONIC KIDNEY DISEASE OF UNKNOWN ETIOLOGY
ON RICE CULTIVATION: A CASE STUDY IN MEDIRIGIRIYA,
SRI LANKA**

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Prevalence of Chronic Kidney Disease of unknown etiology (CKDu) is a major health problem in the North Central province of Sri Lanka. According to literature, majority of CKDu patients are engaged in agriculture or related activities. This study aimed at exploring the socio-economic impact of CKDu on rice cultivation in Medirigiriya, because Medirigiriya reports the largest number of CKDu affected patients in Polonnaruwa district. A pre-tested structured questionnaire survey was conducted with randomly selected CKDu affected (n=60) and non-affected (n=60) paddy farmers. Data were analyzed using descriptive statistics and a regression analysis. According to the results, majority of the affected respondents were male (96%), married (95%), 41 to 60 years old (52%) and comparatively less educated compared to non-affected respondents. CKDu affected respondents have been engaged in agriculture more than 20 years. The affected respondents cultivate only 32% of their available land in average while it is 100% among the non-affected respondents. There is a rapid decrease of the extent of land cultivated by affected respondents while 12% of them have completely left agriculture due to poor health condition. The income from paddy is higher among non-affected respondents compared to the affected respondents. According to the result of regression analysis ($R^2=0.474$) cost of fertilizers ($p<0.05$), cost of labour ($p<0.01$), and cost of herbicides and pesticides ($p<0.01$) had a significantly positive relationship with income of the affected respondents while only cost of fertilizer ($p<0.05$) was significant among non-affected respondents. Making arrangements for CKDu affected paddy producers to get agricultural inputs at a reasonable price, strengthening of agricultural extension service, and introduction of weed competitive rice cultivars to minimize chemical cost are recommended through the findings of this study.

Keywords: Chronic kidney disease, Rice cultivation, Socio-economics factors

**DETERMINANTS OF SMALL SCALE BLACK PEPPER PRODUCTION
IN KANDY DISTRICT: A CASE STUDY IN MEDADUMBARA
DIVISIONAL SECRETARIAT DIVISION**

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Black pepper is the second important spice crop in Sri Lanka. Despite of its importance, little is known about current productivity and factors affecting black pepper production / productivity. Therefore, this study was designed to identify socio economic and institutional factors, which influence productivity of black pepper and constraints faced by the producers. Multistage random sampling technique was used to select 100 small-scale black pepper farmers in Medadumbara Divisional Secretariat Division, Kandy district. Primary data were collected through a questionnaire survey. Data were analyzed using multiple linear regression analysis, Pearson's Chi-square test and Garret's constraint ranking technique. The regression results revealed that farming experience, frequency of extension visits and farm organization's meetings were positively and significantly ($p < 0.05$), while age of the farmer was negatively and significantly ($p < 0.05$) related with the black pepper productivity, indicating that older the farmer (>45 years) lower the productivity. The multiple regression model ($R^2 = 0.86$) indicated that, these four factors explain 86% of the variation in productivity. The Pearson's Chi-square test revealed a significant association between productivity levels with farm characteristics like age and variety of the crop, cropping system and land suitability. Further, the constraint analysis revealed that price volatility, unfavorable whether at flowering stage, high cost of labour and poor marketing linkages were the major constraints in black pepper production. It can be concluded that productivity of black pepper in study area depends on farming experience, frequency of extension visits, farmer ganization's meetings and age of the farmer. Therefore, this study recommends initiating intensive farmer training programs through agricultural extension services. Furthermore, establishing a minimum price for black pepper and developing organized market network are paramount importance.

Keywords: Black pepper, Chi-square analysis, Constraints, Multiple linear regression

ANALYSIS OF SUPPLY RESPONSE OF COCONUT CULTIVATION IN SRI LANKA

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Coconut (*Cocos nucifera*) is a major plantation crop grown in Sri Lanka. The output has been used as local consumption of fresh nuts (59%), coconut based industries within the country (11%) and coconut exports (30%) in 2016. The instability of coconut supply seriously affects local as well as export market potential. Identification of various factors and the extent to which they affect to the current coconut supply have not been examined in the recent empirical work. Using the Nerlovian Partial Adjustment model, this study examines the supply response of coconut in Sri Lanka. The study used time series data of total coconut production, output price, rainfall, fertilizer amount, land extent, and the presence of fertilizer subsidy for a period of 30 years (1985-2015) for the analysis. Among the different types of functional forms tested, the linear model was selected as the best fit model ($R^2=0.897$). The model was tested for autocorrelation and heteroscedasticity using Durbin-Watson statistic and the Breusch-pagan test respectively. The results revealed that the variables, i.e. one year lagged price, two years lagged price, four years lagged price, one year lagged rainfall, two years lagged rainfall, and two years lagged fertilizer amount affect the coconut production significantly ($p<0.05$). The short run and long run price elasticities were estimated for one year lagged, two years lagged and four years lagged output prices respectively. The magnitudes of these elasticity values range from 3.54 to 5.5. The output price is the most influential factor (with $\beta = 0.83-1.13$ for the three lagged price variables considered) followed by rainfall ($\beta = 0.32-0.4$) that determine the coconut production in Sri Lanka. The study concludes that coconut production in the country tends to change as a response to the changes in coconut price both in short run and long run.

Keywords: *Cocos nucifera*, Nerlovian partial adjustment model, Supply response

FACTORS AFFECTING THE USE OF DIALOG GOVI MITHURU SERVICE: A CASE STUDY OF PADDY FARMING SECTOR IN DRY ZONE OF SRI LANKA

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Enhancing the use of mobile phones and mobile agricultural services give the opportunity to gain more valuable information for farmers especially in developing countries. Though information is widely available, low performance of the current extension system creates an information accessibility gap. The purpose of mobile extension service is to address the above-mentioned issue. This study analyzed the factors affecting the use of Dialog *Govi Mithuru* service by the paddy farmers in the dry zone of Sri Lanka. The study used a sample of 180 farmers selected randomly from Anuradhapura, Polonnaruwa, and Ampara districts who use this mobile extension service. Using a semi-structured questionnaire, telephone interviews were carried out to collect data related to the use of Dialog *Govi Mithuru* service for their cultivation needs. A Binary Logistic Regression model was employed to obtain the magnitudes of the factors affecting for the farmers to become a frequent user of this service. The results revealed that the variables such as frequency of government agricultural instructor meetings hold, farmers' engagement in paddy cultivation (full-time vs. part-time), and the satisfaction gained from the service are statistically significant ($p < 0.05$) in determining the farmer being a frequent user. Over 90% of farmers rate the availability of information on new farming techniques as the key benefit gained through the service. However, approximately 18% of farmers perceive that the time of message receiving is inconvenient. Hence it suggests that the service need to be improved with convenient timing of message delivery. The study concludes that farmers perceive mobile agricultural services as a potential source to bridge the information accessibility gap in the country.

Keywords: Binary Logistic Regression, Dialog *Govi Mithuru* Service, Information accessibility gap, Mobile agricultural services.

PRICE BEHAVIOUR OF COMMONLY GROWN VEGETABLES IN ANURADHAPURA

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Next to rice, vegetable is the most important commodity group in Sri Lanka and is always subjected to uncontrollable price fluctuations. Anuradhapura is one of the districts, which contribute immensely to the production of low-country vegetables. However, no published research on the price behavior of vegetables in Anuradhapura district is available, despite its significant impact. Therefore, this research aims to identify the price behavior and price determinants of commonly grown vegetables in Anuradhapura district. For that, time series analysis using the ARIMA model was done. Most frequently grown five vegetables in Anuradhapura district namely, Pumpkin, Brinjal, Okra, Luffa and Bittergourd were included in the study. Weekly nominal prices from January 2007 to December 2016 and primary data were obtained through a field survey (100 farmers and 50 traders selected using a stratified random sampling method). Results revealed that, both nominal and real prices were increasing over time indicating the prevalence of a seasonality effect. Highest price fluctuations were observed in January and lowest in September. The best forecasting ARIMA models were; Pumpkin ARIMA (2,1,54)¹ (0,1,52)⁵², brinjal ARIMA (0,1,[3,4])¹ (0,1,52)⁵², Okra ARIMA ([46 ,55,98] ,1,[2, 34 ,54])¹ (0,1,52)⁵², Luffa ARIMA (0,1,[2,51,55])¹ (0,1,52)⁵², Bitter gourd ARIMA (0,1,55)¹ (1,1,52)⁵². Models were validated and future prices for the year 2018 were forecasted. Fluctuations were ranged from a maximum of 42.88% (Brinjal) to a minimum of -8.76% (Okra). Descriptive analysis revealed that, the impact of adverse weather and lack of market information were the causal factors of price fluctuations which can be solved via efficient market information dissemination system, crop zoning and planning. Based on the above analyses it is possible to state that policy implementations can be done to minimize price fluctuations of commonly grown vegetables in the Anuradhapura district.

Keywords: ARIMA model, Price fluctuation, Price forecasting, Time series analyses, Vegetable prices

GROWTH PERFORMANCE OF SRI LANKAN AGRICULTURE

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Lack of information on past growth performance in agriculture is a major problem in formulating development policies in Sri Lanka. This study attempts to investigate the past performance of agricultural sector by using exponential growth model and multiple regression models. Secondary data of agricultural Gross Domestic Product (GDP) from 1950 to 2017 were collected from Central Bank of Sri Lanka to estimate the models. Compound Growth Rate (CGR) for entire period and average annual growth rate for policy periods were computed. Coefficients of determination (R^2) of all regression models were over 95% and all the coefficients were statistically significant. Overall growth analysis found that, annual agricultural growth rate was 2.36% compared to 4.26% of economic growth. Policy based growth analysis reveals that, the highest annual agricultural growth rate (AAGR) of 4.53% recorded during the period of 2005 to 2015. Sub sector analysis also implied the similar results. The lowest AAGR of 1.54% recorded during the period of 1989–1993. However, the lowest annual growth rate of crop sub sector recorded during the period of 1989–1993 followed by the livestock, forestry and fishing sub sectors during the period of 1994-2004. Decomposition growth analysis shows that, the crop sector was the highest growth contributor to the agricultural sector and the livestock was the lowest contributor. Open economic policies led slowdown the growth rate of agriculture. Trade agreements positively affected the agricultural growth. The study concludes that, the agricultural growth was not satisfactory during the post independent period but, the situation has been improved after 2005. This study suggests that the government should support more trade agreements to enhance agricultural exports and discourage tariff reduction of agricultural imports to develop domestic agriculture.

Keywords: Agricultural growth performance, Agricultural sub sectors, Agriculture Gross Domestic Product, Sri Lanka

FACTORS AFFECTING CONSUMER DEMAND FOR COCONUT OIL IN SRI LANKA

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Coconut oil is the major cooking oil in the Sri Lankan diets but its consumption is declining. It is believed that cheap palm oil price affected to reduce the coconut oil consumption. This study attempts to determine the factors affecting consumer demand for coconut oil in Sri Lanka by using multiple regression technique with double log form of equation. Annual data from 1998 to 2017 collected from the United States Department of Agriculture PSD database and statistical reports of Central Bank of Sri Lanka were used to estimate the model. Cochrane-Orcutt method was applied to correct auto correlation. The estimated coefficients of palm oil price and trend variables were significant at 5% probability level while coefficients of price of coconut oil and per capita gross domestic product were significant at 10% probability level. All variables have expected signs. The model explains 57% of the behaviour of the per capita coconut oil consumption. Estimated elasticity is -0.923 for own price, 1.442 for cross price and 1.158 for income. Results revealed that one percent increase in coconut oil price results in decrease in coconut oil consumption by 0.92 percent, one percent increase in palm oil price increases coconut oil consumption by 1.44 percent and one percent increase in consumer income will lead to increase coconut oil consumption by 1.16 percent. Findings also indicate that coconut oil consumption is decreasing over time. The study concludes that decreased price of palm oil, increased coconut oil price and consumer perception reduce coconut oil consumption. Hence attention should be given in increasing coconut oil production, rationalization of import duties of palm oil and rectifying the ill effect of coconut oil consumption on human health.

Keywords: Coconut oil consumption, Palm oil price, Sri Lanka

SESSION 4

AGRICULTURAL SYSTEMS & MANAGEMENT



POTENTIAL TO EXPAND THE CUT FLOWER INDUSTRY AMONG RURAL HOUSEWIVES IN BANDARAWELA, SRI LANKA

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Cut flowers, which are traded worldwide, have always been the main commodity group within global floricultural trade. The demand for cut flowers is increasing in domestic as well as export markets annually while the world supply is insufficient to satisfy the requirement. In Sri Lanka, flowers are grown commercially in the Western, North Western and Central Provinces. However, the current production is very low and less number of farmers involve in producing cut flowers in commercial scale. This study examined the potential in expanding the cut flower industry in order to increase the income of rural housewives in Bandarawela area. The objectives of this study were to identify the resource availability, limitations and perception of housewives in relation to cut flowers production as a commercial venture. A random sample of 250 housewives were selected from five *Grama Niladhari* divisions in Bandarawela area. Socio-economic data were collected using a semi structured, pre-tested questionnaire. A multinomial logistic regression model was fitted to identify the factors affecting the production of cut flowers. The results revealed that 56% of respondents were willing to produce cut flowers with organizational support while another 29% were willing to produce cut flowers without organizational support. Estimated logistic regression modal indicated that perception on cut flower production among housewives increases with education level (OR=7.328), household size (OR=1.947), knowledge (OR=999.99), upland extent (OR=687.82), water availability (OR=2.291), and fertilizer availability (OR=11.701). The study concludes that, cut flower production in Banadarawela area of Sri Lanka could be increased by having effective extension service; educating the housewives about the industry; increasing accessibility to water and fertilizer and increasing the availably of uplands.

Keywords: Cut flowers, Housewives, Multinomial logistic regression, Perception

**SUSTAINABILITY ASSESSMENT OF PADDY MONOCULTURE AND
PADDY- MAIZE ROTATION SYSTEMS IN ANURADHAPURA
DISTRICT, SRI LANKA**

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Agricultural sustainability assessment is necessary for scientific understanding of policy and planning for sustainable agricultural development. Majority of the Sri Lankan farmers face difficulties in their cultivation, specially paddy and maize. Therefore, this study attempted to assess the sustainability of paddy monoculture and paddy-maize rotation systems through developing indicators for economic, social and environmental sustainability in Anuradhapura district. Three stage stratified random sampling method was utilized to select 100 farmers in each farming system. A pre-tested questionnaire survey was conducted to collect data. Descriptive analysis and multiple linear regression were used to analyze the data. Result showed that most of respondents were males (89% and 99%), married (89% and 99%) and had completed their secondary education (41% and 57%) in paddy monoculture and paddy-maize rotation system respectively. Majority of farmer's primary occupation was farming in both farming systems. Consequently, farmers' average annual agricultural income was LKR 68,364.00 (per acre) in paddy monoculture farming system and LKR 166,770.00 (per acre) in paddy-maize rotation farming system. According to the Total Sustainability Index (TSI), 72% farmers for paddy monoculture farming system and 83% farmers for paddy-maize rotation farming system were sustainable { $TSI = (0.5-1)$ }. Regression result revealed that cost of production per acre, off farm income, distance to public infrastructure, chemical usage per acre, level of integrated pest management for paddy monoculture farming system and total on farm income per acre, distance to public infrastructure, agrochemical per acre, level of integrated pest management for paddy-maize rotation farming system were significantly ($p < 0.05$) influencing on sustainability. Study concludes that both paddy-maize rotation system and paddy monoculture farming system are sustainable while the paddy-maize rotation farming system reflects higher sustainability in Anuradhapura district, Sri Lanka.

Keywords: Paddy- maize rotation farming system, Paddy monoculture farming system, Sustainability

ADOPTION OF ORGANIC FARMING PRACTICES IN BATTICALOA DISTRICT, SRI LANKA

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Although organic farming (OF) is an ecologically and economically sustainable form of agriculture, its adoption rate is still very low among farmers in Sri Lanka. This study was conducted in Batticaloa district, Sri Lanka to determine the present situation of adoption and to identify the factors affecting OF practices. Both non-organic and organic farmers (50 from each) were selected via simple random sampling method and interviewed using pre-tested questionnaires. A binary logistic regression model and a SWOT analysis for the adoption of organic farming were used for data analysis. According to the results, majority of the organic respondents were women (60%) and 44% had acquired at least primary education. Majority of the organic respondents had adopted climate smart organic farming. Organic manure usage (98%), application of compost (84%), maintaining buffer zone for the farm (78%) and integration of crop and livestock (66%) were recognized as mostly adopted climate smart agricultural practices by the organic respondents. According to the SWOT analysis, availability of land and knowledge on preparation of natural pesticide and fertilizers were identified as strengths and lack of credit, limitation in finding raw material were identified as weaknesses. Having a growing market for organic products and availability of effective extension services were the opportunities identified while climate change and poor infrastructure facilities were the potential threats for adopting OF. Study revealed that environmental concern (OR=13.46), farming experience (OR=1.12), average monthly income (OR=0.99), age (OR=0.92) and access to market (OR=0.07) as factors significantly ($P<0.05$) affecting adoption on OF while educational level (OR=0.22) is significantly affecting at $P<0.1$ when compared to non-organic farmers. There are adequate strengths and opportunities to expand organic agricultural practices in Batticaloa district. Therefore it is recommended to have well-planned awareness programs and develop agriculture infrastructure of the district to improve the adoption rate of organic farming.

Keywords: Batticaloa, Climate smart agriculture, Organic farming, SWOT analysis

FACTORS AFFECTING ON WILLINGNESS TO PURCHASE ORGANIC FOODS: A CASE STUDY IN BATTICALOA DISTRICT, SRI LANKA

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Organic food consumption is increasing among Sri Lankan consumers from the recent past as they are more conscious on food safety, health and environment along with nutritive value, taste, freshness and appearance of the food they consume. This study was conducted to determine factors affecting the buyer's willingness to purchase organic products and market potential for organic food products in Batticaloa District. Simple random sampling technique was used to select the sample and a pre-tested questionnaire survey was employed to collect primary data from 50 organic and 50 non-organic products buyers. Binary logistic regression was used to analyse collected data. A SWOT analysis was conducted for the organic market in Batticaloa district. The results revealed that quality of the organic products (OR =121.07), presence of non- communicable diseases (OR= 6.28), number of household members (OR= 0.36) and nutritional value of the organic foods (OR= 0.02) significantly ($p < 0.05$) influenced the buying decision of organic product buyers whereas gender of the respondent (OR=24.59) was significantly affecting on the decision at $p < 0.1$. The SWOT analysis implied that identified niche market for organic products, diversity of commodities and provision of fresh, healthy, village produced organic foods as strengths and unavailability of up-country organic vegetables and lack of marketing promotion as the weaknesses. Favourable government vision and rising demand for organic products highlighted the future potentials and opportunities for organic market. Competition from central market and street sellers, and extreme weather conditions were the main threats identified. The study concludes that the quality of the organic products as the main decision making factor considered by organic- buyers in Batticaloa district in Sri Lanka. These findings would help to understand the underlining buying behaviour of organic buyers and the potentials of the organic market in Batticaloa district.

Keywords: Batticaloa, Buyers willingness, Market potential, Organic products

EFFECTS OF *Gliricidia sepium* AND *Arachis pintoi* ON CINNAMON GROWING SOIL

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A study was undertaken at spice garden Middeniya to examine the selected properties of cinnamon (*Cinnamomum zeylanicum* Blume) growing soil as influenced by growing *Gliricidia sepium* (GS) and *Arachis pintoi* (AP). Six treatments namely, T1 (Control)- cinnamon + recommended dosage of fertilizer (RDF), T2- cinnamon + organic manure (20 t ha⁻¹ yr⁻¹), T3- cinnamon + single row GS + 50% RDF, T4- cinnamon + double row GS + 50% RDF, T5- cinnamon + triple row GS + 50% RDF and T6- cinnamon + AP + 50% RDF were used with triplicates. Soil samples were collected monthly from 0-15 cm soil depth. Standard soil analytical methods were performed to determine soil colour (SC), pH, electrical conductivity, organic carbon, total nitrogen, available phosphorus (P), exchangeable potassium (K), available sulphur (S), biomass carbon (BC), microbial activity (MA), biomass nitrogen (BN) and vascular arbuscular mycorrhizae (VAM) spores. Stem height and diameter of cinnamon were measured as growth parameters. MA was significantly increased in all the treatments compared to control. A significant effect ($P < 0.05$) of all tested chemical parameters except S, P and K contents was observed in all treatments compared to control. Nitrogen content in all other treatments was significantly higher ($P < 0.05$) compared to control (0.38 % \pm 0.07). Among the tested biological properties, BC and BN elicited significant increase ($p < 0.05$) in all other treatments compared to control. VAM count was higher in T6 (2.10 g/mm² \pm 0.22) but was not significantly different with other treatments ($P > 0.05$). Significant improvement in growth was observed in all treatments ($P < 0.05$) compared to control. In conclusion, Cinnamon can be cultivated with half recommended dose of chemical fertilizers with incorporated legumes and organic matter at Middeniya of Sri Lanka.

Keywords: *Arachis pintoi*, *Cinnamomum zeylanicum* (Blume), *Gliricidia sepium*, Soil properties

**SUSTAINABILITY ASSESSMENT OF LOW INPUT PADDY-
LIVESTOCK INTEGRATED FARMING SYSTEM IN
ANURADHAPURA DISTRICT, SRI LANKA**

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Sustainable development in agriculture pays more attention to integrated farming systems with crops, animals, soils, water and other management practices. Paddy and livestock integration is prominent system in the dry zone of Sri Lanka which escalates the socio-economic environment and well being of the farmers. Hence this study attempted to evaluate aggregate economic, social and environmental sustainability of the paddy livestock farming system in Anuradhapura district. Stratified random sampling method was occupied to select 100 farmers from three divisional secretariat divisions. Data were analyzed descriptively and quantitatively. According to the results, 83% were males, 98% were married and 84% reported having moderate housing facilities. Many respondents (46%) attended to formal secondary education followed by primary education (28%) respectively. Many farmer families (46%) consisted with four household members in average. Paddy farming was dominant (80%) as the primary occupation while rearing cattle was a supplementary income source. Mean age of the respondents was 48 years with LKR 264,356.00 seasonal income per acre in average. Further, majority of respondents (92%) cultivated 2.5 acres of their own lands in average. Of all respondents, 86% did not maintain separate pasture lands for their animals. According to Total Sustainability Index (TSI), 86% of farmers were under the sustainable category. Regression results revealed that education level, total household income, total cost of production per acre, total profit per acre, women's participation, level of good agricultural practices, level of integrated pest management, distance for agrarian service centers and crop rotation significantly ($p < 0.05$) influence the sustainability of paddy livestock farming system. The study enfold that paddy livestock integration system in Anuradhapura district is sustainable, but need more intensification with improved breeds, concentrated feed, farmers' awareness and extension facilities for further development.

Keywords: Farming system, Paddy livestock integration, Sustainability

ROLE OF WOMEN IN HOUSEHOLD FOOD SECURITY THROUGH HOME GARDENING: A CASE STUDY ON KANDYAN HOME GARDENS OF SRI LANKA

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Home gardening is a proven way of household food security. There were only few micro level studies were done which analyzed food security and women's role at household level in the Sri Lankan context. Hence, this study examined the women's role in home gardening for assuring household food security using a sample of 130 women (home gardeners and non-home-gardeners) selected from households in Medadumbara divisional secretariat in Kandy. Multistage sampling and snow ball sampling were used to select the sample size and unit of data collection, respectively. A pre-tested questionnaire was administered for data collection. Data was analyzed descriptively and statistically. The Household Dietary Diversity Scale was used to measure household food security. There were nine socio-economic factors of women studied as variables affecting household food security. The results revealed a higher dietary diversity among home-gardeners ($\mu=7.4923$) compared to the medium dietary diversity among non-home-gardeners ($\mu=5.692$). Among home-gardeners, 45% have occupations while it was 84% among non-home gardeners. A 59% of women sell foods from the home gardens and 95% of that income spends to purchase foods unavailable at household. Monthly expenditure is low among home-gardeners compared to non-home gardeners ($P<0.05$). Lower food expenses range per month ($\mu_t=7474$, $\mu_c=10408$) and higher saving range per month ($\mu_t=4508$, $\mu_c=3168$) were recorded in home gardener sample compared to non-home gardener sample, respectively. According to the regression analysis, education level and monthly income significantly affected the household food security in both samples. Furthermore, non-home-gardeners' household food security depended very strongly ($r_s=0.93669$) on monthly income while it was lesser among home-gardeners ($r_s=0.60892$). These findings confirm the importance of home gardens in household food security while highlighting the role of women who contribute to food production, earning income, dietary quality and consumption diversity. Therefore the food security policies should facilitate capacity development among women for home gardening.

Keywords: Economic value of women, Home gardening, Household food security, Women's role

SPATIAL VARIATION OF CROPPING SYSTEMS AND WEED DIVERSITY ALONG TANK CASCADES: A CASE STUDY IN THIRAPPANE TANK CASCADE SYSTEM IN SRI LANKA

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The land use associated with tank cascades demonstrates a challenging environment, essentially transformed from a natural ecosystem into an agro-ecosystem, which leads to create diverse cropping systems and variation in weed diversity. There is no organized information or researches on variation of cropping systems and weed diversity of irrigated lowlands and uplands along the tank cascade systems. Present study aimed to identify the spatial variation of prominent cropping systems and weed diversity along the Thirappane tank cascade system in dry zone of Sri Lanka. A questionnaire survey was used to identify variation of cropping systems and field survey was used to determine variation of weed diversity. Quadrant method was used obtaining weed samples. A sample of 150 farmers and 24 farmer fields were selected from the cascade system representing its total population. Chi-square test and descriptive methods were used to analyze data. Weed diversity was analyzed using Simpson's Diversity Index and Shannon Wiener Index. Maize-sesame (36%) and sesame-long bean (30%) were identified as prominent cropping systems among the recorded six cropping systems. Maize-sesame (36%) was reported as the most prominent cropping system along the cascade. Both Simpson's Diversity Index and Shannon Wiener Index indicated relatively higher values (0.62 to 0.79 and 1.02 to 1.46 respectively) representing rich diversity of the weed population in rice fields. Chi-square test proved that weed diversity is significantly ($P < 0.001$) varied along the cascade system. Further, the results revealed that the most dominant weed species in the upper tank and lower tank area is *Welhiriya* (*Cyperus difformis*) while middle tank area is highly affected with *Batadella* (*Isachne globosa*). In conclusion, there is a significant variation of weed diversity while not having a significant variation of cropping system along the Thirappane tank cascade system in Sri Lanka. The generated information would be beneficial in fulfilling the existing research gap and further developing agricultural activities in the cascade.

Keywords: Cropping pattern, Diversity indices, Tank cascade system, Weed diversity

IDENTIFICATION OF FARMING SYSTEMS IN MAHAWELI SYSTEM “H” IN SRI LANKA

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Mahaweli Development Programme is one of the country's bigger investments in the agricultural sector. Although Mahaweli system H (MH) is comprised of different farming systems, adequate studies have not been conducted to recognize them. The main objective of this study was to identify the existing farming systems in MH. Three hundred farmers were selected representing entire MH using stratified random sampling technique. Data was collected using pre-tested and structured questionnaire from three blocks representing upper (Mahailuppallama), middle (Thambuththegama) and lower (Nochchiyagama) ends of MH. Chi-square test and descriptive methods were used to analyze data. Results revealed that cropping patterns in MH had frequently changed during last five years due to water scarcity. Significant variations in both cropping patterns ($p=0.0000$) and cropping systems ($p=0.0000$) among the upper, middle and lower blocks of the system was recorded. Rice mono-cropping, rice-low country vegetables, rice-root and tubers and rice-oil seed crops were identified as prominent cropping patterns in MH. Rice mono-cropping was identified as the major cropping pattern in both Thambuththegama (40%) and Nochchiyagama (18%) blocks while that was rice-root and tuber crops in Mahailuppallama (13%) block. Rice mono-cropping was identified as the most commonly practiced cropping system in both Mahailuppallama (52%) and Thambuththegama (20%) while that was rice-law country vegetables in Nochchiyagama (19%) block. Rice cultivation with cattle rearing was the prominent farming system in the selected three locations (Nochchiyagama 11%, Thambuththegama 5% and Mahailuppallama 4%). Identification of most prominent farming system, cropping pattern and system is essential and cooperative in developing appropriate and efficient productivity plans to get maximum output from a given land. Hence type of studies would be helpful for the other areas of the Mahaweli system in Sri Lanka.

Keywords: Cropping pattern, Cropping system, Farming system, Mahaweli H



SESSION 05

ANIMAL PRODUCTION & TECHNOLOGY



EFFECTS OF FLOOR AND NEST EGGS ON INCUBATION AND CHICK QUALITY PARAMETERS

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Broiler breeders influence the quantitative and qualitative parameters of eggs and day old chicks. Floor and nest eggs are used by commercial layer farms to perform incubation. This study was carried out to evaluate the eggs and chick quality parameters between floor and nest eggs of broiler breeders. The experiment was conducted at the hatchery, Bairaha Farms PLC in a Complete Randomized Design (CRD) with two treatments. Five replicates were maintained for each treatment and each replicate consisted of 90 eggs. Nine hundred eggs from MX male x Cobb 500 female (35 - 40 weeks of age) were collected from the breeder farm. Eggs were incubated at *Petersime* commercial multi-stage (MS) incubator. Egg quality parameters; initial egg weight and shape index were measured just before the setter period. Egg weight reduction was calculated during incubation period. Live chicks and hatch residues were collected separately at the end of incubation period. Chick quality parameters such as chick weight, chick length and pasgar score were measured. Breakout test was conducted with hatch residues. Data was statistically analyzed using two sample t-test in SAS. Results revealed that there was a significant difference ($p < 0.05$) on hatchability between two types of eggs. Nest eggs reported the highest hatchability (90.0%) compared to floor eggs. Initial egg weight, egg shape index, moisture loss, hatch of fertile, chick weight, chick length, chick yield and pasgar score did not show any significant difference ($p > 0.05$) between two types of eggs. Break out analysis showed that higher embryo mortality and contamination occurred in floor eggs compared to nest eggs. Therefore, it can be concluded that hatchability of nest eggs is better than those of floor eggs. However, floor eggs should be kept separately in the commercial hatcheries to minimize the contamination.

Keywords: Chick yield, Fertility, Hatchability, Hatch of fertile

EVALUATION OF PERFORMANCES OF AQUAPONIC SYSTEM WITH ORNAMENTAL AND TABLE FISH

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Aquaponic system is an integration of fish and hydroponics in a closed recirculating system. The present study was aimed to investigate the suitable fish species and evaluate the performances of tomato plants in the aquaponic systems. The experiment was conducted as Complete Randomized Design with three treatments. Hydroponic system was setup as the control and two aquaponic systems with ornamental (Koi carp) and table fish (Tilapia) were used as treatments. A total of 100 fingerlings were stocked in each aquaponic system. Three replicates, each with six tomato plants were maintained for two systems. Three plants were randomly selected from each replicate for data collection. Body weight, standard length and girth of ornamental and table fish were measured. Data were analyzed using one way ANOVA in SAS. Results revealed that tomato yield showed a significant difference ($p < 0.05$) among systems. Hydroponic system reported the highest tomato yield (303 ± 41 g per plant). The tomato yields in the aquaponic systems with ornamental and table fish were 191 ± 41 g and 112 ± 41 g per plant, respectively. Leaf length, leaf width and number of leaves were significantly different ($p < 0.05$) among systems. However, plant height did not differ significantly ($p > 0.05$). Hydroponic system showed the higher leaf length (26 ± 1 cm), leaf width (17 ± 0 cm) and number of leaves (16 ± 0.6). Table fish (Tilapia) reared in the aquaponic system performed better (final average body weight; 61.4 g, length; 11.3 cm and girth; 6.7 cm) than ornamental fish (Koi carp)(final average body weight; 16 g, length; 8.4 cm, girth; 4 cm). It is concluded that tomato plants in the hydroponic system perform better than aquaponic systems. In addition, table fish in the aquaponic system performs better in terms of growth parameters. Tomato plants perform better in terms of yield in the aquaponic system with ornamental fish.

Keywords: Aquaponic, Hydroponic, Ornamental fish, Table fish

DEVELOPMENT OF A SET YOGHURT USING LOCALLY AVAILABLE WATERMELON VARIETIES

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Health benefits and consumer preference of set yoghurt can be improved by incorporating different fruit pulp or juices. Juices of three watermelon varieties, Thilini, Kinaree C28 and Rocky 475 were used with 25% (v/v) concentration level to develop a set yoghurt and selected the best variety for yoghurt preparation. Four incorporation levels of juice as 15%, 20%, 25% and 30% (v/v), were used to develop the set yoghurt using the selected watermelon variety. Authenticated set yoghurt without adding watermelon was used as the control. Thirty (30) untrained panellists were used in the sensory evaluation to select the best watermelon variety and respective concentration level. Organoleptic, microbiological and physicochemical properties of all samples were analysed during the 21 days of storage period. Parametric and sensory data were analysed using Analysis of Variance procedure and Friedman test, respectively. Rocky 475 variety at 20% (v/v) concentration level resulted the best sensory properties for colour, taste, texture and aroma. Fat content in watermelon incorporated yogurts decreased gradually with the increasing levels of watermelon juice ($p < 0.05$). The highest titratable acidity and the lowest pH were recorded in the control. The syneresis of yoghurt samples were increased and the Total Plate Count (TPC) was reduced ($p < 0.05$) with the increasing levels of watermelon juice. The lowest TPC (\log_{10} 5.72 CFUg⁻¹) was observed in 30% (v/v) incorporation level. Yeast and mould counts of all yoghurt samples were lower than the acceptable range (1×10^3 CFUg⁻¹) during the storage period. This study showed that set yoghurt could be enriched with desirable organoleptic properties, while ensuring microbiological safety by incorporating 20% (v/v) of Rocky 475 variety of watermelon juice.

Keywords: Organoleptic properties, Set yoghurt, Watermelon juice

EVALUATION OF VACUUM LEAKAGE CONDITION OF MEAT PRODUCTS PRODUCED AT KEELLS FOOD PLC - EKALA, JA-ELA

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Leaks in food packages may result in the ingress of gases, microorganisms or contaminants. Keels Food Products PLC is experiencing a large number of returns due to the vacuum leaks. Hence, this study was conducted to evaluate the present circumstances of the company regarding vacuum leakages in their meat products. It was found that packages of sausages and meatballs are mostly returned to the company. Further, these returns were from two distribution channels that are supplying the products to supermarkets and to retail shops through modern and general channels, respectively. Dispatched level data of mostly returned products (250 g, 450 g, 500 g of sausages and 200 g, 500 g of meatballs packages) were collected over a five day period. Bubble test was carried out for 900 returned samples of above products from both distribution channels. Thickness of the bottom and top reels of 250 returned samples were measured by using a gauge meter. The factory introduced a new packaging material and return data were collected. It was revealed that, at the dispatch level all products had similar number of leaks. Further, average number of micro holes (39.7 ± 7.1) and macro holes (38 ± 6.4) were significantly high ($p < 0.05$) in the modern channel while significantly ($p < 0.05$) higher number of micro holes (45 ± 4.4) were reported in the general channel. Significantly higher ($p < 0.05$) number of leaks were observed at the bottom reel ($89.8 \pm 7.41\%$). There was a significant ($p < 0.05$) negative correlation ($r = -0.702$) between the gauge of the packing material and the number of leaks. Further, number of returns were decreased ($p < 0.05$) significantly by introducing a new packaging material with higher gauge ($180 \pm 10.8 \mu\text{m}$). Hence, it is possible to lower the incidences of leakages at the factory by increasing the thickness of the packaging material.

Keywords: Thickness, Vacuum leaks, Vacuum packaging

FORMULATING A GELATIN-FREE SET YOGHURT WITH PATHA

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Lacto vegetarians are reluctant to eat yoghurts due to gelatin as it is a non-vegan compound. Thus, this study was focused in developing a set yoghurt using *Patha* (*Cyclea peltata*) leaf gel as a gelatin substitute. The gelatin was extracted by grinding the leaves. There were four recipes of set yoghurts prepared incorporating different levels (0, 4, 6 and 8 g) of *Cyclea peltata* leaf gel per one liter of yoghurt mix. The other ingredients were used in similar proportions in all four recipes. The yoghurt prepared with zero level of *Cyclea peltata* leaf gel level was considered as the control and it contained 6 gL⁻¹ gelatin instead. The most effective recipe was selected by analyzing for proximate composition, pH, titratable acidity and shelf life and finally by undertaking a sensory evaluation. Leaf gel added set yoghurts possessed lower ($p < 0.05$) pH values compared to control. Titratable acidity was not different ($p > 0.05$) in all four recipes and it was within the acceptable range of 0.8 up to 4 days of storage. There were no Coliforms observed in all four recipes; neither the yeast nor mould was observed up to 12th day of storage. The color and appearance were not different ($p > 0.05$) among the four recipes. Yoghurt prepared with 6 gL⁻¹ of leaf gel had the highest ($p < 0.05$) sums of rank in the sensory evaluation followed by control. The proximate composition was similar ($p > 0.05$) in the yoghurts prepared with 6 gL⁻¹ of leaf gel and control except for crude fiber content which was higher ($p < 0.05$) in the yoghurts prepared with 6 gL⁻¹ of leaf gel. Thus, it can be concluded that *Cyclea peltata* leaf gel can be used as a total substitute for gelatin incorporating up to 6 gL⁻¹ in the preparation of set yoghurt and it can be stored up to 12 days without interfering with sensory attributes.

Keywords: Gelatine substitute, Leaf gel extract, Shelf life, Set yoghurt

EFFECT OF QUANTITATIVE EARLY FEED RESTRICTION ON GROWTH PERFORMANCE AND FAT DEPOSITION IN BROILERS

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The fast growth rate of broilers' is associated with high body fat deposition and nutritional studies have indicated that early feed restriction induces the metabolic programming. This experiment was conducted to study the effect of feed restriction at early age on growth performance and fat deposition in broilers. Two hundred, Cobb-500 day-old chicks were randomly assigned into five treatments with four replicates in a completely randomized design. Treatments were T1: *ad-libitum* feeding (control), T2 and T3: 75% and 50% of *ad-libitum* feeding from day 7 – 14, respectively, T4 and T5: 75% and 50% of *ad-libitum* feeding from day 14 - 21, respectively. All birds were fed with *ad-libitum* before and after the completion of the respective restriction periods, adapting two phase feeding program. Growth performances were recorded weekly and carcass quality parameters and serum lipid profile were measured at slaughtering on the 38th day. Feed intake was significantly lower ($p < 0.05$) in T3 and T5 (2.9 ± 0.04 kg) compared to the birds in the control group (3.2 ± 0.04 kg). However, no differences ($p > 0.05$) were observed in weight gain, feed conversion ratio, and dressing percentage among the treatments. Abdominal fat (13 - 17 g) and muscle crude fat (1.9 - 2.5%) contents in birds fed with restricted diets from day 7 - 14 were significantly lower ($p < 0.05$) compared to the control (27 ± 2 g and $5.06 \pm 0.6\%$, respectively). There was no influence ($p > 0.05$) of treatments on carcass cuts or organ weights, muscle protein content, and serum lipid profile. According to the cost benefit analysis, profit earned per bird from T3 (LKR 187.00) was higher compared to the control (LKR 173.00). In conclusion, 50% feed restriction during day 7 - 14 is a better solution to reduce the fat deposition without interfering on growth performances of broilers with lower cost.

Keywords: Abdominal fat, Carcass quality, Lipid, Restricted feeding

EFFECT OF PHOTO PERIOD ON GROWTH PERFORMANCES OF GUPPY FISH

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Photoperiod has a positive effect on the growth performances of fish by inducing feed consumption, growth of muscles due to the high locomotor activity and efficient usage of nutrients. This experiment focused on determining the effect of photoperiod on the growth performances and survival of guppy (*Poecilia reticulata*) juveniles. There were five treatments with three replicates; A-12 h (hour) lightness and 12 h darkness as the control, B-24 h lightness; C-24 h darkness, D-8 h lightness and 16 h darkness, E-16 h lightness and 8 h darkness. Fish with an average initial weight (2.28 ± 0.10 g) and an average length (1.92 ± 0.24 cm) were randomly distributed at a stocking rate of 20 fish per tank. Total culture period was 10 weeks. Fishes were fed twice a day with a commercial feed (protein 48%). Temperature ($28 - 30^{\circ}\text{C}$), dissolved Oxygen ($7 - 8 \text{ mgL}^{-1}$), pH ($6.5 - 8$) and volume of water (48 liters) were maintained at constant levels throughout the experiment. The average body weight of the fish was measured at 7 days intervals and the standard body length was measured at the beginning and the end of the experiment. Specific growth rate (SGR), weight gain (WG), daily growth rates (DGR), length gain (LG) and condition factor (K) were calculated using the collected data. Significantly higher ($p < 0.05$) average body weight and average body length of guppy were exhibited in treatment E and A. Further, treatment E had a higher ($p < 0.05$) calculated SGR ($2.43\% \text{ d}^{-1}$), WG (363.39%), LG (89.55%), DGR (2.57) and the lowest ($p < 0.05$) K (1.08) among the treatments. There was no mortality reported during the total culture period among the treatments. In conclusion, exposure to 12 and 16 h of lightness enhances the growth performances of guppy juveniles under controlled conditions and photoperiod had not affected on the survival of guppy fish.

Keywords: Growth performances, Guppy, Photoperiod

PROBIOTIC EFFECT OF INULIN INCORPORATED SET YOGHURT PREPARED USING CATTLE AND BUFFALO MILK

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Demand for probiotic food products has been increased remarkably over the last few decades. Yoghurt is one of the popular functional food enriched with probiotic activity. In this study microbiological and physicochemical properties of two set yoghurt types prepared using cow milk (CM) and buffalo milk (BM) were evaluated at 3 different levels of inulin additions (1%, 2% and 3% w/w) in refrigerated storage at 4°C for 21 days. Two types of starter cultures as BB12 (*Bifidobacterium bifidum*) and YC-X11 (*Streptococcus thermophilus* and *Lactobacillus bulgaricus* subsp. *bulgaricus*) were used to prepare the set type yoghurt. Probiotic viable cell counts for all three probiotic micro-organisms, whey separation (syneresis), total acidity and pH were evaluated weekly. Organoleptic properties and viscosity were also evaluated within the first week of preparation. Both inulin incorporated CM and BM showed the higher probiotic counts at the end of the enumeration period (~8.0 log CFU mL⁻¹) while control samples of each group showed significantly lower (~7.0 log CFU mL⁻¹) probiotic counts. The highest probiotic count was recorded in 3% inulin incorporated CM and BM yoghurts from each category. *S. thermophilus*, *B. bifidum* and *L. bulgaricus* counts in CM yoghurts were 9.11 log CFU mL⁻¹, 8.90 log CFU mL⁻¹ and 8.96 log CFU mL⁻¹ respectively and in BM yoghurts those were 8.72 log CFU mL⁻¹, 8.67 log CFU mL⁻¹ and 8.73 log CFU mL⁻¹ respectively. Viscosity of the yoghurt samples were significantly different ($p < 0.05$) among the treatments while the highest viscosity was observed in 2% inulin incorporated yoghurt (CM: 55850 ± 70.71 mPa.s; BM: 86450 ± 70.73 mPa.s). The CM and BM yoghurt containing 2% inulin showed the higher consumer acceptability and probiotic stability during the storage. This study showed that the addition of inulin can improve microbiological, sensory and viscosity of yoghurt prepared from CM and BM.

Keywords: Buffalo milk, Cow milk, Inulin, Probiotic, Set yoghurt

INFLUENCE OF TOTAL MIXED RATION ON PRODUCTIVITY AND COMPOSITION OF MILK OF LACTATING BUFFALOES UNDER THE DRY ZONE FARM CONDITIONS

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A 22 day lactation trial was conducted to determine the effect of total mixed ration on productivity and composition of milk of lactating buffaloes under the dry zone farm condition. Six Murrah × Nili-Ravi cross bred, early lactating buffaloes were blocked according to their parity and randomly allocated into two treatment groups. They were either offered a total mixed ration (TMR) or fed by conventional feeding system with only chopped guinea grass (control group). Milk yield, composition, feed intake were measured daily and milk urea nitrogen (MUN) and body weight were determined weekly. Data were analyzed using Analysis of Variance in SAS. Economic efficiency was evaluated by cost benefit analysis. Milk yield and average body weight were significantly higher ($p < 0.05$) in animals fed with TMR (4.90 ± 0.13 L and 616.54 ± 2.55 kg, respectively) than those fed by the conventional system (2.67 ± 0.13 L and 604.99 ± 2.55 kg, respectively). Milk fat content was significantly higher ($p < 0.05$) in TMR fed group while milk protein, density, solids-non-fat and lactose contents were higher ($p < 0.05$) in the control group. However, the MUN content was not significantly different ($p > 0.05$) when fed with TMR or only with chopped guinea grass. Moreover, average feed intake was higher ($p < 0.05$) in control group (37.98 ± 0.44 kg) than the TMR fed group (28.56 ± 0.44 kg). A higher profit was reported with the TMR feeding (LKR 29.42/animal/day) compared to the control group. The results reveal that, TMR feeding do have a significant impact on milk yield and milk fat content of lactating buffaloes which improves the profit margin.

Keywords: Lactating buffaloes, Milk composition, Milk yield, Productivity, Total mixed ration

DEVELOPMENT OF A STRATEGIC CLEANING PROCEDURE FOR EFFECTIVE WATER USAGE AT THE MEAT PROCESSING FACTORY, KEELLS FOOD PRODUCT PLC

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Wastewater generation at the Keells Food Product factory is above the capacity of the wastewater treatment plant. There are three main product processing lines; skin on sausage, skin less sausage and frozen meat product. All the production lines are mechanized and operated by fourteen different machineries. After any given production each and every machine is cleaned until no physical particles remaining in the machineries and flow area. After cleaning, microbial count should be below 10^2 CFU. The cleaning process produced a massive volume of wastewater due to the absence of a proper cleaning procedure. Thus, a study was conducted at the above factory with the objective to propose a strategic cleaning procedure (SCP) to reduce the amount of wastewater generation. The amount of water used for cleaning these 14 machineries at different processing lines was estimated by two procedures employing a regular labourer; (1) using the current procedure and (2) using a proposed SCP. The data were collected for each machine for seven consecutive production days for the each procedure. The water usage for cleaning using both procedures was compared by a paired T test. According to the results the regular labourer has used 484.5 ± 3.37 of water for cleaning one machine compared to 326.29 ± 3.62 from the proposed SCP which was a significant reduction of 33% due to the proposed SCP. Further, the water meters indicating the water input, water storage and water output were also tested for errors. It was observed that there were defects in water meters. Thus, the Keells Food Product PLC, Gonawila, Makandura has taken necessary steps to adapt the proposed SCP for cleaning the machineries at different processing lines and adjust the defects in water meters. Further, the findings were to be included in the water foot print plan expected to be developed for the factory.

Keywords: Cleaning machinery, Processed meat products, Waste water, Water usage

EFFECT OF MILKING TIME AND STORAGE TEMPERATURE ON THE MICROBIOLOGICAL QUALITY OF RAW MILK

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Farmers tend to chill the evening milk using domestic refrigerators and mix with the morning fresh milk in the following day due to the inadequacy of evening milk collecting facilities. The objectives of the current study were (1) to evaluate whether the Total Plate Counts (TPC) differ in milk samples obtained from different milking times (2) whether the chilled evening milk at farmer refrigerators affect the TPC levels. The data were analyzed as randomized block design for objective one and complete randomized design for objective two. Milk samples (N=180) were collected from 15 dairy farmers in the Anuradhapura District, Sri Lanka. Milk samples were collected from each farmer for three (3) consecutive days. In the first study milk samples were collected as evening (a), morning (b), evening chilled (c) and the mixture of evening chilled with the following day morning fresh milk (d). In the second study, evening fresh milk samples were chilled under laboratory conditions at 4°C, 6°C and 8°C and also at the farmer's refrigerators. All these samples were cultured and evaluated for TPC. The average TPC values obtained for a, b, c and d samples in the first study varied between $\log_{10} 8.13 \text{ CFU mL}^{-1}$ and $\log_{10} 8.18 \text{ CFU mL}^{-1}$ respectively. These TPC values didn't show any significant difference but they were higher than standard TPC level ($\log_{10} 5.0 \text{ CFU mL}^{-1}$) for raw milk. In the second study the lowest TPC values ($\log_{10} 8.13$) were resulted from samples stored at 4°C compared to 6°C, 8°C and farmer's refrigerator. This study concludes that milk stored at the domestic refrigerators fail to maintain the optimum chilling temperature (4°C) and milking time has no effect on the microbiological quality of raw milk.

Keywords: Microbiological quality, Raw milk, Storage temperature

DIETARY SUPPLEMENTATION OF SECONDARY PLANT COMPOUNDS AND ZINC BACITRACIN ON GROWTH PERFORMANCE AND LIPID PROFILE OF BROILERS

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Broiler industry is currently looking for alternatives to increase the efficiency of feed consumption while eliminating the use of antibiotic growth promoters (AGP). This study was conducted to investigate the effect of supplementing broiler chicken diets with secondary plant compounds (SPC) and zinc bacitracin on growth performance and serum lipid profile. Three hundred, eight day-old Cobb500 broiler chicks were randomly allocated to five experimental diets with six replicates each in a completely randomized design. The supplements were mixed in the commercial diet at two different levels (SPC; 10% and 20% Activo[®] and AGP; 20% and 40% Zinc bacitracin (ZB)). Broilers fed on the commercial broiler diets without supplements were considered as the control. Body weights and feed consumption were recorded at weekly intervals and body weight gain and feed conversion ratio (FCR) were calculated. On 42nd day, birds were slaughtered and dressed weight, internal organs weight, and serum lipid profile were measured. Data were analyzed using one way Analysis of Variance in SAS. Dietary intake of 20% Activo[®] resulted significant increase ($p < 0.05$) in body weight gain (2296 ± 51 g) and decrease in FCR (1.55 ± 0.03) compared to the control group (2152 ± 51 g and 1.68 ± 0.03 , respectively). However, weight gains and FCR were similar in ($p > 0.05$) birds fed with different percentages of ZB and Activo[®]. Carcass and internal organ weights were not significantly different ($p > 0.05$) among the treatments. Inclusion of supplements significantly reduced ($p < 0.05$) the serum total cholesterol (160 ± 25 mgdL⁻¹) and low density lipoprotein (72 ± 26 mgdL⁻¹) compared to the control. Therefore, secondary plant compounds used in the study can be utilized at a level of 20% as an alternative to antibiotic growth promoters to improve broiler performance to reduce the serum cholesterol.

Keywords: Antibiotic growth promoter, Broilers, Growth performance, Secondary plant compound, Serum lipid profile

EFFECT OF GLIRICIDIA LEAF MEAL OR HYBRID NAPIER CO3 GRASS LEAF MEAL INCORPORATED RATIONS ON GROWTH OF YOUNG TURKEY BIRDS

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There is no specific feed ration for turkey birds reared in Sri Lanka. They are fed with boiler rations. Therefore, an experiment was undertaken to study the effect of feeding two low cost rations on growth performance of turkey birds. Day old poults were randomly assigned into three treatments in a Randomized Complete Block Design (RCBD) with nine replicates of ten birds for each. Treatments were as follows; Treatment 1 (T1) – Ration incorporated with Gliricidia (*Gliricidia sepium*) leaf meal, Treatment 2 (T2) – Ration incorporated with hybrid Napier CO3 grass (*Pennisetum puerperium* x *Pennisetum americanum*) leaf meal, Treatment 3 (T3 – Control) commercial broiler grower ration. Birds were weighed weekly. At the end of the three months study period a sample of birds were slaughtered to obtain the carcass data. Feed and meat samples were analyzed for nutrient content. There was no difference ($p > 0.05$) in crude protein content in all three rations. Ash content was higher ($p < 0.05$) in T2 compared to T1 and T3. Crude fiber content was higher ($p < 0.05$) in T3 compared to T1 and T2. The lowest ($p < 0.05$) feed intake was recorded in T2 compared to T1 and T3. The highest ($p < 0.05$) average body weight was recorded in T3 compared to T2 which in turn was higher ($p < 0.05$) than T1. Live weight gain was higher ($p < 0.05$) in T2 and T3 compared to T1. The carcass weight, dressing out percentage and feed conversion ratio were not significantly different among treatments. A profit of LKR 457.95/bird was obtained from T2. The profits from T3 and T1 were LKR 355.05/bird and LKR 112.35/bird respectively. Hence, it can be concluded that the ration incorporated with hybrid Napier CO3 grass leaf meal (T2) can be effectively used to replace commercial broiler grower ration for feeding turkey birds in Sri Lanka. And it is profitable than feeding commercial broiler grower ration.

Keywords: Feeding trial, Growth of Turkey birds, Low cost leaf meal rations



SESSION 06

FOOD & POSTHARVEST TECHNOLOGY



**DETERMINATION OF EFFECTIVE CONCENTRATION OF
DIATOMACEOUS EARTH (SiO₂) FOR PADDY, MAIZE AND SOYA
BEAN USING RICE WEEVIL, MAIZE WEEVIL AND PULSE BEETLE**

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Rice weevil (*Sitophilus oryzae*), maize weevil (*Sitophilus zeamais*) and pulse beetle (*Callosobruchus chinensis*) are destructive insect pests of stored grains in Sri Lanka. The loss of grains during storage conditions ($30 \pm 2^\circ\text{C}$, 79 ± 2 r.h.) was 4-6% and 80% loss was due to insect attack. Chemicals have been using in controlling insects of grains. These chemicals are harmful for human besides Diatomaceous earth (DE) is nontoxic to human. In Sri Lanka researches are insufficient to find the best concentration and effectiveness for DE. Therefore, this study was done. First experiment was conducted to determine the effective dose of DE using 0.15, 0.3, and 0.45 gkg⁻¹ concentrations for paddy, soya bean and maize with respected control samples of each crop. In the first experiment, 30 days old adult rice and maize weevils and 5 days old adult pulse beetles were used. The second experiment tested the efficacy of DE under storage conditions ($30 \pm 2^\circ\text{C}$, 79 ± 2 r.h.). Grain weight losses were obtained at weekly intervals up to 12 weeks. The experimental design was a complete randomized design (CRD). In results, there was no significant difference ($p > 0.05$) in insect mortality between treated and untreated maize samples. But insect mortality was significant ($p < 0.05$) between paddy and soya bean samples with their respective controls. Therefore, paddy and soya bean were used for the second experiment. The treatments weren't significantly different between soya bean and paddy. The effective dose of DE was 0.15 g kg⁻¹. Paddy and soya bean which were treated with DE showed significantly reduced weight losses compared to the untreated controls. Therefore, diatomaceous earth can be recommend as an effective chemical for controlling *Stophilus oryzae* and *Callosobruchus chinensis* of stored paddy, pulses but it is not very effective for controlling *Sitophilus zeamais*.

Keywords: Diatomaceous earth, Insects, Mortality, Weight loss

DEVELOPMENT OF YOGURT DRINK BY USING CITRUS FIBER AS A STABILIZER

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This study was conducted to develop a yogurt drink adding a natural stabilizing agent, citrus fiber (*Citrus spp*). Five different levels of citrus fiber, 0.10%, 0.15%, 0.20%, 0.25%, and 0.30% (w/v) were evaluated to select the best incorporation level of citrus fiber for the development of yogurt drink. The selected citrus fiber level was compared with the optimum level of two stabilizers viz 0.3% and 0.035% (w/v) of gelatin and carrageenan, respectively. Authenticated control was conducted without adding any stabilizers. Sensory properties of yogurt drinks were evaluated using thirty (30) untrained panelists. Physico-chemical and microbiological properties were determined over 21 days of shelf life. Parametric and nonparametric data were analyzed using one way Analysis of Variance procedure and Friedman test, respectively. The sample incorporated with 0.2% (w/v) citrus fiber level had the highest overall acceptability ($p < 0.05$). There was a significant difference in pH and titratable acidity among the yogurt drinks prepared with different stabilizers. During the storage period, pH was decreased and titratable acidity was increased ($p < 0.05$). Titratable acidity and pH of 0.2% (w/v) citrus fiber level were 1.05 ± 0.01 and 4.45 ± 0.00 respectively at the end of the storage period. Fat content of 0.2% citrus fiber added yogurt drinks were significantly higher compared to control sample. *Escherichia coli* was not detected in all levels of stabilizers, while yeast and mold counts of yogurt drinks were within the acceptable range (maximum 1×10^3 CFUg⁻¹) during the storage period. The highest overall acceptability was showed by 0.2% (w/v) citrus fiber incorporated yogurt drink compared to the 0.3% (w/v) gelatin and 0.035% (w/v) carrageenan incorporated yogurt drinks. In conclusion, 0.2% (w/v) level of citrus fiber could be used to develop a yogurt drink with desired physico-chemical, microbiological and sensory properties compared with other two stabilizers.

Keywords: Carrageenan, Citrus fiber, Drinking yogurt, Gelatin, Stabilizers

THERMAL EFFECT ON PHYSICOCHEMICAL PROPERTIES AND FATTY ACID PROFILE OF MEE [*Madhuca longifolia* (Konig J.)] OIL

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Heating of oils alter its physicochemical properties and fatty acid profile which leads to health issues in human and cause interferences in food processing. Relative dearth of literature about thermal effect on *mee* oil restricts its potential to serve as an alternative, hence the study was conducted. Oil was extracted by screw pressing of hulled and unhulled *mee* seeds. Acid value (19.2 ± 0.23 mg KOHg⁻¹) and peroxide value (33.33 ± 1.27 meqkg⁻¹) of the unhulled *mee* oil was significantly higher than the recommended levels for human consumption. Therefore, this study was proceeded with the hulled *mee* seed oil and coconut oil as a two factor factorial complete randomized design. The oil samples were heated up to 100°C, 150°C, 200°C and 280°C for 3 hours. The analyzed specific gravity and viscosity at 25°C, smoking point, iodine value and saponification value of the unheated *mee* oil were 0.945 ± 0.00 , 212.4 mPas, 172 ± 1.2 °C, 62.12 ± 0.58 g I₂/100g and 184.44 ± 1.4 mg KOHg⁻¹ respectively. Colour, peroxide value, acid value, free fatty acid percentage (% as oleic) and fatty acid profile of both heated and unheated oil were measured compare to coconut oil. The predominant fatty acids of the unheated *mee* oil was oleic (44.07%), followed by palmitic (19.59%) and stearic (22.39%). The predominant fatty acids of unheated coconut oil were lauric (44.07%) followed by myristic (19.54%) and palmitic (8.94%). Acid value and saturated fatty acids such as palmitic and stearic acid percentage of both heated oil were increased with the elevated temperatures. The measured values for colour as L* and b* for both oils were significantly decreased with increasing temperature. Peroxide value significantly increased up to 200°C in both oils. The study reveals that evaluated physico-chemical parameters and fatty acid profile of unheated *mee* oil were significantly affected by heating except free fatty acid percentage (as oleic).

Keywords: Coconut oil, Fatty acid profile, Heating, *Mee* oil, Physicochemical properties

EFFECT OF IN-VITRO DIGESTION ON ANTIOXIDANT PROPERTIES OF PROCESSED COWPEA AND MUNG BEANS

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Cowpea (*Vigna unguiculata*) and mung beans (*Vigna radiata*) are two types of legumes which are commonly consumed in Sri Lanka, due to their nutritional quality and health benefits. Antioxidants are one of the valuable bioactive compounds found in legumes. However, bioactive properties including antioxidant activity may be altered by digestion and processing. The present study investigated the effect of *in-vitro* digestion on antioxidant capacity of raw, germinated and boiled cowpea and mung beans. The total phenolic content (TPC) and total flavonoid content (TFC) in experimental samples were determined using Folin-ciocalteu method and Aluminium chloride colorimetric method, respectively. The antioxidant activity was determined using DPPH (2,2-diphenyl-1-picrylhydrazyl), ABTS (3-ethylbenzothiazoline-6-sulphonic acid) and FRAP (Ferric reducing antioxidant power) assays. The digested cowpea showed significantly ($p < 0.05$) high phenolics ($13.80 \pm 0.28 \text{ mgGAEg}^{-1}$) and flavonoids ($1.34 \pm 0.02 \text{ mgCEg}^{-1}$) than the undigested cowpea, which had $7.55 \pm 0.28 \text{ mgGAEg}^{-1}$ of phenolics and $0.77 \pm 0.02 \text{ mgCEg}^{-1}$ of flavonoids. Compared to the undigested mung beans (TFC- $0.72 \pm 0.02 \text{ mgCEg}^{-1}$, ABTS- $842 \pm 7.69 \mu\text{mol.g}^{-1}$), the digested mung beans were shown significant ($p < 0.05$) increase in flavonoid content ($1.26 \pm 0.02 \text{ mgCEg}^{-1}$) and antioxidant activity (ABTS- $1225.3 \pm 7.69 \mu\text{mol.g}^{-1}$). Among processing methods, boiling significantly ($p < 0.05$) reduced the phenolics ($6.46 \pm 0.35 \text{ mgGAEg}^{-1}$ of cowpea and $8.37 \pm 0.35 \text{ mgGAEg}^{-1}$ of mung beans) compared to germinated and raw beans (cowpea- $12.17 \pm 0.35 \text{ mgGAEg}^{-1}$, $13.39 \pm 0.35 \text{ mgGAEg}^{-1}$ and mung beans- $18.95 \pm 0.35 \text{ mgGAEg}^{-1}$, $16.85 \pm 0.35 \text{ mgGAEg}^{-1}$ respectively). Boiling significantly ($p < 0.05$) lower antioxidant activity (ABTS- $880.5 \pm 9.42 \mu\text{mol.g}^{-1}$ of cowpea, $673 \pm 9.42 \mu\text{mol.g}^{-1}$ of mung beans) compared to germinated (cowpea- $1413.9 \pm 9.42 \mu\text{mol.g}^{-1}$, mung beans- $1121.3 \pm 9.42 \mu\text{mol.g}^{-1}$) and raw (cowpea- $1301.3 \pm 9.42 \mu\text{mol.g}^{-1}$, mung beans- $1306.6 \pm 9.42 \mu\text{mol.g}^{-1}$) samples. This study reveals that, *in-vitro* digestion increased the phenolic, flavonoid content and antioxidant activity in both cowpea and mung bean samples.

Keywords: Boiled, Flavonoids, Germinated, Legumes, Phenolic, Raw

DETERMINATION OF AN EQUATION TO FIND GLYCEMIC INDICES OF SRI LANKAN TUBERS USING HYDROLYSIS INDICES

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Increased interest in glycemic response of food derives from its linkage with sedentary life style and non communicable diseases such as cardiovascular diseases, obesity and type 2 diabetes. Glycemic indices (GI) of food items are measured by *in vivo* method which is laborious and time consuming. The objective of the current study was to determine an equation to estimate the GI of starchy tubers available in Sri Lanka using the hydrolysis index (HI) of the selected tubers cassava (*Manihot esculanta*), potato (*Solanum tuberosum*), *hulankeeriya* (*Maranta arundinaceae*), sweet potato (*Ipomea batatas*), *raja ala* white and violet (*Dioscorea alata*). The digestible carbohydrate levels were determined in six replicate samples for each of the selected tubers. The boiled tuber portions which contained equivalent amount of carbohydrate were subjected to enzymatic incubation with pepsin and pancreatic α amylase. After 3 hours of incubation, percentage of starch hydrolyzed to maltose was taken as the degree of hydrolysis and plotted against time. The HI of tubers was calculated using the ratio between incremental areas under the hydrolysis curve for the tested food and the standard food (white bread). The HI for cassava, potato, *hulankeeriya*, sweet potato, *raja ala* violet and white were 114 ± 9 , 89 ± 10 , 84 ± 6 , 79 ± 6 , 74 ± 4 and 69 ± 7 respectively. The HI was correlated to the previously published GI values of the six selected tubers and a significant correlation ($r=0.922$; $p=0.009$) was found. $GI=1.333HI - 32.93$ was obtained as an equation to predict the GI of starchy tubers using the HI. Future, similar *in vitro* evaluation among other starchy tubers will help refining the above found equation.

Keywords: Glycemic index, Hydrolysis index, Sri Lankan starchy tubers

EFFECT OF ASCORBIC ACID AND ALOE VERA GEL ON EXTENDING THE SHELF LIFE OF FRESH CUT TJC MANGO

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Mango (*Mangifera indica*) cv. TJC is dominating in the Sri Lankan fruit market. Therefore, a study was conducted to develop fresh cut TJC Mango by using ascorbic acid and aloe vera gel as preservatives. TJC mangoes were purchased from the market (TSS = 20.8 ± 1.56), washed with 200 ppm NaOCl, peeled and cut into cubes (2 x 2 cm). Different concentrations of ascorbic acid (AA) solutions (150, 200 and 250 ppm) and aloe vera (AV) (100, 75, 50%) gel were prepared. The cubes were dipped in AA solutions for 3 minutes followed by 30 minutes dip in AV gel. The treatments were T1 = AV 100% + AA 250 ppm, T2 = AV 100% + AA 200 ppm, T3 = AV 100% + AA 150 ppm, T4 = AV 75% + AA 250 ppm, T5 = AV 75% + AA 200 ppm, T6 = AV 75% + AA 150 ppm, T7 = AV 50% + AA 250 ppm, T8 = AV 50% + AA 200 ppm, T9 = AV 50% + AA 150 ppm and C = control. Then, cubes were packed in transparent high impact polystyrene cups and stored in a refrigerator (7°C). Flesh color, firmness, TSS and TA were measured at 0, 3 and 6 Days After Storage (DAS). A sensory evaluation was conducted for the sample which had the lowest deterioration rate than the control on 3 DAS. The lowest rates of deterioration of flesh color, firmness, TSS and TA were reported by the sample treated with 250 ppm AA followed by 75% AV gel (T4). In conclusion, dipping of TJC mango cubes in 250 ppm ascorbic acid solution for 3 min followed by 30 min dip in 75% Aloe vera gel is suggested for extending storage life of fresh cut TJC mango under refrigerated conditions.

Keywords: Flesh firmness, Fruit quality, Preservatives

OPTIMIZING COLD STORAGE TEMPERATURE FOR PALEE F1 BITTER GOURD

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Cold temperature storage is one of the best methods to maintain the qualitative and quantitative properties of bitter gourds (*Momordica charantia* L.). The experiment was conducted to optimize the cold storage temperature for *palee* F1 bitter gourd variety by using two-factor factorial complete randomized design. Four cold storage temperatures ($6 \pm 2^\circ\text{C}$, $8 \pm 2^\circ\text{C}$, $10 \pm 2^\circ\text{C}$, $12 \pm 2^\circ\text{C}$) were evaluated together with the ambient temperature ($30 \pm 2^\circ\text{C}$) storage. Weight Loss Percentage (WLP), colour, firmness, pH, Total Soluble Solids (TSS), Total Chlorophyll Content (TCC), Ascorbic Acid Content (ACC) and Total Phenol Content (TPC) were determined in two and four days interval for the ambient and cold temperature storage respectively. The fruits stored at 6°C had 18 days of storage followed by 16 days of storage at 8°C . In 6°C had significantly lower WLP ($16.06 \pm 0.4\%$) at 16 days compared to 8°C ($19.43 \pm 0.4\%$). L^* and a^* values were significantly lower at 16 days of storage life in 6°C (35.35 ± 3.02 and -10.73 ± 0.58) compared to 8°C (35.56 ± 3.02 and -10.31 ± 0.58) and b^* value was significantly higher in 6°C (16.73 ± 1.51) compared to 8°C (16.58 ± 1.51). At 16 days of storage, firmness, pH, TSS and TCC were significantly higher at 6°C (54.26 ± 4.04 N, 5.75 ± 0.01 , 5.6 ± 0.06 and 9.05 ± 0.02 mgL^{-1}), in comparison to the storage at 8°C (30.03 ± 4.04 N, 5.64 ± 0.01 , 4.1 ± 0.06 and 5.34 ± 0.02 mgL^{-1}). Significantly lower AAC and TPC (0.00773 ± 0.0002 mgL^{-1} , 0.0316 ± 0.0001 mgL^{-1} respectively) were observed at 6°C compared to 8°C (0.0079 ± 0.0002 mgL^{-1} , 0.032 ± 0.0001 mgL^{-1}) of storage for 16 days. The results indicate that 6°C is the optimum cold storage temperature for *palee* F1 bitter gourd due to lower WLP, higher firmness, TCC and extended storage period.

Keywords: Bitter gourd, Cold storage, Firmness, Total phenol content, Weight loss

DEVELOPMENT OF AN ORGANIC RIPENING AGENT BY KEPPETIYA AND BILIN

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Use of industrial grade artificial ripening agents is highly debatable throughout the world as they may pose negative health impact on consumers. Hence, a study was conducted to develop an organic ripening agent using two biomaterials namely *keppetiya* (*Croton lacciferus* L.) and *bilin* (*Averrhoa bilimbi* L.) and its effect was evaluated on inducing ripening of *Embul* banana. Emanations of fresh leaves, withered leaves and powder samples of *keppetiya* and *bilin* were analyzed by gas chromatography (GC). After that, banana variety *Embul* harvested at mature green stage {Total Soluble Solids (TSS)= $5.6 \pm 0.2\%$ and Titratable Acidity (TA)= $0.55 \pm 0.03\%$ } were exposed to *keppetiya* and *bilin* powder samples namely *keppetiya* 5, 10, and 15%, *bilin* 5, 10 and 15% and *keppetiya: bilin* (1:1) 5, 10 and 15% (w/w) for 24 h in corrugated fiberboard boxes under ambient conditions. Data on pulp firmness, peel color, TSS, TA, pH and physiological weight loss were measured at day 0 (initial) and thereafter at 2 day intervals until the fingers showed brown spots on the peel. Sensory evaluation was conducted by 5 point hedonic scale at table ripe stage. According to results of the GC, ethylene concentrations of fresh, withered and powder forms of *keppetiya* leaves were 973.413, 48.241 and 15. 276 ppm respectively while in *bilin*, these values were 0.802, 1.054 and 9.601 ppm respectively. Visible indices of ripening were first showed by banana exposed to *keppetiya: bilin* (1:1) 15% (w/w) on day two whereas the control sample exhibited these indices on day four. In conclusion, banana exposed to *keppetiya: bilin* (1:1) 15% (w/w) was selected as the best treatment and it had a TSS, TA and firmness of $24.3 \pm 2.0\%$, $1.98 \pm 0.1\%$ and $7.64 \pm 2.6N$ respectively while the control samples had TSS,TA and firmness of $18.5 \pm 2.0\%$, $1.65 \pm 0.1\%$ and $10.58 \pm 2.6N$ respectively.

Keywords: Biomaterials, Ethylene, Gas chromatography

EFFECT OF EXOPOLYSACCHARIDE PRODUCING CULTURES ON COW AND GOAT MILK PROBIOTIC SET YOGHURT

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Goat milk yoghurt has a weaker body and poor textural properties compared with cow milk yoghurt which is due to lack of α_{s1} -casein fraction. This study was conducted to evaluate the effect of exopolysaccharide (EPS) producing cultures on physicochemical, microbiological and sensory characteristics of goat milk (GM) probiotic plain set yoghurt. Probiotic yoghurts were produced with *Bifidobacterium bifidum*-BB12 and one of the high EPS producing yoghurt starters (YF-L903), medium EPS producing yoghurt starters (YC-X11) or commercial starters (STI-12). All three types of yoghurt starters were consisted of *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus* strains. Similarly, set type plain cow milk (CM) yoghurts were prepared to compare microbiological and physicochemical quality of plain GM set yoghurts during (4°C) refrigerated storage for 28 days. pH, titratable acidity, syneresis, probiotic viability and organoleptic properties of yoghurts were evaluated during the storage period. Viscosity and EPS quantity of the prepared yoghurt were evaluated using freshly prepared samples. The high EPS producing YF-L903 led for higher viscosity in GM yoghurt (11500 ± 141 mPa. s) and CM yoghurt (40000 ± 300 mPa. s), while the lowest viscosity values were recorded for yoghurt prepared using the commercial starter culture. YF-L903 resulted the highest EPS production in CM yoghurt (177 ± 11 mgkg⁻¹) and GM yoghurt (118 ± 17 mgkg⁻¹). No significant differences ($p > 0.05$) were observed in count of probiotic micro-organisms among treatments. The final cell concentrations of yoghurt bacteria and *B. bifidum* did not show a significant difference among treatments. CM yoghurt prepared using the medium EPS producing YC-X11 and GM yoghurt with high EPS producing YF-L903 were highly accepted by the consumers. The EPS producing cultures improved overall physical, organoleptic attributes and microbial properties of the goat milk set yoghurt.

Keywords: α_{s1} Casein, Exopolysaccharide, Goat milk, Storage, Viscosity

EVALUATION OF DAWUL KURUNDU LEAF MUCILAGE AS A WAX COATING TO EXTEND THE POSTHARVEST LIFE OF LIME

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The researchers are currently interested in developing waxes from natural compounds of biological origin. The highly viscous leaf mucilage of *Dawul kurundu* (*Neolitsea cassia* L.) was investigated to be used as a wax coating to enhance the postharvest life of lime (*Citrus aurantifolia* L.). *Dawul kurundu* leaves were collected, chopped, crushed and mucilage was extracted with distill water. Lime at correct maturity stage (weight 23.6 ± 2.3 g, Total Soluble Solid (TSS) $8.0 \pm 0.0\%$, Titratable Acidity (TA) $6.90 \pm 0.03\%$ were harvested and divided into 4 lots each containing 30 fruits. Two lots were dipped in prepared wax formulation for 30 seconds. Other two lots were kept without waxing (control). Both treated and control groups were packed in perforated low density polyethylene bags and stored in cold room (8°C and 85%) and under ambient conditions (26°C and 68%). Data on peel color, firmness, TSS, TA, juice pH, Physiological Weight Loss (PWL) were collected at 7 and 4 day intervals for the fruit stored in cold room and ambient conditions, respectively. Firmness, TA and PWL of waxed limes under ambient conditions were 2.37 ± 0.06 kg, $7.06 \pm 0.15\%$ and $17.7 \pm 1.9\%$ respectively and showed a marketable life of 32 days. The control samples showed significantly ($p < 0.05$) lower firmness (2.13 ± 0.06 kg), and TA ($6.53 \pm 0.06\%$) and higher PWL ($29.5 \pm 3.9\%$) thus exhibited a marketable life of 24 days. When fruit were stored at cold room, firmness and TA of treated fruit increased by 0.4% and by 1.6% while PWL was reduced by 12% in contrast to control group. Hence, under cold room, the marketable life was extended up to 63 days in contrast to its un-waxed counterpart where marketable life was 42 days. In conclusion, *Neolitsea cassia* leaf mucilage show promising effect on developing as a wax coating.

Keywords: Firmness, Fruit quality, Storage

EFFECT OF FRUIT PROCESSING WASTE ON PHYSICOCHEMICAL, MICROBIOLOGICAL AND SENSORY PROPERTIES OF PROBIOTIC SET YOGHURT

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The viability of probiotic organisms is important to obtain the expected health benefits from probiotic yoghurt. Therefore, a study was conducted to enhance the viability of probiotic organisms in set yoghurt by incorporating fruit processing waste powder at the rate of 0.2% (w/v). Pomegranate peel powder (PPP), mango peel powder (MPP) and pineapple core powder (PCP) were incorporated into yoghurt and samples were stored at 4°C for 21 d. The viability of yoghurt bacteria and probiotic culture (*Bifidobacterium animalis* subsp. *lactis* - BB12), pH, titratable acidity and syneresis of samples were evaluated on 1st, 7th, 14th, and 21st days. Proximate analysis of both fruit processing waste powders and yoghurt samples, sensory attributes and viscosity of yoghurts were evaluated initially. There was a significant difference ($p < 0.05$) in crude fat, fibre and protein content among all fruit processing waste powders whereas PPP recorded the highest values for all the parameters. There was a significant reduction in pH of all the treatments and increase in titratable acidity during the storage period. The highest viscosity was recorded in the yoghurt with PCP, while the lowest was observed in yoghurt with PPP. The syneresis of all treatments increased during the storage period and the highest syneresis was observed in the yoghurt without adding fruit processing waste, while the lowest was recorded in yoghurt with PPP. A significant increase in probiotic viability was observed in the yoghurt with PCP, whereas probiotic count reduced in PPP incorporated yoghurt during the storage. Sensory data showed that PCP incorporated yoghurt leads for higher rank of appearance, odour, colour and overall acceptability. The yoghurt without adding fruit processing waste showed the highest rank for texture and taste. This study revealed that PCP exhibited prebiotic properties and it could be used as an ingredient in manufacturing probiotic yoghurt.

Keywords: Prebiotic, Storage period, Viability, Yoghurt

DEVELOPMENT OF A RANGE OF INSTANT LATTE INCLUDING MATCHA AND FUNCTIONAL HERBAL INGREDIENTS

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Powder form of green tea called *Matcha* has significant health benefits, but it is not popular across the world except Japan due to its bitterness. Hence, a study was conducted to develop a range of instant *latte*, which is a popular beverage made by steamed milk, using *Matcha*. Five different instant *lattes* were produced as follows; product 1 (ginger and cocoa powder), product 2 (ginger powder and orange grapefruit flavor), product 3 (moringa powder, coconut and mango flavor), product 4 (turmeric, pepper powder and coconut flavor) and product 5 (cinnamon, ginger, cardamom powder and chai flavor). A sensory evaluation was undertaken with 6 trained panelists to select the best three products out of the above five. The highest ($p < 0.05$) overall acceptability was recorded for products 1, 3 and 5. Thus they were subjected to analysis of physico-chemical properties, caffeine content, antioxidant activities and total polyphenol content. The products were also evaluated for microbiological count and sensory properties during storage under refrigerated (4°C), room temperature (32°C) and accelerated conditions (in incubator at 37°C) for 12 weeks to determine the shelf life. There were no significant differences ($p > 0.05$) in relation to sensory properties of each product during the three month storage period. Antioxidant activities of selected three products were 131.50 ± 0.75 , 123.29 ± 1.95 and 201.20 ± 2.10 mg/100 ml of Gallic acid equivalents and the total polyphenol contents were 311.86 ± 4.18 , 248.97 ± 10.05 and 290.12 ± 3.10 mg /100 ml of gallic acid equivalents. Total plate count, yeast and mold, coliform and *E.coli* counts were within the specifications of tea and herbal infusions as per the European guidelines. In accelerated condition, one week is expressed as one month, hence three products have one year shelf life. In conclusion, the products 1, 3 and 5 could be used as instant *lattes* with desired chemical, microbiological and sensory properties.

Keywords: Green tea, Health properties, Sensory evaluation, Shelf life

DEVELOPMENT AND QUALITY EVALUATION OF JACKFRUIT INCORPORATED FROZEN YOGHURT

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Frozen yoghurt can be regarded as a healthy and unique dessert having properties of both yoghurt and ice cream. The health benefits of frozen yoghurt can be improved by incorporating different fruit pulps. The objective of this study was to develop and evaluate frozen yoghurt with jackfruit (*Artocarpus heterophyllus*). Three frozen yoghurts were developed using 10, 15, and 20% of jack fruit pulp (w/w) and plain frozen yoghurt was used as the control. They were evaluated for colour, aroma, texture, taste, meltability, and overall acceptability using nine-point hedonic scale. Then the developed yoghurt formulations along with the control were analysed for moisture, protein, fat, fibre, ash, and total solids content. Shelf-life was tested by measuring the titratable acidity (TA), pH, coliform, yeast and mould, and total plate count during six weeks of storage at -20°C. The yoghurt formulation containing 15% of jackfruit pulp received the highest scores for all the sensory properties tested and it was recorded as the best in overall acceptability. The proximate composition of this formulation was 69.13 ± 1.12% moisture, 5.84 ± 0.12% protein, 3.59 ± 0.39% fat, 9.83 ± 0.98% fibre, 2.55 ± 0.26% ash, and 30.87 ± 1.12% total solids. Moreover, incorporation of 15% jackfruit pulp significantly improved the protein, fibre, and ash content while significantly lowered the fat content of the frozen yoghurt ($p < 0.05$). Gradual increase in total plate count and TA while decreased pH during the storage showed potential growth of microorganisms in the yoghurts. However, total plate count of the jackfruit pulp incorporated frozen yoghurts was less than that of the control and yeast and mould and coliform were not detected. Therefore, it can be concluded that physicochemical, microbiological, and sensory properties of frozen yoghurt improved significantly by adding jackfruit pulp at rate of 15% hence, it can be introduced as a value added healthy dairy product.

Keywords: Frozen yoghurt, Jackfruit, Quality evaluation

**PHYSICOCHEMICAL, MICROBIOLOGICAL AND SENSORY
PROPERTIES OF PROBIOTIC YOGHURT SUPPLEMENTED WITH
INULIN FROM LOCAL YAMS**

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Prebiotics supplemented dairy products are popular among consumers around the world. Inulin is a common ingredient used in food industry as a prebiotic and fat replacer. In this study, inulin was extracted from different local yams namely, *hingurala* (*Dioscoreaalata* L.), *rajaala* (*Dioscoreaalata* L.), *raasavalli* (*Dioscorea alata* L.) and *Jaffnainiala* (*Dioscorea alata* L.) using hot water extraction method and the inulin content was quantified using alcoholic extraction method. The effects of incorporation of extracted inulin at level 0.2% (w/v) on physicochemical, microbiological and sensory properties of yoghurt were investigated with the commercial inulin prepared of same concentration (control). Proximate analysis and viscosity measurement were carried out using freshly prepared yoghurts. Sensory evaluation was done with untrained panellists using a five-point hedonic scale. Counts of yoghurt bacteria and probiotic bacteria, titratable acidity and pH were measured weekly for 28 days. Results revealed that protein, ash, moisture, fat and fibre contents were not significantly different ($p>0.05$) among treatments. Viscosity of the yoghurts were significantly different ($p<0.05$) among treatments. The highest viscosity was recorded in yoghurt containing inulin extracted from *hingurala*, while the yoghurt containing inulin extracted from *rasavalli* showed the lowest viscosity. Microbial count and pH of all treatments were gradually decreased with time and titratable acidity increased with the storage time. Sensory analysis revealed that the yogurt supplemented with inulin extracted from *hingurala* was with the best sensory properties including appearance, texture and overall acceptability. In conclusion, inulin extracted from *hingurala* can be used as a prebiotic in fermented dairy products such as probiotic yoghurt with enhanced physicochemical, microbiological and sensory properties.

Keywords: Dairy products, Prebiotic, Probiotic

SESSION 07



AGRICULTURAL BIOLOGY



EFFECT OF FLOWER BORDER ON NATURAL ENEMY POPULATION IN MUNG BEAN CULTIVATION

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Habitat manipulation is an effective option to conserve beneficial insects within agricultural landscape by providing resources such as nectar and shelter. However, there is lack of information on these ecological techniques under local conditions. Therefore, this study was conducted to assess the effect of flower border on abundance of insect fauna in mung bean ecosystem. Eight mung bean plots (var-MI 06, 5 x 6 m) were arranged in RCBD design with four replicates. Four of which were surrounded with flower borders (FB) using *Atapethiya* (*Tagitus lemmoni*) and *Zinnia* (*Zinnia elegans*), while the others were kept without flower border (WFB). All the plots were maintained without pesticides. Insects were sampled at one-week intervals by sweep-netting. The captures were identified up to families and their abundance and diversity were analyzed by Poisson regression generalized linear model and Shannon diversity index. A total of 3192 insects were collected during the study, belonging to 62 families including pests (34%), natural enemies (32%) and neutral insects (33%). Families Braconidae (40%) and Chrysomelidae (35%) were the dominating groups. Species diversity was higher in plots WFB ($H' = 1.36$) compared to the plots with FB ($H' = 1.29$). Insect pest abundance was significantly higher ($P < 0.001$) in the plots WFB, whereas, the natural enemy abundance was significantly higher ($P < 0.001$) in the plots with FB. Further, population of natural enemies was higher than the population of pests in plots with FB and similar pattern was found over time. However, the population of pests was higher than natural enemies in plots WFB. The average yield with FB ($176.88 \pm 9.27 \text{ gm}^{-2}$) was significantly higher ($P < 0.01$) compared to the yield in field WFB ($143.13 \pm 23.08 \text{ gm}^{-2}$) probably due to the influence of natural enemies. It is concluded that, flower borders around mung bean plots can be effectively used to enhance natural enemy population in agro-ecosystems.

Keywords: Flower border, Habitat manipulation, Insect pests, Natural enemies

FEASIBILITY OF BIOLOGICAL CONTROL OF MITE PESTS USING LOCALLY AVAILABLE PREDATORY SPECIES

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Mite infestation has been a major problem in a wide range of crops grown in Sri Lanka and their population management relies on using acaricides. Biocontrol may be an effective alternate strategy especially using predators. However, only limited information are available on mite predators in local conditions. Therefore, this study was carried out to identify locally available mite predators in selected home gardens in Kandy and Anuradhapura districts and to study the feeding potential and biology of the selected predators. Three predators, *Oligota minuta* (Coleoptera: Staphylinidae), *Stethorus punctum* and *Stethorus tridens* (Coleoptera: Coccinellidae) were identified, while the latter was comparatively uncommon. Feeding rate of *O. minuta* was significantly higher ($P < 0.001$ Odds ratio = 0.439; 0.400, 0.482) than *S. punctum*, therefore, the feeding rates of other growth stages and the life cycle of *O. minuta* was studied using red spider mite as the prey at laboratory condition (25°C). The adult *O. minuta* consumed eggs and nymphs of mites, 153 ± 20.85 , 73.55 ± 14.95 per day respectively. The first, second and third larval instars consumed 16.13 ± 5.9 , 44.47 ± 15.9 , and 115.7 ± 24.9 of eggs and 12.13 ± 5.55 , 26.87 ± 9.12 and 75.1 ± 18.22 nymphs respectively during their each instar period. Feeding rate of the adult *O. minuta* was significantly higher ($P < 0.001$ Odds ratio = 4.489; 3.927, 5.131) than other stages and it was followed by third instars. The egg incubation period of *O. minuta* was 2.4 ± 0.5 days and the neonate larvae were active and light yellow in colour. The duration of the first, second and third larval instars of *O. minuta* were 2.4 ± 0.5 , 2.5 ± 0.5 , 3.4 ± 0.5 days, respectively. The average pupal period was 4.8 ± 0.9 and adult lifespan was 19.7 ± 2.1 days. Therefore, it can be concluded that the adult and third instars of *O. minuta* play an important role as an effective predator in controlling red spider mites.

Keywords: Biological control, Feeding potential, Mite predator, *Oligota minuta*, *Stethorus punctum*

DEVELOPMENT OF A PROTOCOL FOR ROOT INDUCTION USING IN-VITRO RAISED APPLE SHOOTS

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Unavailability of true to type planting material is a major barrier to promote cultivation of apple (*Malus pumila*) in Sri Lanka. Plant tissue culture plays a vital role to overcome this problem. Mass propagation of apple through micro-propagation has already been initiated and a protocol has been developed for seed germination and multiplication. Therefore, this research only aimed to develop a root induction protocol via *in-vitro* raised apple shoots using suitable plant tissue culture media for successful production of planting materials. Five replicates consisting two levels as full and half strength MS media and six levels of Indole Butric Acid (IBA) concentrations (0, 1, 2, 3, 4, 5 mgL⁻¹) were tested at 26°C under fluorescent light. The experiment was conducted as a two factor factorial with Complete Randomized Design (CRD). Average numbers of roots per plant and average length of main roots in rooting media were recorded. The combined effect of the levels of MS media and IBA concentration was significant for number of roots per plant ($p < 0.05$). However, it was not significant for length of roots ($p > 0.05$). At the end of 10th week, the highest average number of roots (3.52) per plant was observed in half strength MS + 2 mgL⁻¹ IBA medium followed by half strength MS + 1 mgL⁻¹ IBA (3.26). The longest average root length (9.51 cm) was observed in rooting medium with full strength MS + 2 mgL⁻¹ IBA. Considering results of the two parameters measured, half strength MS was the best rooting medium (mean 4.84) while IBA 2 mgL⁻¹ (mean 7.46) was the best hormone concentration for highest number of roots per plant for apple.

Keywords: Indole Butric Acid, Micro propagation, Root induction of apple

**EFFECTS OF SPINOSAD ON THE HEAT TOLERANCE OF
Tribolium castaneum AND *Sitophilus oryzae***

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Tribolium castaneum and *Sitophilus oryzae* are serious pests of stored products. Exposure to high or low temperatures is effective in controlling them but expensive. Spinosad, derived from the bacterium *Saccharopolyspora spinosa*, is an effective insecticide but has not been tested with high or low temperatures. This study evaluated whether spinosad affects heat tolerance and heat acclimation of *T. castaneum* and *S. oryzae*. Adults of *T. castaneum* and *S. oryzae* were exposed to 25 ppm (label rate) of spinosad or water (control), acclimated at 35°C for 6 hours, 40°C for 3 hours, and finally held at 45°C for 0, 6, 9, 12, 15, 18, 24 or 30 hours for *T. castaneum* and 0, 6, 8 or 12 hours for *S. oryzae*. The mortality of adults at different durations was recorded and LT_{50} values (duration to kill 50% of population) were calculated. In *T. castaneum* unacclimated adults, LT_{50} was 15.9 hours in 0 ppm and 14.6 hours in 25 ppm. In heat-acclimated *T. castaneum* adults LT_{50} was 21.4 hours and 18.6 hours when exposed to 0 ppm and 25 ppm, respectively. In unacclimated *S. oryzae* adults exposed to 0 ppm, LT_{50} was 6.7 hours, which was increased to 8.2 hours following acclimation. Exposure to spinosad before heat exposure reduced the heat tolerance of *T. castaneum* and *S. oryzae*. Acclimation at intermediate temperatures 35°C and 40°C increased the heat tolerance of both *S. oryzae* and *T. castaneum* adults. More work is needed to determine the effect of spinosad on the heat tolerance and heat acclimation of other stored-product insect species.

Keywords: Heat acclimation, Heat tolerance, LT_{50} , Spinosad, Stored-product insects

DESIGNING, FABRICATION AND EVALUATION OF A PHEROMONE TRAP FOR *Tribolium castaneum* ADULTS

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The red flour beetle, *Tribolium castaneum*, is a serious cosmopolitan pest of stored-products. The traps baited with the synthetic form of its aggregation pheromone 4,8-dimethyldecanal and food-based kairomone are effective in the detection of *T. castaneum* adults, but the efficiency is low. These traps have natural convection of air. However, it has been found that the air flow significantly affects the trapping efficiency of *T. castaneum* adults. Hence, this research was conducted to design, fabricate and evaluate new monitoring traps having forced air convection. Three triangular-shaped traps, a square-shaped trap and a hexagonal-shaped trap having an exhaust fan driven by a motor at the center were prepared using abrasive papers. The efficiencies of the traps having either the pheromone only or both pheromone and kairomone were compared with that of the commercial Dome trap by releasing 200 *T. castaneum* adults inside a 60 cm circle on a cement floor. Trapping percentage significantly differed among the different designs ($p=0.001$) ($p=0.001$) when tested with either the pheromone alone or both pheromone and kairomone. All the five traps designed had higher significant trapping percentages than the commercial Dome trap. Triangular trap with “the pheromone above and kairomone below” had the highest significant trapping percentage and was approximately four times the trapping efficiency of Dome trap. The same triangular-shaped trap ($p=0.0029$), Dome trap ($p=0.0023$) and square-shaped trap ($p=0.0041$) had significantly higher trapping percentages with pheromone+kairomone than the pheromone alone. The triangular trap with the pheromone above and kairomone below can effectively be used for the detection of *T. castaneum* adults. This study reveals that the trapping efficiency of *T. castaneum* adults varies with the trap design, and is increased when the trap has an exhaust fan inside.

Keywords: Exhaust fan, Pheromone trap, Trap designs, Triangular trap

**DEVELOPMENT OF FOOD MEDIUM FOR REARING *Ephestia cautella*
AND *Corcyra cephalonica* USING LOCALLY AVAILABLE FOOD
MATERIALS**

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Ephestia cautella and *Corcyra cephalonica* are economically-important stored-product pests. Mass culturing is a requirement to have them in sufficient numbers to be used in experiments. While the diet has a direct influence on the development and performance of the larvae and emerging moths, there are limitations associated with the currently used rearing media. The aim of this research was to develop a suitable rearing medium for *E. cautella* and *C. cephalonica* using locally available food materials at the market. The ingredients used were red rice, dog feed, broiler starter and rice flakes in the crushed form; dried grapes, dates, ground nut and soy bean in ground form; and rolled oats and wheat flour. Some of these ingredients were incorporated with honey and glycerol. Ingredients were tested in ten different combinations for *E. cautella* and eleven combinations for *C. cephalonica*. Sixteen fertile eggs of a particular species were introduced into each replicate medium and allowed for incubation. The larvae were weighed 17 and 21 days following egg introduction, and emergence of pupae and adults were also recorded. Weight gained in larvae and emergence rate of adults differed across the media tested. Media comprised of honey and glycerol reported significantly higher levels of weight gain and adult emergence. The highest weight gain in larvae of *E. cautella* and *C. cephalonica* was observed with dog feed, rice flakes, rice flour at 1:1:2 which incorporated honey and glycerol at 1:1 while the highest adult emergence of *E. cautella* was observed in the media comprised of 100% red rice which incorporated honey and glycerol at 1:1 ($p < 0.05$). This study reveals that the development of *E. cautella* and *C. cephalonica* varies with the food medium, and honey-glycerol combination enhances the development of these two species.

Keywords: *Corcyra cephalonica*, Dog feed, *Ephestia cautella*, Honey, Rearing media

SESSION 08



CROP SCIENCE



EVALUATION OF COCONUT BASED GLIRICIDIA, WILD SUNFLOWER AGROFORESTRY SYSTEMS TO IMPROVE ITS SOIL PROPERTIES IN A WET ZONE COCONUT PLANTATION

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Aim of this study was to evaluate the potential of using Coconut based *Gliricidia* (*Gliricidia sepium*) and Wild sunflower (*T. diversifolia*) agroforestry systems, to improve soil fertility of degraded lands in the low country wet zone and to demonstrate the potential such approaches for increasing the land productivity to meet the increasing demand for coconut in the future. Study location was Ketakalapitiya estate of Kurunegala plantations, which belongs to Boralu soil series in the low country wet zone (WL₃). *G. sepium* and *T. diversifolia* loppings were added to the manure circle of the coconut palms under the supervision of the Coconut Research Institute of Sri Lanka. The experiment was conducted in a randomised complete block design with four treatments and three replicates. Treatments were Coconut based agroforestry system with *G. sepium*, with *T. diversifolia*, with both species and sole Coconut. Soils from two depths, 0 – 15 cm (topsoil), 15 – 30 cm (subsoil), and two locations, from manure circle and coconut square were analysed for chemical, physical and biological properties. Results showed a significant ($p < 0.05$) accumulation of soil organic matter in agroforestry systems *G. sepium*, *T. diversifolia* and both, and it was localised to manure circle. Manure circle was significantly ($p < 0.05$) rich in total nitrogen in systems intercropped with *G. sepium* compared to the rest. Available Phosphorous content was the highest in the manure circle of the system intercropped with *G. sepium*. *T. diversifolia* showed the highest exchangeable potassium, nonetheless limited to the manure circle. Soil microbial activity was significantly high in *G. sepium*, and *T. diversifolia* intercropped fields within the manure circle. This study confirms that addition of *G. sepium* or *T. diversifolia* loppings to the manure circle of coconut fields replenish soil fertility of degraded coconut growing soils in the low country wet zone of Sri Lanka.

Keywords: Coconut, *Gliricidia sepium*, Low country wet zone, *Tithonia diversifolia*

EX-VITRO ROOTING MEDIUM FOR IN-VITRO PROPAGATED SHOOTS OF TEA

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The study was carried out to develop an efficient *ex vitro* rooting medium for *in vitro* propagated shoots of tea (*Camellia sinensis* (L). O. Kuntze). Micro-shoots derived from the third sub-culture of cotyledon cultures of TRI 2043 cultivar were used as planting materials. Effect of five different rooting media were tested and those were 7C jiffy pellet (T1), coir dust: sand (1:1) (T2), coir dust (T3), coir dust: sand: soil (1: 1: 1) (T4) and refuse tea (T5). Micro-shoots were treated with IBA 50 mgL⁻¹ pulse treatment for 3 hrs before introducing into plastic trays with different rooting substrates. Rooting performance was evaluated after 10 weeks by measuring survival rate of micro-shoots, root initiation, mean number of roots per plant and mean root length. Mean values were analyzed using ANOVA and results showed no significant difference ($p > 0.05$) on mean number of roots per plant and mean root length among five different rooting media. The highest mean number of roots (21) per plant was observed in T3 medium. The highest mean root length of 2.96 cm was observed in the T2 medium. When considering physical properties *viz* bulk density, moisture, C: N ratio and chemical properties *viz* pH, EC of five different media, T4 medium showed the highest value in the preferable range. After six weeks of establishment, root initiation was 100% in T2, T3, and T4 media. Ten weeks after planting, survival percentages varied between 55-75% and the highest survival percentage of 75% was recorded in T4 medium. Material cost of T1, T2, T3, T4 and T5 media for rooting of 1000 micro-shoots were LKR 5000.00, 95, 90.00, 100.00 and 228.00, respectively. It is conclude that, T2 and T4 media could be selected as an optimum media for *ex vitro* rooting of tea micro-shoots.

Keywords: Micro propagation, Pulse treatment, Refuse tea, Root initiation and elongation.

FATE OF ENGINEERED NANOPARTICLES IN DIFFERENT SOILS OF SRI LANKA

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Nanotechnology has been a hype in recent sciences leading to mass production and the inevitable release of diverse engineered nanoparticles (ENPs) into the environment. As a result, agricultural soils are gradually becoming a primary sink for ENPs with diverse applications. The fate of ENPs may be different from the generalised hypothesis, due to inherent heterogeneity of Sri Lankan soils. This study was steered to uncover the still not known behaviour of ENPs in dominant agricultural soils of Sri Lanka. Titanium Dioxide (TiO₂) was the selected ENP, as it shows a wide range of applications. Paddy grown Low Humic Gley (LHG) and Reddish Brown Earth (RBE) soils were treated with 10 ppm of TiO₂, after amending with municipal solid waste compost. The behaviour of TiO₂ was tested for leaching and colloidal absorbance using a leaching column and an incubation study, with and without organic matter (OM). Results from the ICP-MS revealed that leaching of TiO₂ from RBE was 0.04%, compared to 0.4% from LHG after the first week. No significant difference ($p > 0.05$) was observed with the presence of OM in RBE, while the leaching was 0.2% in LHG. The cumulative TiO₂ leaching was 0.14% in RBE and 0.62% in LHG with the absences of OM, after the third week. No significant variations ($p > 0.05$) either in pH or EC were observed in the incubated soils and the leachate from both RBE and LHG with added TiO₂. The incubation study showed that TiO₂ tends to reduce organic carbon percentage of LHG with the absence of OM. organic carbon % of RBE was not changed with TiO₂. The active carbon content of both soils did not show a substantial variation with TiO₂. Added TiO₂ resulted a reduction in potentially mineralisable nitrogen in the absence of OM, in both soils, at two months after incubation. This study concluded that TiO₂ might potentially immobilise in RBE soils than in LHG, yet OM has more potential in immobilising. Colloidal absorbance via CEC sites would result long-term retention of TiO₂ and may amplify in trophic levels too.

Keywords: Engineered nanoparticles, Incubation study, Leaching column study, Titanium dioxide

STEM CUTTINGS OF DIFFERENT MATURITY CLASSES OF TOMATO: A VIABLE OPTION FOR SEEDLINGS

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Tomato (*Solanum lycopersicum* L.) is an important vegetable crop for the farmers in Sri Lanka. The majority of tomato farmers rely mainly on seeds for cultivation. Propagation through stem cuttings provides a viable option to address the seed related issues such as genetic variations, poor quality, and high cost. This study was conducted during 2018 *Yala* season, to identify the suitability of stem cuttings as a propagation material. Stem cuttings of different maturity classes *viz*; softwood, semi-hardwood and hardwood of tomato variety *Thilina*, and three F1 hybrids, *Padma*, *Ceres*, and *Big beef* were evaluated for growth and yield, in a Completely Randomized Design (CRD), under protected conditions, in Hayleys Agro Farms (Pvt). Ltd, Divithotawela. Effect of variety, maturity class, and variety and maturity class interaction were not significant ($p > 0.05$) at nursery stage for root length, root dry weight and shoot dry weight of plants originated from cuttings. Days to flower initiation and tomato yield did not show significant differences. Hence, all three maturity classes of stem cuttings of tested varieties can be used to propagate tomato. Flowering was hastened by five days (24 days \pm 0.41) in variety *Thilina* which originated by cuttings compared to the plants of the same variety raised by seeds (28.67 days \pm 0.67). Moreover, the yield of 2.2 kg/plant \pm 0.22 in plants raised by cuttings was not significantly different from the yield of 2.17 kg/plant \pm 0.14 in plants raised by seeds. Use of stem cuttings as a propagation material reduced the production cost by 12% compared to a crop raised by seedlings. In conclusion, in place of seeds, stem cuttings of any maturity class can be used to propagate tomato with no significant effect on fruit yield.

Keywords: Maturity class, Propagation, Stem cutting, Tomato

**COMPARISON OF PERFORMANCE OF COMMON BEAN VARIETIES
FOR VEGETABLE AND SEED PRODUCTION
IN THE UP-COUNTRY INTERMEDIATE ZONE OF SRI LANKA**

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Bean (*Phaseolus vulgaris* L.) is an important vegetable crop grown in some of the agro-ecological regions of the country to produce green vegetable and seeds. The agronomic and economic implications related to growing bean crop for vegetables and seed are not well documented. Therefore, present study was conducted at the Agriculture Research Station, Rahangala (IU_{3d}) during 2018 *Yala* season, to evaluate the performance of different pole bean and bush bean varieties grown for vegetable and seed production under Up-country Intermediate Zone (UCIZ) conditions. Study was carried out in a Randomized Complete Block Design (RCBD) with three replicates. Pole bean varieties, *viz.* Cora- black (CB), Capri (CP) and Bandarawela green (BWG) and bush bean varieties, *viz.* Sanjaya (SJ) and Top crop (TC) were tested. Phenological data had no significant difference ($p < 0.05$) for both pole and bush bean varieties. Among pole bean varieties, CP recorded the highest fresh pod yield ($11.7 \pm 0.726 \text{ tha}^{-1}$), number of pods per plant and individual fresh pod weight and they were not significantly different with BWG. CP recorded the highest pod length ($18.6 \pm 0.156 \text{ cm}$) and BWG recorded the highest pod girth ($4.0 \pm 0.013 \text{ cm}$). Bush bean varieties were not significantly different in fresh pod yield, seed yield and quality related parameters. Marketable seed yield was significant among varieties and the highest values were recorded in CP ($1.32 \pm 0.042 \text{ tha}^{-1}$) and TC ($0.96 \pm 0.006 \text{ tha}^{-1}$). In conclusion, CP and BWG varieties of pole bean and SJ and TC varieties of bush bean are the best varieties for green pod production under UCIZ conditions. Moreover, CP and TC are the best varieties for seed production in pole bean and bush bean respectively. According to the cost analysis, seed production in the pole bean was more profitable (54%) than in the bush bean.

Keywords: Bush bean, Marketable seed yield, Pole bean, Seed production, Vegetable production

EFFECT OF FOLIAR NUTRIENTS APPLICATION ON GROWTH AND YIELD OF COWPEA

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Recently, application of foliar nutrients has been a common practice among pulse farmers for exploiting greater yields. Despite not having a recommendation for short-season legumes, farmers are using foliar nutrients in different forms even without knowing the effectiveness. A field experiment was conducted to assess the effectiveness of commonly used foliar nutrient applications on growth and yield of cowpea (*Vigna unguiculata* (L.) Walp.) with four supplementary inorganic fertilisers. The experiment was conducted at the Field Crop Research and Development Institute, Mahailuppallama (DL_{1B}), during April – July (*Yala*), in 2018. The field experiment was arranged in a randomised complete block design with ten treatments in three blocks. Foliar nutrients; KNO₃ 5 gL⁻¹ and 7.5 gL⁻¹, Ca(NO₃)₂ 4.1 gL⁻¹ and 6.06 gL⁻¹, Albert solution 1 gL⁻¹ and 2 gL⁻¹, Urea 2.5 gL⁻¹ and 5 gL⁻¹ were coupled with basal nutrient and ratios of recommendation. The two control treatments were sole water spray with basal dressing and zero fertilisers. Foliar nutrient mixtures applied three weeks after planting and after the first harvest. Dry matter production and yield was observed at 50% flowering and harvesting. SPAD readings and leaf area index at 50% flowering stage was insignificant ($p < 0.05$) for all treatments. Total root length in KNO₃ 7.5 gL⁻¹ treated was significantly lower compared to the treatments with sole water with basal and urea 5 gL⁻¹ sprayed treatments, while other treatments were similar with the highest and lowest. Total plant N uptake at 50% flowering was significantly higher in Albert solution 2 gL⁻¹ treated plants and quantitatively it was 19.4 gkg⁻¹. The final yield of KNO₃ 7.5 gL⁻¹ treated plants was significantly higher compared to Urea 2.5 gL⁻¹ and Albert solution 2 gL⁻¹ treated plants. Highest seed yield was 3.12 tha⁻¹, whereas the lowest was 1.59 tha⁻¹, however, seed yield of the rest of the treatments remained insignificant to the highest and the lowest. Despite the highest performances of KNO₃ 7.5 gL⁻¹, rest of the foliar applications were similar ($p > 0.05$) indicating a low response to foliar nutrient application and adequacy of the current fertiliser recommendation for achieving higher yields from cowpea; probably for all short-season pulses too.

Keywords: Cowpea, Effectiveness, Foliar application

EFFECT OF MATURITY STAGE AND INDOLE BUTYRIC ACID CONCENTRATION ON PROPAGATION OF GUAVA THROUGH STEM CUTTING

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Guava (*Psidium guajava* L.) is a widely cultivated and nutritious fruit crop in Sri Lanka. Propagation of guava through stem cutting is an important option to maintain the quality of guava varieties. However, studies are limited in Sri Lanka on suitable type of the stem cutting and concentration of rooting hormone. Therefore, two factor factorial experiment was conducted to evaluate the performance of softwood and semi-hardwood guava cuttings on rooting at three concentrations of Indole Butyric Acid (IBA), 0 ppm, 1500 ppm and 3000 ppm. Treated cuttings were maintained in a mass propagator in a completely randomized design with three replicates. Survival percentage at two months of propagator period and root and shoot growth characters by destructive sampling at 3.5 months was recorded. There was no interaction ($p > 0.05$) between type of cutting and concentration of the rooting hormone on tested parameters. Survival percentage of the cuttings at 2 months was significantly differed ($p < 0.05$) by the type of stem cutting and the highest value showed in semi-hardwood (88.73%) followed by softwood cuttings (73.01%). However, there was no significant variation in survival due to IBA concentration. Shoot growth characters had no significant difference on type of cutting. The highest leaf number (8.59 ± 1.75), shoot number (2.26 ± 0.82) and shoot length increment (8.0 ± 0.73 cm) were observed in the cuttings treated with 3000 ppm IBA followed by 1500 ppm IBA and the lowest was in 0 ppm. The enhancement of root dry weight in 3000 ppm IBA by 61% and 163% compared to 1500 ppm IBA and 0 ppm IBA, respectively was significant. In conclusion, guava can be propagated using either softwood or semi-hardwood cuttings with 3000 ppm IBA concentration.

Keywords: Guava, Indole butyric acid, Propagation, Semi-hardwood, Softwood

EVALUATING NEW TREE SPECIES FOR THEIR POTENTIAL AS SHADE TREES IN TEA PLANTATIONS

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Tea (*Camellia sinensis* (L). O. Kuntze) is a shade loving plant. It has become mandatory to have proper shade in tea plantations to reduce the deleterious impacts of climate change. *Albizia moluccana* is the only recommended high-shade species currently available in low-grown tea in Sri Lanka. Due to the unpopularity of *A. moluccana*, yield loss and death of tea plants were reported in the recent past in the absence of shade. Thus, studies on alternate shade trees for tea plantations are warranted. A preliminary experiment was conducted at Haupe Estate, Kahawatte, in the low country of Sri Lanka to compare the early-stage physiological, microclimatic, soil and yield parameters of tea, under potential new high-shade species, *Cassia nodosa* and *Derris microphylla* grown under three spacings 6x6, 6x9, 9x9 m (six systems) with *Albizia moluccana* grown under 6x6 m spacing (recommended system). The experiment was carried out as a randomized complete block design, with seven treatments. There were no spacing by species interaction identified for all the measured parameters ($p > 0.05$), indicating the two alternative species had similar effects independent of their spacing. Similarly, when the six alternative systems (species x spacing) were compared with the recommended system (*A. Moluccana* 6x6), there were no effects identified ($p > 0.05$) for all the parameters measured. Therefore, *D. microphylla* and *C. nodosa* species are equally good at providing the ecological services provided by *A. moluccana* as high-shade in tea plantations irrespective of the spacings utilized. However, it is too early to draw firm conclusion as most of the beneficial effects of shade are associated with adaptive responses which needs long-term repeated assessments.

Keywords: High-shade trees, Microclimatic parameters, Physiological parameters, Soil, Tea, Yield

DETERMINATION OF BEST POTTING MEDIA FOR *Livistona rotundifolia* TO MINIMIZE LEAF YELLOWING

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Livistona rotundifolia (Lam.) Mart. (*Arecaceae*) is an ornamentally important species used for landscaping and commonly marketed as a potted plant for outdoor decorations. *L. rotundifolia* is commonly known as queen palm, which has huge demand in foreign market, and derives higher profit in horticultural industry. However, research is hindered by lack of information on germination, seedling growth and management practices. Yellowing of leaf tips decrease the commercial value of the plant due to problems in present potting media. Potted plants in soil and sand free medium have higher commercial value in foreign market. Therefore, this research was conducted in Madawala zone of Mike Flora (Pvt) Ltd, Rumbukkana under net house conditions to find-out the most suitable, commercially viable media for *Livistona rotundifolia* potted plants. Hence, this study aimed at describing leaf yellowing of *L. Rotundifolia* potted plants in different potting medium with the age. Thirty-six treatments comprised 1, 3 and 12-month old coir dust as major potting medium, compost, cow dung and elephant dung as filling materials and full, half and zero concentrations of $\text{Ca}(\text{NO}_3)_2$ as supplement. The experiment was conducted as a three-factor factorial in complete randomized design with three replicates each. The effectiveness of those treatments was determined by measuring the yellowed leaf area, pH and EC of the media once a week. Results revealed that yellowing area of the leaf does not change significantly ($p < 0.05$) with the age of the coir dust and type of the filling material. But, yellowing area was significantly ($p < 0.05$) differ with the concentration of the $\text{Ca}(\text{NO}_3)_2$. There was no significant ($p < 0.05$) difference between 0.5 gL^{-1} and 1 gL^{-1} concentrations of $\text{Ca}(\text{NO}_3)_2$. However, 0.5 gL^{-1} concentration of $\text{Ca}(\text{NO}_3)_2$ maintained best EC range ($10\text{-}40 \text{ dSm}^{-1}$) that showed minimum leaf yellowing at any age (1-12 month) of coir dust with any of above filling material. Therefore, we can recommend *L. Rotundifolia* growers to add 0.5 gL^{-1} of $\text{Ca}(\text{NO}_3)_2$ to potting medium to minimize leaf yellowing.

Keywords: Calcium nitrate, Compost, Cow dung, Elephant dung, Potting media

PHYTOREMEDIATION OF PHOSPHATES AS A REMEDY FOR EUTROPHICATION

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Eutrophication is a globally concerned water quality impairment as a result of excessive nutrient discharge primarily by phosphorus/phosphates to waterbodies from agricultural and other anthropogenic origins. Beyond a threshold of $>0.03 \text{ mgL}^{-1}$ of phosphates, usage of such eutrophied waterbodies leads to severe health and environmental concerns to adjacent communities and ecosystems. Phytoremediation, a cost-effective plant-based approach, has been identified as sustainable and environmentally friendly remediation. The broad objective of the study was to assess the efficacy of locally available macrophytes for phosphate phytoremediation. From the preliminary study, *Eichhornia crassipes* (water hyacinth) and *Pistia stratiotes* L. (water lettuce) were selected as candidate macrophytes. The efficacy of the two selected macrophytes was tested in ambient atmospheric conditions, in a greenhouse using floating sieves. Phytoremediation efficacy in different contact times, introductory weights, pH values and initial phosphate concentrations were assessed. The phosphate sequestration ability of *E. crassipes* and *P. stratiotes* were estimated. A fresh weight of $250 \pm 5 \text{ g}$ of two macrophytes was introduced into to a 3 L of 25 mgL^{-1} of phosphate solutions, and after 48 hours of equilibrium time resulted phosphate removal efficiencies were 71.6% and 76.8% from *P. stratiotes*, *E. crassipes*, receptively. The most effective introduction biomass was 550 g for both *P. stratiotes* and *E. crassipes* with removal efficiencies of 77.1% 80.1%, respectively. Maximum removal efficiencies of 77.7% and 83.7% were observed for *P. stratiotes* and *E. crassipes* at pH of 7. *P. stratiotes* reached to its maximum removal efficiency of 88.2% in 25 mgL^{-1} , while in *E. crassipes*, highest uptake was 46.99 mgL^{-1} at 250 mgL^{-1} , despite the highest removal efficiency of 89.5% was at 25 mgL^{-1} . *P. stratiotes* and *E. crassipes* showed a potential of fixing 35.4% and 41.6% of phosphorus from eutrophied water body after five days, indicating a higher efficacy in phytoremediation and a candidacy of being a good source of phosphorus fertilizer in future.

Keywords: *Eichhornia crassipes*, *Pistia stratiotes*, Phosphates, Phytoremediation, Removal efficiency

ANTIOXIDANT ACTIVITY OF SRI LANKAN BLACK TEA

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Tea is a popular beverage derived from tender leaves of Tea plant which is rich in dietary polyphenols. Tea polyphenols including catechin derivatives are responsible for antioxidant activity which is the main causative factor for the health benefits of tea. Present study focused to determine antioxidant activity of Sri Lankan black tea based on tea growing elevations. Random tea samples were obtained from 35 black tea manufacturing factories representing all the tea growing elevations of Sri Lanka including; Western high, Western medium, Uva high, Uva medium and Low grown. Freeze-dried tea brews were prepared to quantify the antioxidant activity of black tea using microtitre plate reader with two antioxidant assays namely; DPPH (2,2-diphenyl-1-picrylhydrazyl) with radical scavenging ability and FRAP (ferric reducing antioxidant power). Total polyphenol content of freeze-dried and non-freeze-dried samples was determined using modified Folin-Ciocalteu method. Results revealed that, total polyphenol content of all freeze-dried tea samples exceed the minimum ISO standard of ISO 14502-1:2005 and were significantly ($p < 0.05$) high. Western high, Western medium, Uva high, and Uva medium had higher total polyphenol content than low grown teas. Both antioxidant assays revealed a significantly ($p < 0.05$) lower antioxidant activity in low grown tea than teas from other elevations. A correlation was observed among the total polyphenol content and the antioxidant activity of Sri Lankan black teas. In conclusion, low grown black tea contain low amount of antioxidant activity compared to high and medium grown teas in Sri Lanka.

Keywords: Antioxidant activity, Black Tea, DPPH, FRAP, Polyphenol content

ROLE OF BIOFILM BIOFERTILIZER ON GROWTH, YIELD AND NUTRITION OF RICE

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Rice (*Oryza sativa* L.) is the largest food crop production system in Sri Lanka. Extensive use of synthetic fertilizers in these systems to obtain high crop yields is witnessing serious negative impacts. Biofilm biofertilizer (BFBF) is identified as a supplementary strategy to cut down the chemical fertilizer (CF) requirement. Early studies have identified that BFBF application can cut down up to 50% of the CF from Department of Agriculture (DOA) 2001 recommendation for rice without hampering grain yield. Since the DOA recommendations have changed, there are no sufficient studies carried out to evaluate the effect of BFBF application with the new recommendation (2013). Therefore, this study was conducted to evaluate the potential of BFBF on growth, yield and nutrition by analyzing the plant, rhizosphere soil and microbial parameters. Six treatments consisted of different levels (0, 65%, 80% and 100%) of DOA 2013 CF and BFBF + 65% CF and BFBF+80% CF arranged in randomized complete block design with three replicates an established in *Thoda* farm Dehiaththakandiya Sri Lanka. Treatments with the 65% CF + BFBF showed decrease ($p < 0.05$) in number of tillers per hill, and number and weight of unfilled grains per panicle, compared to DOA 100% CF (2013). Furthermore, the 65% CF + BFBF treatment showed increase ($p < 0.05$) of soil moisture and rhizosphere soil nitrogen compared to 65% CF. Nonetheless, no any significant ($p < 0.05$) differences were observed in seed nutrition and microbial parameters among treatments. It is concluded that BFBF contributes in achieving a sufficient grain yield without changing the nutrition level, improving grain filling and increasing soil fertility while reducing the amount of CF. However, further studies are required to confirm the effects of BFBF + CF in rice to interpret the most suited BFBF + CF combination based on DOA 2013 recommendation.

Keywords: Biofilm biofertilizer, Chemical fertilizer, Grain yield, Rice

PATTERNS OF TREE DIVERSITY IN RELATION TO DISTURBANCE REGIMES IN A TROPICAL SECONDARY LOWLAND RAINFOREST IN KAHAWATTA, RATHNAPURA DISTRICT, SRI LANKA

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Degraded secondary forests are highly heterogeneous in terms of existing vegetation and resource availability. Comparative analysis of this heterogeneity makes it easier to apply standard sets of restoration strategies across various spatial scales. We studied the patterns of tree diversity in relation to successional stages and disturbance regimes in a tropical secondary lowland rainforest, Kahawatta, Rathnapura District, Sri Lanka. Thirty-one plots (20×20 m) representing five land use categories; productive tea lands (n = 5), marginal tea lands (n = 5), scrub (n = 5), and two blocks of woodlands (n= 10 and n= 6), were laid. The latter three categories were abandoned tea fields at different times. All trees with diameter at breast height (dbh) greater than 1 cm within each plot were counted, identified, and their dbh values were recorded. At plot level, ground cover of *Lantana camara* L., slope, altitude, and distances from neighboring main road, nearest human settlements, and nearest natural forest were recorded. Using published allometric equations for tropical trees, Above Ground Biomass (AGB) were computed. Using georeferenced images, a map of the spatial distribution of canopy cover was produced. A total of 1,302 trees belonging to 60 species and 33 families were found. *Symplocos cohinchinensis* (Lour.) S. Moore. was the most abundant. Non-tea land use categories were similar in terms of tree diversity ($p=0.58$), but tea lands and the scrub had low AGB in contrast to the woodlands ($p<0.0001$), as expected. Moreover, the sites close to a natural forest reserve showed high species richness ($p=0.0001$). These results facilitate the matching of ecological requirements of species with the site quality for ecological restoration of abandoned tea fields.

Keywords: GIS mapping, Land use change, Restoration, Secondary forest succession

ASSESSMENT OF GENETIC DIVERSITY OF GENUS NYMPHOIDES

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Genus *Nymphoides* contain approximately 50 known species that vary in growth habit, inflorescence architecture, vegetative, floral and seed morphology. It is difficult to identify different species of the genus due to its high similarities in morphological characters. Capturing of diversity has great implications on conservation and utilization of the genetic resources. Currently, DNA barcoding is frequently used in assessing genetic diversity of genomes. Genetic diversity of plant species belonging to genus *Nymphoides* found in Sri Lanka, is not well studied. Therefore, this study was conducted to optimize molecular based protocols to use in DNA barcoding of the genus *Nymphoides*. Genomic DNA from leaves of the respective plant samples was isolated using a modified cetyltrimethylammonium bromide method. Chloroplast ribulose-1, 5-bisphosphate carboxylase (*rbcL*) gene specific universal barcoding primers were assayed and the size of the amplified gene region was approximately 700bp. Protocol of *rbcL* amplification was modified for future DNA sequencing. The amplified *rbcL* gene region was digested with *EcoRI* restriction enzyme in further confirmation of the resulted gene product. With the *EcoRI* digestion, the *rbcL* gene product was digested to produce two fragments (~ 200 and 450bp). Results indicated that modified protocols can be used in DNA barcoding of genus *Nymphoides* to assess genetic diversity of the genus.

Keywords: Chloroplast genome, DNA barcoding, *EcoRI* restriction digestion, *rbcL*

EFFECT OF DIFFERENT SUNN HEMP SEED RATES AND INOCULATION ON WEED SUPPRESSION AND NODULATION

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Green manuring can be a sustainable alternative to minimize the overuse of inorganic fertilizers in rice cultivation. A field experiment was conducted to evaluate the effect of different seed rates and inoculation of sunn hemp on weed management and nodulation in order to increase its ecological benefits. A factorial experiment with four replicates was established as Randomized Complete Block Design in the research unit of the Faculty of Agriculture, Rajarata University of Sri Lanka, Puliyankulama during June – August 2018 with a seeding rate treatment (0, 20, 40 and 80 kg ha^{-1}) and rhizobial inoculation treatment (inoculated, control). Plant density, shoot and root biomass, weed density and biomass and nodule number were evaluated. There was no interaction ($p > 0.05$) between inoculation and seeding rates of sunn hemp on any of the parameters tested. However, nodule production of sunn hemp was significantly higher (46%) in the inoculated plots compared to those non-inoculated. Increasing the seed rates of sunn hemp from 20 to 40 kg ha^{-1} and 40 to 80 kg ha^{-1} significantly increased the plant density by 113% and 75%, respectively. The increasing seed rate of sunn hemp from 20 to 40 kg ha^{-1} increased the plant shoot and root biomass by 76% and 77%, respectively. When increasing the seed rates from 40 to 80 kg ha^{-1} significantly increased the shoot and root biomass by 129% and 125%, respectively. Furthermore, compared to fallow, seed rate of 20, 40 and 80 kg ha^{-1} significantly decreased the density of weeds by 34%, 48% and 70%, respectively and decreased the weed biomass by 27%, 25% and 35%, respectively. It is concluded that the increasing the seed rates of sunn hemp than the recommendation of 20 kg ha^{-1} found to be highly beneficial but the effect of inoculation need to be further explored.

Keywords: Green manure, Inoculation, Nodulation, Seed rate, Sunn hemp

EFFECTIVENESS OF LIQUID BIO-FERTILIZERS ON ORGANICALLY GROWN RADISH IN THE MATHALE DISTRICT, SRI LANKA

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Bio-fertilizers have been introduced as a remedy to overcome the low productivity in organic farming. The information regarding the effectiveness of Bio-fertilizers on organic vegetable cultivation in Sri Lanka is limited. A pot experiment was conducted to evaluate the effectiveness of liquid bio-fertilizers viz. Eco seed treat plus and Eco green plus on growth and yield of organically grown radish (*Raphanus raphanistrum* subsp. *Sativus*) cv – *Beeralu*. The experiment was arranged in Complete Randomized Design (CRD) in a shade house with 4 treatments and 5 replicates in Mathale district. Tested treatments were T₁ Control (without bio-fertilizer), T₂ Eco seed treat plus, T₃ Eco green plus, T₄ Eco seed treat plus + Eco green plus. Each replicate consisted of 7 plants. Eco seed treat plus was used as a seed treatment. Three applications of Eco green plus were done in 10 days intervals starting from 10 Days of Seed Emergence (DSE). Plant height at 9 DSE, was significantly higher in T₂ (4.79 cm) and T₄ (4.61 cm) when compared to T₁ and T₃. At 18, 35 DSE and at harvest, T₄ recorded the highest number of leaves (4.84, 15.68 and 23.80) with the highest leaf length (3.45 cm, 12.87 cm and 20.42 cm). The longest roots (12.0 cm) with highest root diameter (1.23 cm) were recorded in the same treatment. The highest fresh weight of leaf (1.38 kgm⁻²), root (1.18 kgm⁻²) and whole plant (2.56 kgm⁻²) were also recorded in the same treatment. The highest dry weight of leaves (0.09 kgm⁻²), roots (0.08 kgm⁻²) and whole plants (0.18 kgm⁻²) were also recorded by T₄ treatment. In conclusion, use of Eco seed treat plus and Eco green plus in combination has a significant positive effect on growth and the yield of radish when compared to their sole use.

Keywords: Bio-fertilizer, Eco green plus, Eco seed treat plus, Organic farming, Radish

DEVELOPMENT OF AN AUTOMATED OPERATION FOR VARIABLE SPEED DRIVE COUPLED FAN MOTOR IN TROUGH WITHERING

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Sri Lankan black tea is manufactured in traditional factories with old machineries, thus productivity remains low with high energy consumption. Conventional method of controlling the withering process with manually operating withering fans is very inefficient in energy point of view. Thus, withering process accounts about half of the total electrical energy consumption in the tea industry. Present study focused to identify energy efficient withering process using the interactions among internal bed pressure, air temperature and airflow, while controlling the airflow manually with traditional handkerchief monitoring system to gain optimal withering characters. The correlation of above parameters is used to develop logic and a controlling system in managing the motor speed using controllable Variable Speed Drive (VSD) device to introduce better and less energy consumed withering process. The best airflow rate to maintain the handkerchief floating throughout the withering was identified by the correlation of airflow rate over the time and it was 500 rpm. Accordingly, a program coding was developed and applied to the micro-controllers as required to automate the withering process by using the AVR studio software to configure with AVR 328 microcontroller using Language C. Finally, the conventional withering was compared with VSD coupled automated fan motor withering on energy consumption, withering quality and duration. Results revealed a reduction on energy consumption in automated withering process with an average of 43.5% compared to the conventional. Visual or physical difference among automated and conventional withered leaf was not seen. An extended duration for automated withering was found, which negligible. In conclusion, an automated VSD coupled fan motor introduces less energy consumed withering process for the Sri Lankan black tea industry than manually controlled VSD or conventional withering.

Keywords: Automated withering, Energy consumption, Tea manufacture

EVALUATION OF MOSS GEL AS A LOW COST SOLIDIFYING AGENT TO SUBSTITUTE AGAR IN PLANT TISSUE CULTURE

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High cost of production is one of the major constraints in plant tissue culture which is mainly due to high chemical cost. Agar is the most commonly use solidifying agent which cost 60-70% (1 kg = LKR 8000 Brand Maron-India) of the total cost of tissue culture media components. Preliminary study was conducted to identify the suitability of moss gel (1 kg = LKR 3800) as a low cost substitute for Agar in shoot induction and multiplication of banana, shoot multiplication and rooting of orchids and anthurium. Suitability and best concentration of the moss gel were assessed using survival percentage, multiplication rate and number of shoots and roots per culture. Moss gel concentrations of 6.5 gL⁻¹, 7 gL⁻¹, 7.5 gL⁻¹ were selected as treatments and those were compared with the control (Agar 7 gL⁻¹). In banana, high shoot survival percentage (94.4%) was recorded in 6.5 gL⁻¹ moss gel treatment and the lowest (55.5%) was in the control treatment. There were no significant differences among four treatments ($p > 0.05$) for multiplication rate, number of shoots per culture in banana and number of roots per culture in orchid and anthurium. According to the results, moss gel 7 gL⁻¹ was suitable for Banana multiplication (1.48 ± 0.39) and anthurium multiplication (9.27 ± 2.58), whereas, moss gel 6.5 gL⁻¹ was suitable for orchid multiplication (3.57 ± 0.52). Compared to the control, the highest average number of shoots (2.23 ± 1.48) per culture in banana and the highest average number of roots (2.02 ± 0.61) per culture in anthurium were recorded in moss gel 7.5 gL⁻¹ and the highest average number of roots (3.88 ± 0.72) per culture in orchid was recorded in moss gel 6.5 gL⁻¹. In conclusion, moss gel can be used as a low cost substitute for Agar in tested plants.

Keywords: Low cost tissue culture, Mossgel, Solidification agent

EVALUATION OF MORPHOLOGICAL DIVERSITY OF GENUS NYMPHOIDES IN ANURADHAPURA DISTRICT, SRI LANKA

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Nymphoides is a genus of aquatic flowering plants in the family Menyanthaceae. The genus has approximately 50 species throughout the world and four species were reported in Sri Lanka namely *N. indica*, *N. hydrophylla*, *N. aurentiaca* and *N. parviflora*. Even though *Nymphoides* diversity is studied extensively using morphological features in other countries, its diversity is yet to be explored in Sri Lanka. Therefore, this study was conducted to evaluate the morphological diversity of plants in the genus using 18 vegetative and reproductive characters. Plants were collected from randomly selected tanks in Anuradhapura district. Thirty plant samples in three replicates were obtained from 20 tanks in the district. Ward hierarchical cluster analysis with Gower distance was performed to assess the characters using R studio package. Based on the variation associated with morphologically important vegetative and reproductive characters, plant samples were classified in to three major groups (cluster I, II and III). Plants that produce flowers containing over five petals with pubescence were grouped in to cluster II and III and identified as *Nymphoides indica* (L.) Kuntze (*Maha ambala/ Kiri Kumudu*). All plants that produced flowers with five petals without pubescence were included in the cluster I. However, individuals of cluster I showed morphologically different characters among them. In conclusion, studied plants revealed the diversity in morphological characters, but additional morphological characters are needed to be captured to evaluate the high morphological diversity among the plants.

Keywords: Cluster analysis, *Nymphoides indica*, Vegetative and reproductive characters, Ward hierarchical clustering

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