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Hanthana Essence

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Postgraduate Institute of Agriculture, University of Peradeniya, Sri Lanka

SMART AGRICULTURE FOR SUSTAINABLE FARMING

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Postgraduate Institute of Agriculture (PGIA)
University of Perdeniya, Sri Lanka



34th PGIA

Annual Congress 2022

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PGIA Congress 2022

34th PGIA

Annual Congress 2022

Inside

I. Message from the Director

II. Message from the Coordinator

III. PGIA Congress 2022 Winners

01.

Efficacy of Introduced Non-Chemical Methods to Control Wax Moth in Honeybees in Sri Lanka

02.

Indiscriminate Fertilizer Application Has Degraded Vegetable Cultivating Soils in Central Highlands

03.

Gene pyramiding for common bean Rust-Resistance

04.

An unrevealed potential of Trees Outside Forest Sources in Sri Lanka : Upper Mahaweli Catchment landscape restoration through Homegardens

05

Variability of Soil pH and EC as Affected by Water Source, Cropping System, andSoil Order in Rice Cultivated Soils of Sri Lanka.

06

Variability of Soil pH and EC as Affected by Water Source, Cropping System, and Soil Order in Rice Cultivated Soils of Sri Lanka.

07

Gliricidia and Column Supports for the Production of Terminal Shoot Cuttings of Black Pepper

08

Food waste habits of families in the western province of Sri Lanka

09

Is insecticide tolerance in pests important in crop production?

10

Overcoming the digital barrier among the elderly population for mobile banking services in Sri Lanka

11

Sugarcane is a rich germplasm: why not exploit it properly in producing improved cultivars

12

Why Government Interventions in Homegarden Development are not succeeded?

13

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

14

Effect of Socio-Economic and Institutional Factors on the Choice of Food Production System Practiced in Home Gardens Gardens in Mahakanumulla Village Tank Cascade System (VTCS)

15

The future of the most famous food legume under soil moisture shortage in the inter season

16

Does Production Diversity Influence the Dietary Diversity in Rural Agricultural Context in Sri Lanka?

17

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

18

Towards building strong partnership between fishermen and other stakeholders in managing small-scale fisheries

19

Assessing the impact of elevational variation on health related properties in green leaves, black tea, green tea and instant tea made out of selected cultivar (TRI 2025) in low, mid and up country of Sri Lanka

20

Can we identify all Cinnamomum species in Sri Lanka?

21

Fungi as Biocontrol Agents in Management of Big Onion Diseases in Sri Lanka

22

Treasure in the wild: Cinnamomum species



Message from the Ditrector/ PGIA

It gives me a great pleasure to send this message as the Director of Postgraduate Institute of Agriculture (PGIA) on the occasion of the Institute publishing the Hantana Essence, a journal that is designed for disseminating information of research findings of the Institute to the general public. Since its establishment in 1976, the PGIA has enthusiastically engaged in human resource development as the national leader of postgraduate education in Agriculture in Sri Lanka. The Institute has so far produced over 5000 graduates in almost all disciplines in Agriculture. Before the Sri Lanka Qualification Framework (SLQF) Guidelines were launched by the UGC, every MSc student had to produce a Directed Study Report engaging in research mostly during the last semester of their study program while for research degrees such as MPhil by coursework and research, MPhil by research, PhD by coursework and research, PhD by research and MBA the students

Guidelines were imposed, Directed Study component (earlier 2 credits) has become a 5 credit Guided Independent Study providing opportunity for a much larger research component. Furthermore, the research degrees were designated as MSc (course work and research), MPhil (by research), PhD (by research), MBA (by course work and research) and MBA (by research) having the requirement of completing 1, 2, 3, 0.5, and 1 years' worth of full-time research or equivalent. Though these studies have been published in subject specific advanced scientific journals, the important scientific breakthroughs, innovations and inventions were not accessible to the general public in palatable and understandable manner. As development of agricultural sector involves swift adaptation of the new technologies, innovative solutions to burning issues and inventions leading to patents by the producers, manufacturers and the agri business sector, dissemination of the valuable findings to the general public had been the vital link missing in agricultural research at least at the level of postgraduate studies. Publication of Hantana Essence journal was one of the most effective steps taken by the PGIA to bridge the crucial gap between researchers and agriculture practitioners.

It is wonderful to see that the Hantana Essence journal is produced in a very vivid and attractive manner with text that is comprehensible and joyful to the reader. All scripts were written by the postgraduate students themselves and it has been a quite different and rewarding experience, far from their training in research manuscript writing. I would like to congratulate all involved including the Chief Editor and the Board for accomplishing such a wonderful task of bringing the journal to the present attractive state.

I sincerely hope the new volume of Hantana Essence, coming out at the dawn of the 34th Annual Congress of PGIA, would be the much awaited colourful bridge between the postgraduate research community of the PGIA and the general public.

Prof. C.M.B. Dematawewa
Director/PGIA



Message from the Congress Coordinator

It is with great pleasure that I write this message for the second volume of "Hanthana Essence: PGIA Congress in Brief." Hanthana Essence: PGIA Congress in Brief represents the collective thinking of a group of innovative academics, graduate students, their supervisors, and editorial board members with whom I am privileged to work. There is no secret that the landscape of scholarly publishing is quickly changing, as is the necessity of presenting complex research in simple language.

We want Hanthana Essence: PGIA Congress in Brief to look and feel different, and to serve as a vehicle for a new type of conversation among stakeholders. We want Hanthana Essence: The PGIA Congress in Brief to be the premier magazine for communicating postgraduate research to all stakeholders, including policymakers and the farming community.

The PGIA Annual Congress has evolved into one of the country's most prestigious scientific platforms. Hanthana Essence: PGIA Congress in Brief is one of the results of the PGIA's 34th Annual Congress which will be held as a virtual event this year, with the theme "SMART Agriculture for Sustainable Farming." Prof. Owen Atkin (Australian National University) will deliver the keynote address, and two invited speakers, Prof. Gordon A. Gow (University of Alberta, Canada) and Prof. Emmanuel Frossard (Institute of Agricultural Sciences, Switzerland), will participate online.

We received 49 full-length original research papers this year. 47 papers were chosen to be presented at the Congress after a rigorous peer-review process. The Congress's eight technical sessions are designed to identify common interests and foster collaboration across disciplines. The sessions will include oral and poster presentations, and presenters who demonstrate high levels of scientific excellence will be recognized with awards. This year, we organized four pre-congress workshops to help young scientists develop their skills in publishing and presenting scientific information. The PGIA Congress Research Brief Competition continued, with the goal of communicat-

Hanthana Essence: PGIA Congress in Brief (Volume 2) includes 22 research briefs received for the competition.

I must give special thanks to Prof. C.M.B Dematawewa, Director, Postgraduate Institute of Agriculture and the Chief Editor, Dr. SDS Hemachandra of The Hanthana Essence: PGIA Congress in Brief (Volume 2). I would also be remiss without acknowledging the contributions of Dr. Sewwandhi Chandrasekara in coordinating and editing this volume. I sincerely thank Prof. LHP Gunaratne, Prof. RM Fonseka and Prof. VA Sumanasinghe for their service as evaluators of the research brief competition. Tireless dedication of all members of the Subcommittee and the organizing committee of the PGIA Congress 2022 has made launching Hanthana Essence: PGIA Con-

My hope is that Hanthana Essence: PGIA Congress in Brief will continue to excel and build for the future in order to provide the best platform for postgraduate students to share outstanding science. I sincerely hope that all stakeholders will eagerly access
Hanthana Essence: PGIA Congress in Brief for the informative and stimulating science presented in simple language.

Prof. K.W.L.K. Weerasinghe
Coordinator 34th Annual Congress of the PGIA

34th PGIA Annual Congress 2022

34th PGIA Congress Winners

Research Brief Competition



S. A. D. Thakshila



H.A.N. Upekshani



H.M.P.S. Kumari

Oral Presentations



J.B.D.A.P. Kumara



K.A.P. Dalpathadu



B.S. Bandusekara



W. A. M. Lowe



P. Kowshayini

Poster Presentations



P.A.M. Dias



W.C.S. Wanasinghe

Overall Best Presentation



J.B.D.A.P. Kumara

PGIA Alumina Awards



B.S. Bandusekara



P. Kowshayini



J.B.D.A.P. Kumara



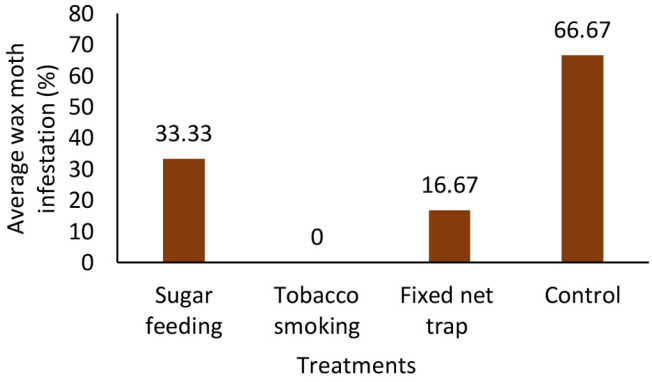
Efficacy of Introduced Non-Chemical Methods to Control Wax Moth in Honeybees in Sri Lanka

S. A. D. Thakshila



The greater wax moth (*Galleria mellonella*) is an extremely destructive pest problem for rearing honeybees in Sri Lanka. These moths can destroy bee colonies in a very short period. With time some control methods are followed by beekeepers based on their experience, but the efficacy of such treatments is not adequately investigated. Therefore, we conducted this study to investigate the effectiveness of the introduced non-chemical strategies to control the wax moth problem.

Findings



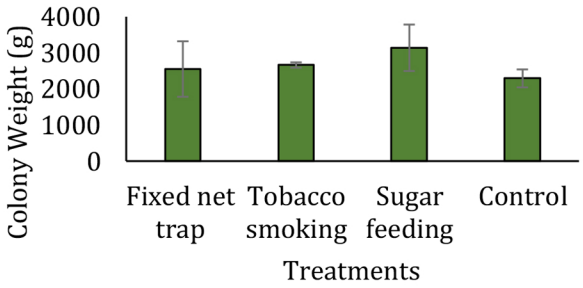
The average wax moth infestation among treatments

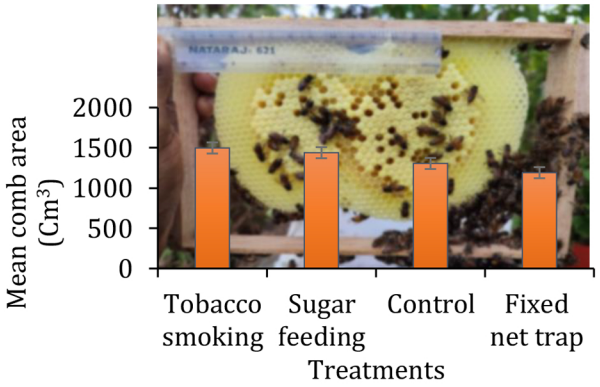
Infestation of the wax moth was lowest in the tobacco smoking method than in other methods and control (did not receive any treatments).



Smoking with dried tobacco leaves:
8-10 puff of smoke through the gate within 1-2 minutes

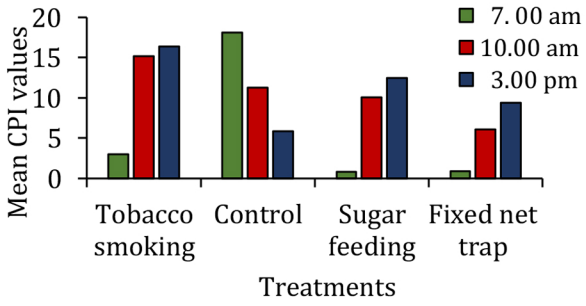
Effect of the colony growth





The colony performance was higher in all the treatments than in the control.

Colony Performance Index (CPI)



The CPI values of 7.00 am were different ($p<0.05$) among treatments and control. High in control but, with the time (10.00 am and 3.00 pm), there is no difference between the treatments and control.

Conclusion

All the treatments, tobacco smoking, fixed net trap, and sugar feeding help to reduce wax moth infestation in comparison with control. The practice of smoking colonies with dried tobacco leaves was successful in controlling wax moth infestation without affecting the overall colony performance.

2

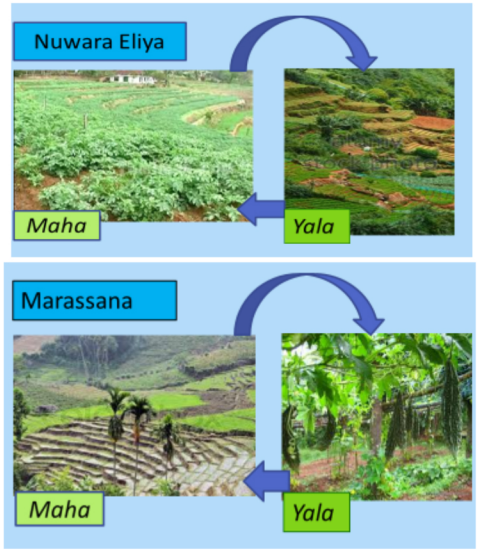


Indiscriminate Fertilizer Application Has Degraded Vegetable Cultivating Soils in Central Highlands

H.A.N. Upekshani

Cropping systems in central highlands

In Sri Lanka, about 50% of vegetable is produced in the Up Country. Vegetable cultivating fields in these areas are plowed at least three times a year and cultivated with either potato-vegetable-vegetable (in Nuwara Eliya) or paddy-vegetable-vegetable (in Marassana) using heavy doses of synthetic and organic fertilizers. Indiscriminate loading of plant nutrients as fertilizers could pollute the cultivating soils and the surrounding environment.

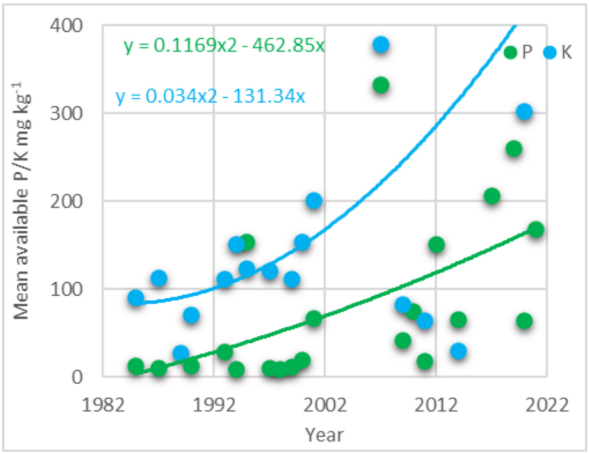


Land use in *Yala* and *Maha* seasons

Nutrient status in soil

This study was conducted using 100 farmer fields in Nuwara Eliya (NE) and Marassana (M) to assess the current status of chemical properties. The pH, pH buffer capacity, electrical conductivity, total carbon and nitrogen contents were comparatively higher in soils in NE along with plant available Phosphorous (P), Potassium (K), Magnesium (Mg), Sulphur (S), and Zink (Zn).

Nutrient levels in soils from both regions exceeded the levels considered as optimum for crop production. For example, P content in 90-100% studied fields exceeded the optimum levels (30 mg/kg) in both areas. Almost all fields had lower S, Cu and Zn contents than their optimum.



Changes in available P and K contents during 1982-2022.

Soil P exceeded environmental threshold

Changes in soil phosphorus contents over the last 40 years in these areas is being increasing in at an alarming rate (~5 mg/kg every year) and all soils analyzed in this study exceeded the maximum agronomic threshold levels (60 mg/kg). Similar trend was observed for the K as well.

Unless policy makers take stern action to curtail the indiscriminate use of fertilizers in these environmentally sensitive watersheds, cost of soil and water pollution cannot be recovered by any means in time to come. Farmers must be educated regarding the environmental threat hidden in their fields and soil test-based fertilizer application should be encouraged.

3

Gene pyramiding for common bean Rust-Resistance ınce

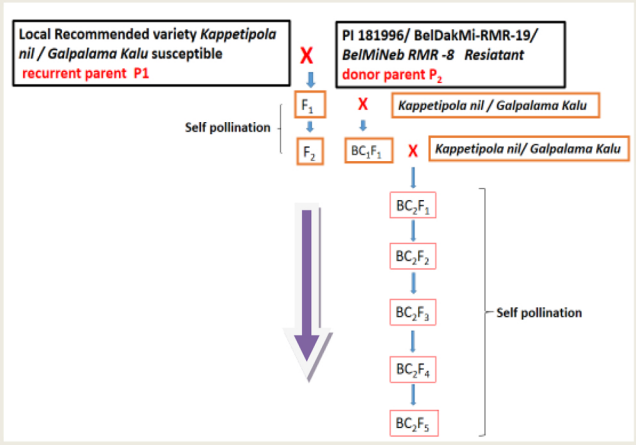
H.M.P.S. Kumari

Bean rust is one of the major diseases of common bean ((*Phaseolus vulgaris)* reported worldwide.



Rust infected bean leaves

This is the first effort in Sri Lanka on the development of rust-resistant snap bean breeding lines by gene pyramiding assisted by phenotypic screening and molecular markers. Interestingly, the rust-resistant genes *Ur-3* and *Ur 11* are suitable to overcome all reported rust races in Sri Lanka. Those resistant genes derived from imported resistant germplasm such as PI 181996, BelMiNeb-RMR-8, and BelDakMi-RMR-19, were incorporated into local popular varieties Kappetipola nil and GalpalamaKalu (Capri). Different Resistant progenies were obtained from different cross combinations among them.



New breeding line development process

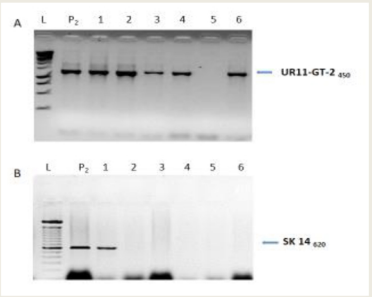
Only rust-resistant lines advanced to the next generation. Standard phenotypic disease screening methods were used to identify the newly developed resistant lines.

Phenotypically resistant plants obtained from these crosses were tested and confirmed with sequence-characterized amplified region (SCAR) markers linked to two rust-resistant genes; SK 14 (linked to Ur-3) and GT-2 (linked to Ur-11). Molecular markers assisted in selecting progenies with relevant genes, and SCAR marker GT 2 showed higher reproducibility (50% to 80%) than SK 14 (30-60%).

Advanced lines (BC2F5:4) with introgression of *Ur-3* and *Ur-11* rust-resistant genes, and having other desirable agronomic traits were selected for field trials. Four resistant lines obtained from the crosses (Kappetipila nil x BelDakMi-RMR-19, Galpalama Kalu x BelMiNeb RMR -8, Kappetipolanil x PI 181996, and Kappetipila nil x BelMiNeb RMR -8) were evaluated under field conditions. The selected lines were productive as other locally improved varieties and are selected for further variety recommendation process.



Field evaluation of new bean lines



Molecular marker responses for resistant lines



Pod characteristics of advanced resistant lines

A range of resistant genotypes was obtained with the introgression of *Ur-3* and *Ur-11* rust-resistant genes. These genotypes can be recommended as new resistant breeding varieties and used as the base population for future rust disease-resistant breeding programs in Sri Lanka.



An Unrevealed Potential of Trees Outside Forest Sources in Sri Lanka : Upper Mahaweli Catchment Landscape Restoration through Homegardens

H.M.Badra

What is the unrevealed potential of Homegardens as a Trees Outside Forest Source?

Upper Mahaweli Catchment (UMC) of Sri Lanka known as the heart of the country, has been degrading severely due to large scale deforestation over the last centuries and forest cover has now become restricted to isolated patches. Restoration through afforestation and reforestation incur huge cost and are limited to a few species which unable to compensate for the loss of tree diversity. Tree rich Homegardens (HGs) are able to overcome this challenge with high potential of restoration at low cost while maintaining high tree density and diversity and providing most of the ecosystem services as provided by a small patch of forest.

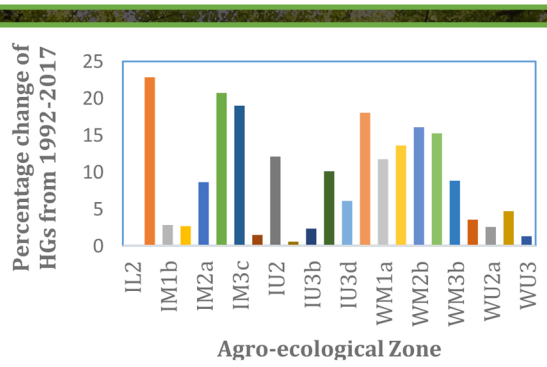






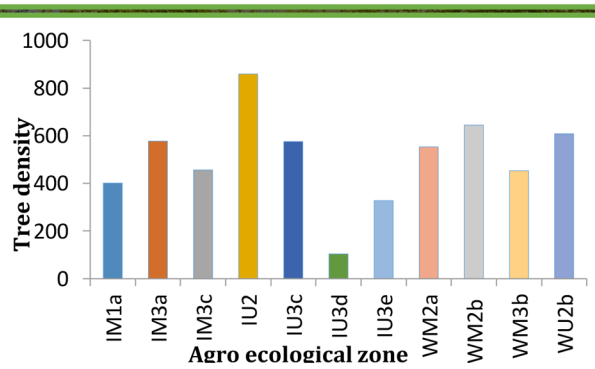
What are the significant findings?

- The extent of HGs has been increased significantly all agro-ecological zone. It means there is high potential in terms of extent.
- The average is in (505.45 trees/ha) of HGs is comparable with the tree density of south-Asian tropical rain forests. It indicates the high potential with tree density.
- However, there is a tendency of spreading exotic species rapidly to contribute high tree density of HGs in some agro-ecological regions such as IU_2 ,WM_{2a} and WM_{2b}.
- Number of Socio-economic, demographic, spatial and institutional related factors are influenced on tree density.



What was the research focus towards HGs ?

The catchment restoration potential of HGs is determined by the extent and qualitative characteristics such as tree density and diversity. Hence, it is important to know the distribution, changes of extent, and factors effect on tree density to explore the restoration potential of HGs.



How did we analyse the potential?

Temporal and spatial distribution of HG s of UMC in relation to agro-ecological regions was assessed using Landsat Images acquired in 1992 and 2017. Then, tree density was estimated using a 500 random sample of HGs located in the UMC with respect to the ecological zones. Finally, factors such as Socio-economic, demographic, spatial and institutional related factors which determine the tree density were evaluated using a regression analysis.

What policy makers should do with HGs?

- Special attention should be paid to promote HGs with high tree density and diversity.
- The study proposes to introduce special incentive package for HGs owners who are maintaining them with high tree density with native species in order to restore ecosystem services for the sustainability of the UMC.
- This study can be taken as a model to explore catchment restoration potential through HGs.



Variability of Soil pH and EC as Affected by Water Source, Cropping System, and Soil Order in Rice Cultivated Soils of Sri Lanka.

K.H.B.H.Delgoda

Rice is the staple food of the people in Sri Lanka. In Sri Lanka rice is cultivated mostly in Dry zone and Intermediate zone. Generally, rice is cultivated under submerged or alternate wetting and drying conditions. Soil reaction (pH) and electrical conductivity (EC) are considered as two major chemical parameters which determine rice yield. Since Dry Zone is having high evaporation, supplementary irrigation may cause to accumulate some salts. Therefore, this study was conducted to study the variation of pH and EC in rice cultivated soils as affected by major water source used for rice cultivation, rice-based cropping system adopted and rice growing soil orders in different agro-climatic zones (ACZs) in Sri Lanka.

Sample collection and processing

A total of 1000 soil samples were collected from lowland rice cultivated fields belonging to six agro-climatic zones (ACZs).

Measuring of soil pH and EC

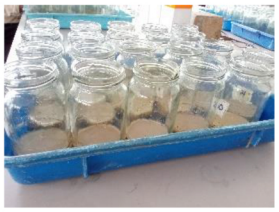
In the laboratory pH and EC were measured by using pH and EC meter.

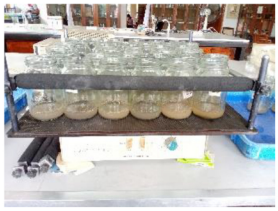
Statistical analysis

Statistical analyses were performed using SAS 9.1 software













The pH of paddy soil samples was in the range of 3.01-7.73 with a mean value of 4.98. Soil EC values were in the range of 1.09 to 3,169 μScm^{-1} with a mean value of 148.5 μScm^{-1}. Low country Dry zone (LD), LI and UI recorded higher pH values. Upcountry Intermediate zone recorded the highest EC values. soil pH values only in LD were affected by the interaction of water sources used and soil orders.

Conclusion

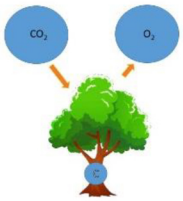
Only Soil pH was different among ACZs. More than 80% of the tested soil samples were non-saline. Overall results of this study revealed that, rice growing soils in Sri Lanka are not in the optimum range of pH for rice production. However, EC is not beyond the threshold level for rice production. Appropriate agronomic management practices need to be adopted to maintain pH and EC in rice growing soils at their optimum range.



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

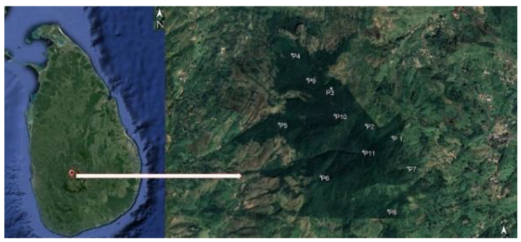
B. M. B. Weerakoon

The global attention for Climate change has increased during last few decades since its impact to the environment and human is significant. Carbon sequestration is the main process that forests can contribute to control climate change.



Sub montane forests have mixed characters of montane forests and lowland rain forests. Even the extent of these forests are low, the contribution to carbon storing potential as the biomass of these ecosystems cannot be neglected.

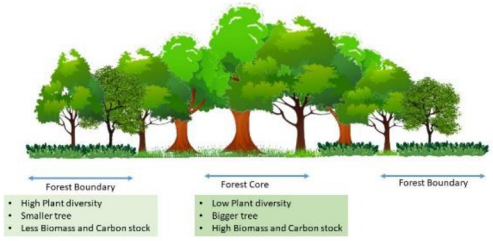
Rilagala Conservation forest is an isolated sub montane forest patch located in Nawalapitiya, Sri Lanka with an extent of 209 ha. Eleven plots of 25 m x 25 m were randomly demarcated covering the forest (8 plots in forest boundary [P1- P8], 3 plots in forest interior [P9-P11]). Tree species, Diameter at Breast Height (DBH) data were collected; and tree diversity, above ground biomass and Carbon stocks were calculated.



Location of the Rilagala Conservation forest

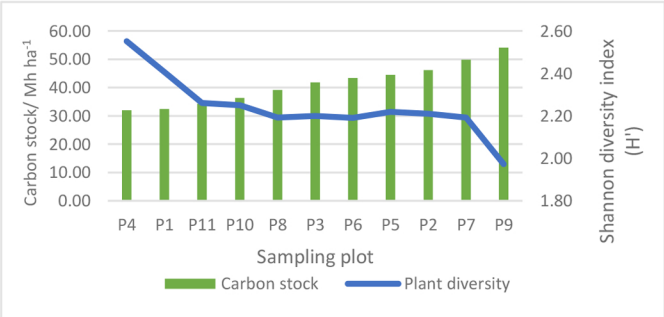
There is a variation in the vegetation structure of a forest from boundary to the interior. This variation leads to different in tree composition, species richness and diversity.

The highest tree diversity and species richness were recorded at the forest boundary plot. However, highest biomass and carbon stock was recorded at a forest interior plot.



Bigger trees can store more carbon as the biomass. Thus, high plant aboveground biomass was recorded in the plots with larger trees. Tree diversity has decreased with the tree size. Plots with larger trees had comparatively low tree diversity.

Tree diversity and Carbon stock variation across the Rilagala conservation forest



The highlight of this study is the importance of forest patches to store carbon and mitigate climate change. Areas with big trees can store more Carbon regardless the location within the forest. But the tree diversity and density were low in those areas. High attention needs to be given for conservation of these isolated forest patches because the threat of deforestation and fragmentation of these forest are high.



Gliricidia and Column Supports for the Production of Terminal Shoot Cuttings of Black Pepper

A.A.C.H. Dharmasena

A cutting with five nodes and two healthy lateral active shoots from the terminal parts of the pepper vines are selected as terminal shoot cuttings for the propagation. These cuttings are usually bigger in size and contain more food reserves, which facilitate a higher establishment rate in the nursery, exhibiting enhanced growth when planted in the field.

However, terminal shoot cuttings that can be harvested from a pepper field is limited to only 2-3 cuttings per vine, hence maintaining a source for planting material in the form of a mother plant garden is required to collect a greater number of terminal shoot cuttings at once.



A terminal shoot cutting of black pepper

Gliricidia supports

Gliricidia sepium sticks are used as the live support to trail the pepper vines.





Column supports

In this method, *Gliricidia* is used as live support; however, around the *Gliricidia* stick there has been established a plastic wire mesh. The space between the wire mesh and the *Gliricidia* stick is filled with a coir dust and cow dung mixture.





Single pepper vine per supporter is planted 7.5 cm apart from the base of the *Gliricidia* stick in both supports. With the time, vines are pruned and terminal shoot cuttings are harvested for the planting material production process. After the pruning, the newly arrived shoots from the main stems are allowed to grow again along the support.

Terminal shoot cutting production

- ✓ The mean number of terminal shoot cuttings produced with column and *Gliricidia* supports were 5.9 and 8.5 respectively per vine.
- ✓ It is important maintaining more than 7 shoots per vine until pruning of mother pepper vines when using column type supports.
- ✓ To maximize terminal shoot cutting production, training of more than one pepper mother vine to a column type support is recommended.



FOOD WASTE HABITS OF FAMILIES IN THE WESTERN PROVINCE OF SRI LANKA

R. G. I. C. Waidyarathne

What is Food Waste?

Food waste is the amount/quality of food that goes down because of consumers, retailers, or those who serve food.

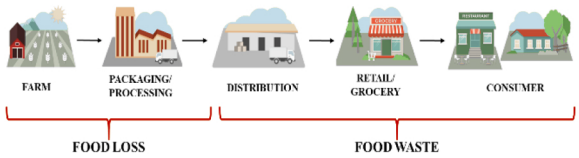


Figure 1: Food Supply Chain

Food Waste Around the World

About 17% of the world's food supply is wasted annually in retail stores and homes. On the other hand, 821 million people are malnourished. So, to make a sustainable food system, we need to reduce food waste and ensure that people who need food can get it.

Food Waste in Sri Lanka

Sri Lankan families throw away more than 1.6 million tons of food every year, and no one knows why. This study looks at how people buy and prepare food and how that affects the amount of food they throw away.

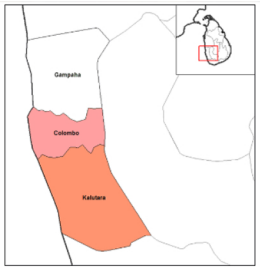


Figure 2: Study Site - Western Province of Sri Lanka

What the Study Found?

Of the sample, 61% was urban, and 39% was rural. Both food buyers and makers were mostly women. A family spends an average of LKR 10,000 - 20,000 per month on food. Our study found that leftovers and food expiration are the leading causes of food waste in households. Cooked rice and raw vegetables are the most wasted foods per week.

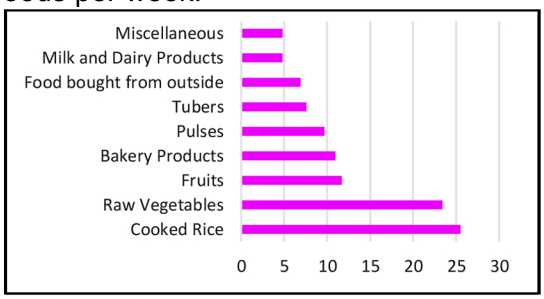


Figure 3: Wasted Percentage of Food Commodities

This study says that Sri Lankan households waste food because of how they buy and cook food. It showed that buying food in bulk / low quality to save money led to more food waste. But, contrary to common opinion, the intention to waste food did not affect food waste amount. Thus, food waste is not a planned behaviour.

Conclusion

Based on the results, changing how households buy and cook food could reduce food waste. Eventually, learning how to reduce food waste makes the food system more sustainable.

Is insecticide tolerance in pests important in crop production?



J.P. Marasinghe

The aphid, *Myzus persicae* is a sucking pest of many crops that has gained international prominence through vectoring plant viruses and withstanding insecticide toxicity. The widespread of aphid borne virus diseases questioned the effectiveness of the control measures taken against the vector. The claims on control failure of insecticides, made by the farmers in several agriculture intense areas and the extension staff of the Department of Agriculture had intensified the gravity of the problem. Therefore, it was planned to test the insecticide resistance status in the pest with the background of supportive factors in order to find possible solutions to the issue.





Aphids were collected from cabbage cultivations in 3 locations of wet, dry and intermediate zones, and reared in potted cabbage plants at the Horticultural Crop Research and Development Institute, Gannoruwa. Batches of aphids were exposed in repeated terms to concentration gradients of six commonly used insecticides using the leaf dip bioassay, for mortality assessment. For confirmation of resistance, the underlying mechanisms with respect to metabolic resistance and target site insensitivity were explored using biochemical assays.

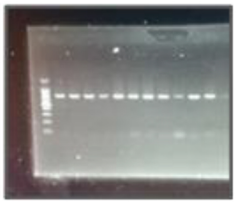




Also, the genetic variations of the populations were analysed using cytochrome c oxidase (*mt COI*) gene, considering the ability of *M. persicae* to evolve under biological and environmental pressure.

The concentrations giving 50% mortalities of the populations and the mortalities (%) at the DOA recommended rates were estimated using dose-mortality graphs.





A moderate resistance was detected against thiamethoxam (17 –25%), acetamiprid (11-15%), carbosulfan (20-28%) and etofenprox (20-41%). Resistance to profenofos was lower (4-9%).

Insecticide	DOA recommended dosage per 16 L tank	Mortality (%)		
		Kandy	Anuradhapura	Badulla
Thiamethoxam 25% WG	8 g	75	83	80
Acetamiprid 20% SP	16 g	85	83	89
Profenofos 50% EC	32 ml	91	96	92
Carbosulfan 20% SC	48 ml	80	72	77
Etofenprox 10% EC	24 ml	68	80	59

Elevated activity of metabolic enzymes, esterases, glutathione s transferases were observed indicating increased metabolism of pesticides. Also, monooxygenases-based detoxification was noticeable. A moderate resistance with the insensitivity of target site acetylcholinesterase was evidenced for organophosphates and carbamates. Two genetic types/ haplotypes were identified among the populations (GenBank accession numbers- OP185221, OP185222).

Insecticide resistance is a dynamic phenomenon which needs continuous monitoring to determine the validity of existing recommendations since any mechanism already known to exist may change over the time. Accordingly, launching a resistance management programme is important for profitable crop production



OVERCOMING THE DIGITAL BARRIER AMONG THE ELDERLY POPULATION FOR MOBILE BANKING SERVICES IN SRI LANKA

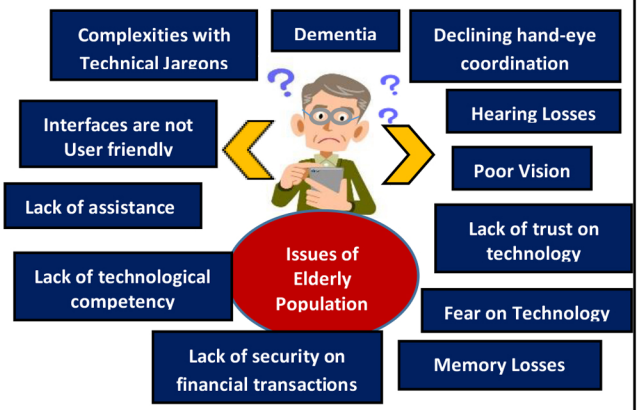
W.M.D.A.K Wickramasinghe

Mobile Banking

In the current dynamic business world, banking institutions are always searching for innovative and creative digital solutions to remain one step ahead of their rivals. With the advancements in technology, mobile banking has surpassed traditional banking and offers a wide range of banking services, at the fingertips.

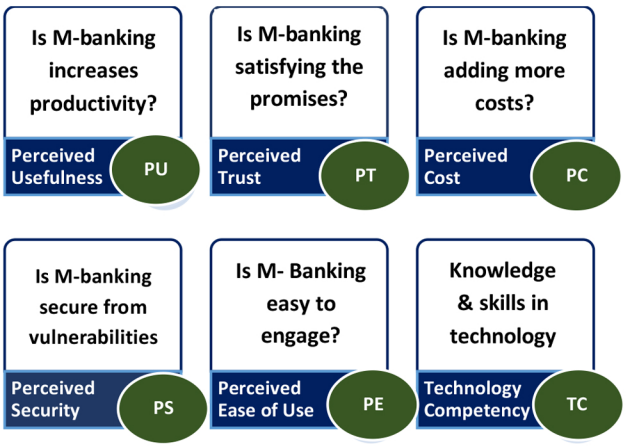
Mobile Banking VS Elderly population

When compared with the younger generation, elders have not grown up with technology and have less involvement with technological advancements. Therefore, the younger generation is leading in the use of technology, while the elderly are lagging.

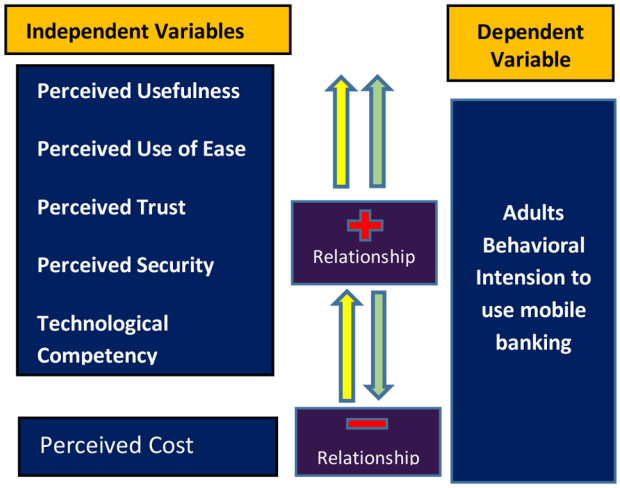


TAM Model

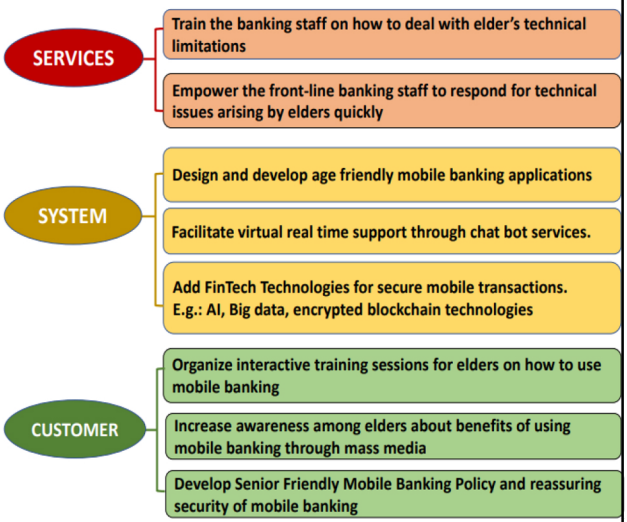
Technology Acceptance Model (TAM) is the most standardized and accepted in the IT domain, explaining elder's behavioral intentions in adopting digital banking for their day-to-day financial transactions.



Summary of Findings



Implications of Findings





Sugarcane is a rich germplasm: why not exploit it properly in producing improved cultivars ?

A.M.M.S. Perera

Sri Lanka produces 9% of the local sugar requirement. Sugarcane varieties play a major role in sugar industry as they increase sugar yields. The cultivated sugarcane varieties are rich in cane and sugar yields with moderate fibre content. It is selected from seedlings produced through crossing of sugarcane plants. Therefore, identification of suitable parents for crossing activities is important in sugarcane breeding.

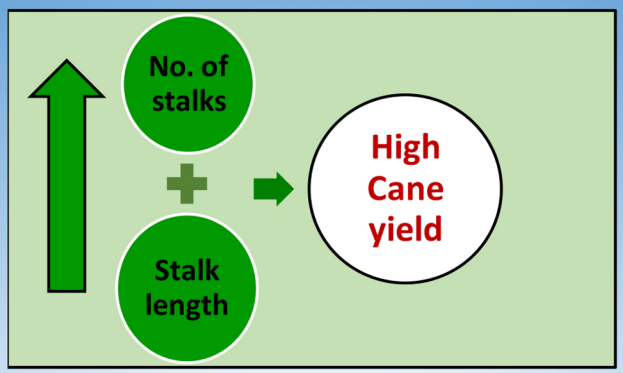
How do we identify the suitable parents?

Sugarcane germplasm → What should be done? → Sugarcane accessions in germplasm → How? → Identify the relationship of the parameters & grouping accessions



Character	Parameters
Cane yield	Field brix, Plot weight, No. of stalks, Length and diameter of stalks, Rind hardness
Sugar yield	Lab brix, Pol in juice, Purity, Fibre percent , Pure obtainable cane sugar

What we have found?



- Stalk diameter
- Fibre content

↑ ↓

- No. of stalks
- Extractable - sugar

Therefore, accessions with higher number of lengthy stalks with moderate fibre and diameter can be taken as suitable parents for breeding for high cane yield with good milling qualities.

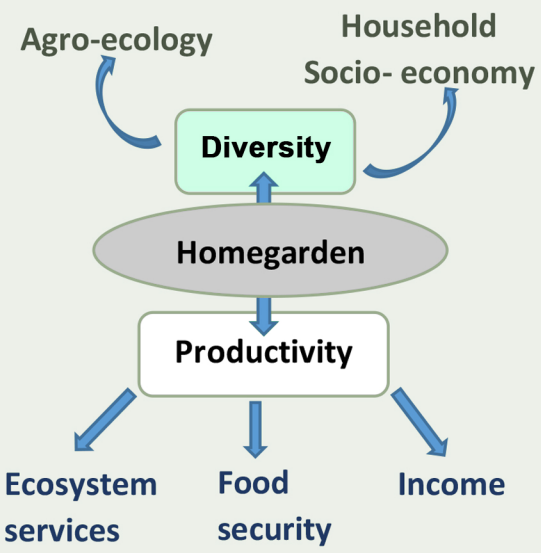




Why Government Interventions in Homegarden Development have not succeeded?

Niluka Kuruppuarachchi

Essence of the homegardens



In a system, emerging one component may suppress another component if not managed properly.

Let's make effective interventions

Sri Lankan government interventions to develop homegardens through blanket decision making mainly focus the whole island as a unit. Further, the interventions are being made through administrative units (provinces, districts, and divisions). This approach leaves no room to consider climatic and soil differences leaving the respective government unable to accomplish its expected objectives in long run.

Need to support in minimizing drawbacks.

Our aim: Recognize the influence of administrative units on differences in homegardens

We tried to find similar homegardens using common variables and group them within districts

Unknown Facts on Home Gardens

We found that, both socio-economic and ecological variables are important in identifying heterogeneity of homegardens. Such heterogeneity prevents assembling distinct groups within and between districts.

Then, what extent the administrative implications are valid for a district to be considered as one unit?

There are more appropriate approaches than using district boundaries.

Paying no attention to agro-ecology, floral and faunal diversity and socio-economic conditions of different areas might be the reason for collapsing of objectives in the long run.

How to make an effective intervention?

As per our findings we suggest that the interventions should be based on climatic factors or agro-ecological zoning. Specific inputs and advices are to be provided matching to the heterogeneity exists at the field level.



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

M. A. Madushani

Banana anthracnose

- Cause by *Colletotrichum musae*
- Prominent, widely distributed postharvest disease in the world
- Directly influence the quality, nutritive aspects and marketable value of the fruits

Chemical control of postharvest pathogens causes residual toxicity, pollution and resistance development

Trichoderma spp.

- Widely used as biocontrol agents for controlling a wide range of plant diseases

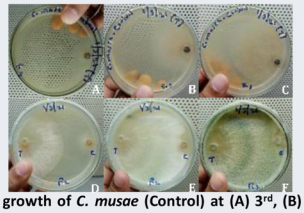
Objective

To assess the use of locally isolated *Trichoderma virens* in biocontrol of banana anthracnose disease with a suitable low-cost substrate to adopt at the farmer level.

Effectiveness of *T. virens* against *C. musae*

- ***In-vivo* by dual plating**

5mm diameter gel plugs of *T. virens* and *C. musae* pure cultures were placed on the sterile PDA medium in opposite directions and growth of both fungi was measured

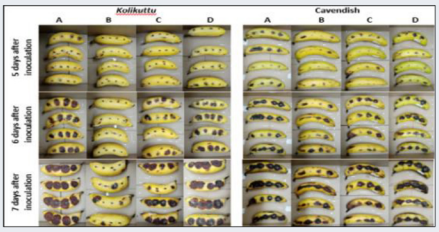


The colony growth of *C. musae* (Control) at (A) 3rd, (B) 5th, (C) 7th day after inoculation and the colony growth of *T. virens* against *C. musae* at (D)3rd, (E)5th, (F) 7th days after inoculation

- *T. virens* have suppressed the growth of *C. musae* by 74.10±8.9 % after 7 days of incubation at 28±1 °C

- ***In-vitro* by application of *T. virens* to *C. musae* inoculated ripened banana of *Kolikuttu* and *Cavendish* varieties**

Three different spore suspensions (10^5, 10^6, and 10^7 spores/ml) of *T. virens* were applied for bananas. Equal volume of *C. musae* spore suspension (10^6 spores/ml) was inoculated. The percentages of lesion development on infected wounds were assessed.

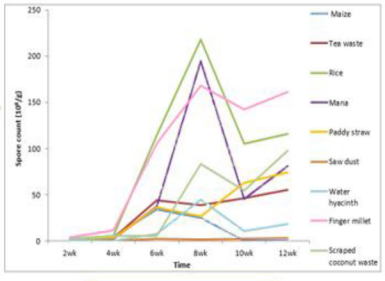


Anthracnose disease severity of *C. musae* on Cavendish and *Kolikuttu* fruit peel
(A)No *T. virens* (B) *T. virens* (10^7 spore/mL) (C) *T. virens* (10^6 spore/mL) (D) *T. virens* (10^5 spore/mL)

- Disease severity on kolikuttu was 0% and Cavendish 19 % at the 5th day of *T. virens* spore application ($1x10^7$ spores/ml)

Selection of suitable substrates for mass production of *T. virens*

- Rice seeds
- Maize seeds
- Finger millet seeds
- Paddy straw
- Dried water-hyacinth plant pieces
- Saw dust
- Dried *Panicum maximum* (Mana) leaves
- Tea waste Scraped coconut waste



soaked in bleach solution → soaked in sucrose solution → Removed excess water & drained → Inoculated with *T. virens* → Taken the Spore count of *T.virens* (cfu/g)



A- *P. maximum* B- Paddy straw C- Maize D- Coconut waste E- Rice F- Tea waste G- Saw dust H-Water hyacinth I- Finger millet

Conclusion

- *T. virens* successfully inhibits the growth of *C. musae* in both *In-vivo* and *In-vitro* conditions
- $1x10^7$ spores/ml concentration of *T. virens* was effective to control banana anthracnose
- Based on the spore concentration, viability, and easiness of handling;
  - Rice seeds
  - *P. maximum* leaves
  - Finger millet seeds

  were efficient as locally available low-cost substrates for the mass production of *T. virens* at room temperature (28 °C)



Effect of Socio-Economic and Institutional Factors on the Choice of Food Tank Cascade System (VTCS)

P.S.H. Silva

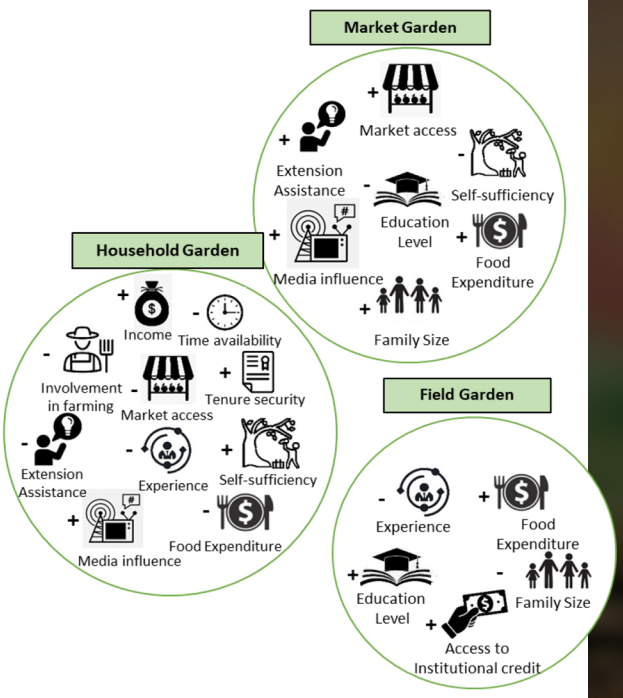
Introduction: There are three food production systems based on a variety of type-specific general features for home gardens. Based on some of these features, these three types of home food production systems can be identified in a village tank cascade system in the dry zone of Sri Lanka namely household gardens, market gardens, and field agriculture/field gardens. People have selected one of these food production systems based on many factors such as species density, species type, production objective, economic role, labor source, harvest frequency, cropping pattern, and input cost.

This study was done to identify how different socio-economic and institutional factors affect the choice of food production system practiced in home gardens.

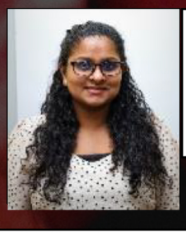
Method: Home garden food production system was revealed through the characteristics shown in the home garden. Then the effect of different socio-economic and institutional factors was analysed for the existing food production system practiced in the home garden. Data were collected randomly from 102 households within the hydrological boundary of the *Mahakanumulla* Village tank cascade system.

Results: The figure summarizes the results of this study. It depicts how the choice for three types of food production systems in the home gardens in VTCS are affected by different factors negatively and positively.

Conclusion: Promoting either a home garden or field garden is appropriate in a situation when a pressing need for food security exists. Promoting a market garden or field garden is more appropriate in an agricultural context where the primary concern is people's financial well-being. Promoting either a home garden or a market garden will be appropriate to meet daily nutritional needs since they have a larger nutrient diversity than a field garden.



Significance: Each type of food production system plays different roles in fulfilling a household's essential requirements such as fulfilling the daily nutrient requirement, ensuring food security, and mitigating food scarcity. Policymakers can predict farm management decisions and plan evidence-based strategic government intervention to ensure food security, mitigate food scarcity and enhance the livelihoods of people in village settings.



THE FUTURE OF THE MOST FAMOUS FOOD LEGUME UNDER SOIL MOISTURE SHORTAGE IN THE INTER SEASON

W.G.I.P. Wijayaraja

What is the most famous food legume?

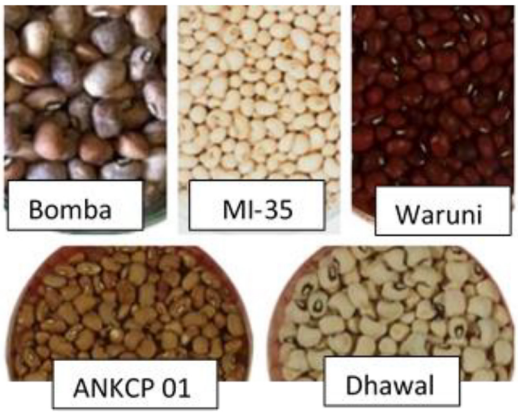
Cowpea is the most well-known and important food legume that grows in Sri Lanka's Dry Zone between two major rice growing seasons. Cowpea will face numerous challenges as soil water availability decreases during the inter-season.

Hasn't cowpea already been growing in the Dry Zone without any problem?

Yes, farmers have already been growing cowpeas. However, due to future trends in rising temperatures and changes in the patterns of rainfall, available soil water in the inter-season will be substantially reduced. As a result, the cowpea will face a water shortage.

What will happen to the cowpea crop in the future?

To explore that a study was conducted using five commonly-grown cowpea varieties in Sri Lanka under reduced soil moisture conditions in the FCRDI, Mahaillupallama under the financial support of AHEAD Project of the World Bank and MOHE.





Reductions in photosynthesis, number of pods per plant, number of seeds per pod, and leaf size were noticed because of lack of soil water. Altogether , they cause a yield reduction in the five varieties.

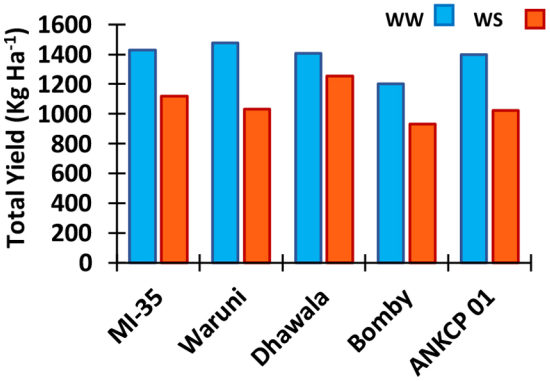


Figure 1: Yield of five cowpea varieties. WW- Well watered and WS- Water stressed conditions.

Which variety should be selected based on their yield potential under water shortage?

Variety **Waruni** performed well even with less soil moisture availability. Therefore, **Waruni** would be more suitable for cultivation under lower moisture conditions.



Soil moisture conservation measures needs to be taken to protect residual moisture of the main seasons.



Does Production Diversity Influence the Dietary Diversity in Rural Agricultural Context in Sri Lanka?

UWNN Nayanathara

What is dietary diversity and why it is important?

Several factors contribute to the nutritional status of a person. Dietary diversity is one of them. Having a diverse diet reduces the chance of nutrient deficiencies. Dietary diversity is the number of different foods or food groups consumed by a person over a given reference period. Lack of Diversity is one of the leading causes of the prevalence of undernutrition in Sri Lanka.



Figure 1: A food plate showing a diverse diet

Why the linkage between production diversity and dietary diversity is important?

Agricultural households in Sri Lanka are mostly subsistence oriented. In such contexts, what agricultural households produce directly affects their diet. This suggests a direct linkage between production diversity and dietary diversity. However, production diversity may be low with commercial farmers. Higher-income may improve dietary diversity even though production is not diverse in such a case. Understanding this relationship is essential in deciding the policy actions needed to increase dietary diversity in rural agricultural households.

What we did?

We calculated the dietary diversity of the households and studied the factors affecting dietary diversity in *Mahakanumulla* Village Tank System in the dry zone in Sri Lanka. This is a system where 80% of the population is involved in farming. Paddy is the most cultivated crop and around 60% of the paddy production is consumed at home.

What we found?

As shown in figure 2, nearly all the households consumed cereals, oils and fats and vegetables and only a few consumed eggs, meat, and fruits considering the average daily consumption during 4 months. Furthermore, dietary diversity did not vary between the cultivation seasons.

We found that when production diversity increases, dietary diversity also increases significantly. Therefore, increasing production diversity could improve the nutrition of the rural agricultural households in Sri Lanka, and nutrition development programmes may

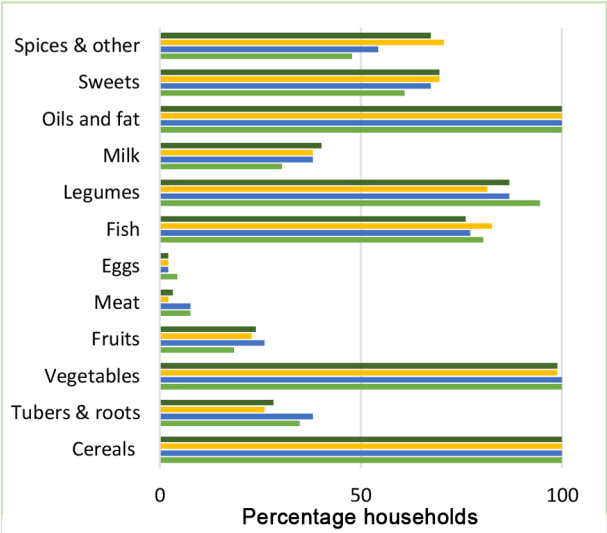


Figure 2: Consumption of at least one item in a food group by households

benefit from encouraging production diversity in rural agricultural contexts. In addition, the education level of the household head, income and household size significantly affect the household dietary diversity (figure 3).

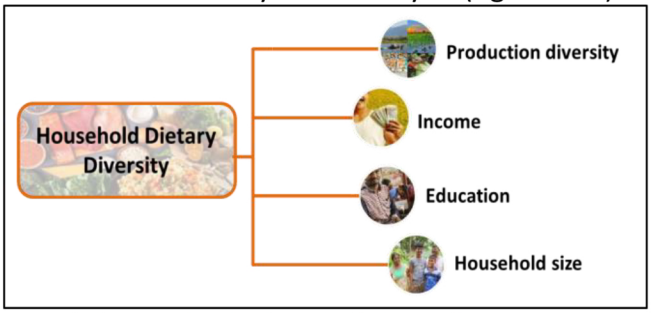


Figure 3: Factors affecting household dietary diversity



CAN WE COUNT ON TROPICAL HOMEGARDENS TO ENRICH

HOUSEHOLD DIETARY DIVERSITY?

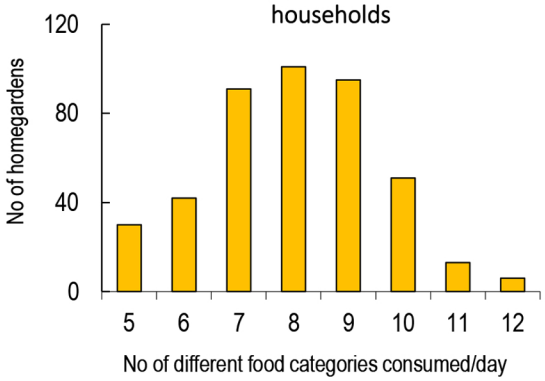
W. A. M. LOWE





Homegardens are resourceful ecosystems that provide essential services to the environment and mankind. Their contribution to secure **household dietary diversity** is among the top most provisional services. We assessed the scope of contribution of homegarden resources for the household food basket in Jaffna, Matale, Ratnapura, and Hambantota districts.

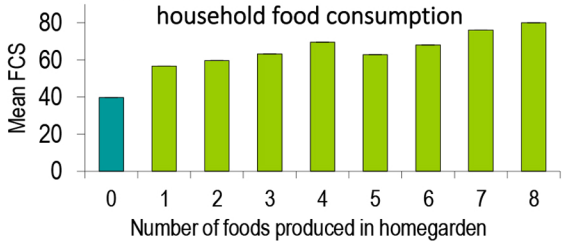
Figure 1. Dietary diversity of the studied households



As per the **food consumption score (FCS),** which describes household dietary intake, showed that majority (89%) of the study sample was in acceptable level. Moreover, a household consumes at least 08 different food categories/day (Figure 1). **The higher the number of resources originated from homegarden, higher the dietary-diversity.**

On average, 1/3 of the households had received at least one food item derived from neighboring homegardens which basically improved the dietary-diversity. Most shared foods were jackfruit and breadfruit, which are auxiliary staples in general and supplementary foods as well. Yams, fruits, leafy-vegetables and coconuts were also popular items shared. **Coconut** was the number one homestead produced resource, followed by **jackfruit and other tropical fruits** (mango, guava, soursop and pomegranate).

Figure 2. Impact of homestead foods on household food consumption



We revealed that utilizing **at least one food category from homegarden, could improve household dietary-diversity,** significantly (Figure 2). However, the majority of the homestead resources were plant-based, except in Jaffna where livestock and poultry in homegarden was very common. Obviously, many of these plant-based resources were from perennial trees. Therefore, it is advisable to properly manage the tree composition and any possible, viable annual crops as a timely option to promote household dietary diversity. If possible, allowing livestock (dairy and poultry) as a component in homegarden is advisable and absolutely beneficial in fulfilling the animal protein demand of the household.



Towards building strong partnership between fishermen and other stakeholders in managing small-scale fisheries

R. A. D. S. Ranatunga

Importance of the small-scale fisheries sector and current issues

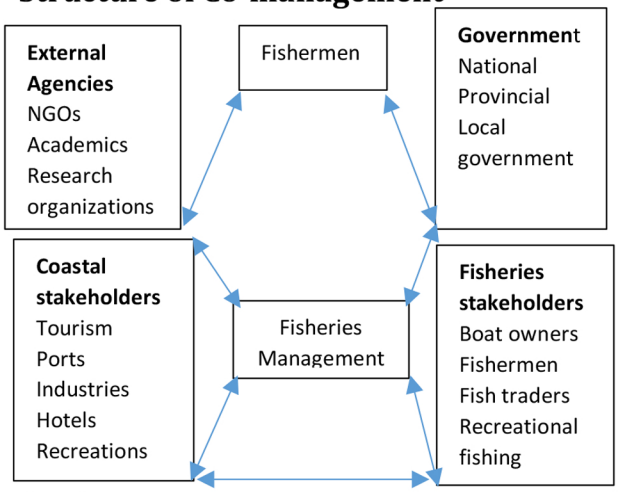
Small-scale fisheries (SSF) sector plays a significant role in nutrition and food security, employment generation and poverty alleviation in Sri Lanka. However, managing SSF has become a serious challenge due to the issues emerging from conflicts among diverse parties competing for oceanic resources, increased number of resource users and the climate change.

Community Involvement in fisheries management

It is widely recognized that a strong partnership among diverse stakeholders called co-management is one of the best strategies to manage SSF. This strategy has been attempted in small-scale fisheries in a number of countries including Sri Lanka.



Structure of Co-management



Study

This study examined case studies from Uruguay, Zambia, Timor Leste, and Sri Lanka, where SSF plays a significant role in fisheries to find out what preconditions were required to establish a strong partnership between fishermen and other stakeholders.

Results:

The study revealed that the presence of strong, committed and respected local leaders, unity, and cohesion of community networks, availability of strong local organizations, and enforcement of indirect regulations such as community-based protected areas and closed seasons, and strong local knowledge base on ecological systems had a positive impact on the establishment of strong partnerships for effective co-management process.



ASSESSING THE IMPACT OF ELEVATIONAL VARIATION ON HEALTH RELATED PROPERTIES IN GREEN LEAVES, BLACK TEA, GREEN TEA AND INSTANT TEA MADE OUT OF SELECTED CULTIVAR (TRI 2025) IN LOW, MID AND UP COUNTRY OF SRI LANKA

K.A.P. Dalpathadu

Sri Lanka produces black tea in the form of Orthodox and Cut Tear and Curl (CTC), Green tea (GT), Flavored tea, and Instant tea. Instant tea powder has emerged as a new and fast-evolving industry in tea producing countries. Extracting the liquor from green leaves, different tea grades, tea wastes (Broken Mixed Fannings -BMF) and macerated fermented leaves were used as the raw materials to produce instant tea.



Figure -1 Manufacturing of black tea including BMF

This study was conducted to determine the effect of different raw materials, such as green tea leaves, black tea grades (BOP, BOPF, Dust-1, and BMF), obtained from three elevation categories in Sri Lanka's Up Country (UC), Mid Country (MC) and Low Country (LC), and green tea (Gun Powder-GP, Dust, and BMF), which can be used in instant tea manufacturing, and to assess the variation in health-related properties, such as Total Poly phenol content (TPC), Total Antioxidant Activity (TAOA), caffeine and catechin, that can be changed during the production of instant tea.

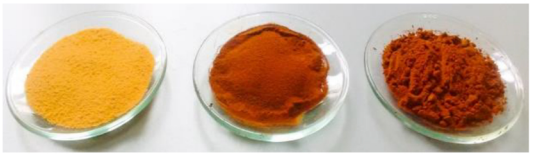


Figure 2: Instant tea powder from green tea and black tea

Total Polyphenol Content

Results revealed that the TPC contents of oven-dried fresh leaf samples were significantly different among elevation categories ($p<0.05$). UC tea had the highest mean TPC, followed by LC and MC tea.

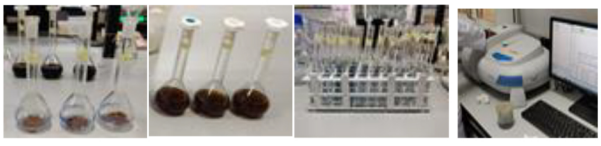


Figure 3: Analysis

green tea had the higher overall TPC than black tea grades. The TPC percentages increased by 2-fold in instant tea powder compared to the values obtained when the contents in raw materials were concerned.

Total Antioxidant Activity

The Total Antioxidant Activity was lower ($p < 0.05$) in UC fresh leaf compared to MC and LC. The GT dust has significantly higher TAOA, compared to BMF and GP. TAOA content of instant tea powder was 3 times higher than the values obtained for the raw materials.

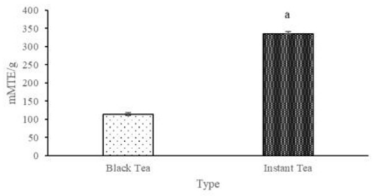


Figure 4: TAOA comparison between Black tea and Instant tea

Caffeine Content

Caffeine content was changed among different black tea grades, including BMF, at the UC, MC and LC elevations. The mean caffeine contents of black tea grades were significantly higher in LC even though no variation was observed in GT grades. The caffeine concentration of BOP, BOPF, Dust1, and BMF had no effect on the caffeine level of instant tea.

Catechin Content

Tea catechins are total catechin, epigallocatechin gallate (EGCG), epigallocatechin (EGC), epicatechin gallate (ECG), and epicatechin (EC).

Table 1: Concentration of catechin in BMF among three elevation

	EGC (%)	Catechin (%)	EC (%)	EGCG (%)	ECG (%)	TC (%)
Up country	1.42±0.58^{a}	0.21±0.12^{a}	0.71±0.36^{a}	0.85±0.47^{a}	0.41±0.08^{a}	3.61±0.29^{a}
Mid country	0.19±0.05^{b}	0.06±0.00^{b}	0.19±0.05^{b}	0.25±0.03^{b}	0.30±0.02^{b}	0.99±0.06^{b}
Low country	0.06±0.13^{b}	0.01±0.04^{b}	0.07±0.08^{b}	0.16±0.05^{b}	0.20±0.04^{c}	0.50±0.45^{b}

There was a significant difference in EGCG, catechin, EC, and Total Catechin in IT than BMF. Therefore, these findings could be used in the food and pharmaceutical industries and also to produce value added products to suit customers preferences.



Can we identify all *Cinnamomum* species in Sri Lanka?

H.A.B.M. Hathurusinghe

Ceylon Cinnamon, scientifically known as *Cinnamomum zeylanicum* or *Cinnamomum verum* is the pride among the world's spices. The Government targets more foreign revenues from Cinnamon Industry. More importantly, Sri Lanka received GI indication for Cinnamon in Europe.

Historical evidence suggests that cultivated Cinnamon originated in the central hills of Sri Lanka. Other than the cultivated species, there are seven wild relatives in Sri Lanka. Traditionally, these species were categorized based on the taste of the bark, for example, Pani-Miris Kurundu, Miris Kurundu, Sevel Kurundu, and Thiththa Kurundu.

Scientists have tried to separate them through leaf morphology, venation, and some genetic methods. However, the species delimitation has not been very successful so far.

Therefore, the current study included an ISSR analysis and bark powder morphology of all *Cinnamomum* species found in Sri Lanka. Further, floral morphology, including the Scanning Electron Microscopy of pollen grains, was assessed to identify cultivated and several other wild *Cinnamomum* species.

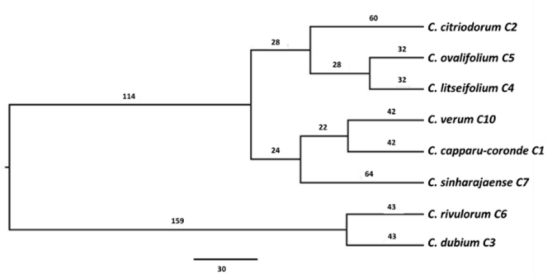


Figure 1: Genetic relationship of genus *Cinnamomum* in Sri Lanka based on ISSR

Though several polymorphic ISSR regions were identified, ISSR marker analysis could not reliably distinguish closely related species with sufficient statistical confidence.

The wild cinnamon species *C. sinharajaense* and *C. capparu-coronde*, as well as the domesticated species *C. verum*, have considerably larger flowers than other species. The colour and shape of flowers can help distinguish between species like *C. sinharajaense* and *C. capparu-coronde.*



Figure 2: Representative flower samples of cinnamon wild and cultivated species.(A)- *C. sinharajaense* (B)- C. verum. (C)- *C. dubium,* (D)- *C. capparu-coronde*, (E)- *C. rivulorum,* (F)- *C. litseifolium,* (G)- *C. ovalifolium,*

The size of the pollen, the length of the spines, the distance between the spines, and the ornamentation on the spines were all major contributors to species-level diversity. Such variations require in-depth examination including all the species.

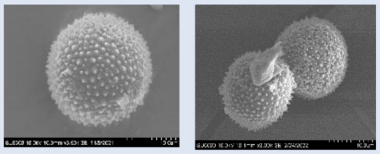


Figure 3: Scanning electron microscopy (SEM) images of pollen grains of *C. verum* and *C. rivulorum*

Adulteration of powdered Ceylon Cinnamon is a serious concern at the industry level. Having a simple mechanism for identification would be important for regulatory purposes. Microscopic analysis of powered cinnamon could separate common species. Interestingly, the size and shape of the bark fiber vary between wild and domesticated species.

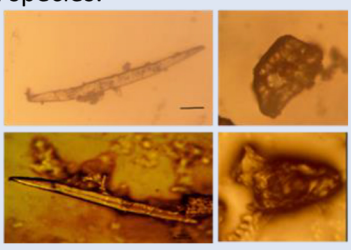


Figure 4: Powder Microscopy of *Cinnamomum verum* and *C. ovalifolium* species for xylem fiber and stone cell



Fungi as Biocontrol Agents in Management of Big Onion Diseases in Sri Lanka

L N R Gunaratna

Big onion is one of the most important spice crops throughout the world since it is used as spice or as medicine. In Sri Lanka the low country Dry Zone provides almost all of the crop's climatic needs and cultivation is predominantly concentrated in four districts of Sri Lanka *i.e.* Matale, Anuradhapura, Mahaweli H and to a lesser extent in Polonnaruwa.





Big onions are prone to different diseases which may initiate at any stage of its growth in the field or during storage.

Management of Big onion diseases using chemicals

The chemical control strategies (include fungicides) are costly, pollute the environment and are potentially harmful to the animals and humans

The use of microbes for pest management in agriculture is one of the most effective strategies of biological control. Among the various Fungi used for the management of plant diseases, *Trichoderma* spp. play a vital role.

In the present study, locally isolated *Trichoderma* spp. were applied to soil prior to planting and coated seeds with the *Trichoderma* inoculum before planting. Both methods of introducing the *Trichoderma* inocula reduced damping off disease significantly in the field condition. Subsequent *Trichoderma* spp. treatments *viz.* seedling root dipping or soil application at the time of transplanting were equally efficient means to control basal rot disease of big onion. This is the first record of an effective locally produced *Trichoderma* inoculum for the control of onion diseases in Sri Lanka. Further, the effect of the aforementioned pre-harvest treatments on the control of diseases during the storage were evaluated. But there was no significant effect of pre-harvest treatments with *Trichoderma* spp. on the control of diseases during storage. Although application of *Trichoderma* spp. under storage conditions is also another promising strategy to overcome post-harvest losses and further research works are necessary to conduct in the future.



Treasure in the wild: Cinnamomum species

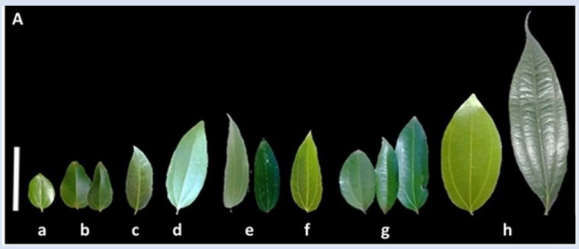
B. S. Bandusekara

Recent scientific evidence ensures true cinnamon's superiority in health properties, aroma, taste and flavour.

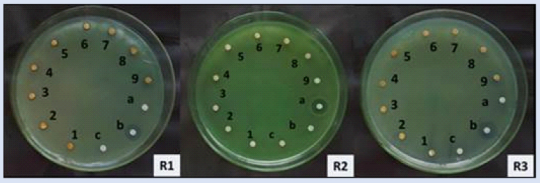


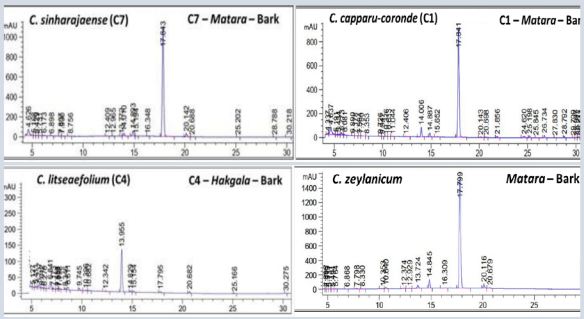
Cinnamon crop wild relatives

Humans have utilized genetic material from Crop wild relatives for thousands of years to improve the quality and yield of crops. Similarly, several wild species of cinnamon have also gained attention as valuable crop wild relatives.



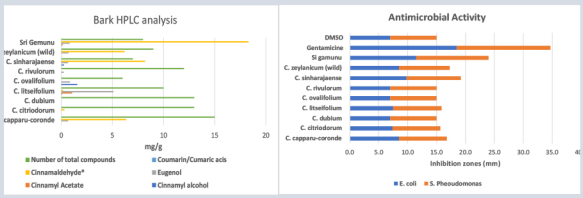
Investigation: The present study investigated and compared the biochemical composition (Bark - HPLC) and the antimicrobial activity of *Sri Gemunu* (g) and all wild species found in Sri Lanka. Those are *C. ovalifolium* (a), *C. litseifolium* (b), *C. citriodorum* (c), *C. capparu-coronde* (d), *C. dubium* (e), *C. rivulorum* (f), and *C. sinharajaense* (h).





Findings

Interestingly no species had a detectable level of coumarin or coumaric acid. Coumarin is considered a carcinogenic compound when available in high quantities and is present in relatively higher concentrations in cassia cinnamon.



From the wild species, *C. sinharajaense* showed the highest bark cinnamaldehyde content (8.20 mg/g) and antimicrobial activity (9.3 mm), followed by *C. capparu-coronde*. *C. litseifolium* showed the highest amount of bark eugenol (5.11 mg/g). Those chemicals are the most economically important compounds for the cinnamon industry.

The results also showed a strong positive correlation between antimicrobial activity and trans-cinnamaldehyde content in *Cinnamomum* species in Sri Lanka.

Potentials

C. sinharajaense and C. capparu-coronde can potentially be valuable candidates for application in the pharmaceutical industry and future breeding programs.

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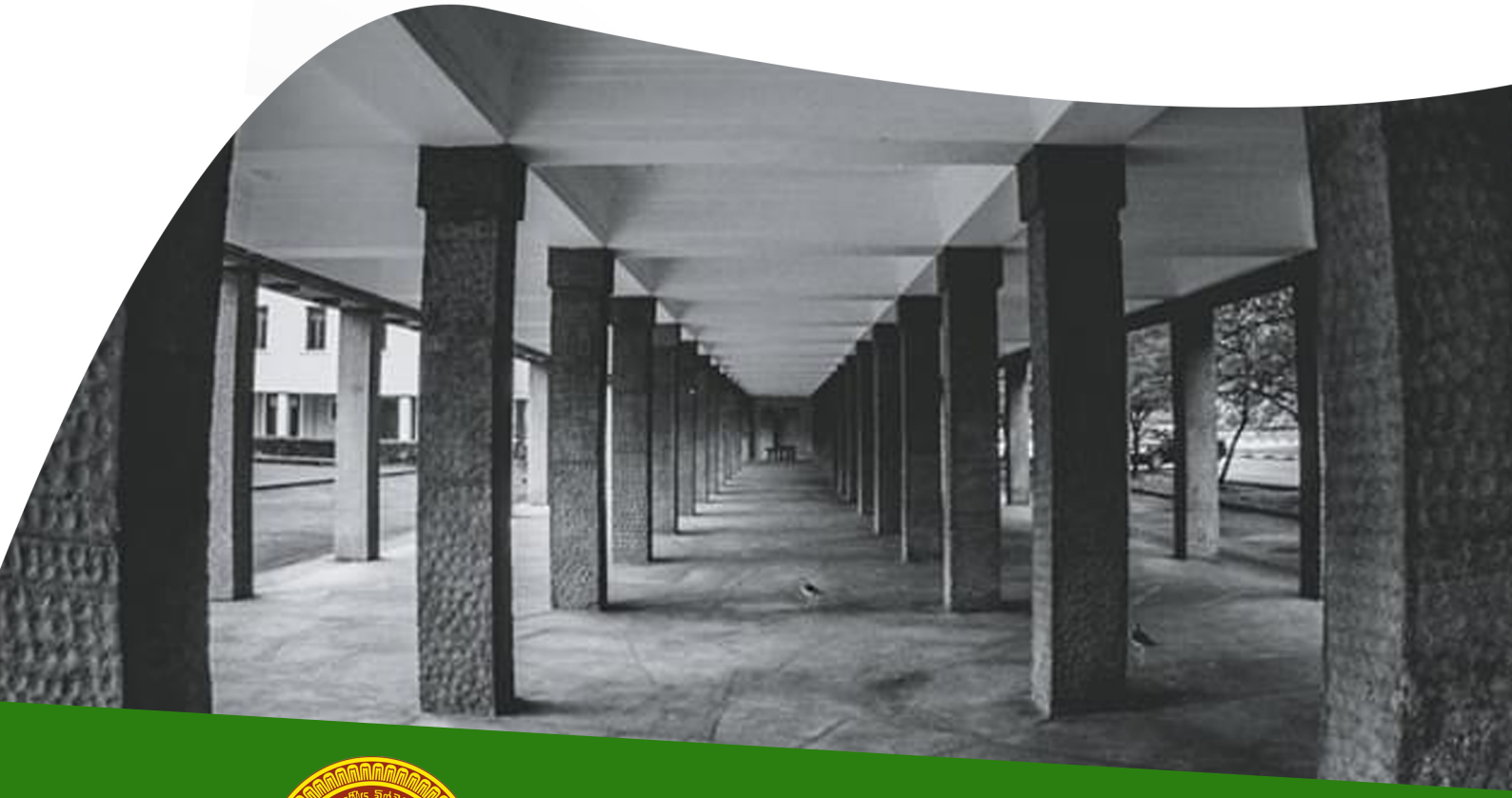

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