11th INTERNATIONAL CONFERENCE ON DRY ZONE AGRICULTURE (ICDA 2025)

"Multidisciplinary Approaches for Regenerative Agriculture"

CONFERENCE PROCEEDINGS

Faculty of Agriculture, University of Jaffna, Sri Lanka

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"Multidisciplinary Approaches for Regenerative Agriculture"

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Message from the Vice-Chancellor

Prof. S. Srisatkunarajah
Vice Chancellor
University of Jaffna
Sri Lanka

It is with profound honour and intellectual pride, I extend my warmest greetings to all distinguished scholars, researchers, practitioners, students, and guests gathered for the 11th International Conference on Dry Zone Agriculture (ICDA-2025), hosted by the Faculty of Agriculture, University of Jaffna. This year's ICDA-2025 theme, "Multidisciplinary Approaches for Regenerative Agriculture," captures the essence of academic inquiry in the 21st century. As a higher academic institution rooted in the heart of Sri Lanka's dry zone, we are acutely aware of the ecological sensitivities and socio-economic realities that shape the complexity of issues in agricultural systems in marginal environments, which cannot be explored through a single disciplinary lens. This awareness has been a catalyst for our continued investment in knowledge generation that is both locally grounded and globally informed. The concept of regenerative agriculture transcends conventional agricultural improvement; it is a transformative vision. It compels us to restore, not only ecosystems, but also relationships between knowledge and practice, science and society, tradition and innovation. This conference, therefore, is more than a gathering of expertise, it is a forum for reimagining the future of agriculture through evidence, ethics, and empathy.

The Faculty of Agriculture bears the burden of agricultural growth, which is essential to the community; therefore, leading the region's agricultural endeavors and encouraging self-sufficiency and food security is the Faculty of Agriculture's responsibility. As crucial cogs in the wheel of agricultural excellence, agricultural graduates could put their skills to use and contribute to the country's economy. In this juncture, I am immensely proud of the Faculty of Agriculture for convening this prestigious international conference for the eleventh consecutive year. Their consistent pursuit of excellence has not only elevated the academic profile of this university but has positioned ICDA as a critical platform for scholarly exchange and policy dialogue in South Asia and beyond.

While congratulating all who contributed dedicatedly with the intellectual stewardship, I trust that the insights, debates, and partnerships emerging from ICDA 2025 will meaningfully advance the science and practice of regenerative agriculture.

Let this conference serve as a beacon of innovation, inclusivity. I wish you all a deeply enriching and impactful experience.

All glory to the Almighty.

Message from the Conference Chair

Prof. K. Pakeerathan
Dean
Faculty of Agriculture
University of Jaffna
Sri Lanka

It is truly an honor and a great pleasure to present the message from the bottom of my heart and soul as the conference chair to the proceedings of the 11th International Conference on Dry Zone Agriculture-2025 (ICDA-2025). The theme, "Multidisciplinary Approaches for Regenerative Agriculture," encapsulates the diverse research outcomes derived from scholarly findings in the era driven by artificial intelligence. Faculty of Agriculture, as a leading academic institution having a unique dry zone agriculture-related research culture, hosts its international conference in its 11th series, with an abundance of outstanding research papers submitted by both National and International researchers to disseminate the multifaceted groundbreaking research findings that are most appropriate to dry zone agriculture. Within the economic crisis of the country and the re-emergence from the post-COVID-19 pandemic catastrophe, the successful organization of ICDA consecutively for a decade demonstrates how advanced planning and coordinated work of dedicated master minded multiple human talents without considering their golden time and the strong support from the University administration.

ICDA's notable achievement has deeply influenced the global Agricultural research community and has been recognized, consequently, with their assistance, to guide its unwavering advancement in all respects of the term. As dean of the faculty and conference chair, I would like to express my profound gratitude and appreciation to all volunteers who contributed to the success of the ICDA-2025. The presence of the chief guest, keynote speaker, session evaluators, and various authors and reviewers is a testament to the quality of the technical program.

I would like to acknowledge all the organizing team members, and thank all the delegates in the congregation, students, and staff of the Faculty of Agriculture, University of Jaffna, the donors, the contributors, the Chief Guest, and others for your presence and support to ICDA-2025.

I aspire for the ICDA-2025 to be immensely successful and to significantly aid in the development of Global Dry Zone Agriculture by addressing the climate delima encompassing modern technology.

Message from the Convener

Mrs. K. Nishanthan
Senior Lecturer
Department of Agronomy
Faculty of Agriculture
University of Jaffna
Sri Lanka

It is with great pleasure and commitment that I welcome you to the 11th International Conference on Dry Zone Agriculture (11th ICDA-2025), organized by the Faculty of Agriculture, University of Jaffna. This year's conference, held under the theme "Multidisciplinary Approaches for Regenerative Agriculture," brings together a diverse community of scholars, researchers, practitioners, and students who are united in their pursuit of sustainable agricultural solutions for dry zone regions.

As climate change and resource constraints continue to challenge food security and rural livelihoods, ICDA-2025 offers a vital platform for sharing scientific insights, innovative practices, practical applications, and collaborative strategies. I believe this conference offers an invaluable platform to address these challenges through its well-defined thematic tracks. We can collectively contribute to a resilient and regenerative future for agriculture through a multidisciplinary approach and integrated research, ultimately supporting a healthier society.

I extend my heartfelt gratitude to all participants, presenters, reviewers, sponsors, and organizing committee members for your unwavering support and dedication. Your contributions are instrumental to the success of ICDA-2025 and the advancement of our shared vision.

Once again, I warmly welcome you all to ICDA-2025 and wish you a productive and inspiring experience.

Message from the Finance Chair

Dr. N. Thiruchchelvan
Senior Lecturer
Department of Agricultural Biology
Faculty of Agriculture
University of Jaffna
Sri Lanka

It is my privilege to contribute this message to the proceedings of the 11th International Conference on Dry Zone Agriculture (ICDA 2025) in my capacity as the Finance Chair. This conference serves as a distinguished platform for researchers to showcase their valuable findings and foster potential industrial collaborations. ICDA has become a hallmark annual event of the Faculty of Agriculture, University of Jaffna, reflecting the faculty's growing research capacity and commitment to academic excellence.

At this important juncture, I would like to express my sincere gratitude to all our sponsors, whose generous support has been instrumental in making this event a reality. Their contributions have not only empowered this event but also strengthened the bridge between academia and industry.

I extend my heartfelt wishes to the entire ICDA organizing team. May this event be conducted in a well-coordinated and impactful manner, firmly establishing its place in the academic calendar of the faculty.

Message from the Joint Secretaries

Dr.S.Thatchaneshkanth
Senior Lecturer
Department of Animal Science
Faculty of Agriculture
University of Jaffna
Sri Lanka

Mrs.T.Thavarupan
Lecturer
Department of Agricultural Engineering
Faculty of Agriculture
University of Jaffna
Sri Lanka

It is with great pride and a deep sense of responsibility that we welcome all participants to the 11th International Conference on Dry Zone Agriculture (ICDA 2025). This year's theme, "Multidisciplinary Approaches for Regenerative Agriculture" highlights the urgent need for collaborative and sustainable solutions to the challenges facing dry zone regions worldwide.

As Joint Secretaries, we are honored to convene a global community of scholars, scientists, policymakers, and practitioners from diverse fields; including Agricultural Economics and Extension, Animal Science, Aquaculture, Crop Science, Food Science and Nutrition, Plant Protection and Biotechnology, Soil Water and Environmental Sciences.

Dry zone agriculture today demands more than adaptation; it calls for transformation. From restoring degraded ecosystems to empowering communities and leveraging innovative technologies, this conference serves as a vital platform for knowledge exchange and meaningful partnerships.

We extend our sincere thanks to all presenters, delegates, reviewers, session chairs, sponsors, and partners. Your contributions are the backbone of this event.

May ICDA 2025 inspire pioneering research, informed policies, and collective actions that advance regenerative agriculture and global food security.

We look forward to enriching discussions and shared progress toward a more resilient future.

Addresses from the Professional Excellencies

PLENARY ADDRESS

Plant-Parasitic Nematodes: A Hidden Threat to New Zealand and Global Agriculture

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New Zealand

Nematodes are the most abundant multicellular organisms on Earth, occupying nearly all ecological niches. These worm-like animals belong to the phylum Nematoda in the kingdom Animalia. Plant-parasitic nematodes (PPNs) represent approximately 10% of this phylum. They are microscopic and can cause significant damage to host crops by limiting the plant's ability to absorb nutrients and water. The majority of PPNs are soil-borne and are found globally, parasitizing nearly all vascular plants. Due to their detrimental impact on agriculture, billions of dollars are lost each year worldwide.

Above-ground symptoms caused by PPNs, such as leaf discolouration, stunted growth, and wilting, are often indistinguishable from symptoms caused by other abiotic or biotic factors. This similarity frequently leads to misdiagnosis and incorrect management decisions. Globally, the number of researchers working on phytonematology is limited, which has resulted in reduced research output and minimal knowledge dissemination to the wider community.

New Zealand is a country whose economy heavily depends on agricultural production. Like in many other countries, New Zealand farmers have long struggled with pests and diseases that cause substantial economic losses. While New Zealand researchers did engage in phytonematological research decades ago, the past 20–30 years have seen little to no significant work in this field. As a result, the economic impact of plant-parasitic nematodes on New Zealand agriculture remains poorly understood. Currently, there are only a handful of nematologists in New Zealand, and Lincoln University is the only institution with established capacity to conduct nematological research within a university setting.

Due to limited research and a lack of publicly available resources, awareness of PPNs among growers and the general public remains extremely low. However, ongoing research at Lincoln University alongside efforts at a few other institutions is working to bridge this gap by producing relevant scientific knowledge and increasing awareness of the harmful impacts nematodes have on agriculture.

So far, we have conducted studies across a range of cropping systems, from arable to horticultural crops, and have worked to raise awareness among farmers, industry stakeholders, and the general public. Our research has been carried out in collaboration with industry partners, government institutions, Māori communities, and international collaborators. Following are some of the work done here in New Zealand.

The best method to understand infield nematode distribution

Proper identification of PPN distribution is a crucial step in effective nematode management. Nematodes are not evenly distributed in soil; their abundance and diversity are closely linked to the soil's physical and chemical properties. For example, root-knot nematodes typically prefer sandy soils, where they can reproduce rapidly, whereas clay soils tend to suppress their population density. Therefore, having a sound understanding of nematode distribution within a field is vital for designing effective management strategies.

Historically, nematode management strategies were often based solely on the presence or absence of nematodes in a field. This approach has frequently led to the overuse of nematicides that are highly toxic to beneficial flora and fauna, pose risks of groundwater contamination, and are costly for growers.

In nematode surveys, a commonly used approach involves collecting 4–6 composite soil samples across the field in a "W" pattern. While this method offers a general overview of nematode distribution, it often fails to capture "hot spots", areas with particularly high nematode populations, thereby leading to inaccurate predictions and suboptimal management recommendations. To overcome this limitation and accurately assess nematode distribution is a crucial factor. The research group at Lincoln University had adopted a more refined and spatially intensive sampling method to overcome this issue. This method is an adaptation from the site-specific nematode sampling done at Louisiana State University in the USA. With advancements in nematology and an improved understanding of nematode biology, we are now able to manage nematode populations more precisely. Targeted applications of nematicides can now be made only in areas where nematode pressure is high, thereby reducing chemical use and its associated environmental impacts.

The method utilized at Lincoln University initially involves dividing the selected field into several subsections, depending on its size. From each subsection, 4–5 composite soil samples were collected (Figure 1). Each composite sample consisted of 10–12 soil cores taken using a 2 cm diameter soil corer, within a radius of approximately 4 meters (Figure 1). The exact location of each sampling point was geo-referenced using a GPS unit. Soil from these composite samples was used to quantify nematode populations through the centrifugal sugar flotation method. The resulting data were used to generate maps indicating nematode distribution across the field using the ArcGIS mapping system (Figure 2).

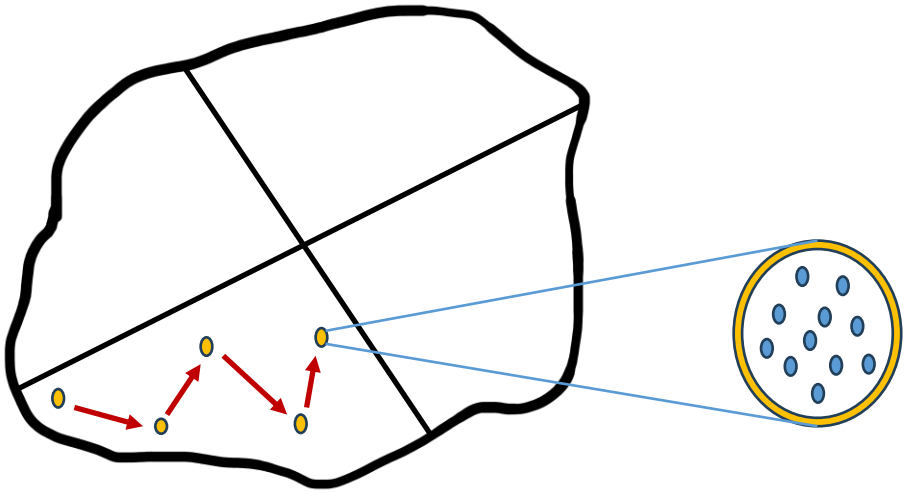

Figure 1: Visual representation of subdividing a field of approximately 20 hectares into 5-hectare blocks for zigzag pattern sampling. Each sampling point consists of 10–12 soil cores collected using a 2 cm diameter soil corer, to a depth of 20–30 cm.

This method of sampling can be utilised to divide the field into sections having high levels of nematode damage. These selected areas can then be treated separately, targeting regions with nematode populations above threshold levels. This approach ultimately leads to reduced chemical usage and cost savings for growers (Figure 3). As the nematode behaviour is known to be somewhat universal, such methods can be used to manage nematode issues in any part of the world.

Figure 2: Nematode distribution in a wheat field, developed using the ArcGIS Geographical Information System. The diameter of the circles indicates root lesion nematode densities at each sampling site. Larger circles represent higher nematode populations, while smaller circles indicate lower densities.

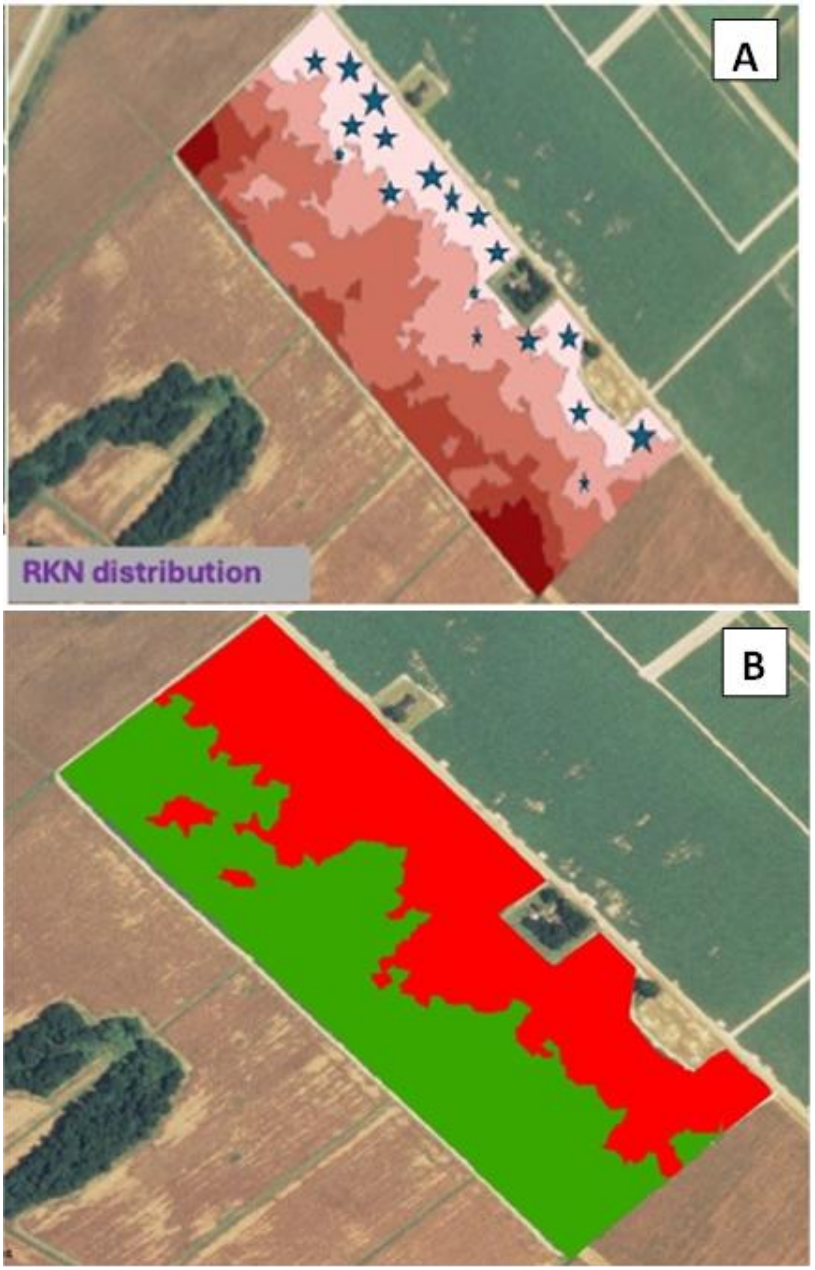

Figure 3: A) Development of management zones using soil textural data and root-knot nematode (RKN) distribution. Map generated using the ArcGIS Geographical Information System.
(B) Targeted nematode management based on soil texture and nematode distribution data. Red areas indicate zones treated with a nematicide due to high levels of root-knot nematodes (*Meloidogyne* spp.).

Research on Biosecurity

Nematodes are microscopic animals and cannot move long distances on their own. However, they can be passively transmitted through contaminated planting materials, soil, and equipment. With the increase in global trade, a wide variety of planting materials are exported across borders. Unfortunately, this movement often carries multiple risks, including the spread of pests and diseases such as PPN into regions where they were previously absent. To prevent the introduction of such threats, many countries with agriculture-dependent economies have established strict biosecurity protocols at their borders.

Over the past few decades, a variety of nematicides have been used worldwide to eliminate nematodes from commercial plant imports. While these chemicals are often effective, they pose serious risks to human health, animal safety, and the environment due to their high toxicity.

In New Zealand, a few highly toxic nematicides have historically been used at the border to control nematodes on horticultural plant imports. However, decisions to remove these products from the market have forced regulatory agencies to seek alternative, safer methods.

In 2024, our research team at Lincoln University successfully developed a novel treatment that combines hot water and a chemical application to eradicate nematodes from imported horticultural plants. This method is now being adopted as part of New Zealand's border protection strategy. The approach has significant implications for safeguarding the country's agricultural sector and demonstrates an innovative, globally applicable strategy for managing nematode-related issues in plant biosecurity.

In my presentation at ICDA 2025, I will showcase examples of nematode-focused research conducted in New Zealand and discuss our future research directions aimed at enhancing nematode management in the agricultural sector, both nationally and with broader relevance to Sri Lankan and global agriculture.

KEYNOTE ADDRESS

Effects of Organic Matter Application for Sustainable Rice Cultivation

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Japan

1. Characteristics of paddy field soil and the role of organic matter

Paddy fields are a good environment for realizing sustainable agriculture. Waterlogging management in paddy fields puts the soil in a reductive condition, slows the decomposition of organic matter, and allows it to accumulate in the soil. Nitrogen is fixed by algae living in the ponding water on the paddy field, and phosphorus becomes available under reductive conditions. Nutrients are supplied by irrigation water. In addition, substances that cause injury by continuous cropping and salt damage are easily washed away by the water, making these damages less likely to occur. Among these characteristics, the accumulation of organic matter in soil is particularly important in contributing to sustainable agriculture. Organic matter in soil maintains and improves the soil environment and functions by improving biological properties, physical properties, and chemical properties, thereby maintaining high crop productivity.

2. Effect of organic matter application to paddy fields

Organic matter is supplied to paddy fields both naturally and artificially. Weeds, including algae, and dead rice leaves are sources of the organic matter. Rice straw, stubble, and residual roots become sources of organic matter if they are plowed into the soil. When these residues are returned to the soil, the larger the rice plants, the greater the amount of residual organic matter supplied. In general, the more organic matter is applied and the longer the years of application, the more organic matter accumulates in the soil and the more the soil fertility improves, and the higher the soil fertility, the better the rice growth and yield. However, when organic matter decomposes under reductive conditions, substances that inhibit rice growth are produced, which may inhibit rice growth. This phenomenon is likely to occur when organic matter containing a large amount of easily decomposable organic matter, such as rice straw or rice bran, is applied. Since combine harvesters became widespread in Japan in the 1970s, it has become common to cut rice

straw at harvest time and return it to paddy fields. For this reason, rice straw is the most common organic matter applied to paddy fields. The other most common organic matter artificially applied to paddy fields is cow manure compost.

We investigated the effects of continuous application of rice straw and cow manure compost on soil fertility and rice growth and yield. Our results showed that continuous application of organic matter led to the accumulation of soil organic carbon and available nutrients, improving soil fertility (Figure 1). Rice yields also tended to be higher in treatments with greater accumulations of soil organic carbon and available nutrients, but there were some exceptions.

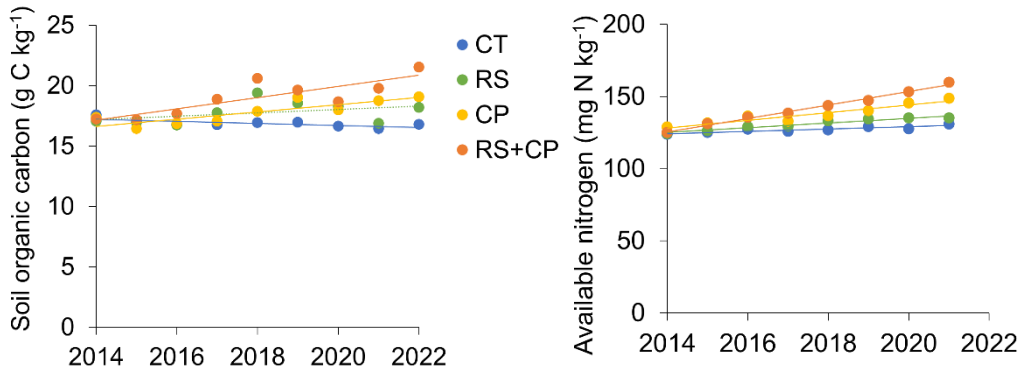

Figure 1: The change in soil organic carbon and available nitrogen for 8 years of continuous application of organic matter. CT is no organic matter, RS is rice straw, CP is cow manure compost, and RS+CP is RS plus CP applications.

3. Effect of organic matter application as an alternative to chemical fertilizers

Nutrients in organic matter are released during the decomposition process and are absorbed by crops. Therefore, organic matter with high nutrient content can be used as fertilizer or as an alternative to chemical fertilizers for crop cultivation. We are conducting research into the use of defatted rice bran (rice oil cake) and organic sludge from a local rice oil factory in rice cultivation as an alternative to nitrogen fertilizer. A field experiment has been conducted in which defatted rice bran pellets (hereafter referred to as defatted bran) and a mixture of defatted rice bran and organic sludge, composted and pelletized (hereafter referred to as defatted bran sludge compost), are used as test materials and applied as base fertilizer in rice cultivation. There were four treatments - chemical fertilizer, defatted bran, defatted bran sludge compost, and nitrogen-free, with four replications. Chemical fertilizer plot was applied with nitrogen, phosphate, and potassium fertilizers as basal. The defatted bran and defatted bran sludge compost plots were applied defatted bran or defatted bran sludge compost as basal, based on the total nitrogen content. The nitrogen-free plot was applied with phosphate and potassium fertilizers as basal.

As a result, the growth and yield of the rice in the defatted bran plot were equivalent to

that in the chemical fertilizer plot and were significantly improved over the nitrogen-free plot. The growth and yield of the rice in the defatted bran sludge compost plot were inferior to the chemical fertilizer plot, but were improved compared to the nitrogen-free plot. As mentioned above, it was predicted that when defatted bran decomposes under reductive conditions, it produces substances to inhibit the growth of rice. However, this study revealed that application of defatted bran does not inhibit rice growth, but increases rice growth and yield as a substitute for nitrogen fertilizer. The defatted bran sludge compost can effectively utilize both the defatted bran and organic sludge discharged during the rice oil production process, and since the easily decomposable organic matter that inhibits growth is reduced through composting, it was expected to produce better results than defatted bran. However, the compost showed a low effect on increasing rice growth and yield, and cannot be used as a substitute for nitrogen fertilizer in rice cultivation.

4. Nutrient supply from organic matter

The above-mentioned test materials were buried in the paddy field to examine the nitrogen supply pattern. The results showed that the defatted bran released about 80% of its nitrogen during one crop period, while the defatted bran sludge compost released about 30% of its nitrogen. Furthermore, the nitrogen mineralization derived from the test materials during waterlogging incubation revealed that nitrogen in defatted bran continued to become mineralized from early stages of the incubation, and about 50% of the nitrogen was mineralized by the time the accumulated temperature corresponding to the harvest period was reached. With defatted bran sludge compost, less than 10% of the nitrogen was mineralized immediately after application, and there was almost no nitrogen mineralization thereafter, indicating that no inorganic nitrogen was supplied at the accumulated temperature corresponding to the harvest period.

Considering this result with the results of the field experiment, the nitrogen supplied from the defatted bran increased the growth and yield of rice as a substitute for nitrogen fertilizer. It is believed that the defatted bran sludge compost was less effective in improving the growth and yield of rice plants when used as a substitute for nitrogen fertilizer because the amount of nitrogen it supplied was small. The defatted bran sludge compost used in this study has been shown to promote the growth of vegetables in an upland field experiment conducted by other researchers. It is thought that the decomposition rate of organic sludge mixed with the defatted bran may differ between paddy fields and upland fields. The nitrogen and other nutrients that remain without being released from the test materials accumulate in the soil. Furthermore, some of the inorganic nitrogen that is not absorbed by the rice is taken up by microorganisms and accumulates in the soil, making it available to subsequent rice crops. Therefore, once applied, some of the nutrients from the organic matter are lost outside the paddy field, but with continued application, they accumulate and become available for the next crop.

Food processing residues are organic matter that is usually discarded, but many of them contain high nutrient contents. Oil cakes such as defatted bran, which were used in this study, are high in nitrogen. Bone meal is high in phosphorus, and fish meal is high in nitrogen and phosphorus. It is necessary to consider how to effectively use these materials

as fertilizers for crop cultivation, taking advantage of their respective nutrient contents and nutrient supply characteristics.

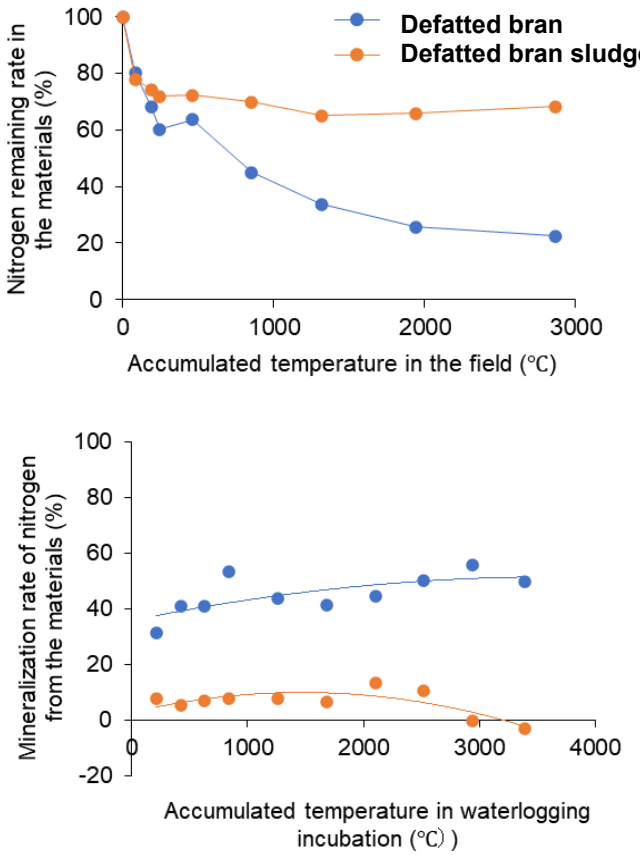

Figure 2: The change in nitrogen remaining rate in the materials during the period from plowing to harvesting of rice cultivation (above). The change in mineralization rate of nitrogen from the materials during water logging incubation (below).

INVITED GUEST ADDRESS

Machine Learning and Smart Agriculture

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Department of Electrical and Electronic Engineering
Faculty of Engineering
University of Peradeniya, Sri Lanka

Introduction

The integration of modern technologies and practices is causing a significant transformation in the global agricultural sector. Machine learning is one important and impactful technology of this evolution. It is a subset of artificial intelligence and it enables computers to learn patterns from data and make intelligent decisions with minimal human intervention. Over the past one and a half decades, significant progress has been made on machine learning, and it has evolved from simple rule-based algorithms to complex models that can independently learn from data and execute intelligent actions. Machine learning is also a key enabler in the context of smart agriculture and holds significant potential to provide effective solutions to a myriad of challenges within the agricultural sector, including crop management, yield estimation, weather forecasting, soil analysis, and the enhancement of overall productivity.

What is Smart Agriculture?

Smart agriculture, or precision agriculture as it is also known, makes use of digital technologies such as sensors, Internet of Things, remote sensing, drones, and data analytics to manage farming practices efficiently. Smart agricultural practices aim to optimize inputs such as water, fertilizers, and pesticides to ensure sustainable yields while minimizing environmental impact. Machine learning tools support these goals by delivering clear insights and actionable recommendations that improve the quality of decision-making.

Machine Learning Applications in Smart Agriculture

1. Crop Health Monitoring

Machine learning algorithms and especially convolutional neural networks have emerged as powerful tools in crop health monitoring and detection of diseases. In combination with image processing, CNN models can analyze terrestrial and aerial imagery, including data captured by drones and satellites of crops, to detect anomalies such as pest infestations and disease symptoms. These models are trained on labelled datasets of healthy and unhealthy plant images and videos. For instance, smart systems trained to detect common fungal diseases, rice blast or bacterial leaf blight, can alert farmers in real-time, enabling the precise and timely application of pesticides to control the extent of infestation outbreaks. The use of such smart practices will reduce chemical use thereby promoting a more environmentally sustainable approach to agriculture.

2. Yield Prediction

Accurate prediction of crop yields is crucial for key tasks such as planning, supply chain logistics, and food security. Crop yield prediction using traditional statistical methods presents several limitations. These approaches typically assume linear relationships between variables and therefore fail to capture the complex, non-linear interactions that influence crop yield prediction. Moreover, traditional statistical approaches lack the ability to make use of new data in real-time. On the other hand, machine learning models can make use of a variety of input features, including historical yield data, soil parameters, weather data, irrigation and farming practices, to estimate future yields. To this end, linear, polynomial regression models, random forest and support vector machines show great promise for this purpose. The adoption of machine learning models for prediction enables farmers and other stakeholders to make intelligent decisions regarding optimal planting dates, irrigation scheduling, and harvesting periods.

3. Weed Management

Weed infestation represents a major challenge in Sri Lanka, as it adversely affects agricultural productivity. The adoption of integrated weed management practices, including manual weeding and selective use of herbicides, has proven effective in some areas of the dry zone, yet there is much potential to pilot machine learning-based image recognition systems, which can distinguish between crops and weeds. The integration of remote sensing technologies and computer vision techniques with imagery collected through vision-based Internet of Things devices, robotic platforms and drones offers an effective approach for detecting common weed species in rice paddies and plantation crops. Moreover, the precise localization of weeds enables farmers to apply herbicides or insecticides selectively, thereby minimizing the excessive use of agrochemicals. There has been a growing body of research focused on the application of machine learning for weed management, where object detection models such as YOLO (You Only Look Once) and

Faster R-CNN are popular. When integrated into automated field robots, such models enable the execution of precision tasks such as mechanical weeding and selective herbicide spraying.

Investigation into Plant Stress Detection

Global food demand is projected to rise by 60–70% by 2050 to support a population exceeding 9 billion, requiring at least a 40% increase in agricultural productivity. However, this goal is severely challenged by various plant stresses that impact crop growth and yield. Plant stress refers to any internal or external factor that disrupts a plant's normal metabolism, development, or productivity.

These stresses are broadly classified into biotic and abiotic types. Biotic stress is caused by living organisms such as pests, pathogens, and competing plants. Abiotic stress, on the other hand, includes non-living environmental factors such as drought, extreme temperatures, salinity, and nutrient imbalances.

Among these, nutrient deficiencies, particularly nitrogen deficiency, are a leading cause of reduced crop yields worldwide. Nitrogen is essential for photosynthesis, protein synthesis, and cellular energy transfer, making its availability critical for healthy plant growth. Nitrogen deficiency alone contributes significantly to global yield losses. As a vital component of chlorophyll, amino acids, and ATP, nitrogen directly influences plant photosynthesis and metabolism. When nitrogen levels are insufficient, plants exhibit symptoms such as yellowing of older leaves (chlorosis), stunted growth, weak shoot development, and reduced fruit quality.

Traditional nitrogen monitoring methods, such as soil testing and laboratory-based tissue analysis, are often destructive, time-consuming, and unsuitable for real-time, large-scale implementation. Furthermore, these methods are limited in their ability to provide early warnings before visual symptoms appear. In the context of modern agriculture, especially in large-scale greenhouses and crop fields, there is a growing need for efficient, automated, and scalable monitoring systems capable of detecting nitrogen deficiency at early stages.

While previous research has separately explored vision-based methods using RGB imaging and signal-based approaches involving electrophysiological measurements, limited work has been done to integrate both techniques. Most existing studies are constrained to laboratory settings with controlled conditions, which often fail to capture the complexity of real-world agricultural environments. In addition, many nutrient deficiency and disease-related studies have relied on isolated leaf images captured against plain, directly separable backgrounds. While useful in controlled scenarios, such datasets do not reflect the challenges present in field conditions, where complex backgrounds, varying plant orientations, and dynamic lighting conditions make accurate detection significantly more difficult.

We aim to develop a combined system for detecting nitrogen deficiency in Chilli plants using both vision-based and electrophysiological techniques. The focus on Chilli plants is deliberate due to their fast-growing nature and high sensitivity to nutrient imbalances. Additionally, Chilli is a widely cultivated crop across diverse climates, making the outcomes of this study broadly applicable. Given the lack of publicly available datasets relevant to the specific objective of this project, detecting nitrogen deficiency in Chilli plants through both imaging and electrophysiological signals, a custom data collection system was developed. A review of existing literature highlighted the need for an automated, scalable, and minimally intrusive setup to ensure consistent and repeatable data collection without depending on manual intervention.

The first step was to design a system capable of automating image collection over an extended period. Considering constraints such as budget, durability, and image resolution, ESP32-CAM modules were selected as the imaging devices that offered a balance between cost-effectiveness and sufficient image quality, making them ideal for use in a multi-camera environment. The main goal is to enhance detection accuracy and response time by fusing visual symptom analysis with internal bioelectrical signal patterns. The research involves the development of a robust image acquisition and analysis pipeline, the setup of a plant signal monitoring system, and the implementation of a machine learning model trained on both data streams to classify nitrogen deficiency levels.

For the vision-based analysis, RGB images are captured hourly using four ESP32-CAM modules installed in the greenhouse. These images are transmitted wirelessly to a central Raspberry Pi, which then uploads the data to Google Drive for remote access. The captured images are preprocessed through color balancing, contrast enhancement, background removal, and segmentation techniques focused on mature leaves. Feature extraction is performed to analyze leaf color variations, especially yellowing, which serves as an indicator of nitrogen stress. These features are then used to train a machine learning model capable of classifying the severity of nitrogen deficiency.

Simultaneously, the electrophysiological aspect of the study involves recording plant bioelectrical activity using stainless steel electrodes inserted into the stems. These signals are collected at regular intervals and processed to filter out noise and normalize baselines. Key signal characteristics such as amplitude fluctuations, entropy, and frequency domain features are analyzed to identify physiological stress responses. The underlying hypothesis is that changes in the plant's bioelectrical signals may precede visible symptoms, providing a window for early intervention.

The core novelty of this research lies in the fusion of these two data streams. By aligning temporal features from both visual and electrophysiological sources, the study explores the potential of a multimodal detection system. A machine learning model is trained on the combined dataset to determine whether bioelectrical signals can act as early warning indicators and whether this improves the accuracy of nitrogen deficiency classification compared to using vision-based methods alone. The integration also considers practical

deployment factors by using low-cost RGB cameras and simple electrode setups, ensuring that the solution remains field-viable and scalable.

This research is expected to deliver several significant outcomes. First, it aims to develop and validate a dual-modal nitrogen deficiency detection system that integrates vision-based and electrophysiological data. Second, it will produce a comprehensive, synchronized dataset consisting of Chilli plant images and corresponding bioelectrical signals captured under varying nitrogen supply levels. Additionally, the study seeks to provide valuable insights into the temporal relationship between internal physiological stress responses and the days required for visible symptoms to appear, which is crucial for enabling early intervention.

By addressing current limitations in plant stress detection, such as delayed symptom recognition and lack of scalability, this integrated system represents a step forward in the development of real-time, non-invasive, and automated decision support tools for agriculture. It is designed to be practical and cost-effective, making it suitable for deployment in real greenhouse environments rather than just controlled laboratory settings.

The proposed integrated approach will not only improve the accuracy and timeliness of nitrogen deficiency detection but also align with the broader vision of smart agriculture. By combining computer vision and plant electrophysiology, the system offers a more holistic view of plant health, enabling earlier and more informed management decisions. Furthermore, the methodology is both adaptable and scalable, with the potential to be extended to a wide range of crops and plant stress conditions, thereby offering a practical and field-deployable solution for enhancing crop health monitoring and optimizing nutrient management.

Closing Remarks

Machine learning delivers innovative solutions to complex challenges faced by the agricultural sector both in Sri Lanka and worldwide. As research advances and digital infrastructure expands, the integration of machine learning into smart agriculture is increasingly positioned to play a pivotal role in enhancing global food security, promoting sustainable agricultural practices, and enabling effective adaptation to climate change.

ABSTRACTS

Agricultural Economics and Extension

The Role of Farmers' Capitals in Drought Adaptation: A Case Study of Small-Scale Farmers in the North Central Province, Sri Lanka

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Drought is a natural phenomenon induced by climate change. Farmers in the Dry Zone who practice agriculture under small-scale irrigation are most vulnerable to drought. Literature shows that there is limited understanding of how different forms of capital influence farmers' drought adaptation. This research attempted to identify the relationship and influence between farming households' capitals (Human, Cultural, Social, Natural, Built, Financial, and Technological) and farmers' adaptation in the North Central Province of Sri Lanka (adaption was measured using ten commonly used adaptation strategies using a 1-5 scale) A mixed-methods approach was adopted. A questionnaire was used to collect the data. The sample size (n=356) was selected among the farming households (N=3163) using a stratified random sampling method from three Divisional Secretariat Divisions (DSD), Mahawillachhciya, Kahatagasdigilya, and Medirigiriya. Pearson's correlation and multiple linear regression analysis were performed using the Statistical Package for the Social Sciences (SPSS). It was found that there is a negative strong correlation between capitals of Human (r=-.548, p<0.01), Cultural (r=-.678, p<0.01), Social (r=-.585, p<0.01), Natural (r=-.643,p<0.01), Financial (r=-.547,p<0.01), Technological (r=-.629, p<0.01) and farmers adaptation while it was found that there is a negative moderate correlation related to Build capital (r=-.467, p<0.01). These results suggest that when farming households' capital is reduced, farmers are motivated to increase their adaptation to manage the adverse effects of drought. Capitals of Human (β=-.270, p=.498) and Social (β=-.135, p=.702) did not significantly impact farmers' adaptation. Capitals of cultural (β=-1.525, p=.000), Natural (β=-1.400, p=.000), Built (β=-.606, p=.000), Financial (β=-.465, p=.014), and Technological (β=-.414, p=.018) had significant negative impacts on farmers' drought adaptation. Seven farmers' capitals explain 64% variation in farmers' drought adaptation (R = 0.801; R^2 =0.642; Adj. R^2 = 0.635). Overall, seven capitals have a significant influence on farmers' adaptation, and policymakers should pay more attention to cultural and natural capitals when making policies to enhance farmers' drought adaptation and build resilience.

Keywords: Capitals, Climate Change Drought, Farmers' adaptation, Resilience

Effect of Climate Variability on Coconut Farming: A Bayesian-Ricardian Approach using Panel Data from the Western and North Western Provinces of Sri Lanka

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Coconut is a vital agricultural commodity in Sri Lanka and tropical economies, sustaining global agricultural stability and the livelihoods of millions. However, it is highly susceptible to climate change since its reproductive development is more sensitive to changes in temperature, precipitation distribution and adverse weather conditions including droughts and floods. This leads to the reduction in both nut weight and yield, subsequently reducing coconut farmers' income. Therefore, this study aims at quantifying the impact of climate change on coconut profitability. The study addresses the lack of a robust framework for quantifying the uncertainty associated with climate change impacts on coconut profitability by employing a Bayesian-Ricardian approach, which uniquely integrates uncertainty into economic projections. The analysis utilized previously collected monthly profit data from 67 coconut estates, spanning from 2002 to 2018 and climate data from the Worldclim web site extracted through QGIS. A Ricardian model was employed for the analysis and as panel data was available, a pooled regression model was estimated using Bayesian methods to simulate marginal effects of temperature and precipitation under different climate scenarios. The impact of long-term average temperature and long-term average precipitation on profitability exhibits a probability exceeding 70% and 99% of being negative across different scenarios respectively. Additionally, extreme droughts before twelve months lead to an average monthly profit reduction of 31.81% per hectare, with losses ranging between 42.3% and 21.4% at a 95% credible interval. Therefore, the findings reveal that climate change has a significant negative impact on coconut estate-level profitability. Since the temperature, variability of precipitation patterns and frequency of drought events are expected to increase, estate holders will suffer large losses in the future. To mitigate these effects, it is essential to develop climate resilient coconut cultivars, adopt precision agricultural technologies and improve water management practices.

Keywords: Bayesian Analysis, Climate Change, Coconut, Profitability, Ricardian Analysis

Evaluating Technical Efficiency and Technology Gaps in Asian Agriculture: A Stochastic Meta-frontier Analysis

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Agriculture plays a vital role in poverty alleviation across Asian countries as a considerable portion of the rural population depends on it for their livelihood. However, the Asian agriculture sector faces numerous challenges, including fluctuations of input prices, shifting consumer demands with population growth, unsustainable farming practices and most importantly, the impacts of climate change and extreme weather conditions. To overcome these challenges, Asian countries aim to maximize their output efficiently using available inputs. This study reveals the current efficiency levels and potential improvements in Asian agriculture by assessing technical efficiency and technology gap ratios in the whole agricultural sector, including crop production, livestock, and integrated farming systems across 28 Asian countries from 1992 to 2021, classified based on income levels. The Cobb-Douglas production function was used as the functional form of stochastic frontier analysis, covering key inputs- land, labor, fertilizer, and pesticides. Deflated values of agricultural production served as the primary output variable. The study examines variations in production technologies among high-income, upper-middle-income, and lower-middle-income countries using a stochastic meta-frontier model. The findings indicate that the average technical efficiency in the Asian agricultural production is 0.54, showing that agricultural output could increase by 46% if all countries operated at their maximum efficiencies. Among three income groups, upper-middle income countries exhibited the highest average technical efficiency at 0.82, showing their capacity to utilize inputs relative to their group-specific production frontiers. Technology gap ratios further highlighted the disparities in potential output, with high-income countries reaching 52% of their potential, while upper-middle income countries and lower-middle income countries achieving 62% and 49% respectively. These findings emphasize the need for targeted interventions, such as facilitating technology transfer from high-performing countries, investing in extension services, improving access to quality inputs, and encouraging data-driven agricultural practices, especially in lower-middle income countries to enhance technical efficiency and bridge the efficiency gaps.

Keywords: Asian agriculture, Income level, Stochastic meta-frontier, Technical efficiency

Awareness and Perspective of Post-harvest Losses in Vegetable Crops among Agricultural Undergraduates in Sri Lanka

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Post-harvest losses in Sri Lanka significantly impact food security and agricultural productivity among vegetable crops, fruit crops, diversified crops and overall crop harvest. The study was aimed to search for awareness and knowledge gaps, providing insight into curriculum reform to raise knowledge, among agricultural undergraduates in Sri Lanka. Despite the growing recognition in awareness of post-harvest losses, there are major gaps in the accuracy of the knowledge and integration of technological advancements in solutions to reduce the loss. A Survey was conducted from December (2024) to February (2025) among agricultural undergraduates studying in their third and fourth year. Data were collected using a self-administered online questionnaire comprising open-ended and closed-ended questions. The study revealed that 93.1% of the respondents were aware and knowledge about post-harvest losses in vegetable crops. Among them majority of 79.4% of the respondents identified poor farmer awareness as the main challenge in reducing post-harvest losses in Sri Lanka. According to the undergraduates' view, study identified mechanical damage during harvest and post-harvest handling as the major cause of post-harvest loss in vegetable crops. Undergraduates stated that both the government and private sector are effective in addressing post-harvest losses in vegetable crops. However, when they were examined on modern technological integration into post-harvest management, the majority (73.5%) stated about cold storage facilities, which shows a considerable knowledge gap among the agricultural undergraduates in Sri Lanka regarding modern technological adaptations. Although their awareness of postharvest vegetable loss increased with their academic exposure. The understanding and recognition level of awareness among the agricultural undergraduates about post-harvest loss influences the direction of future agricultural practices and policy building which positively on food security and sustainability in Sri Lanka's agriculture post-harvest wastage.

Keywords: Post-harvest loss, Sri Lanka, Undergraduates

Breaking Barriers to Good Agricultural Practices: Evidence-Based Insights from Stakeholders in the Northern Province

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Amid increasing globalization and its implications for public health and trade, food safety has emerged as a critical concern. In Sri Lanka, agriculture remains a cornerstone of the national economy, necessitating adherence to internationally recognized standards, such as Good Agricultural Practices (GAP). Despite the introduction of GAP certification in 2007, adoption remains limited, particularly in the Northern Province. This study aims to identify and analyze key barriers to GAP certification and propose strategic interventions to enhance its adoption and effectiveness. Using a mixed-methods approach, data were collected from 35 purposively sampled stakeholders across nine categories, including five Agricultural Instructors, three Agribusiness development officers, three GAP Technical Assistants, seven GAP Certified farmers, nine Non-GAP Certified Farmers, two GAP Sales outlets, two GAP Training officers, two SME's involved in the value chain, and 2 GAP Certifying officers. Tools included structured surveys, in-depth interviews, and FGDs, supported by secondary sources. Quantitative data were analyzed using descriptive statistics, correlation analysis, and Relative Importance Index (RII) rankings; qualitative inputs were analyzed thematically. Findings revealed low GAP awareness among non-certified farmers and strong dissatisfaction with market incentives among certified farmers. A statistically significant correlation was observed between training exposure and awareness levels. Key barriers included insufficient market demand (RII = 0.88), knowledge gaps (RII = 0.81), certification costs (RII = 0.77), and infrastructure deficiencies (RII = 0.71). Retailers reported minimal consumer interest, with only 12–15% of shelf stock being GAP-certified. Cluster analysis further grouped stakeholders based on attitudes and engagement, revealing critical disconnects between supply, policy, and market actors. To address these findings, the study proposes a multi-pronged strategy: enhancing training and awareness, establishing a centralized market intelligence system, incentivizing certifying officers, introducing premium-based pricing models, and strengthening certified product distribution. These reforms are vital to ensure food safety, raise agricultural profitability, and elevate Sri Lanka's position in global agri-trade.

Keywords: Agricultural policy, Farmer incentives, Food safety, Market barriers, Sustainable Agriculture

Effects of Digital Addiction and Phubbing on the Social Well-being of Agriculture Undergraduates: A Case Study of Rajarata University of Sri Lanka

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The next step in agriculture is precision agriculture, which relies on digital technologies and big data. For effective outcomes, users and operators mustn't be affected by digital addiction. In Sri Lanka, after the COVID pandemic, students have become more reliant on digital platforms, increasing their exposure to digital devices and the risk of digital addiction and phubbing behavior. In the Sri Lankan context, especially among agriculture undergraduates, no prior study has explored how these behaviors affect the effective use of smart technologies, AI, and big data in the agricultural sector. Moreover, their potential link to reduced social well-being remains unexamined. This study aims to address this gap by investigating the interrelationships among digital addiction, phubbing, and social well-being. Therefore, this study was conducted as a case study at Rajarata University of Sri Lanka to assess the current situation among undergraduate students in agriculture. A cross-sectional survey was conducted in 2024 with 266 undergraduates (75% females and 25% males) aged around 24 years. Data were randomly collected on demographics, digital device usage, social networking (SN), social support (SS), self-control (SC), fear of missing out (FOMO), digital addiction (DA), phubbing behavior (PB), and social well-being (SWB). Structural equation modelling was performed using AMOS and SPSS 26. On average, undergraduates used two digital devices and 21 software applications for 12 hours daily. FOMO ($p<0.001$), SC ($p=0.003$), and English literacy (EL) ($p=0.013$) were major factors linked to DA. DA ($p<0.001$) and SC ($p=0.003$) were connected to PB. SWB was significantly influenced by DA ($p=0.001$), FOMO ($p<0.001$), SS ($p=0.002$), and EL ($p=0.021$). The model explained 44% of DA, 84% of PB, and 34% of SWB.DA directly affects SWB, while PB has no significant impact. To address exhibit concerns, educational institutions can implement awareness programs, train academic staff on digital well-being practices, and promote the use of app usage limiters and data limiters to manage usage and time consumption, and enhance student support systems, including English language and communication skills. Introducing "digital detox" initiatives can also foster healthier digital habits. Further research with larger, more diverse samples is needed to develop broadly applicable strategies for balanced digital use in higher education.

Keywords: Internet addiction, Smartphone addiction, Social media addiction, Youth education, Youth social well-being.

Analysis of Paddy Price Fluctuations in the Ampara District of Sri Lanka

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This study addresses the limited research on district-level paddy price fluctuations in Ampara, a key rice-producing region in Sri Lanka, which has been overlooked in favor of national-level analyses. It aims to analyze short- and long-term price dynamics of various paddy grain types using ARDL modelling, incorporating the effects of rice imports and inter-district production. The research integrates quantitative and qualitative approaches to identify factors driving price volatility and assess its impact on farmer income and economic vulnerability. Findings will inform policy recommendations to enhance price stability and market resilience in Ampara's paddy sector. Employing a mixed-method approach, the research combines time-series analysis using the Autoregressive Distributed Lag (ARDL) model and data collected over 22 years (2000-2022). The data includes total production in the Ampara district, annual rice import quantities for Sri Lanka, and prices of short-grain, long-grain red, and long-grain white rice. The study focuses on understanding the effects of local production levels, imports, and market dynamics on short- and long-term paddy price behavior, particularly for short-grain, long-grain white, and long-grain red rice varieties. The ARDL model reveals that rice imports and production levels negatively influence short-grain rice prices in neighboring districts, while long-grain white rice prices exert a positive influence on short-grain prices. Similarly, long-grain white and red rice prices are sensitive to both local and external production factors, reflecting broader market dynamics that affect price stability. The study highlights the significant roles of historical prices, imports, and inter-district production in shaping current price trends. The findings underscore the economic vulnerability of paddy farmers, particularly during harvest periods when price drops reduce income stability. Although government policies are aimed at price stabilization through procurement programs, they are often insufficient due to infrastructural and financial constraints.

Keywords: Ampara District, ARDL Model, Paddy, Price Fluctuations

Animal Science and Aquaculture

Enhancing Growth Performances of Broilers Through Dietary Supplementation of Cinnamaldehyde and Eugenol: A Natural Alternative to Conventional Antibiotic Growth Promoters

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Finding alternatives to antibiotic growth promoters (AGPs) has been a challenge for the broiler industry due to increasing restrictions on their use. The study aimed to evaluate the effect of three inclusion levels (3%,6%,9% per kg of feed) of cinnamaldehyde and eugenol on the growth performance of broilers as a potential substitute to AGPs. A total of four hundred eighty Cobb-500-day-old chicks were raised to the age of 35 days in a randomized block design with eight dietary treatments, each replicated six times with 10 birds per each replicate. Treatments based on added Growth promoters (GP) to the basal diet: negative control-NC (without GP), positive control-PC (AGP -Zinc bacitracin), cinnamaldehyde at 3% (T3), 6% (T4), 9% (T5) or eugenol at 3% (T6), 6% (T7), 9% (T8) added per kg of feed. The feed intake (FI) and live body weights were measured separately for each replicate at weekly intervals. The weight gain, feed conversion ratio (FCR) and Performance efficiency factor (PEF) were calculated for the total growing period. One-way Analysis of Variance procedure was used to compare the performances of the treatments. Birds fed PC diet significantly increased ($p<0.05$) live weight (2056±22.23 g), weight gain (2009±22.07 g) and improved FI (2887.9±38.4) compared to the other treatments. However, except for the birds fed the highest level of cinnamaldehyde (T5), other cinnamaldehyde and eugenol fed birds significantly increased ($p<0.05$) the live weight and weight gain compared to the NC birds. The significantly lowest ($p<0.05$) FCR was recorded in 3% cinnamaldehyde fed birds (T3). The highest ($p<0.05$) PEF was also recorded in 3% cinnamaldehyde fed birds, and that was statistically similar to PC. Conclusively, the present study demonstrated that birds fed diets containing 3% and 6% cinnamaldehyde and 3%, 6% and 9% of eugenol, improved the growth performances compared to birds fed without growth promoters (NC) by improving FCR.

Keywords: Alternative, Antibiotic growth promoters, Inclusion levels

The Extraction of Fish Bone Powder From *Hypostomus plecostomus* as a Source of Calcium

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The invasive *Hypostomus plecostomus* is commonly known as suckermouth catfish or locally as tank cleaners, which are rapidly spreading across Sri Lanka, negatively impacting the ecosystem and inland fisheries. This species is considered an underutilized fish species, and the preparation of value-added products from underutilized invasive *H. plecostomus* is important for the sustainability of the inland fishing industry and ecosystem. The primary objective focused on the use of fish bone powder from unconsumable waste parts of invasive suckermouth catfish, such as fins, head and scales, as a source of calcium. The specific objectives of this study were to determine the most effective NaOH concentration and boiling period to obtaining the maximum calcium yield from sucker mouth catfish bone. The experiment was a two-factor factorial complete randomized design, and factors were 1, 1.5, and 3% of NaOH concentrations and 30 and 60 minutes of boiling periods. Collected fish wastes from the Victoria Reservoir, Digana (Central Province, Sri Lanka) were oven dried and broken into small pieces, and boiled with NaOH to remove the organic matter and treated with 0.1% HCl for neutralization and obtained fish bones (FB). FB were crushed and sieved to obtain fish bone powder (FBP). The calcium (Ca) yield, phosphorus (P) yield, soluble organic matter (SOM), crude protein (CP), crude fat (CF), and ash content of FBP were measured, and analysis of the variables was done at $p<0.05$; mean separation was done by Duncan's multiple range test. The results revealed that the highest Ca yield, SOM, and ash content were 0.375 (g/g), 83% and 72%, respectively, while the lowest CP and CF were observed by the 3% and 60-minute treatment. The P yield was not significantly affected by either NaOH concentration or boiling period. Therefore, the highest purity and Ca yield were obtained from the most effective treatment, which was 3% NaOH concentration and a 60-minute boiling period.

Keywords: Calcium, Crude fat, Crude protein. Phosphorus, Soluble organic matter

Enhancing Growth and Survival of Mrigal (*Cirrhinus mrigala*): Effects of High-Protein Diets on Early Development

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This study evaluated the effects of high-protein formulated diets on the early growth and survival of *Cirrhinus mrigala* (Mrigal) larvae under hatchery conditions at the Iranamadu Aquaculture Development Centre, Kilinochchi, Sri Lanka. Day-old larvae (initial mean weight: 0.003 g, length: 0.493 cm) were stocked at 100 larvae per tank in nine 100-L fiber-reinforced plastic tanks and reared for 36 days under three dietary treatments: T1 (control: boiled, mashed chicken egg), T2 (55% crude protein feed), and T3 (65% crude protein feed), each replicated thrice. Formulated feeds comprised fishmeal, shrimp meal, soybean meal, and a vitamin-mineral premix, ground to a particle size suitable for larval consumption. Larvae were fed to apparent satiation four times daily, with growth parameters (weight and length) measured every 15 days and survival rates assessed at the trial's end. Larvae fed the 65% protein diet exhibited significantly higher growth (final mean length: 1.84 cm, weight: 0.060 g) compared to the 55% protein group (1.70 cm, 0.055 g) and the control (lowest growth). Survival rates were numerically higher in the protein-fed groups (70.27% for 55% protein, 73.47% for 65% protein) than in the control (47.10%), though differences were not statistically significant ($p>0.05$). Enhanced growth in high-protein groups is attributed to improved amino acid availability and feed digestibility, while higher survival likely results from better nutrient profiles, reducing stress and microbial contamination compared to the control. These findings underscore the efficacy of 65% protein-formulated feeds in optimizing larval development, offering a cost-effective strategy to enhance hatchery efficiency and support sustainable Mrigal aquaculture in Sri Lanka.

Keywords: Aquaculture, *Cirrhinus mrigala*, High-protein diet, Larval growth, Survival rate

Phenotypic Diversity and Socio-Economic Data Related to Village Pig Farming in Kalamulla, Kalutara District of Sri Lanka

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Village pigs (VP) are the native pigs in Sri Lanka. However, data on population diversity is scarce. A study was undertaken to investigate the phenotypic diversity of VP and socio-economic status related to VP farming. Phenotypic data were collected from a population of 26 VP (n=3 sows, n=7 boars, n=3 sucklings, n=4 barrows and n=9 gilts) in Kalamulla, Kaluthara district. Qualitative data included coat colour type and pattern, ear type and orientation, tail type, and snout shape, while quantitative data included body weight, body length, tail length, ear length, chest girth, height at withers, abdominal circumference, and face length. A pre-tested structured questionnaire was used to collect socio-economic data from seven VP-rearing farmers. All the data were analyzed using R statistical software. Black colour was the dominant coat colour (50%) of the population. White-black (34.7%), black-white (11.5%) and white (3.8) coat colour were also prominent. The population had only smooth skin type, straight head profile and straight hair type. Most of the VP had a forward-oriented, erect ear type (77%) and straight backline. The majority of VP had long and thin snouts (61.5%) and curly tails (54.0%). Only 3.8% of VP had tusks. Body weight, body length, tail length, ear length, chest girth, height at withers, abdominal circumference, and face length were 25.7±4.29, 64.1±3.75, 21.0±1.49, 10.2±0.53, 67.1±4.31, 45.3±2.16, 73.0± 4.86 and 21.2±1.06 cm, respectively. The VP were reared under a free-range backyard system for meat purposes. They are fed with swill obtained from the nearby hotels in Kaluthara. The majority (71.5%) of farmers had medium-sized (10-50 animals) herds. Village pigs receive little veterinary care or government attention. Despite being raised in harsh conditions, they offer high returns due to low maintenance costs. However, their population is declining, and without prompt action from stakeholders, these pigs may soon face extinction in the region.

Keywords: Free range system, Native pigs, Population diversity, Qualitative and quantitative data

Incorporation of Palmyrah (*Borassus flabellifer*) Tuber Flour in Developing a Soft Serve Ice Cream Dry Premix: Assessment of its Physical, Chemical, and Microbiological Properties

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Ice cream, a popular frozen dairy dessert, now includes dry premixes for convenience. However, current versions often lack optimal taste, texture, and stability. There is a need for an improved soft-serve dry premix offering better flavor, consistency, shelf-life, and affordability to meet consumer and food service demands more effectively. This study developed a soft-serve ice cream dry premix aligned with Sri Lanka Standards Institution (SLSI) guidelines, aimed at providing a convenient, cost-effective, and shelf-stable product for consumers and manufacturers. The formulation included milk powder, sugar, stabilizers, emulsifiers (Distilled Monoglyceride, Glycerol monostearate) and flavoring agents to ensure a creamy texture, pleasant flavor, and extended shelf life. Novel to this formulation was the addition of Palmyrah tuber flour, rich in dietary fiber, to enhance the premix's nutritional profile. Substituting milk powder with Palmyrah flour at inclusion levels of 10%, 15%, and 20% demonstrated nutritional enhancement. The treatment combination with the highest overall acceptability was selected through sensory analysis. Data collected by sensory were analyzed by Friedman non-parametric test with a 95% confidence interval. Physiochemical parameters were tested for the control and three levels of Palmyrah flour substitution, and the best one among them was selected. Microbiological analyses confirmed the premix's and microbial safety over a 28-days. Key findings indicate that the formulation containing 12% fat with 100% DMG emulsifier (control) has the highest sensory appeal, but 20% of Palmyrah Substituted sample resulted in high dry matter, crude fat, fibre and protein, energy and ash. Although the inclusion of Palmyrah tuber flour improved the nutritional profile, higher replacement levels negatively impacted taste and texture, leading to lower acceptability in sensory evaluations. The study successfully developed a soft-serve ice cream dry premix that aligns with Sri Lanka Standards Institution (SLSI) guidelines, offering a convenient, cost-effective, and shelf-stable product, and the formulation achieved a desirable creamy texture and flavor profile while enhancing nutritional value.

Keywords: Ice cream dry premix, Palmyrah (*Borassus flabellifer*) tuber flour, Soft serve ice cream

Meat Consumption Behaviour in Western Province, Sri Lanka: Drivers, Trends, and Future Outlook

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Understanding consumer behaviour related to meat consumption and attitudes towards the different meat types offers valuable insights for local producers and potential investors. Therefore, this study aimed to explore meat consumption behaviour among consumers in Western Province, Sri Lanka, and identify current patterns and attitudes towards different meat types. A pre-tested structured questionnaire was used to collect socio-demographic information, and meat consumption behaviour and attitudes towards the different meat types from a stratified sample of 395 respondents across Colombo, Gamapaha and Kaluthara during June to August 2024. The data were analyzed using descriptive and selected non-parametric tests. The sample was predominantly female respondents (67.8%), with the majority in the age group of 21-30 years (53.41%) and 46.45% living in semi-urban areas. The majority of respondents (88.57%) preferred chicken, followed by beef (5.82%), pork (5.06%) and mutton (3.54%), consuming it 2-3 times weekly and purchasing 0.5 to 1 kg (51.39%) of fresh meat from meat shops (68.1%). Additionally, 83.04% consumed processed meat products, with sausages (63.41%) being popular due to their ease of cooking (35.38%). A significant correlation ($p<0.05$) was found between the type of meat consumed and gender, age, occupation, and religion. Meat consumption frequency, amount purchased at one time, and market choice were also found to have significant differences ($p<0.05$) across the demographics. While many perceive chicken meat to contain antibiotics, harmful substances, and hormones, its affordability, versatility and cultural significance often outweigh these concerns. Higher costs limit the consumption of beef and mutton. The consumer preferences in the Western Province are driven by affordability, cultural norms, and perceived safety. Chicken dominates the market, while demand for other meats remains limited by cost. These patterns offer clear opportunities for targeted investment, consumer education, and development of safer, value-added meat products to better align with evolving consumer expectations.

Keywords: Consumer, Meat types, Preference, Sri Lanka

An Assessment on Current Knowledge and Adoption of Napier Fodder for Enhancing Milk Production in Smallholder Dairy Farms in Kandawalai Veterinary Surgeons Division

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Our country heavily relies on importing milk and milk products, which account for 58% of national consumption, to bridge the gap between supply and demand. Consequently, there is an urgent need to increase local milk production. A holistic approach to improving milk production involves improving both the quality and quantity of cattle feed. This can be achieved by promoting the cultivation of Napier fodder for cattle feeding. This study aimed to assess the knowledge, awareness, and adoption of Napier fodder among smallholder dairy farmers in the Kandawalai Veterinary Division. The study investigates the impact of Napier fodder on milk production, identifies key factors affecting its adoption, and proposes recommendations to overcome existing barriers. Data were collected through structured questionnaires from 125 randomly selected dairy farmers. The responses were analysed by thematic categories and processed in Microsoft Excel. The research findings reveal that 67% of Napier fodder cultivators are male, and 81% of farmers maintain herds of one to five milking cows. Although 85% of farmers are aware of Napier's benefits, only 4% dairy farmers cultivate and feed it daily. Intensive management systems with Napier feeding result in higher average milk production (6.8 liters/cow/day) and better body condition scores (2.5 to 3.0 BCS), and disease incidence below 2%. Conversely, semi-intensive systems without Napier feeding show lower productivity and higher disease rates. Key constraints include limited resources for fodder cultivation (42%) and inadequate technical knowledge (15%), with 64% of farmers expressing a need for financial support to cultivate Napier fodder. The low adoption rate underscores the need for targeted technical training, improved access to resources, and government subsidies to enhance Napier fodder production for dairy productivity.

Keywords: Cattle farming, Fodder, Milk production, Napier

A Study on the Productivity and Viability of Women-Led Backyard Poultry Systems in Selected Villages of Kilinochchi District, Sri Lanka

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The present study evaluates the performance of women-led backyard poultry (WLBP) systems in four selected villages: Barathipuram (BP), Kirishnapuram (KP), Vivekananda Nagar (VN), and Malayalapuram (MP) in the Kilinochchi District through an integration of backyard poultry best practices through the Farmer Field Business School (FFBS) Approach and village-based savings and credit mechanisms. The detailed data were gathered in January 2025 from 126 WLBP farmers. KP had the highest proportion of WLBP small-scale farmers (33%), followed by BP (24%), VN (23%), and MP (21%). All villages recorded 2,050 hens during the period. In BP, 67% of farmers produced eggs, averaging 284 eggs per farmer, whereas in MP, only 15% produced eggs, with an average of just 83 eggs per producer for the last 3 months. The highest poultry mortality rate was observed in MP at 39%, followed by KP at 25%, BP at 22%, and VN at 15% in the first six months. Additionally, losses in chick numbers are being replaced by traditional hatching methods. Correspondingly, BP recorded the highest average monthly income (LKR 12,000) from egg sales, followed by KP (LKR 9,000), VN (LKR 7,500), and MP (LKR 2,750), excluding their home-level consumption. The established group-based savings and credit initiatives support to development of backyard poultry. They mobilize LKR 1,330,680, alongside recycled loans of LKR 1,033,000. The loan range is LKR 15,000 to 35,000, and the average savings per farmer is LKR 10,560 to date. These differences in management, particularly evident in locally available resources for feeding, healthcare, and record-keeping. The findings suggest that BP farmers and their poultry systems are more effective. It is recommended to refine these practices and develop a replicable backyard poultry model suited for Kilinochchi conditions.

Keywords: Backyard Poultry, Egg Production, Feeding Kilinochchi, Poultry Farming

Crop Science

Effect of Seed Priming Agents on the Germination of Rice (*Oryza sativa* L.): A Laboratory Investigation on Germination Performance

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Seed priming has emerged as a promising strategy to enhance germination and early seedling vigor under abiotic stress, particularly salinity stress, which adversely affects rice production. This study was conducted under laboratory conditions at the Department of Crop Science, University of Peradeniya, Sri Lanka, following a completely randomized design. The experiment evaluated the effects of six seed priming agents: mannitol, calcium chloride ($CaCl_2$), magnesium chloride ($MgCl_2$), sodium nitroprusside (SNP), zinc sulfate ($ZnSO_4$), and gibberellic acid (GA_3) on the seed germination of a salinity-susceptible rice variety, Bg 300. Seeds were primed in different concentrations of each agent: Mannitol (10, 20, 30, 40, 50 g/L), $CaCl_2$ (10, 15, 20, 25, 30 g/L), $MgCl_2$ (0.25, 0.5, 0.75, 1, 1.25 g/L), SNP (0.01, 0.016, 0.021, 0.026, 0.031 g/L), $ZnSO_4$ (2.5, 5, 7.5, 10, 12.5 g/L), and GA_3 (0.025, 0.05, 0.075, 0.1, 0.125 g/L). Germination parameters including, germination percentage, mean germination time, time for 50% germination, germination value, vigor index, radicle and plumule length, and radicle: plumule ratio, were assessed over a five days. Data were subjected to analysis of variance using statistical analysis software, and differences between treatment means were analyzed using Duncan's multiple range test at $p \leq 0.05$. GA_3 at 0.125 g/L, SNP at 0.031 g/L, $MgCl_2$ at 1 g/L, $CaCl_2$ at 10 g/L, mannitol at 30 g/L, and $ZnSO_4$ at 2.5 g/L were identified as optimal concentrations enhancing seed germination without reducing the quality of the seedling. GA_3 and SNP significantly accelerated the germination, while $MgCl_2$ and $ZnSO_4$ maintained stable germination indices across concentrations. $CaCl_2$ and mannitol at higher concentrations exhibited inhibitory effects due to osmotic stress. The selected priming agents were previously reported to be effective in mitigating salinity stress. Therefore, these findings highlight the potential use of these seed priming agents for improving crop establishment of rice in stress-prone environments. Future research should focus on evaluating the long-term field performance and stress adaptation of primed seeds.

Keywords: Paddy, Priming treatments, Stress, Tolerance

Influence of Soil Moisture Levels and Cytokinin Application on the Photosynthesis of Mung Bean (*Vigna radiata* L.) Variety 'Harsha'

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Mung bean (*Vigna radiata* L.) is a vital legume crop that is widely grown for its nutritional value as well as for its ability to fix atmospheric nitrogen to enrich the soil. However, soil moisture stress is a major limitation which reduces the yield of Mung bean, and the application of cytokinin is known to mitigate stress in plants. The focus of this study was to analyse the photosynthetic response of the mung bean variety 'Harsha' to different soil moisture levels and the application of cytokinin (kinetin). The experiment was conducted as a completely randomized design (CRD) with 2 factors; two levels of moisture (80% field capacity and 40% field capacity), and two cytokinin levels (0 and 150 mg/L kinetin) under greenhouse conditions. Kinetin was foliar sprayed for five times in weekly intervals after flowering. The rate of photosynthesis and stomatal conductance were measured once after flower initiation. Flower and fruit setting were measured daily basis. Data was analysed using Statistical Analysis Software (SAS). According to the results, the cytokinin application did not significantly affect photosynthetic rate and stomatal conductance. The photosynthetic rate of plants grown under high soil moisture was 10.1 µmol CO_2 $m^2s^1plant^1$, whereas those under low moisture conditions showed nearly a 50% reduction, showing the significant impact of water availability on photosynthetic efficiency. A similar trend was observed in stomatal conductance, which dropped from 0.08 mol H_2O m^{-2} $s^{-1}plant^{-1}$ in well-watered plants to just 0.02 under moisture-limited conditions. The interaction effect did not significantly affect the rate of photosynthesis ($p>0.05$). Kinetin application resulted in 3 days earlier flowering compared to control plants. Interestingly, a higher number of flowers were observed in plants treated with cytokinin under high soil moisture conditions. The interaction effect significantly affected the flowering and pod setting ($p<0.05$).

Keywords: Cytokinin, Mung bean, Photosynthesis, Soil moisture

Effect of Salinity on Root Characteristics of Saline Susceptible Rice Seedlings

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The root system of a plant is more exposed to and affected by soil salinity, and it requires adaptations to withstand soil salinity. The salinity effect on root characteristics determines the resistance to salinity. Studying the root characteristics of rice under soil salinity is crucial for understanding the adaptive mechanisms and identifying its responses to salinity. Saline-susceptible varieties are those that exhibit distinct responses to salinity stress. Therefore, root characteristics of a widely grown saline susceptible rice variety, Bg 300, at its seedling stage were evaluated under different levels of electrical conductivity (i.e., 0.3, 0.4, 0.75, 1.5, 3, and 4 dSm^{-1}). Rice seedlings were grown in pots inside a greenhouse at the Faculty of Agriculture, University of Peradeniya. The experiment was laid out in a completely randomized design with five replicates. One-month-old seedlings were harvested, and root length, root volume, root thickness, and root surface area were measured and analyzed. Results revealed that salinity level beyond a threshold of 3 dSm-1 significantly reduced the root length of the rice plant; at 4 dSm^{-1} salinity, root length was reduced by 36% to 3 dSm^{-1}, while significantly increasing the average root diameter of the rice plant by 43.3% ($p<0.05$). As a result, root volume remained unaffected by salinity stress. Salinity stress may have inhibited cell division and elongation, resulting in shorter roots, while thicker roots formed due to increased lignin and suberin deposition—an adaptive response that enhances salt tolerance by limiting ion uptake, promoting ion compartmentalization, and strengthening oxidative defence. Overall, soil salinity more than 3 dSm^{-1} resulted in activation of salt tolerance adaptations, which led to short and thick roots in rice seedlings.

Keywords: Lignin, Osmotic stress, Root diameter, Root length, Salinity

Effects of Soil Silicon Enrichment on the Growth and Dry Matter Partitioning in Rice (*Oryza sativa* L.)

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Although Silicon (Si) is not an essential element for plant growth, Si enhances stress tolerance, strengthens cell walls, and promotes plant growth; however, its bioavailable forms in soil are often limited. The study investigated the effects of soil Si enrichment on growth, root anatomy, and dry matter partitioning of rice. The experiment was conducted in a glasshouse at the University of Peradeniya as a pot experiment, using the drought-tolerant rice variety BG250, to evaluate its response under different levels of water supply. The soil used in the experiment belonged to Low Humic Gley. A completely randomized design with two treatments and 20 replications was adopted, including treatments as Si applied and not applied. As reported in the literature, a basal application of powdered silicic acid at 3 g kg^{-1} was incorporated into the soil for the experiment. A month after transplanting, plants were harvested. The variables, namely, stomatal density, specific leaf area (SLA), root dry weight, root length, root average diameter, shoot dry weight, and plant height, were quantified. Si fertilization significantly improved shoot dry weight by 45% compared to the non-fertilized control. Increased dry matter accumulation in shoots relative to roots indicated significantly improved biomass allocation of 62%, which was attributed to strengthened cell walls and better nutrient uptake. However, no significant differences were observed in root biomass, average root diameter, SLA, or stomatal density. Si-treated plants also showed a significant increase in height of 28%, indicating enhanced plant vigor during the vegetative phase. These results demonstrate how Si may improve biomass partitioning and rice growth. To evaluate the long-term effects of Si under natural circumstances, field trials may be necessary. Moreover, future studies must address how other nutrients interact with Si to enhance grain quality and yield.

Keywords: Dry matter accumulation, Rice, Shoot dry weight, Specific leaf area

Identification of Promising Advance Breeding Lines through Preliminary Yield Evaluation from Fourth-Generation Hybrid Clones of Cluster Onion (*Allium ascalonicum* L.)

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Cluster onion *Allium ascalonicum* L. is one of the most important crops grown in Sri Lanka and has a lot of economic importance and nutritional value. However, its production is limited by reduced yield, inferior bulb quality, and less ability to withstand environmental stresses. Therefore, earlier research was initiated with the hybridization of selected parents, and the F1 population has been advanced vegetatively to fourth-generation clones (F1V4). Those clonal families were used in this experiment, focusing on assessing the morphological traits and preliminary yield of these fourth-generation hybrid clones derived from five cross combinations. Sixty different entries, including 58 hybrid lines and one recommended cultivar (Vethalam) and an advanced breeding line (KCRO 15 -01), were tested using Randomized Complete Block Design (RCBD) with three replications. Each 0.3m2 plot had 30 plants with a spacing of 10cm × 10cm. Observation recorded on germination, plant height, bulb size, Total Soluble Solids (TSS) at maturity, and yield per plot. The performances among the hybrid lines were compared using statistical tests of Tukey's mean separation. This study has exploited ample variations among the test entries in all parameters tested. Two entries, AHC_24_02 and AHC_24_41, had higher yield, good bulb quality, and high per day productivity than the standard checks, along with a few promising lines for desired traits. The present study points out that the application of a specific hybridization program can greatly expand the genetic pool and which will enrich the crop improvement of cluster onion using these clonal families.

Keywords: Characterization, Cluster onion, Hybridization, Hybrid clones

Cluster Analysis and Genetic Diversity Studies among Hybrid Clones of Cluster Onion (*Allium cepa* L.)

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Onion (*Allium cepa* L.) is one of the most valuable vegetable spice crops that belongs to the family Alliaceae (2n=16). It is a valuable economic crop as an entomophily cross-pollinated vegetable. A hybridization experiment of onion was initiated in Sri Lanka in 1996 with a reciprocal crossing parental combination. However, the existing knowledge about onion genetic diversity and resources is to be reviewed periodically for the efficient management of germplasm and selection of parents for crossing. This study was conducted at the Home Garden, Faculty of Agriculture, University of Jaffna, Kilinochchi, located in the lowland dry zone agroecological region, characterized by red-yellow latosol soil and flat to slightly undulating topography. The objective was to identify promising third-generation hybrid clones of cluster onion. This research was laid out as non-replicated from 94 clonal families originating from a five-cross combination of selected parental lines. These materials were studied morphologically and analysed with fourteen observed agronomic parameters for evaluating the performance of hybrid clones. Five plants were selected for data observation from the twenty plants of each clonal family. Results indicated that ample variation was found in the traits of the tested entries. The population generated from crosses showed a significant difference among all parameters tested. Flowering percentage and average leaf count were removed for cluster analysis based on high correlation values shown in the matrix. The first four principal components (PC) explained about 75.86% total variability among the four components: PC1 (7 traits), PC2 (3 traits), PC3 (3 traits), and PC4 (4 traits) contributed to variability. The variable showed a moderate correlation with their respective principal components. Performed cluster analysis revealed that there are three major clusters at 100 distance level. This study will be used for further selection of the tested clonal families.

Key word: Cluster onion, Germplasm, Hybrid clone

Identifying Seed Germination Requirements of Selected Lesser-known Fruit Species in Sri Lanka

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Although recognized as excellent sources of nutrients and dietary supplements, some fruit species introduced to Sri Lanka are still not widely cultivated. Poor seed germination may limit their cultivation, but understanding their germination requirements could help promote wider use among local communities. We examined the seed viability, germination under three light regimes (24-hour darkness, 24-hour light, and 12-hour light/12-hour dark), and two dormancy breaking treatments [500 ppm gibberellic acid (GA_3) and manual scarification] on fresh seeds and seeds stored under room temperature in an unsealed polythene bag for one month in three lesser-known, introduced fruit species: *Carissa bispinosa*, *Psidium friedrichsthalianum*, and *Sandoricum koetjape*. A total of 100 seeds [20 seeds per replicate (n=5)] from each species were used for all experiments with a Completely Randomized design. Results revealed that fresh seeds of all species exhibited a viability above 80 %, but after one month of storage, the viability of *P. friedrichsthalianum* seeds reduced significantly ($p<0.001$). Both fresh and stored seeds of this species did not germinate under 24-hour dark condition; however, germinated well under 24-hour light condition ($p<0.001$). Fresh and stored seeds of *C. bispinosa* germinated well across all tested light regimes while those of *S. koetjape* germinated well under 24-hour light, and 12-hour light/12-hour dark conditions. However, the time taken for germination of *C. bispinosa* was significantly reduced under continuous darkness (24-hour dark condition) ($p<0.001$) while *S. koetjape* showed a reduced germination time and higher germination percentage under a 12-hour light/12-hour dark cycle. Application of GA_3 significantly decreased the germination time (in 4 days) for both fresh and stored seeds of *P. friedrichsthalianum* ($p<0.001$), without affecting the final germination percentage. In contrast, manual scarification had no significant effect on the germination of any of the species tested. These findings suggest that the light conditions of typical of tropical regions are conducive to the germination of these exotic species. However, to popularize these lesser-known fruit species, other factors such as social, nutritional, and sensory aspects should be further studied.

Keywords: *Carissa bispinosa*, Introduced fruit species, *Psidium friedrichsthalianum*, *Sandoricum koetjape*, Seed germination

Effect of Biofertilizers Containing N-Fixer Application on Growth and Yield of Rice (*Oryza sativa* L.) Variety Bg 300

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Rice (*Oryza sativa* L.) is one of the most important staple food crops. The usage of chemical fertilizers supplies essential nutrients, increases the growth and yield of rice.It causes several health hazards. The study was conducted at Rice Research Station, Paranthan, during Yala 2021 to determine the effects of biofertilizers containing N- fixer application on the growth and yield performance of rice Bg 300, and reduced chemical fertilizer for yield maximization with minimum hazards. The experiment was laid out in the Randomized Complete Block Design with twelve treatments and three replicates. The treatments were T1: - *Azotobacter*; T2: - *Azotobactor* + Nitrogen (N) at 100% of recommended rate; T3: - *Azotobacter* + N at 50% of recommended rate; T4: -*Rhizobium*; T5: - *Rhizobium* + N at 100% of recommended rate; T6: - *Rhizobium* + N at recommended rate 50%; T 7: -Azolla; T8: - *Azolla* + N at 100% of recommended rate; T9: - *Azolla* + N at 50% of recommended rate; T10: N at 100% of recommended rate; T11: - N at 50% of recommended rate and T12: - Control (without fertilizer) using Bg 300 rice variety. The plant height (cm), number of tillers and panicles/m^2, panicle length (cm), 50% heading, 85% of maturity, 1000 grains weight (g), and grain yield (t/ha) were collected and subjected to ANOVA with means separation using the DMRT at 5% of significant level. The results reveled that T3: *Azotobacter* + N at recommended rate 50% as found to be the best in promoting the plant height (100.60 cm), tiller production/m^2 (280), panicles /m^2 (280), filled grain/panicle (140) and yield (4.174 t/ha). The control treatment, where no fertilizers were showed the lowest growth attributes and yield. The application of bio fertilizer *Azotobacter* + N at 50% recommended rate indicated the maximum values for growth and yield parameters and can be used as an alternative way in the production of rice to boost the yield with reduced cost and hazards to human health and environment.

Keywords: Biofertilizer, Growth, Nitrogen, Rice, Yield

Evaluation of the Effect of Spatial Arrangement of Two Companion Crops on the Yield of Onion (*Allium cepa* L.) in Jaffna District of Sri Lanka

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Onion (*Allium cepa* L.) is one of the main cash crops cultivated in the dry zone of Sri Lanka, including the Jaffna district where it holds significant agricultural importance. However, onion cultivation faces low productivity due to intensive monocropping, pest prevalence, weed problems, and high production costs. Intercropping provides a potential pathway for a sustainable agriculture system by improving yield with the effective use of resources through crop diversification. Thus, a field study was conducted in a farmer's field, Achchuvely, Jaffna district, Sri Lanka, to assess the impact of intercropping onion with two companion crops under different spatial arrangements. The experiment was laid out in the factorial randomized complete block design with two factors and three replicates. The treatments were two companion crops (radish and beetroot) and three spatial arrangements (monocropping, intercropping of single row onion with single row companion crop, intercropping of double row onion with double row companion crop). Plant growth parameters such as plant height, number of leaves, and yield parameters such as number of bulbs per cluster, bulb index, weight of cluster per plant, bulb mass, and yield were recorded. The collected data were analyzed using the SAS statistical package. The results revealed that among the spatial arrangements, the double-row pattern significantly ($p < 0.05$) increased the number of bulbs per cluster (6.64), weight of cluster per plant (39.63 g), and bulb yield (29.62 tons/ha) than monocropping and single-row intercropping. Among the companion crops, intercropping of onion with radish recorded significantly the highest number of bulbs per cluster (6.27), weight of cluster per plant (37.19 g), bulb mass (6.2g), and the yield (26.62 tons/ha). The land equivalent ratio was 1.21 for onion intercropped with radish at a double-row planting pattern. It indicated that intercropping performed better than monocropping. It can be concluded that the intercropping of onion with radish using a double row intercropping pattern could be advised since it improves the yield and land utilization.

Keywords: Intercropping, Land equivalent ratio, Onion, Spatial arrangements, Yield parameters

Food Science and Nutrition

Quality Standard Improvement in Paddy Parboiling Process of Traditional and Improved Paddy Varieties Through Hydro-Thermal Treatment

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Paddy parboiling unit was fabricated to produce SriLankan quality standard parboiled rice of two improved Sri-Lankan rice varieties: At 362, Bg 366 and one traditional rice variety "Addakari" at different parboiling conditions such as duration of soaking (hours), and three steaming methods: Pressurized-Soaking Steam (PSS), Un-soaked Steam (USS) and Soak Steam (SS). Quality standards of parboiled paddy were investigated for head rice yield (HR) during milling and resistance starch formation (RS) during cooking and texture during extrusion, with raw paddy rice as a control. Results show that PSS recorded the highest head rice yield as (90 ± 5%), which was achieved as a higher milling yield than the other traditional steaming methods investigated, which achieved this for 2 days of soaking duration (48 hours) and 30 minutes of steaming. All other compared steaming methods (USS and SS) achieved a moderate head rice yield of 70 ± 5%. The cooked rice kernel had high RS and a lower extrusion percentage (65 ±5%). Among the combined parameters tested in this investigation traditional variety "Addakari" performed higher RS than the improved paddy variety under the improved PSS streaming process with lower extrusion outcome (75 ± 5%). Raw rice showed lower RS with higher extrusion output (90 ± 5%) and lower milling recovery yield (65 ±5%) than all other parboiled rice samples investigated. Findings reveal that traditional variety performed a higher quality standard of parboiled rice than improved paddy variety.

Keywords: Dehusking, Hydro-thermal treatments of soaking, Milling and texture analysis, Paddy, Steaming and drying

Development and Characterization of a Dermocosmetic Lotion Incorporating *Nymphaea erangae* and *Atalantia ceylanica*

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The global cosmetic industry continuously enriches with different novel herbal cosmetics. *Nymphaea erangae* (NE) and *Atalantia ceylanica* (AC) are popular for their remarkable dermocosmetic and medicinal properties. NE contains flavonoids, alkaloids, and tannins, whereas AC contains essential oils, coumarins, and flavonoids that are crucial for skin tone improvement while minimizing damage from oxidative stress, harmful radiation, and carcinogens. However, no evidence has been reported for herbal cosmetic production synergizing their properties. The objective of this study was to develop a novel body lotion combining these herbs and standardize it through a systematic quality evaluation. Treatment 1 (100% chemical formulation), treatment 2 (96% chemical formulation and 4% NE Flower extract (NEFE), 2% AC leaf extract (ACLE)), treatment 3 (commercial cosmetic body lotion). The experimental design was CRD, and two-way Analysis of variance was used to analyze the data using R Studio (version 4.1.1). Comparative analyses were performed on radical scavenging activity (RSA), flavonoid content, sun protection factor (SPF), moisture retention, pH stability, spreadability, and viscosity. The RSA was measured according to the DPPH assay, flavonoid content was determined using Aluminum chloride colorimetric method, SPF was measured using UV spectrophotometric testing and Mansur equation. Moisture, pH and viscosity were measured using moisture meter, pH meter and viscometer respectively. Spreadability was measured using the parallel plate method. The study revealed that treatment 2 (NEFE 4% and ACLE2%) demonstrated the significantly highest RSA, 74.67%, flavonoid content, 536.27 ppm, sun protection factor (SPF, 34.08), and moisture content (58.5%). Physicochemical properties over a 50-day shelf-life showed no significant difference in net change in pH (5.32 to 5.30), spreadability (32.03 cm^2 to 33.71 cm^2), and viscosity (43.43 cP to 43.83 cP). Considering the results, we can elucidate that the NEFE and ACLE-based dermocosmetics occupy significant photo-protective and moisturizing properties, offering a leading-edge solution for aesthetic skin care.

Keywords: *Atalantia ceylanica*, Dermocosmetic, *Nymphaea erangae*, Secondary metabolites

Consumption Patterns and Awareness of Underutilised Fruits among Agricultural Undergraduates in Sri Lanka

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Underutilized fruits offer significant nutritional and economic value, but remain marginalised in mainstream food systems. As future advocates in the agricultural sector, agricultural undergraduates must develop a comprehensive awareness and understanding to effectively shape public perceptions. However, research on their awareness and consumption remains limited. This study evaluates the consumption patterns, awareness, and utilisation barriers of 12 selected underutilised fruits (Lovi, Ugurassa, Naran, Sapodilla, Himbutu, Madan, Beli, Nelli, Weralu, Donga, Kirala, and Laulu) among agricultural undergraduates in Sri Lanka. A structured, closed-ended online questionnaire was distributed among agricultural undergraduates from nine universities across the country. Using a convenience sampling approach, responses were obtained from 302 undergraduates. Descriptive and inferential statistical analyses were conducted using R software. Results showed 72.85% (n=220) of undergraduates were aware of underutilised fruits, and the frequency of consumption varied, with the majority consuming these fruits rarely or never, indicating a relatively infrequent consumption pattern. Most respondents consume these fruits raw (59.1%) or as juice (27.09%), primarily sourced from local markets (35.28%) and home gardens (32.70%). Statistical analysis revealed that income level significantly influenced consumption ($p<0.05$) of Naran and Beal, while purchasing habit, residential background, and education level showed no significant effects on consumption frequency. Awareness of their health benefits was high (86.4%) primarily through informal education, and the awareness did not significantly ($p>0.05$) vary with the study year of undergraduates. Additionally, 81.13% of students expressed willingness to promote underutilised fruits in their future careers. Despite high awareness, consumption of underutilised fruits among agricultural undergraduates remains low, largely influenced by socio-economic factors. This highlights the need for targeted curriculum enhancements and practical initiatives that promote engagement, entrepreneurship, and value chain development to support sustainable integration of underutilised fruits into food systems. This initiative facilitates the integration of these underutilised food sources into mainstream dietary practices.

Keywords: Agricultural undergraduates, Awareness, Consumption patterns, Underutilised fruits, Sri Lanka

Feasibility of Developing Biodegradable Cups from Tea Factory Waste Coated with Pectin Extracted from Citrus Peel Waste

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The excessive use of synthetic plastic packaging materials continues to pose serious environmental and health risks due to their non-biodegradable nature and potential migration of toxic substances into food. Therefore, this study investigated the feasibility of producing eco-friendly biodegradable cups from tea factory waste reinforced with pectin extracted from citrus peel waste. The research was categorized into two phases: (1) formulation and evaluation of three base layer ratios using tea waste and citrus peel semi-solid residue (1:1, 1:2, and 2:1) combined with 1% cellulose, 2 mL glycerol, and 98 mL water per 100 g paste; and (2) development of coatings using cellulose and extracted pectin in two ratios (5.3:0.7 and 5:1) with 0.2 mL glycerol and 99.8 mL water. A total of six treatments (three bases × two coatings) were subjected to structural and mechanical evaluations, including Fourier Transform Infrared (FTIR) spectroscopy and Thermogravimetric Analysis (TGA) for functional group analysis and thermal behavior, respectively. Physical properties such as thickness (1.75 – 2.52 mm), tensile strength (3.89 – 8.53 MPa), burst strength (320 – 456 g/cm²), weight load resistance (2 – 6 kg), and water leakage time (up to 180 min) were assessed. The results of the above properties were analyzed using one-way analysis of variance with significant differences between means determined at a $p<0.05$ level. FTIR spectroscopy provides insights into the functional groups present in both the coating and base layers, indicating a complex chemical structure in each layer. The TGA assesses the weight loss of the base layer and coating layer as temperature incre ases. Results of the TGA study show that weight loss starts above 150˚C, indicating better thermal stability for both layers. Biodegradability, color change, and pH stability of the above cups were analyzed after food contact. The most promising formulation was the 1:1 base coated with cellulose and pectin in a 5:1 ratio, which showed excellent strength, water resistance, thermal stability, biodegradability, and food safety compatibility (pH variation < 0.2; color stability score > 4). This study demonstrates the potential of reusing agro-industrial waste such as tea waste and citrus peel for developing sustainable packaging solutions, supporting circular economy goals. The findings highlight a viable path for large-scale application in eco-friendly packaging industries, replacing petroleum-based polymers with renewable, biodegradable alternatives.

Keywords: Biodegradable cup, Citrus peel, Pectin, Sustainable packaging, Tea Factory waste

Plant Protection and Biotechnology

Evaluating Phenotypic and Biochemical Parameters of Wheat (*Triticum aestivum* Jinmai No. 1) in Response to Biostimulants Under Salinity-induced Stress

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Bread wheat (*Triticum aestivum* L.) belongs to the Poaceae family, is a widely cultivated cereal crop worldwide. However, increasing soil salinity has led to significant yield losses in wheat. Amino acid (AA)-rich biostimulants induce crop resilience to abiotic stress. Still, its efficacy for overcoming salinity stress in cereals remains unexplored. Recent studies show the capability of fish biostimulants (FB) to alleviate salinity stress in Asteraceae crops. Therefore, in this study, we investigated the salinity impact by applying different treatments(T) (0, 1%, 2%, 3%, 4% v/v) of FB on Jinmai No. 1 wheat subjected to induced salinity levels (0, 40 mM, 80 mM, 120 mM NaCl) with non-treat controls, Experimental setup arranged in a completely randomized design with 4 replicates. Data were analyzed in a two-way ANOVA using SPSS. Results showed the abundance of stress-responsive AAs in FB, which significantly improve seed germination and plant growth parameters while mitigating the negative impact of salinity. T1 reported the highest seed germination and plumule development. Under severe salinity (S120 mM), results showed significantly higher values for relative water content (0.81±0.00%), leaf count (5.25±0.25), carotenoids (0.23±0.03 gml^{-1}), in T1 and internode count (2.87±0.3), total chlorophyll count (1.68±0.03 gml^{-1}) in T2 and shoot weight (1.46±0.12 cm) in T3 conversely, significantly lower soluble carbohydrates (78.60±10.0 mg g^{-1}) in T2 and antioxidants including superoxide dismutase (31.02±0.20 μml^{-1}), peroxidases (2.68±0.63 μml^{-1}), in T4 compared to the control. Moreover, these parameters fluctuated depending on their role in plant stress alleviating mechanisms. Therefore, it can be elucidated that the use of FB is a sustainable approach for improving crop resilience under salinity stress, contributing to eco-friendly modern agriculture.

Keywords: Antioxidants, Fish biostimulants, Nutrient supplements, Salt stress, Sustainable agriculture

Management of Okra Yellow Vein Mosaic Virus Disease Using Plant Extracts

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Okra (*Abelmoschus esculentus* L.), or lady's finger, is a member of the Malvaceae family and commonly referred to as the "villager's vegetable." It is valued for its high nutritional content, including essential minerals, vitamins, and fiber. In Sri Lanka, okra is mainly cultivated in the dry zone, particularly in the Jaffna region. However, its production is significantly affected by Okra Yellow Vein Mosaic Disease (OYVMD), a major viral threat to okra cultivation. The objective of this study was the management of the OYVMV disease and its vector through botanical extract application. The local okra variety (TV 7) selected for this study was grown in the field under RCBD with three replicates. Six treatments viz., Neem oil 2% , 2% Neem leaf extract, 2% onion bulb extract, Imidacloprid 350 g/l SC, control (no botanicals or chemical application), and water application. The quantitative data were subjected to Analysis of variance (ANOVA), and where significant differences were obtained (p-value of 0.05 or less), Duncan's multiple range test (DMRT) was employed to separate means. Among the treatments, neem oil, neem leaf extract and Imidacloprid 350 g/l SC were effectively reduced the disease incidence with the mean value of 24.47%, 25.97% and 21.14% at 50 days after planting (DAP) and 47.43%, 45.70% and 47.56% at 70 DAP respectively, compared to control. These three treatments also gave the better yields with the mean value of 9.91, 9.967 and 10.147 t/ha respectively. Plant extracts used as bio-pesticides were used to manage the disease to avoid the hazardous effects of chemicals on human health and being the eco-friendly. In conclusion, the okra growers are advised to apply plant extracts as bio-pesticides to control YVMVD diseases and their vector to enhance the okra production.

Keywords: Disease incidence, Management, Okra, Plant extracts, Yield

Evaluation of Potential and Biology of *Spodoptera pectinicornis* (Hampson) for the Biological Control of Aquatic Weed *Pistia stratiotes*

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Pistia is considered the most invasive aquatic monocot weed globally due to its high multiplication potential. The larvae of the phytophagous *Spodoptera pectinicornis* (Lepidoptera) were found to damage *P. stratiotes* extensively. Hence, this study aimed to investigate the biology and feeding potential of *S. pectinicornis.* Initially, aquatic weed *Pistia* was reared in a container with pond water, and the bioagent, *S.pectinicornis*, was inoculated on *Pistia* to study its life cycle. The life cycle of *S. spectinicornis* consists of four stages: egg, larvae, pupa, and adult. The mean diameter of an egg was 0.317 ± 0.020 mm. There were six larval instars in *S. pectinicornis*. The sex differentiation was observed in the 5th and 6th instars, and the testes' mean length and width were 1.187 ± 0.11 mm and 0.716 ± 0.085 mm, respectively. Sexual dimorphism was observed; male and female genital distances were 0.219 ±0.021 mm and 0.701 ± 0.058 mm, respectively. Adult males had pectinate antennae, whereas females had filiform antennae. The leaf damage by different instars of larval *S. pectinicornis* were 1st instar 0.017 cm^2 (0.348%), 2nd instar 0.025 cm^2 (0.528%), 3rd instar 1.50 cm^2 (30.564%), 4th instar 2.634 cm^2(58.132 %), 5th instar 3.306 cm^2 (67.342 %), 6th instar 4.482 cm^2 (91.256%) in 12hours. The larvae cause significant damage to the leaves, apical buds, and flowers of *Pistia*, with leaf damage reaching 91%, adversely affecting photosynthesis. Most feeding occurred during the later larval instars, which correlates with maximum damage. But it was observed that *P. stratiotes* reproduced through stolons, producing 8–9 young plants per colony, which were relatively unaffected by phytophagy, while seed production was compromised. Even though the rapid reproductive cycle of *S. pectinicornis* minimizes photosynthesis and seed production, developing a management strategy focused on controlling stolon multiplication is essential to mitigate the spread of *P. stratiotes*.

Keywords: Feeding Potential, Morphometrics, *Pistia*, Sexual dimorphism, *Spodoptera pectinicornis*

Bionomics of Polyphagous Red Spider Mite, *Tetranychus urticae* Koch Under *In-vitro* Conditions

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The red spider mite (*Tetranychus urticae* Koch) is a substantial agricultural pest with a broad host range and high reproductive potential. This study explores the biological traits such as development stages, reproductive biology and morphology of red spider mite under laboratory conditions (31 ± 1℃ and 54 ± 3% RH). The red spider mite was reared on a 2.5 cm leaf disc array set up in a petri dish. Reading was taken at four-hour intervals to measure the development period. The results revealed that, its life cycle comprised egg, larva, protonymph, deutonymph, and adult stages. The immature stages were distinguished by brief periods of quiescence known as nymphochrysalis, dutochrysalis, and teliochrysalis. The male and female had recorded incubation periods of 65.07 ± 1.83 and 64 ± 0 hours, larval periods of 13.60 ± 2.53 and 16.80 ± 3.10 hours, protonymphal periods of 8.53 ± 1.41 and 11.47 ± 2.10 hours, and deutonymphal periods of 12 ± 0 and 14.93 ± 2.37 hours, respectively. Male development took shorter (140.27 ± 4.40 hours) than female (151.20 ± 3.10 hours) from egg to adult emergence. On average, 122.10 ± 19.77 and 85 ± 18.56 eggs were produced by mated and unmated females, respectively. Sexual dimorphism was observed in the deutonymphal stage, as the body size of females (0.34 ± 0.02 mm length and 0.27 ± 0.02 mm width) was higher than that of males (0.30 ± 0.02 mm length and 0.20 ± 0.02 mm width). Studying the bionomics of red spider mites under in-vitro conditions would be helpful to set the optimum conditions for rearing or mass multiplication of red spider mites for various research studies.

Keywords: Development period, Life cycle, Morphology, Reproductive biology, *Tetranychus urticae*

Effect of Biofumigation on *Meloidogyne incognita* and Microbial Biomass Carbon in Tomato Cultivation

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Biofumigation using cruciferous crop residues provides an eco-friendly and sustainable method for managing *Meloidogyne incognita* and improving soil health in tomato cultivation. This study evaluated the comparative efficacy of mustard, cabbage, cauliflower, and radish residues applied at 0.5%, 1%, and 2% w/w, along with *Pochonia chlamydosporia*-enriched farmyard manure (FYM) and a chemical nematicide (Velum Prime, Fluopyram 34.48% SC). The incorporation of residues significantly ($p \leq 0.05$) reduced nematode infection and reproduction parameters. Among the treatments, mustard at 2% w/w recorded the highest reduction in gall formation (93%) and egg masses (89%) per plant. Principal Component Analysis (PCA) distinctly grouped the high-dose biofumigant treatments (2% w/w) as most effective, with lower infection levels, while 1% applications also showed statistically similar effects in many parameters. Plant growth parameters such as height, shoot and root length, and biomass were significantly enhanced by biofumigation, particularly with mustard at 1% and *P. chlamydosporia*-enriched FYM. Soil microbial health was also influenced by the treatments. The highest microbial biomass carbon (MBC) was recorded in *P. chlamydosporia* treatment (310 µg/g), followed by 1% biofumigation treatments (255–285 µg/g), indicating microbial stimulation. However, 2% w/w application slightly reduced MBC (215–230 µg/g), while Velum Prime recorded the lowest (180 µg/g), suggesting suppression of microbial activity. Dehydrogenase enzyme activity followed a similar trend, with the highest activity in *P. chlamydosporia* (70 µg/g) and the lowest in Velum Prime (41 µg/g). Overall, 1% biofumigation and *P. chlamydosporia*-FYM were most effective in suppressing *M. incognita* and improving plant and soil health, highlighting their potential for integrated PPN management.

Keywords: Biofumigation, Dehydrogenase enzyme, Microbial biomass, *Pochonia chlamydosporia,* Root-knot nematode

Soil, Environment and Water Sciences

Effect of Different Types of Soil Amendments on the Soil Aggregate Stability in *Eleusine coracana*-Grown Soil

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Stability of aggregates plays a crucial role in determining the physical health of soils. Soil amendments applied in agriculture may induce various properties, such as soil water repellency (SWR), which can influence the stability of aggregates. This study examined the effects of different soil amendments and their SWR on aggregate stability in *Eleusine coracana* (finger millet) grown soil. Cattle manure (CM), water-repellent leaf litter (*Casuarina equisetifolia*, CE), CE-derived biochar (BCCE), and quick lime (CaO) were mixed with sieved surface soil (3% CM, 3% CE, 3% BCCE, 1% CaO). Only soil was used as the control. The experiment followed completely randomized design with treatments in triplicate. Soil mixtures were filled into polybags (3750 g per bag) while maintaining the homogeneity of the bulk density for treatments. The moisture content was initially maintained at 80% of the field capacity of soil (450 cm^3 per polybag) to ensure initial homogeneity. Germinated *E. coracana* seeds were transplanted and kept in a protected house. Initially, the SWR of mixtures was determined using the water drop penetration time (WDPT) test. At the 10^{th} week, all aggregates were separated into two-equal (7 cm) layers (TL: top layer and BL: bottom layer) of each polybag and the percentage of water-stable aggregates (% WSA) was determined using wet sieving apparatus. The 3% CE-amended sample showed slight SWR, while others were non-repellent. The 3% CE-amended sample showed the highest % WSA (TL: 99.21% and BL: 99.23%, $p<0.05$) due to the high initial hydrophobicity of CE. The control showed the lowest % WSA (TL: 76.17% and BL: 75.52%, $p<0.05$). Results showed that the slightly repellent 3% CE significantly enhanced the % WSA. SWR reduces the water entry into the aggregates and lowers pressure buildup, enhancing their resistance to disruption. Results validation under field conditions is required to ensure field applicability.

Keywords: Soil amendments, Stability of aggregates, Water repellency

Impact of Heating Temperature on Water Repellency and Functional Group Alterations of Leaf Litter Ash from Japanese Cedar (*Cryptomeria japonica*) and Japanese Cypress (*Chamaecyparis obtusa*)

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Water repellency (WR) is a phenomenon where soil resists wetting due to the presence of organic matter (OM). Compositional and structural changes in this OM can alter the degree of WR, subsequently affecting the bio physicochemical properties of soils. Forest fires can transform biomass into ash with varying hydrophobicity levels, which in turn affect the soil hydrology by reducing water infiltration and disrupting moisture distribution. However, limited information exists on how temperature variations affect WR and functional groups of litter ash during heating. This study investigated the temperature influences on WR and functional groups in leaf litter ash of Japanese cedar (CED) and Japanese cypress (CYP). The litter of these two coniferous species are rich in hydrophobic resins and waxes to induce WR and are susceptible to wildfires. Leaf litter was heated at 100, 200, 300, 400, 500, and 600 °C for 20 min in a muffle furnace, with a control sample at 28 °C. The degree of WR (contact angle; θ) and functional group changes were measured with the molarity of ethanol droplet test and Fourier transform infrared spectroscopy (FTIR), respectively. The control samples of both species were highly water-repellent (θ = 125° and 119°) for CED and CYP, respectively. Litter WR decreased with increasing temperature to become wettable at 600 °C (θ = 90°). In FTIR analysis, three absorbance peaks of B, C, and E were recorded (wavenumbers = 3020–2800 cm^{-1}, 1640–1600 cm^{-1}, 1170–950 cm^{-1}, respectively), which consist of hydrophobic functional groups causing ash WR. These peaks disappeared at 300–400°C, parallel to the disappearance of ash WR. Simultaneously, peaks D and F (wavenumbers = 1400 cm^{-1} and 872 cm^{-1}, respectively) appeared, which may not cause ash WR. These findings highlighted the heating effect on WR and the functional groups of litter ash, providing insights into post-fire soil hydrology. To reflect real field conditions, further studies should focus on variations in oxygen availability, heating rates, and moisture conditions.

Keywords: Forest fires, Functional groups, Leaf litter ash, Temperature, Water repellency

Impact of Different Cover Crop Management Systems on Soil Properties

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Rubber (*Hevea brasiliensis*) is a vital plantation crop in Sri Lanka, contributing significantly to the agricultural sector. However, continuous rubber cultivation causes a decline in soil fertility, negatively impacting long-term productivity. The study aimed to characterize the soil chemical properties in immature rubber lands under different cover crop management practices. Eighteen soil samples were collected from 0 - 0.15 m depths in three different immature rubber lands (Blocks) situated within the Boralu soil series at Clyde estate. Each site represented a different cover crop condition (treatment): Fully Established Cover Crop, 12 months (FCC), Partially Established Cover Crop, 6 months (PCC), and Natural Vegetation Cover (NVC). *Mucuna bracteata* was utilized as a cover crop, and a consistent fertilizer application was employed across all sites. The collected soil samples were analyzed for key chemical properties, including soil pH, soil organic carbon (SOC), exchangeable potassium (Ex. K), exchangeable magnesium (Ex. Mg), total nitrogen (TN), and available phosphorus (Av. P). The study employed a Randomized Completely Block Design (RCBD), with data analyzed using analysis of variance (ANOVA) followed by mean separation using the Least Significant Difference (LSD) test. The experimental setup included three treatments (FCC, PCC, and NVC), with three sites considered as blocks. The results indicated that SOC (1.3 ± 0.09%), Av. P (20.17 ± 0.19 mg kg^{-1}), Ex. K (59.3 mg kg^{-1}), and Ex. Mg (24.25 ± 8.28 mg kg^{-1}) was significantly highest under FCC, while TN (2.4 ± 0.19 mg kg^{-1}) was highest under NVC. All measured soil chemical parameters exceeded the existing soil nutrient conditions in the Boralu soil, SOC (0.9–1.3%), Av. P (20–35 mg kg^{-1}), Ex. K (40–60 mg kg^{-1}), Ex. Mg (20–30 mg kg^{-1}), and TN (0.09–0.13%). However, soil pH did not significantly differ among the three cover crop management practices. Overall, the FCC significantly improved most soil chemical parameters, except TN. These findings emphasize the potential benefits of cover crop management in enhancing soil chemical properties in immature rubber plantations in Sri Lanka.

Keywords: Boralu soil series, Cover crop management, Fertility, Soil erosion

A Systematic Review of Emerging Contaminants in Surface Waters: Sources, Impacts, and Monitoring Approaches

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Emerging contaminants (ECs) such as pharmaceuticals, personal care products, endocrine-disrupting chemicals (EDCs), microplastics, and industrial additives are increasingly being discovered in surface waters globally. These unregulated and persistent pollutants originate from diverse sources including urban wastewater, agricultural runoff, and industrial effluents. Even though there have been extensive studies on ECs in marine and soil matrices, their presence, migration, and monitoring in surface freshwater systems remain a growing concern. The aim of this systematic review is to identify the major sources and types of ECs in surface waters, summarize their ecological and health impacts on humans, and assess conventional and emerging methods for monitoring ECs. The PRISMA guideline was used to ease the review process. Fourty peer-reviewed papers between 2010 and 2024 were examined, selected from Scopus, ScienceDirect, SpringerLink and Wiley Online Library databases using keywords including "emerging contaminants," "surface water," "monitoring techniques," "ecological impacts," and "wastewater pollution." The findings highlight wastewater outfalls, agricultural pesticides, and industrial effluents as dominant sources. ECs enter water bodies via runoff, leaching, sewer overflow, and atmospheric deposition. ECs pose grave health issues such as hormonal interference, reproductive disorders, and antibiotic resistance in human beings, as well as endocrine dysfunction and death in aquatic organisms. Classical methods such as gas chromatography-mass spectrometry (GC-MS) and liquid chromatography (LC-MS/MS) are precise and costly and require a lot of time. New technologies such as biosensors and remote sensing approaches using UAVs are being developed as potential alternatives for bulk, real-time surveillance. EC pollution control requires a multi-dimensional approach, including regulation, technological advancement, and awareness among the public. This review necessitates the construction of sustainable water monitoring systems to ensure the integrity of aquatic ecosystems and human health.

Keywords: Biosensors, Emerging contaminants, Monitoring techniques, Remote sensing, surface water, Wastewater pollution

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