PROCEEDINGS
SYMPOSIUM ON AGROBIODIVERSITY FOR CLIMATE CHANGE ADAPTATION, FOOD AND NUTRITION

Mainstreaming Agrobiodiversity Conservation and Use in Sri Lankan Agro-ecosystems for Livelihoods and Adaptation to Climate Change (BACC) Project

&

Mainstreaming Biodiversity Conservation and Sustainable Use for Improved Human Nutrition & Well being-Biodiversity for Food and Nutrition (BFN) Project

23rd - 24th May 2019

Plant Genetic Resources Centre, Gannoruwa, Sri Lanka
Proceedings of the Symposium on
Agrobiodiversity for Climate Change Adaptation,
Food and Nutrition
2019

These Proceedings comprise the abstracts of Symposium on Agrobiodiversity for Climate Change Adaptation, Food and Nutrition. The copyrights of abstracts belong to the authors. The abstracts reflect the authors’ opinions, and in the interest of timely dissemination, they are published without any change. Their inclusion in these proceedings does not necessarily constitute endorsement by the editors.

ISBN: 978-955-7247-02-1

Published by
Mainstreaming Agrobiodiversity Conservation and Use in Sri Lankan Agro-ecosystems for Livelihoods and Adaptation to Climate Change (BACC) Project and Biodiversity for Food and Nutrition (BFN) project

Cover page designed by
Farah Fazlulhaq

Printed by
Agriculture Publication Unit, Department of Agriculture, Gannoruwa
EDITORIAL BOARD

Members

Dr. Gamini Samarasinghe
Mr. Athula Liyanage
Dr. John Toby Hodgkin
Dr. Danny Hunter

Editorial Assistants

Ms. Nethmini Samaradiwakara
Mrs. Navoda Bandaranayake
AGENDA
23-MAY-19

09.00 am  Inaugural Session
10.00 am  Key Note Speech
          Building Food Sovereignty through Sustainable Agriculture
          By Prof. Gamini Senanayake

        Invited Presentations
        Chairperson - Dr Jerry Jayawardana
        Venue - Main Auditorium, PGRC

11.25 am  Adapting to Climate Change: The Agrobiodiversity contribution
          Dr. John R. Toby Hodgkin, Honorary Research Fellow, Bioversity International and
          Platform for Agrobiodiversity Research, Italy. Agrobiodiversity consultant, BACC
          Project

11.40 am  Biodiversity for Food and Nutrition: Achieving sustainable food systems and
          healthy diets
          Dr. Gamini Samarasinghe, National Project Coordinator, Biodiversity for Food and
          Nutrition Project, Additional Director, Plant Genetic Resources Center, Sri Lanka

11.55 am  Agrobiodiversity for Policies, economics, marketing and value chains and
          industrial opportunities- Towards Updating of the National Action Plan for
          Conservation and Sustainable Utilization of Agrobiodiversity in Sri Lanka
          Jeevika Weerahewa, Professor of Agricultural Economics, Department of Agricultural
          Economics and Business Management, Faculty of Agriculture, University of
          Peradeniya, Sri Lanka

12.10 pm  Harnessing agro-biodiversity for sustainable diets, human health and nutrition:
          are we on the right track?
          Dr Renuka Silva, Department of Applied Nutrition, Faculty of Livestock, Fisheries &
          Nutrition, Wayamba University of Sri Lanka

12.25 pm  Panel Discussion
23-MAY-19
Technical Session 1-Agrobiodiversity for Food and Nutrition
Chairperson - Dr Rohan Wijekoon
Venue-Main Auditorium, PGRC

Oral Presentations

02.05 pm Evaluation of Antioxidant Potential of Selected Local Varieties of Banana Blossoms
Akshamal HKSL, Samarasekara JKRR, Manamgoda DS and Jayawardana SAS

02.20 pm A nutritional evaluation of selected traditional underutilized pulses grown in Sri Lanka
Kulasinghe WMAA, Wimalasiri KMS, Samarasinghe WLG, Silva R and Madhujith T

02.35 pm Productivity enhancement of foxtail millet-green gram intercropping system: A step towards bringing foxtail millet back to the plate of Sri Lanka
Indrachapa CAI, Ranil RHG, Dissanayaka DMSB, Chamara RMR and Suriyagoda LDB

02.50 pm Proximate analysis and development of cookies from underutilized “nipa palm kernel”
Rajapakshe K and Wijesekara I

03.05 pm Proximate composition and antioxidant properties of soy incorporated ready to serve (RTS) fruit drinks prepared using soursop (Annona muricata L.) and watermelon (Citrullus lanatus Thunb.)
Perera MPMSH, Karawita RS, Gunawardhana HMDM., Sivakanesan R and Sarananda KH

03.20 pm Panel Discussion

Poster Presentations

Cooking Characteristics of Selected Sri Lankan Traditional Rice Varieties (Oryza sativa L.)
Rathnayake RMNDK and Adikari AMMU

Contribution of dry zone home gardens for household food security: case study in Vavuniya district of Sri Lanka
Senarathna SASR, Ginigaddara GAS, Kodithuwakku AN and Vimaladhas V

Flour analysis and development of gluten-free muffins from traditional yam “maha angili ala”
Kalhari DLS, Gunasekara GDM, Wijesekara I, Weerasuriya M, and Wickramasinghe I

Elemental composition analysis of selected seaweed varieties in Sri Lanka
Jayakody MM, Vanniarachchy MPG and Wijesekara I
23-MAY-19
Technical Session 2-Agrobiodiversity for Identification, Conservation, Valuation & Sustainable use of Traditional Knowledge
Chairperson – Prof Gamini Senanayake
Venue-Main Auditorium, PGRC

Oral Presentations

03.35 pm  Farmer adaptable variety selection to enhance crop diversity through Farmer Field Fora: A Practical Approach
Wasala SK, Kondasinghe KMCL, Wickramasooriya MNK and Wasala WMD

03.50 pm  An ethnobotanical survey of medicinal plants used in Gampola, Pahala Giribawa and Wannikudawewa in Sri Lanka
Sugathadasa KSS and de Silva MAN

04.05 pm  Plant species diversity in different land uses in Ududumbura area of mid country intermediate zone of Sri Lanka
Chandrapala AG, Kendaragama KMA, Gunasekara IC, Wetthasinghe SK, Dissanayake KGDC and Wasundara WMUPM

04.20 pm  Halgolla forest reserve as an agro-biodiversity refugium
Chathuranga WGD, Wanigasinghe IM, Dhanapala WAMNS, De Silva WAPP, Gunaratne AMTA

04.35 pm  Application of traditional knowledge in coping with climate change impacts on food production - a case study in cascaded tank-village system in Palugaswewa, Sri Lanka
Anuradha GPWS, Premarathne NMKC and Ginigaddara GAS

04.50 pm  Application of traditional ecological knowledge for sustainable soil restoration with special reference to knuckles region, Sri Lanka
Gamachchige RN and Thennakoon TMSPK

05.05 pm  Panel Discussion

Poster Presentations

Effectiveness of selected indicators for identification and prediction of soil biodiversity in wet zone home gardens of Sri Lanka
Kodithuwakku RD, Fonseka WAND, Wijekoon WMRWB and Sumanasena HA

Investigating the optimum growth requirements of Senna alata (L.) Roxb. (emperor's candlesticks) for developing herbal cosmetic industry in Sri Lanka
Gamage DGND, Abeyesinghe DC, Wijesekara RGS, Prathapasinghe GA, Dharmadasa RM and Someya T

Diversity of yam (Dioscorea spp.) accessions revealed by phenotypic and SSR markers
Munaweera TIK, Samarasinghe WLG, Edirisinghe ESC, and Dasanayake PN
Ethnobotanical survey of underutilized edible plant species in three selected villages in wet intermediate and dry zones in Sri Lanka
Abeywickrama KGTAK, Samarasinghe WLG, Wijerathna RMS, Ranil RGH and Hunter D

Valuing agrobiodiversity for mainstreaming into bluegreen village programme: “food mandala” as a tool of reciprocity for enhancing resilience
Perera HAKI., Herath HMLK. And Randeni RPLC

24-MAY-19
Technical Session 3-Agrobiodiversity for Human Health & Livelihood Development
Chairperson – Prof. Gamini Pushpakumara
Venue - Main Auditorium, PGRC

Oral Presentations

08.35 am  Antioxidant capacity, phenolics, and ascorbic acid contents in selected indigenous root and tuber crops of Sri Lanka
Rupasingha, KBGPP, Senarathne, SMACU and Ratnayake, RHMK

08.50 am  Antioxidant properties of selected pigmented and white long grain rice varieties of Sri Lanka at market available polishing rates
Abeysekera WKSM, Abeysekera WPKM, Lakshan SAT, Samaranayake MDW, Liyanage SL, Premakumara GAS and Aheysiriwardena Sumith de Z D

09.05 am  Efficiency of freeze-dried bitter gourd powder as a fat replacer on the quality attributes of chicken meat paste
Karunarathne ADR, Wijesinghe SKD and Jayasena DD

09.20 am  In vitro study on the allergenic effects of selected agro foods, green tea (Camellia sinensis L. kuntze) and seafood in causing IgE independent basophil degranulation
Wijerathna C, Handunnetti SM, Fernando N and Premawansa S

09.35 am  Incorporation of herbal plant extracts; Zingiber officinale Roscoe and Phyllanthus emblica L. to suppress glyceamic impact of cane sugar
Samarasinghe CH, Jayasinghe MA, Senadheera SPAS, Wijesekara I, and Ranaweera KKDS

09.50 am  Panel Discussion
Poster Presentations

Local root and tuber crops for improved nutrition, well-being and community development
Godamulla D, Samarasinghe WLG, Sartaj AB, Samaradiwakara SHMRNP, Abeywickrama KGTAK and Hunter D

α-amylase and α-glucosidase enzyme inhibitory activities of selected millet types and sorghum varieties of Sri Lanka
Senevirathne IGNH, Abeysekera WPKM, Abeysekera WKSM, Jayanath NY, Premakumara GAS, and Wijewardana DCMSI

Phenolic contents and pancreatic lipase and cholesterol esterase inhibitory activities of selected millet types and sorghum varieties of Sri Lanka
Indrachapa S, Jayathilaka SI, Abeysekera WPKM, Jayanath NY, Premakumara GAS and Wijewardana DCMSI

Determination of viability of Bifidobacterium animalis sub species lactis in garlic (Allium sativum L.) incorporated synbiotic butter
Premerathne JMNH and Mudannayake DC

Assessment of agrobiodiversity in Kandyan home gardens-A case study
Warnasooriya PGAS, Weerakkody WAP and Bandaranayake, PRSD

A comparative study to develop calcium, zinc and antioxidant rich drinking yoghurts using plant and pharmaceutical sources
Samarathunga RMJN, Jayasinghe MA, Edirisinghe MP, Wijesekara I, Abeysundara De AP, and Senadheera SPAS

Formulation of non-animal-based stabilizer combination to replace gelatine in set-yogurt
Kuuppu KAYR and Abeysundara PDA
24-MAY-19
Technical Session 4-Agrobiodiversity for Eco system services & Climate change Adaptation
Chairperson - Dr Toby Hodgkin
Venue - Main Auditorium, PGRC

Oral Presentations

10.35 am  Adaptability of selected lablab and winged bean varieties to diverse ecosystems in Sri Lanka
Malathy P, Siriwardena SMSP, Darshani RMS, Nilanthi WDGP and Pooten PNMV

10.50 am  Prospects for realization of benefits rising from in situ conservation of agrobiodiversity in different agro-ecosystems in Sri Lanka
Herath HMLK, Dunisinghe P, Manawadu L, Dayawansa WGMG, Liyanage ASU and Gunarathna KKDK

11.05 am  Constraints faced by farmers of minor irrigation systems in mitigating the impact of climate change: case study from Anuradhapura district, Sri Lanka
Premasiri PMSS, Dissanayake SP and Ginigaddara GAS

11.20 am  Constraints on adaptation for wetland agriculture to mitigate climate risk; a case study in Kaduwela wetland, Sri Lanka
Navarathne WRMDP, Dissanayake SP and Ginigaddara GAS

11.35 am  Villagers’ perception on introducing sustainable agro tourism programme for rural livelihood upliftment in Palugaswewa cascade system, Sri Lanka
Dayarathna GWGVM, Dissanayake SP and Ginigaddara GAS

11.50 am  Panel Discussion

Poster Presentations

Smallholder vegetable farmers’ choices for adaptation to climate change in Anuradhapura district, Sri Lanka
Ariyadasa WGS and Kopiyawattage KPP

Study of salinity levels and impact of salt water intrusion on coastal paddy areas of wet zone of Sri Lanka
Opatha KN and Lokupitiya E

Effects of Climatic Variation on Yield of Upcountry Tea: A Case Study based on Up country Tea Estates of Kelani Valley Plantations PLC in Sri Lanka
Manawasinghe KS, Abeyasinghe DC, Weerakoon A and Thennakoon TMNS
24-MAY-19
Technical Session 5-Agrobiodiversity for Policies, Economics, Marketing & value chains & Industrial Opportunities
Chairperson – Prof. Buddhi Marambe
Venue-Main Auditorium, PGRC

Oral Presentations

02.05 pm  Government policy incentives for conservation and utilization of agrobiodiversity in Sri Lanka: evidence from a content analysis
Swarnathilake C, Udani K, Pushpakumara DKNG and Weerahewa J

02.20 pm  Phytochemical screening and analysis of anti-glycation activity of developed herbal tea with Goose berry, Ginger, Coriander
Priyadarshana PHMG, Jayasinghe JAVR, Perera HKI, Udari AHGS

02.35 pm  Strategies to overcome the production and marketing issues of the products at BFN sites
Kuruppuarachchi KANL, Seneviratne NDSL, Rienzie R, and Gunaratne LHP

02.50 pm  Public awareness and perception on government interventions to conserve and promote agro-biodiversity in Sri Lanka
Udani K, Swarnathilake C, Pushpakumara DKNG, Weerahewa J

03.05 pm  Development of a participatory guarantee system to support small scale producers of ‘Biodiversity for Food and Nutrition’ (BFN) crops
Rienzie R, Gunaratne LHP, Ranil RHG and Kuruppuarachchi KANL

03.20 pm  Panel Discussion

Poster Presentations

Effect of commercial liquid smoke flavoring on physico-chemical properties in Tilapia (Oreochromis niloticus L.)
Lelwela GKTN, Wijesinghe SKD, Himali SMC and Abeyrathne EDNS

The economic value of care role of women: A case in Kandyan home gardens, Sri Lanka
Ranasinghe SC, Somaratne KWHAN, Ginigaddara GAS and Premarathne NMKC

Bio-diversified food and nutrition value chains in Sri Lanka: constraints and opportunities for value chain upgrading
Samarasinghe, KP, Seneviratne NDSL, Hemachandra, SD

Development of Jackfruit (Artocarpus heterophyllus L.am.) incorporated frozen yoghurt
Dissanayaka TMPM, Gimhani KHI and Champa WAH

03.30 pm  Closing Ceremony
CONTENTS

KEYNOTE SPEECH

Building Food Sovereignty through Sustainable Agriculture

Gamini Senanayake, Senior professor in Agricultural Biology,
University of Ruhuna, Sri Lanka

INVITED SPEECHES

Adapting to Climate Change: The Agrobiodiversity contribution

Dr. John R. Toby Hodgkin, Honorary Research Fellow,
Bioversity International and Platform for Agrobiodiversity Research, Italy,
Agrobiodiversity consultant, BACC Project

Biodiversity for Food and Nutrition: Achieving sustainable food systems and, healthy diets

Dr. Gamini Samarasinghe, National Project Coordinator, Biodiversity for Food and Nutrition Project. Additional Director Plant Genetic Resources Center,
Sri Lanka

Agrobiodiversity for Policies, economics, marketing and value chains and industrial opportunities- Towards Updating of the National Action Plan for Conservation and Sustainable Utilization of Agrobiodiversity in Sri Lanka

Jeevika Weerahewa, Professor of Agricultural Economics, Department of Agricultural Economics and Business Management, Faculty of Agriculture,
University of Peradeniya, Sri Lanka

Harnessing agro-biodiversity for sustainable diets, human health and nutrition: are we on the right track?

Dr Renuka Silva, Department of Applied Nutrition, Faculty of Livestock, Fisheries & Nutrition, Wayamba University of Sri Lanka
AGROBIODIVERSITY FOR FOOD AND NUTRITION

Evaluation of Antioxidant Potential of Selected Local Varieties of Banana Blossoms
Akshamal HKSL, Samarasekara JKRR, Manamgoda DS and Jayawardana SAS

A nutritional evaluation of selected traditional underutilized pulses grown in Sri Lanka
Kulasinghe WMAA, Wimalasiri KMS, Samarasinghe WLG, Silva R and Madhujith T

Productivity enhancement of foxtail millet-green gram intercropping system: A step towards bringing foxtail millet back to the plate of Sri Lanka
Indrachapa CAI, Ranil RHG, Dissanayaka DMSB, Chamara RMSR and Suriyagoda LDB

Proximate analysis and development of cookies from underutilized nipa palm kernel
Rajapakshe K and Wijesekara I

Proximate composition and antioxidant properties of soy incorporated ready to serve (RTS) fruit drinks prepared using sour sop (Anona muricata L) and watermelon (Citrullus lanatus Thunb.)
Perera MPMSH, Karawita RS, Gunawardhana HMDM, Sivakanesan R, and Sarananda KH

Cooking Characteristics of Selected Sri Lankan Traditional Rice Varieties (Oryza sativa L.)
Rathnayake RMNDK and Adikari AMMU

Contribution of dry zone home gardens for household food security: case study in Vavuniya district of Sri Lanka
Senarathna SASR, Ginigaddara GAS, Kodithuwakku AN and Vimaladhas V

Flour analysis and development of gluten-free muffins from traditional yam “maha angili ala”
Kalhari DLS, Gunasekara GDM, Wijesekara I, Weerasuriya M, and Wickramasinghe I

Elemental composition analysis of selected seaweed varieties in Sri Lanka
Jayakody MM, Vanniarachchy MPG and Wijesekara I
AGROBIODIVERSITY-IDENTIFICATION, CONSERVATION, VALUATION AND SUSTAINABLE USE OF TRADITIONAL KNOWLEDGE

Farmer adaptable variety selection to enhance crop diversity through Farmer Field Fora: A Practical Approach
Wasala SK, Kondasinghe KMCL, Wickramasooriya MNK and Wasala WMD

An ethnobotanical survey of medicinal plants used in Gampola
Pahala Giribawa and Wannikudawewa in Sri Lanka
Sugathadasa KSS and de Silva MAN

Plant species diversity in different land uses in Uduombura area of mid country intermediate zone of Sri Lanka
Chandrapala AG, Kendaragama KMA, Gunasekara IC, Wetthasinghe SK, Dissanayake KGDC and Wasundara WMUPM

Halgolla forest reserve as an agro-biodiversity refugium
Chathuranga WGD, Wanigasinghe IM, Dhanapala WAMNS, De Silva WAPP, Gunaratne AMTA

Application of traditional knowledge in coping with climate change impacts on food production - a case study in cascaded tank-village system in Palugaswewa, Sri Lanka
Anuradha GPWS, Premarathne NMKC and Ginigaddara GAS

Application of traditional ecological knowledge for sustainable soil restoration with special reference to knuckles region, Sri Lanka
Gamachchige RN and Thennakoon TMSPK

Effectiveness of selected indicators for identification and prediction of soil biodiversity in wet zone home gardens of Sri Lanka
Kodithuwakku RD, Fonseka WAND, Wijekoon WMRWB and, Sumanasena HA

Investigating the optimum growth requirements of Senna alata (L.) Roxb. (emperor's candlesticks) for developing herbal cosmetic industry in Sri Lanka
Gamage DGD, Abeyesinghe DC, Wijesekara RGS, Prathapasinghe GA, Dharmadasa RM and Someya T

Diversity of yam (Dioscorea spp.) accessions revealed by phenotypic and SSR markers
Munaweera TIK, Samarasinghe WLG, Edirisinghe ESC and Dasanayake PN

Ethnobotanical survey of underutilized edible plant species in three selected villages in wet intermediate and dry zones in Sri Lanka
Abeywickrama KGTAK, Samarasinghe WLG, Wijerathna RMS Ranil RGH and Hunter D

xiii
Valuing agrobiodiversity for mainstreaming into bluegreen village programme: “food mandala” as a tool of reciprocity for enhancing resilience

Perera HAKI., Herath HMLK and Randeni RPLC

**AGROBIODIVERSITY FOR HUMAN HEALTH AND LIVELIHOOD DEVELOPMENT**

Antioxidant capacity, phenolics, and ascorbic acid contents in selected indigenous root and tuber crops of Sri Lanka

Rupasingha, KBGPP, Senarathne, SMACU and Ratnayake, RHMK

Antioxidant properties of selected pigmented and white long grain rice varieties of Sri Lanka at market available polishing rates

Abeysekera WKSM, Abeysekera WPKM, Lakshan SAT, Samaranayake MDW, Liyanage SL, Premakumara GAS and Abeyesiriwardena Sumith de Z D

Efficiency of freeze-dried bitter gourd powder as a fat replacer on the quality attributes of chicken meat paste

Karunarathne ADR, Wijesinghe SKD and Jayasena DD

In vitro study on the allergenic effects of selected agro foods, green tea (*Camellia sinensis* L. kuntze) and seafood in causing IgE independent basophil degranulation

Wijerathna C, Handunnetti SM, Fernando N and Premawansa S

Incorporation of herbal plant extracts; *Zingiber officinale* Roscoe and *Phyllanthus emblica* L. to suppress glyceamic impact of cane sugar

Samarasinghe CH, Jayasinghe MA, Senadheera SPAS, Wijesekara I, and Ranaweera KKDS

Local root and tuber crops for improved nutrition, well-being and community development

Godamulla D, Samarasinghe WLG, Sartaj AB, Samaradiwakara SHMRNP, Abeywickrama KGTA and Hunter D

α-amylase and α-glucosidase enzyme inhibitory activities of selected millet types and sorghum varieties of Sri Lanka

Senevirathne IGNH, Abeysekera WPKM, Abeysekera WKSM, Jayanath NY, Premakumara GAS and Wijewardana DCMSI

Phenolic contents and pancreatic lipase and cholesterol esterase inhibitory activities of selected millet types and sorghum varieties of Sri Lanka

Indrachapa S, Jayathilaka SI, Abeysekera WPKM, Jayanath NY, Premakumara GAS and Wijewardana DCMSI

Determination of viability of *Bifidobacterium animalis* subspecies lactis in garlic (*Allium sativum* L.) incorporated synbiotic butter

Premerathne JMNH and Mudannayake DC
Assessment of agrobiodiversity in Kandyan home gardens - A case study
Warnasooriya PGAS, Weerakkody WAP and Bandaranayake, PRSD

A comparative study to develop calcium, zinc and antioxidant rich drinking yoghurts using plant and pharmaceutical sources
Samarathunga RMJN, Jayasinghe MA, Edirisinghe MP, Wijesekara I, Abeysundara De AP, and Senadheera SPAS

Formulation of non-animal-based stabilizer combination to replace gelatine in set-yogurt
Kauppu KAYR and Abeysundara PDA

AGROBIODIVERSITY FOR ECO SYSTEM SERVICES AND CLIMATE CHANGE ADAPTATION

Adaptability of selected lablab and winged bean varieties to diverse ecosystems in Sri Lanka
Malathy P, Siriwardena SMSP, Darshani RMS, Nilanthi WDGP and Pooten PNMV

Prospects for realization of benefits rising from in situ conservation of agro-biodiversity in different agro-ecosystems in Sri Lanka
Herath HMLK, Dunisinghe P, Manawadu L, Dayawansa WGMG, Liyanage ASU and Gunarathna KKDK

Constraints faced by farmers of minor irrigation systems in mitigating the impact of climate change: case study from Anuradhapura district, Sri Lanka
Premasiri PMSS, Dissanayake SP and Ginigaddara GAS

Constraints on adaptation for wetland agriculture to mitigate climate risk; a case study in Kaduwela wetland, Sri Lanka
Navaratne WRMDP, Dissanayake SP and Ginigaddara GAS

Villagers’ perception on introducing sustainable agro tourism programme for rural livelihood upliftment in Palugasewa cascade system, Sri Lanka
Dayarathna GWGVM, Dissanayake SP and Ginigaddara GAS

Smallholder vegetable farmers’ choices for adaptation to climate change in Anuradhapura district, Sri Lanka
Ariyadasa WGS and Kopiyawattage KPP

Study of salinity levels and impact of salt water intrusion on coastal paddy areas of wet zone of Sri Lanka
Opatha KN and Lokupitiya E

Effects of Climatic Variation on Yield of Upcountry Tea: A Case Study based on Upcountry Tea Estates of Kelani Valley Plantations PLC in Sri Lanka
Manawasinghe KS, Abeysinghe DC, Weerakoon A and Thennakoon TMNS
AGROBIODIVERSITY FOR POLICIES, ECONOMICS, MARKETING AND VALUE CHAINS AND INDUSTRIAL OPPORTUNITIES

Government policy incentives for conservation and utilization of agro-biodiversity in Sri Lanka: evidence from a content analysis
Swar Nathilake C, Udani K, Pushpakumara DKNG and Weerahewa J

Phytochemical screening and analysis of anti-glycation activity of developed herbal tea with Goose berry, Ginger, Coriander
Priyadarshana PHMGC, Jayasinghe JAVR, Perera HKI, Udari AHGS

Strategies to overcome the production and marketing issues of the products at BFN sites
Kuruppuarachchi KANL, Senevirathne NDSL, Rienzie R, and Gunaratne LHP

Public awareness and perception on government interventions to conserve and promote agro-biodiversity in Sri Lanka
Udani K, Swar Nathilake C, Pushpakumara DKNG, Weerahewa J

Development of a participatory guarantee system to support small scale producers of ‘Biodiversity for Food and Nutrition’ (BFN) crops
Rienzie R, Gunaratne LHP, Ranil RHG and Kuruppuarachchi KANL

Effect of commercial liquid smoke flavoring on physico-chemical properties in Tilapia (Oreochromis niloticus)
Lelwela GKTN, Wijesinghe SKD, Himali SMC and Abeyrathne EDNS

The economic value of care role of women: A case in Kandyan home gardens, Sri Lanka
Ranasinghe SC, Somaratne KWAN, Ginigaddara GAS and Premarathne NMKC

Bio-diversified food and nutrition value chains in Sri Lanka: constraints and opportunities for value chain upgrading
Samarasinghe, KP, Senevirathne NDSL, Hemachandra, SD

Development of Jackfruit (Artocarpus heterophyllus Lam.) incorporated frozen yogurt
Dissanayaka TMPM, Gimhani KHI and Champa WAH

LIST OF REVIEWERS
FORWARD

This century from its beginning started facing many challenges with climate change, food security and environmental pollution. Sustainable development goals were introduced by United Nations to alleviate the major problems by 2030. In line with that goals, Ministry of agriculture aims to increase domestic agricultural production to ensure food and nutritional security, promote agro-based industries and enhance living standards of farming community. In the past livelihoods were entangled with the surrounding biodiversity thus almost all the human needs were catered from the sustainable use of biodiversity. However, with the urbanization and prevailing intensified agricultural systems low priority is given to the existing agro-biodiversity within the country. With funding from Global Environmental Facility such an attempt of FAO (for BFN Project) and UNEP together with Bioversity International was the two projects executed Biodiversity for Food and Nutrition and Biodiversity for Adaptation to Climate Change projects implemented by the Department of Agriculture through Ministry of Mahaweli Development and Environment. These projects drive towards mainstreaming agrobiodiversity towards food security and to adapt climate change scenarios prevailing within the country.

Two projects have conducted activities since the inception and the symposium organized is a platform to showcase important research and development work under broader category towards elite group of personnel in the country.

The national coordinators of Mainstreaming Biodiversity Conservation and Sustainable Use for Improved Human Nutrition and an well-being (BFN) and Mainstreaming Biodiversity Conservation and Sustainable Use for Climate Change Adaptation (BACC) projects are pleased in presenting the proceedings of the symposium ‘ Agrobiodiversity for Climate Change Adaptation, Food and Nutrition’ at the termination of project activities. The proceedings include 49 peer reviewed abstracts accepted by rigorous review in which 26 are presented orally and 23 are as posters. The coordinators are grateful for all authors who have submitted output of their dedicated research and development work related to conservation and sustainable use of agrobiodiversity. Also, we strongly believe this symposium will enable peer scientists to move forward with more collaborative work in future for conservation and sustainable use of agrobiodiversity.

National Project Coordinators

Dr. Gamini Samarasinghe- Biodiversity for Food and Nutrition

Mr. Athula Liyange – Biodiversity for Adaptation to Climate Change
KEYNOTE AND INVITED SPEECHES
There are 32 countries in the world, facing food crisis. Almost 870 million people in the world are estimated to be chronically undernourished. Unfortunately, the countries facing the extreme climate risks are the countries having food insecurity. Therefore, with the climate change effects food insecurity in these countries will become worse. The modern agriculture does not have any solution to this problem as it is one of the main contributors to the climate change conditions. Therefore, the only solution to this problem is achieving food sovereignty through sustainable agriculture. On the other hand, agriculture, climate change, food sovereignty and poverty reduction are inseparably inter-linked. According to FAO, agricultural production must increase by an estimated 70% to feed the projected world population of 9 billion by 2050. Therefore, key stakeholders in the agriculture sector have a big responsibility to increase the agricultural production, while maintaining the agro-biodiversity which is inseparably linked with sustainability.

Globally, the present agriculture directly accounts for 13.5% of greenhouse gas emissions and indirectly for another 17% due to deforestation and unsustainable land-use changes. On the other hand, in many cases, those who have contributed the least to global warming and climate change are the ones to suffer the most from its harmful effects. About 60% of ecosystem services are already degraded mainly due to unsustainable intensive agriculture. Intensive agriculture is heavily depending on non-renewable energy. Further, modern agriculture is insufficiently prepared to cope with unpredictability due to climate change. Climate Change alters almost all aspects of agriculture viz., the types of crops planted, dates of planting, tillage and harvest, crop management, soil fertility, ecosystem health and pest and diseases. Therefore, we need to develop new agricultural models based on our indigenous agricultural practices which have already proved their sustainability over thousands of years. Therefore, we are compelled to revert back to “nonscientific” polyculture (mixed cropping) from “scientific” monoculture. Polyculture is the sustainable farming system prevailed in Asia for more than 2500 years. It ensures food sovereignty by means of diet diversity, diversified income generation, production stability, (against the Climate Change), minimization of risk of climate change, low pest and diseases incidences, efficient use of labour, intensification of production with limited natural resources and maximization of returns under low levels of technology. It also maintains agro-biodiversity ensuring the food sovereignty in spite of Climate Change.

Requirements to build food sovereignty are climate-smart practices based on indigenous knowledge, ecosystem approach at landscape level, conservation of local germplasm and landraces, production of varieties and breeds adapted to climate change. To fulfil above requirements investments are needed in
filling data and knowledge gaps and R&D on traditional technologies. The main requirement is to have a consistency between agriculture and food sovereignty policies and climate change policies. The other important thing is to develop 'agrarian citizenship', where the political and material rights and practices of rural dwellers are based not solely on issues of rural political representation but also on their relationship with the socio-ecological metabolism between society and nature. This is important because, agrarian citizenship recognizes nature's role in the continuing political, economic, and cultural evolution of a broadly-defined and evolving agrarian society, being predicated upon transcending the metabolic rift between humans and nature.
The fifth Assessment Report of the International Panel on Climate Change (IPCC) concluded that all aspects of food security are potentially affected by climate change, including food availability, access to food, nutrient utilization and stability of food supply and that negative impacts on average crop yields and increases in yield variability are already occurring. The Report noted that rural areas will experience major impacts on water availability and supply, food security, infrastructure and agricultural incomes, including shifts in the production areas of food and non-food crops around the world and that coastal systems and low-lying areas will increasingly experience submergence, flooding and erosion throughout the twenty-first century and beyond due to rising sea levels.

The effects of even a 1.5°C rise in temperature on Sri Lanka’s rural communities and food production are likely to be devastating and significant impacts on food production and rural livelihoods can already be identified. However, both adaptation and mitigation actions taken at national level can limit the impact. The most recent IPCC Report exploring the challenges involved in keeping global warming below 1.5°C noted that adaptation options that reduce the vulnerability of human and natural systems have many synergies with sustainable development and will include ensuring food and water security, reducing disaster risks, improving health conditions, maintaining ecosystem services and reducing poverty and inequality.

Agrobiodiversity - the diversity of crops, animals and other organisms found in and around production systems - can play a key part in adaptation and mitigation of climate change and in strengthening the resilience of rural communities. Substantial information on the ways in which this can be done, through improving ecosystem services and increasing the diversity found in production systems, has come from Global Environment Facility supported projects in Sri Lanka and from other initiatives around the world.

Sri Lanka’s agricultural policies and those that address the challenges of climate change have already begun to recognize the importance of supporting eco-friendly agriculture based on improved diversity deployment. In this paper we explore what actions might further strengthen the contribution of agrobiodiversity to the delivery of ecosystem services, adaptation to climate change and improving resilience.
Current food systems are unsustainable. Although yields per hectare have gone up significantly in many parts of the world in the last few decades, over 800 million people still go to bed hungry every night while many more suffer from food system failures to deliver on much needed micronutrients. Soils, biodiversity and habitats are increasingly degraded. Local and native crops, many of which are climate resilient – and nutrient-rich, are rapidly disappearing. Current food systems are not only failing the environment, they are failing nutrition. Poor diet from current food systems are now the number one driver of ill health and public health costs globally. A key cornerstone of sustainable food systems and healthy diets is food biodiversity broadly defined as “the diversity of plants, animals and other organisms used for food, covering the genetic resources within species, between species and provided by ecosystems”. Nutritional diversity required for a healthy life is dependent on this diversity. Yet there remain many political, social, economic and technical barriers to mainstreaming such food biodiversity to improve food systems and health. The GEF-funded Biodiversity for Food and Nutrition (BFN) initiative represents a unique and novel approach to better linking food biodiversity, diets and nutrition and sustainable food systems. It is a multi-country, cross-sectoral initiative that has researched and promoted local food biodiversity and which has worked across sectors, promoting multi-stakeholder partnerships, avoiding solid approaches, to better link: evidence; policy and markets; awareness and understanding. In doing so, it has brought about widely supported, science-based and actionable recommendations; stimulated higher levels of investments; and triggered increased political commitment for the creation of enabling policy environments for the transition to sustainable food systems.
Towards Updating of the National Action Plan for Conservation and Sustainable Utilization of Agrobiodiversity in Sri Lanka

Jeevika Weerahewa and Gamini Pushpakumara

Faculty of Agriculture
University of Peradeniya

Agrobiodiversity comprises of genetic resources of crops, livestock, poultry, aquatic life, insects, and microbiological species. Sri Lanka is a home to a wealth of agrobiodiversity that has both global and local importance. However, it is currently under threat from a variety of factors that include unsustainable agriculture production practices, changing land use patterns, popularization of improved plant varieties and animal breeds, and climate change. Conservation of agrobiodiversity is crucial in designing strategies for development of rural economies. Sustainable utilization of agrobiodiversity is one of the assured ways of its conservation and the key to achieve long term sustainable agricultural development of a country.

Sustainable utilization of agrobiodiversity has been highlighted in a number of national policy documents of the Government of Sri Lanka emanating from the ministries responsible for natural resources, agriculture, livestock, fisheries, land and water. The National Action Plan for Agrobiodiversity Conservation and Sustainable Utilization in Sri Lanka issued in 2008 (NAP-ACSU-2008) has been the overarching plan in this respect. It presents a number of issues with respect to agrobiodiversity conservation, policy recommendations and specific actions paying due attention on economics, marketing, value chains and industrial opportunities. It, however, is timely to update the NAP-ACSU as some issues highlighted in 2008 have been resolved and new issues have emerged since its launch. Furthermore, it is prudent to include more statements pertinent to conservation and sustainable utilization of livestock, poultry, aquatic life, insects, and microbiological species in the NAP-ACSU as the existing version is largely devoted for conservation and sustainable utilization of the crop wild relatives. A special emphasis on progenitors, wild relatives and wild species of under-utilized species and varieties should be paid in updating the NAP-ACSU-2008 as needed policies, programs and projects are already in place to promote utilization of improved plant varieties and animal breeds. In light of above concerns, an attempt was made to update the NAP-ACSU-2008. The objective of this note is to illustrate the process adopted in updating and to present key features of the updated NAP-ACSU.

The key issues identified in the NAP-ACSU-2008 were classified into following five broader groups in the updated NAP-ACSU. They are (i) inadequacies in financial and non-financial incentives for on-farm and off-farm conservation, (ii) inadequate access to plant and animal genetic material of under-utilized plant varieties and animal breeds and their over-exploitation, (iii) dominance of improved plant varieties and animal breeds in farming systems, presence of invasive species, disabilities in plant/animal
physiology due to climate change, and chemical resistance, (iv) absence of well-developed markets and insufficient demand for traditional culinary, and (v) limited research, information and education system.

Subsequently, the policy recommendations identified in the NAP-ACSU-2008 were mapped against each of the issues identified above. They were named as; (a) provision of incentives for in-situ and ex-situ conservation, establishment of partnerships, and ensuring of farmers’ rights, (b) improved access to planting material and animal breeding material including pollinators and soil micro-organisms, (c) promotion of environmentally friendly farming systems, (d) development of markets for produce obtained from traditional varieties and species and promotion of traditional culinary, and (e) promotion of research, characterization and inventorization of genetic resources, provision of information, inclusion of agrobiodiversity in formal education system and capacity building at all levels.

Actions proposed in the NAP-ACSU-2008 are classified into eight groups namely (I) Current knowledge, knowledge gaps on agrobiodiversity resources base in Sri Lanka and assessment and documentation of agrobiodiversity components; (II) Enhance benefits sharing from agrobiodiversity; (III) Strengthening of national literacy on agrobiodiversity; (IV) Strengthening of national research capacity and research on agrobiodiversity; (V) Promotion of agrobiodiversity conservation and utilization; (VI) Enhancement of market availability; (VII) Linkages to existing projects; and (VIII) Policy issues and threats to agrobiodiversity. All of the specific actions presented under above eight groups were presented under the respective issue and policy recommendations in the updated NAP-ACSU.

A number of issues cited in the NAP-ACSU-2008 has been successfully addressed, at least at a pilot scale, after the launching of the same in 2008. Anecdotal evidences indicate that there has been an expansion of agrobiodiversity research, increased availability of databases pertinent to various aspects of agrobiodiversity and higher awareness on the benefits of agrobiodiversity among the public compared to the status in 2008. The unresolved issues include, among others, promotion of farming systems with traditional species and verities and connecting the farmers who utilize agrobiodiversity with global and local value chains to serve the high-end consumers. Actions required to address such issues were strengthened in the updated NAP-ACSU.

As per the studies conducted on indigenous livestock and poultry, it has been noted that conservation of indigenous livestock and poultry populations will undoubtedly help in improving the livelihoods of those who rear them and in increasing the adaptability of systems to varying climates and preserve the rural culture, society and religious life of the rural Sri Lankan society, as a whole. A policy brief issued by GEF-UNEP-ILRI project provides six broad recommendations promote conservation and sustainable utilization of Farm Animal Genetic Resources (FAnGR). They include (i) implementation
of new projects and programs, (ii) development of new guidelines when implementing projects, (iii)
implementation of strategic interventions, (iv) amendments to regulations, (v) strengthening of
implementation of clauses relevant to existing legislations, and (vi) changes to existing policies and
regulations. Some of the specific actions identified under above areas are already included in NAP-
ACSU-2008 and the rest was added in updating the NAP-ACSU.

The actions proposed in NAP-ACSU-2008 with respect to aquatic resources were updated by adding
the policy statements and actions of the National Policy and Strategy on Cleaner Production for
Fisheries Sector which was developed by the Ministry of Fisheries and Aquatic Resources in
collaboration with Ministry of Environment and Natural Resources in 2008. The updated NAP-ACSU
emphasizes conservation of coastal and aquatic environments to ensure long term sustainability of eco-
system which is a primary requirement in retaining aquatic genetic resources.

The actions proposed in NAP-ACSU-2008 with respect to insects, particularly pollinators, and
microorganisms, particularly soil-based microbes, were updated by adding the relevant statement in the
proposes activities to identify and conserve useful BES such as natural enemies, pollinators and soil
microorganisms for sustainable agricultural productivity.

The Overarching Agriculture Policy (OAP), which is being developed by the Department of National
Planning of the Ministry of National Policies and Economic Affairs, will be the effective policy for
agriculture during 2020-2030. Therefore, the specific policy recommendations and actions in the
revised version of NAP-ACSU were aligned to the relevant policy statement of the OAP, namely (1)
Promote and support exploration, conservation and utilization of biodiversity and sustainable
management of natural resources, (2) Promote eco-friendly farming systems for sustainable and
efficient agricultural production, and (3) Ensure sustainable land management through proper land use
planning and rational allocation of lands for different agricultural ventures for enhanced land
productivity, while minimizing land degradation.

The updated NAP-ACSU has been justified under the national policy of the Government of Sri Lanka
titled “Sustainable Sri Lanka 2030: Vision and Strategic Path” as the latter presents a number of policy
statements and strategies addressing various issues related to biodiversity. The national policy treats
natural eco systems, water resources and unique landscapes of the country as important resources to
reap economic benefits and considers strategic conservation and improvement of the existing
environmental systems and settings as a guiding principle of the National Physical Planning Policy. It
pays a special attention to loss in biodiversity due to climate change and proposes various remedies and
measures to conserve biodiversity.
The updated NAP-ACSU needs to be circulated at a consultative workshop to obtain comments from stakeholders attached to relevant government agencies, universities, private sector organizations, farmer societies and community-based organizations. Upon inclusion of comments, the revised NAP-ACSU needs to be validated by the relevant stakeholders.
Agrobiodiversity plays an important role in supplying sustainable nutritious diets to consumers hence improving health and nutrition of the population. Agrobiodiversity provides the basic resources farmers need to adapt to variable conditions in marginal environments and the resources required to increase productivity and the livelihoods of all farmers. Although it is estimated that of a total of 300,000 plant species globally, only 10,000 have been used for human food since the origin of agriculture, only 150–200 species have been commercially cultivated of which only four – rice, wheat, maize and potatoes – supply 50 per cent of the world’s energy needs, while 30 crops provide 90 per cent of the world’s caloric intake.

With demographic and nutrition transition took place in the last few decades, the diets of Sri Lankans are shifting towards more ‘Westernized’ dietary patterns. As a result, wide spread of under nutrition including micronutrient deficiencies in rural populations along with remarkably rising rates of diet related-non-communicable diseases such as diabetes, cardiovascular disease, obesity and overweight among urban populations are evident in Sri Lanka. Health approaches used so far such as supplementation of micronutrients to vulnerable groups, fortification of food and health education without integrating ‘food and nutrition literacy’ to the health messages failed to tackle these problems. Crop diversity and wild-harvested plants and animals provide significant contributions to human diets. Healthy human nutrition is best achieved by consuming diverse diets and varied food supply. Home gardens are a long-established tradition and offer great potential for improving household food security and alleviating micronutrient deficiencies. However, detailed evidence of their importance in terms of energy intake, micronutrient intake and dietary diversification is scarce. A recent research done in Nawalapitiya in Central Province of Sri Lanka showed that well managed home gardens contribute significantly to the dietary diversity of village households and home garden produce provides considerably to the micronutrient intakes.

Agriculture policy in Sri Lanka focuses mainly on increasing food production, especially rice and other staple foods but not the other nutrient dense crops such as pulses, yams, fruits and vegetables. Ignorance of the need to address the local food and nutrition needs in the current agricultural policy emphasizes the urgent need of revising it and meaningful integration with health and nutrition policies. Non-availability of the food composition data of the local varieties of food crops including underutilized crops limits educating the general public on nutritional value of consuming such crops. Recently, nutritional compositions of several crops including varietal differences in Sri Lanka were analysed. This information can be effectively used to popularise the consumption of traditional cereals, pulses,
vegetables, leafy vegetables and fruits as an important source of micronutrients. Department of Agriculture has initiated ‘Hela Bojun’ food outlets throughout the country as a mean of popularising the traditional local food recipes. The food items currently available through ‘Hela Bojun’ are predominantly traditional breakfast meals and traditional snacks, which cannot always be categorized as ‘healthy’. Therefore, more attention has to be paid in creating awareness and interest among new generations about healthy eating and the nutritional value of traditional foods and recipes, while trying to reduce the influence of the growing fast food culture.

An evidence-based innovative approaches are required diversify the diets and to utilize rich agrobiodiversity in sustainable manner in Sri Lanka. These approaches need collaboration with multi-stakeholders such as government institutions, non-governmental organizations, Universities, social media and mass media. Attention is required on supporting agriculture by small-scale farmers, the evaluation and use of local foods and their variety, popularising traditional cuisines, culturally sensitive agricultural methods, food literacy integrated nutrition education rather than just health education, research on novel and improved methods of food storage and processing and enhanced attention to marketing of produce of small-scale farmers.
AGROBIODIVERSITY FOR FOOD AND NUTRITION
At present, scientists try to find natural antioxidants which have the potential to counterbalance the effects of oxidative stress and the deleterious effects on human health caused by synthetic antioxidants. Banana can be easily grown in different parts in Sri Lanka and a large number of bananas are consumed every year. Therefore, investigation of natural antioxidants present in selected local banana varieties may reveal the potential sources of natural antioxidants. Methanolic extracts (absolute methanol) of four different cultivars of banana blossoms (Seeni, Kolikuttu, Neelamalu, Red) were analyzed for total phenolic content and expressed as gallic acid equivalents. The flavonoid content was expressed as quercetin equivalents. The \textit{in vitro} total antioxidative activity of the blossom extracts was compared with the standard and expressed as Trolox equivalents. The reducing power, 1,1-diphenyl-2-picrylhydrazyl (DPPH) and 2,2-azinobis (3-ethylbenzothiazoline-6-sulfonic acid) radical cation (ABTS$^+$) scavenging activities, Ferric Reducing Antioxidant Power (FRAP), Oxygen Radical Absorbance Capacity (ORAC) were measured and compared with respective standard antioxidants. The ion chelating activity was measured as ferrozine equivalents. The Neelamalu variety contained the highest polyphenol content (216.55 $\pm$ 11.89 mg of gallic acid equivalents/g of extract) and the highest ferrous iron chelating activity (13.86 $\pm$ 0.85%). The Seeni blossom contained the highest radical scavenging activity with a least IC$50$ value of 230.16 $\pm$ 14.91 $\mu$g/mL for ABTS$^+$ and highest inhibition percentage (31.33 $\pm$ 2.16) for DPPH test. The Red banana blossom contained the highest ferric reducing antioxidant power (337.1 $\pm$ 27.0 mg of trolox acid equivalents/g of extract). This study revealed antioxidant properties of methanolic extracts of banana blossoms exhibiting a new hope for a natural source of antioxidants compounds for food and nutraceutical industries.

**Keywords:** Antioxidants, Banana blossoms, Methanol extract, Oxidative stress
This study was to investigate the nutritional composition of three cowpea varieties, three green gram varieties and two horse gram varieties, which are traditionally grown pulses in Sri Lanka. Samples were collected from each agro-climatic zone of the country and they were cleaned, disintegrated to a fine powder and pooled, by homogenizing equal amounts of samples collected from each agro-climatic zone separately to obtain composite samples, which represents the whole of Sri Lanka. These samples were analysed for proximate composition, dietary fibre, minerals (Mg, K, Ca, Al, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Sn, Pb, Li, Be, V, Ga, Rb, Sr, Mo, Cd and Ba), fat-soluble and water-soluble vitamins. The results generated by analysing these samples have shown that all the pulses analysed comprised with 3.26±0.16% to 20.72±0.43% of crude protein, 3.51±0.03% to 6.61±0.16% of ash, 0.39±0.00% to 2.88±0.08% of crude fat, 41.71±0.06% to 52.15±0.21% of total carbohydrates and 21.09±0.03% to 33.71±0.11% of dietary fibre. All the pulses analysed were rich in Fe, Cu, Ca, Zn, Mn, Mg, K, Na and Rb. Further, all cowpea and green gram varieties were richer in thiamine and riboflavin than other samples analysed. Green gram (411.97±1.88 µg/100g to 606.26±1.74 µg/100g) and horse gram (84.16±1.01 µg/100g to 89.19±1.66 µg/100g) varieties were richer in vitamin A than other pulses analysed. Cowpea varieties contained a considerable amount of vitamin K (9.11±0.02 µg/100g to 26.96±0.00 µg/100g) compared to other commodities. Inter-species and intra-species differences and similarities in the nutritional composition of tested commodities were observed. The effect of environmental and soil conditions, anti-nutritive factors and bioavailability of nutrients should be analysed to obtain data that are more comprehensive. A compositional database on traditional pulses is not available in Sri Lanka. This study would be beneficial to get a general consciousness on the composition of traditional pulses available in Sri Lanka.

**Keywords:** Cowpea varieties, Green gram varieties, Horse gram varieties, Nutritional composition, Traditional pulses
Foxtail millet (FM) [Setaria italica L.] is cultivated in arid and semi-arid regions of the world due to its high food, nutritional and medicinal values. Foxtail millet is grown in different crop combinations to enhance the productivity of cropping systems. Though FM possesses significantly high amount of nutritional and medicinal properties, it still remains as an underutilized and neglected crop in Sri Lanka. A field experiment was conducted to investigate the productivity of FM - green gram (GG) [Vigna radiata (L.) Wilczek] intercropping system under different rates of nitrogen (N). Nitrogen rates (0, 50 and 100% of the recommended N application for minor millets and green gram) and cropping systems (FM-GG, sole FM and sole GG) were assigned in main plots and sub plots respectively in a split-plot design. Plant growth, N accumulation, land equivalent ratio (LER), and competitive ratio (CR) were measured. The results showed that LER of FM-GG intercropping system under different N rates varied from 1.16 to 1.78. Highest LER was observed in 0% N applied plots followed by 100% and 50%. Partial LER of GG was lower than FM, indicating the dominant effect of the major crop in each system. CR showed that FM competes better with GG to produce a higher yield. The yields of mono cropping and intercropping were not significantly different under different N levels. Grain N concentration was also similar between two cropping systems (p>0.05), but there was a trend of higher N accumulation in GG in mono cropping compared to that in intercropping. Thus, FM-GG intercropping appeared to be a compatible cropping combination with a higher productivity over foxtail millet mono cropping system which is rarely practiced by Sri Lankan farmers.

**Keywords:** Competitive ratio, Foxtail millet, Green gram, Intercropping, Land equivalent ratio
Nipa palm (*Nypa fruticans*) is one of the underutilized mangrove plants in Sri Lanka. The key objective of this study was to investigate the proximate values and characteristics of *Nypa fruticans* kernel flour. In addition, cookies were developed by incorporating Nipa kernel flour (0, 10, 20, 30, 40, 50%, w/w) and to the best of our knowledge; this is the first report regarding the food use of Nipa kernel in Sri Lanka. Nipa palm fruits were plucked from mangrove site in Ambalangoda, Sri Lanka, washed, and kernel was separated from the outer pericarp. The kernel was oven dried, grinded, and sieved to yield kernel flour. The mature kernel samples were analyzed according to AOCC procedures and protein and fat contents of the kernel flour were 7.57 ± 0.28% and 2.95 ± 0.07%, respectively. The heavy metal analysis from atomic absorption spectroscopy revealed that, Cu and Zn were detected in Nipa kernel flour were 0.34 ± 0.01 and 1.38 ± 0.08 ppm, respectively. The highest protein content and lowest fat content were observed in 40% Nipa kernel flour added cookies. The appearance and baking conditions of Nipa palm kernel flour contained cookies were similar to the cookies contained 100% wheat flour. According to the sensory evaluation, the cookies contained 30% Nipa kernel flour had the highest overall acceptability of the consumers. Collectively, the results of this study showed the potential application of Nipa kernel flour in manufacturing of cookies.

**Keywords:** Cookies, Nipa kernel, *Nypa fruticans*
PROXIMATE COMPOSITION AND ANTIOXIDENT PROPERTIES OF SOY INCORPORATED READY-TO-SERVE (RTS) FRUIT DRINKS PREPARED USING SOURSOP (*Annona muricata* L) AND WATERMELON (*Citrullus lanatus* Thunb)

Perera MPMSh, Karawita RS, Gunawardhana HMDM, Sivakanesan R, Sarananda KH
1National Food Promotion Board, Narahenpita, Colombo, Sri Lanka
2Department of Biochemistry, Faculty of Medicine, University of Peradeniya, Sri Lanka
3Department of Biosystems Engineering, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka
rohankrs@gmail.com

Fruits are rich in phytochemical, vitamin and minerals, therefore considered as essential dietary components with antioxidant properties. This study was conducted to prepare soy incorporated Ready-To-Serve Fruit Drinks (SRTSCFs) using watermelon (*Citrullus lanatus*) and Soursop (*Annona muricata*) which could be considered as a healthy fruit drink. Soy milk was prepared by soaking soybean seeds (Pb-1) overnight followed by hot extraction (soy seeds: water, 1:4 W/V ratio) and pasteurization. Fruit extracts were prepared by blending deseeded flesh into pulp and mixed with appropriate quantity of boiled cooled water (flesh: water 1:0.5 W/V ratio) followed by pasteurization. Soy and fruit extract were mixed in 2:1 V/V ratio. Sensory evaluation was conducted by a trained taste panel. The Brix values were recorded using a hand refractometer (ATAGO-HSR-500) and pH was determined using Nippon pH meter. Proximate composition was analyzed following AOAC methods. Antioxidant properties were determined using DPPH assay and total phenolic content. Two SRTSCFs recorded significantly higher (p<0.05) mean ranks for color, flavor, texture and overall acceptability than that of controls purchased from local market. Soursop RTS had higher fat and protein content (5.12% and 15.27% respectively) than watermelon TRS (0.27% and 11.44% respectively). Watermelon RTS had higher total carbohydrate content (88.05%) than sourso TRS (77.18%). Soursop RTS had higher crude fiber and ash content (0.75% and 0.18% respectively) than watermelon RTS (0.15% and 0.15% respectively). Watermelon RTS had higher total phenolic content and DPPH radical scavenging activity (41.20 mg/GAE/100g and 476.09 TE/100g respectively) than sourso RTS (27.16 mg/GAE/100g and 190.78 TE/100g respectively). All SRTSCFs had the shelf life of 8 months period. Soy incorporated Ready-to-serve fruit drinks could be prepared successfully using watermelon and sourso as natural healthy fruit drinks.

**Keywords:** Antioxidants, Fruit drinks, Soybean, Soursop, Watermelon
Consumer preference for traditional rice is increasing in Sri Lanka due to the high nutritional properties of these varieties which are promoted through Sri Lankan indigenous medicine. However, consumer awareness of traditional rice varieties has not been satisfactory. This study was carried out to evaluate some cooking characteristics of selected underutilized Sri Lankan traditional rice varieties with the aim of identifying cultivars having desirable cooking characteristics that can be popularized among consumers, and to increase the interest on further research using these varieties. Eight traditional rice varieties namely; Ranthabili (RT), Kirinaaran (KN), Sudumurunga (SM), Kahawanu (KW), Kahamaala (KM), Hangimuththan (HM), Batapolal (BP), and Beethheenati (BH) were used in this study. HM and SM varieties were obtained from Galle district. BH, BP, KW and KM varieties were obtained from Matara district, and RT and KN varieties were obtained from Kandy district. The paddy was dehusked, and whole grain rice was used to determine minimum cooking time (MCT), gelatinization temperature (GT), percentage gruel solid loss (PGSL), volume expansion ratio (VER), and water uptake ratio (WUR) in triplicates. According to the results, MCT, PGSL, VER and WUR of the selected varieties were varied from (20.97±0.66) min to (51.04±0.56) min, (3.27±0.01) % to (10.06±0.00)%, (0.83±0.00) to (1.51±0.29), and (1.05±0.00) to (2.02±0.00) respectively. High, High-Intermediate, Intermediate and Low GT classes were identified from the selected varieties the majority of which had low GTs. An exceptionally high MCT and exceptionally low WUR was found in BP variety when compared to the other varieties. The results showed significant difference (P<0.05) between selected varieties for MCT, WUR and PGSL. There was no significant difference between the varieties for VER. It can be concluded that some selected traditional rice varieties show desirable cooking properties which can be used to popularize them among the community and which can be used in further research.

**Keywords:** Cooking characteristics, Gelatinization temperature, Traditional rice, Volume expansion ratio, Water uptake ratio
Home gardening is common in most tropical countries and it plays an important role in supporting households in various ways. In Sri Lanka, Vavuniya is one of districts in the Dry Zone of Sri Lanka that has severely been affected by civil war in the recent past and experienced harsh climatic conditions. After the successful post war resettlement programs in the district, establishing home gardens was one of the strategies to meet the food security of people. This study was conducted to assess the contribution of home gardening for the household food security in Vavuniya district. A sample of 100 home gardeners and 30 non-home gardeners of both women-headed families in Cheddikulam Divisional Secretariat Division (DSD) was selected by simple random sampling method. A pre-tested questionnaire was used for data collection. The Household Dietary Diversity Score (HDDS) was used to measure household food security with respect to the access of households to different foods. Data were analyzed by descriptive analysis and one-way ANOVA using Statistical Analytical Software (SAS). The results showed a significant difference in HDDS of home gardeners and non-home gardeners (p = 0.0471). Based on HDDS, the population was classified into three groups for their household food security: highly food-secured (FS) (>6), medium FS (4.5-6) and less FS (<4.5). Sixty six percent (66%) of home gardeners belonged to highly FS group while 33% and 16% of home gardeners belonged to medium and less FS groups, respectively. Among the non-home gardeners, 47% was identified as highly FS while 40% and 13% belonged to medium and less FS groups respectively. The home gardeners fulfilled their requirement of eggs (73%), green leaves (60.9%), fruits (53.8%) and vegetables (31.5%) from their own home gardens. These findings confirm home gardening as a viable strategy for household food security of the selected women-headed households in Vavuniya District of Sri Lanka.

**Keywords:** Dry Zone, Home Gardening, Household Food Security, Vavuniya District, Women-headed families
In the present study, physico-chemical properties of flour obtained from fully matured traditional yam “Maha angili ala” (*Dioscorea alata*) were investigated. Proximate analysis according to the standard AOAC procedures revealed that protein, ash, and fat contents of flour (moisture content, 5.25 ± 0.14%, dry basis) obtained from oven-dried and powdered “Maha angili ala” yams were; 6.99 ± 0.62%, 3.54 ± 0.16%, and 0.56 ± 0.08%, respectively. Colour analysis by a digital chromometer resulted $L^*$, $a^*$, $b^*$ values of flour were; 70.36 ± 0.80, 5.57 ± 1.64, and 16.63 ± 0.77, respectively. The starch granules were oval shaped in microscopic view and the water holding and oil holding capacities of the flour were; 1.58 ± 0.01 g of water/ g of flour and 0.86 ± 0.03 g oil/ g of flour, respectively. Moreover, gluten-free muffins were developed from “Maha angili ala” flour with either guar gum or xanthan gum as stabilizer. Gluten-free foods are recommended for Celiac disease. For the control analysis, wheat flour was used to develop control muffins. The guar gum added muffins were the most preferable according to sensory evaluation results. Collectively, this study suggested that “Maha angili ala” flour could be a potential source to develop gluten free muffins. Further, product quality and shelf-life analysis of developed muffins are in progress.

**Keywords:** Bakery foods, *Dioscorea* spp., Gluten-free, Muffins
Seaweeds are a rich source of health beneficial bioactive nutraceuticals and currently they are under-utilized in Sri Lanka. Thus, there is a potential to utilize seaweeds in new product developments in Sri Lanka. The elemental composition is significant when incorporating seaweeds in product developments. Thus in the present study, an elemental composition analysis of Ulva fasciata obtained from 3 locations Mirissa, Matara, Down South, Sri Lanka (Latitude: 5°56'53.74" (5.948262) north and Longitude: 80°28'17.71" (80.471588) east) and Point Dondra, Matara, Down South Sri Lanka (Latitude: 5° 55' 7.9" (5.9189) north and Longitude: 80° 35' 24.8" (80.5902) east) and from Galle, Down South, Sri Lanka (Latitude: 6°02'01.1"(6.033634) north and Longitude: 80°12'52.2" (80.214509) east) and red algae varieties Gracilaria edulis and Gracilaria sp. obtained from Kalpitiya, Sri Lanka (Latitude: 8°15'40.8"N (8.261340) Longitude: 79°46’33.9"E (79.776077), (Latitude: 8°13’35.0”N (8.226388) Longitude: 79°43’34.8”E (79.726325) respectively. The elemental analysis was carried out with 2 replicates using the XRF instrument. The results revealed that the predominant mineral of Ulva fasciata obtained from the 3 locations and Gracilaria sp. as Calcium. While the predominant mineral in Gracilaria edulis was Potassium. All the 5 varieties have various concentrations of elements such as, K, Ca, Mn, Fe, Cu, Zn, Br and Sr. A significantly high Lead content was observed in Ulva fasciata obtained from Point Dondra, Down south, Matara, Sri Lanka. The elemental compositions showed variations among the same species obtained from different locations. The results also revealed that seaweeds is a good source of certain essential and trace minerals thus the consumption of seaweeds will provide these minerals to the human body.

Keywords: Elements, Gracilaria edulis, Gracilaria sp, Ulva fasciata, Minerals
AGROBIODIVERSITY - IDENTIFICATION, CONSERVATION, VALUATION AND SUSTAINABLE USE OF TRADITIONAL KNOWLEDGE
Farmer Field Fora (FFF) is a community based non-formal education approach which ensures sharing knowledge among farmers, scientists and extension officers. An FFF was conducted in farmer fields at Giribawa and Millaniya in 2017 Yala (dry) season with the objective of selecting okra varieties based on farmer requirements while enhancing the available crop diversity in these areas. Small scale traditional farmers were engaged with this study. Based on the farmer required plant and pod characters, ten traditional okra accessions that are conserved at Plant Genetic Resources Centre were used for the study. The trials were established according to the farmer practices in fields of 2-3 leading farmers in the farmer organizations and one properly maintained trial from each location was selected for the field fora. Data collection was done at different important stages of crop growth with the active participation of farmers and officers. At the podding stage FFFs were organized in these locations with the participation of okra growing farmers, scientists and extension officers. Farmer opinions related to performances of accessions, their indigenous knowledge and practices and scientific explanations were discussed while making the selections. Their opinions were collected based on a simple questionnaire. Out of ten local okra accessions tested, three accessions (AC013392, AC013604 & AC15692) were selected by Giribawa farmers and three accessions (AC013392, AC013615 & AC15185) were selected by Millaniya farmers. The selection was based on yield, pod characters, suitability for home garden cultivation and environmental adaptation. This study revealed that the FFF with participatory selection is an appropriate method to identify farmer adaptable varieties for specific locations which automatically enhance the crop diversity. The practice was highly accepted by farmers.

**Keywords:** Crop diversity, Environmental adaptation, Farmer participation, Traditional Okra accessions
An ethno-botanical survey of medicinal plants used by the communities of Gampola, Pahala, Giribawa and Wannikudawewa in Giribawa Divisional Secretariat Division, Sri Lanka was undertaken to document traditional knowledge on medicinal plants, with the aim of supporting studies related to the conservation of biodiversity. A total of 40 informants from each community were assessed using a structured open-ended questionnaire survey at household level, focus group discussions, and dialogue techniques. Interviews were mainly focused on medicinal plants used by the community for healthcare needs and other uses. A total of 293 medicinal plants belong to 80 families were recorded. The best representing botanical families were Fabaceae (14%), Rutaceae (6%), Malvaceae (5.5%) and Cucurbitaceae (4%). Leaves were the most frequently used plant part (35%) to treat different illnesses followed by the whole plant and roots of 16%, bark (13%) and fruits (10%). A total of 28 different illnesses were recorded. The highest number of species was used to treat pains, stomach aches, fractures and dislocations, headaches, wounds and snake poisons. Twenty-four medicinal plants were used to treat animal diseases. Other than the medicinal uses, 62 medicinal plants were also used to make different kinds of food and 21 plants were used as edible fruits. Community informants are the holders of knowledge on medicinal plant uses and practical applications. Since this knowledge is not generally passed from generation to generation there is a considerable risk that it will be lost over time. The findings of the survey revealed that the knowledge of rural communities on local medicinal flora can be included in developing community-based conservation programs.

**Keywords:** Ethnobotany, Informants, Medicinal plants, Rural community, Traditional knowledge
PLANT SPECIES DIVERSITY IN DIFFERENT LAND USES IN UDUDUMBARA AREA OF MID COUNTRY INTERMEDIATE ZONE OF SRI LANKA

Chandrapala AG, Kendaragama KMA, Gunasekara IC, Wettasinghe SK, Dissanayake KGDC and Wasundara WMUPM
Natural Resources Management Centre, Department of Agriculture, Peradeniya, Sri Lanka
ag.chandrapala@yahoo.com

Species diversity is a key indicator of ecosystem health. Identification of diverse land uses is essential for maximizing ecosystem services. This study was conducted in year 2018 to determine the plant species diversity and dominant tree species in four dominant land uses (natural forest, home gardens, spices gardens and abandoned shifting cultivation lands) in Ududumbara, area of the mid country intermediate zone. To determine the plant species diversity and dominant species in each land use, the number of individuals over 5 cm DBH in each plant species were counted in 5m x 5m quadrats in four replicates in randomly selected locations. The plant diversity was computed using Simpson’s diversity index (SDI). The dominant plant species were determined using Relative Importance Value (RIV) of each species. Additionally, soil samples were collected up to 30 cm soil depth in each land use to determine the soil fertility status. Highest plant diversity was recorded in home gardens (SDI = 0.86) followed by natural forest (SDI = 0.82). Welang (Pterospermum suberifolium) (RIV 18.3) was the dominant plant species in natural forest. Banana (Musa spp.) (RIV 15.4), Mahogany (Swietenia macrophylla) (RIV 17.2) were the dominant fruit and timber species respectively in home gardens. Pepper (Piper nigrum) (RIV 26.3) was the dominant species in spice gardens. Abandoned shifting cultivation recorded the lowest plant diversity (SDI = 0.56) and Gadumba (Trema orientalis) (RIV 11.6) was the dominant plant species. Highest soil fertility status (available phosphorus, potassium and organic matter content) was recorded in home gardens followed by natural forest. Based on the results it was concluded that home gardens are the most diverse land use in the Ududukumbura area, and there is a need to improve the sustainability of other land uses such as shifting cultivation.

Keywords: Dominant species, Home gardens, Natural forest, Plant diversity
Halgolla Forest Reserve (HFR) is an isolated tropical wet evergreen lowland rainforest fragment, which is located in Kandy district in Sri Lanka. It is bordered by coffee and tea plantations and Kandyan home gardens. Although this forest fragment is only 4.35 ha in size, it may harbor high biodiversity that regulate various biotic interactions of agricultural crops in the adjacent villages. However the edges of the fragment are highly disturbed by human activities which threaten its high biodiversity. The aim of this study was to investigate the biodiversity of HFR in order to understand the sustainable use of the forest patch in an agro-forest matrix. Both faunal and floral surveys were conducted to sample the forest edge adjacent to home gardens and forest interior habitats from April to October 2018. Eighteen plots (six plots each per habitat) of 10 m² were established using stratified random sampling method. All plants (> 1.3 m dbh) in each site were tagged, recorded and identified in order to determine the plant diversity. Faunal groups were identified monthly from 06:00-09:00 h and 15:00-18:00 h. Point counts and line transect (2 X100 m) methods were used for the faunal survey. A total of 99 angiosperm species, belonging to 35 families were identified. Rutaceae, Annonaceae, Moraceae, Rubiaceae and Anacardiaceae were the dominant plant families in the forest fragment. The highest floral species diversity was observed in the forest interior. Higher abundance of *Coffea arabica* L., *Garcinia quaeisita* Pierre, *Areca catechu* L., *Camellia sinensis* (L.) Kuntze and *Syzygium aromaticum* (L.) Merr. & Perry was recorded at the forest edge. A total of 110 species were identified by the faunal survey including 73 vertebrate species and 37 species of invertebrates. The highest species richness and the diversity of faunal groups (69 species) were observed in forest edges than the interior (48 species). The high diversity of fauna and flora represents the rare and ecologically important species which need conservation attention. Thus, the result of this survey provides crucial information about the biodiversity of the organisms in this fragmented forest patch.

**Keywords:** Agro-forest matrix, Faunal diversity, Floral surveys, Fragmented forests, Halgolla
Application of traditional knowledge in food production system is known to be disappeared in Sri Lanka at present. Beneficial role of using traditional knowledge is in sustaining food production systems which are associated with traditional knowledge. Cascaded tank-village system is presumed to be significant in dry zone faced with the risk of droughts. Meanwhile, productivity of traditional cascaded tank-village system is at present badly affected by climate change, and therefore it is crucial to find measures to support food production especially in dry zone cascaded tank-village system. Considering the long-trusted advantages of using traditional knowledge in responding to climate risks associated with cascaded tank-village system, it is high time to explore the current situation by using traditional knowledge within local communities. In order to understand the level of utilization of traditional knowledge in food production by local communities, this exploratory study examined randomly selected 120 farmers in Palugaswewa cascade system in Anuradhapura district. A pre-tested questionnaire and four key personal interviews were administrated for data collection. Results revealed that, 52% of the farmers use traditional practices for food production, processing, storing and preservation. Meantime, 48% of farmers do not use traditional practices due to various limitations. Among those, 33% do not use local traditional knowledge due to less popularity where 29% have limited access to traditional equipment and seeds and 21% have limited knowledge on practices. The findings indicate that further studies on use of traditional knowledge in food production of cascaded tank-village system are necessary with the emphasis on promising practices that can be up-scaled for overcoming climate change impacts on food production.

**Keywords**: Cascaded tank village system, Food production, Traditional knowledge
APPLICATION OF TRADITIONAL ECOLOGICAL KNOWLEDGE FOR SUSTAINABLE SOIL RESTORATION WITH SPECIAL REFERENCE TO KNUCKLES REGION, SRI LANKA

Gamachchige RN1, Thennakoon TMSPK2

Department of Geography, University of Sri Jayawardenapura,

ravigamachchi@sjp.ac.lk

Soil degradation has been identified as an environmental issue in protected areas in Sri Lanka and it is particularly adverse in mountainous protected areas like Knuckles region. Rural communities living in Knuckles region are using diverse traditional methods to protect soil and restore their agro-ecosystems. The current research was carried out to investigate the use of traditional knowledge by local communities in restoring their soil environment, focusing on theoretical stages of ecological restoration viz. identifying degradation, dealing with degradation, minimizing degradation and evaluating restoration. This study was conducted in selected 7 Grama Niladhari (GN) divisions, out of 77 in the Knuckles Conservation Region. Selection of GN divisions was done through vulnerable cluster analysis of the Purposive Multi-Dimensional Optimization method. Both primary and secondary data were used for the study, and the primary data were collected through interviews, observations and questionnaires. Both qualitative and quantitative methods were used to analyse data. Mini tab and GIS software were used for statistical and spatial analyses. Documented traditional knowledge on restoring soil environment was validated through group discussions. There is no explicit categorization of traditional knowledge on eroded soil. Use of appropriate crop species better perform under specific soil characteristics was noted. Categorization of soil is linked to 5 main components and 18 sub-components of soil constituents. Identified soil restoration practices include preparation of situation specific soil mixtures, modification of topography for better site usability, adaptations of land use complement topography, and change of flow of the eco-system. Given the significant positive relationship between level of usage of traditional knowledge for soil restoration (or decreasing of soil degradation) and the harvest of the crops, it is necessary to promote the use of traditional knowledge in Knuckles Conservation Region for sustainable soil restoration.

Keywords: Knuckles Region, Soil Restoration, Traditional Ecological Knowledge
Assessment of soil biodiversity and determination of its loss requires the development of reliable indicators. Such indicators, if easily measurable, can empower and enable farmers to carry out assessment of soil biodiversity on their own land. In order to determine such indicators twenty four plots of 1m² area were sampled up to a depth of 0 – 15 cm across three prominent land use systems namely; home garden, mixed cropping and Owita at two different location under each system, identified as plot type 1 and plot type 2, in Milleniya, Sri Lanka. Plot 1: top soil is not compacted (loosely arranged), organic matter rich, low gravel and sand, soil color is 10YR 4/1 dark gray and plot 2: top soil is compacted, less organic matter, high amount of sand and gravel, soil color is 2.5Y 7/4 pale brown. Both plots were identified from the same soil, Boralu series of RYP soils (Typic Paleudults) Sub samples were analyzed for number and diversity of earthworms, vesicular arbuscular mycorrhiza (VAM) fungi spore density (spores/gm), other bacteria and Fungi (cfu/g). Significant (p<0.05) interactions were found between land use system and plot type for each parameter selected (p<0.05). In all land use systems, a significantly (p<0.05) higher abundance of the above mentioned organisms were observed in plot type 1 compared to plot type 2. Number of earthworms, bacteria as well as fungi species were significantly (p<0.05) higher in plot type 1 than in plot type 2, irrespective of the land use systems. It can be concluded that visual deterioration of the physical status of top soil is highly associated with soil biodiversity. According to the results, the lands with plot 1 topsoil characteristics are having higher soil biodiversity than the lands with plot 2 characteristics. As the tested parameters are easily measurable, farmers could be able to do biodiversity predictions of their own land easily. Thus, the tested parameters could be used by farmers as indicators for the assessment of soil biodiversity in agricultural lands.

Keywords: Indicators, Land use Systems, Soil Biodiversity
INVESTIGATING THE OPTIMUM GROWTH REQUIREMENTS OF *Senna alata* (L.) Roxb. (EMPEROR’S CANDLESTICKS) FOR DEVELOPING HERBAL COSMETIC INDUSTRY IN SRI LANKA

Gamage DGND¹, Abeysinghe DC¹, Wijesekara RGS², Prathapasinghe GA², Dharmadasa RM³, Someya T⁴

¹Faculty of Agriculture & Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila. 60170, Sri Lanka
²Faculty of Livestock, Fisheries & Nutrition, Wayamba University of Sri Lanka, Makandura, Gonawila. 60170, Sri Lanka
³Industrial Technology Institute, 363, Bauddhaloka Mawatha, Colombo 7, Sri Lanka
⁴ALBION Co., Ltd, Ginza 1-7-10, Chuo-ku, Tokyo, 104-0061, Japan

nadeeshanigamage89@gmail.com

Recent attention of herbal cosmetic manufacturers has driven on developing aseptic skin care products using *Senna alata* (L.) Roxb due to its excellent anti-microbial properties. At present, *S. alata* is utilised as one of key ingredients in skin care formulations among nearly 40% of Sri Lankan herbal cosmetic manufacturers. Thus, the aim of the present study is to provide scientific evidences on best growing requirements to support increasing innovations, productions and researches based on *S. alata*. The experiment was designed as 4x2 factorial design with a control and four replicates in each 16 treatment combinations. Four treatments were fertilizer (organic - 1x10^4 kg/ha, inorganic - 50Urea: 50TSP: 50MOP Kg/ha), spacing (100cm, 150cm between plants), irrigation (with, without) and 50% shade (with, without). Fertilizers were applied two times during the period of 90 days cultivation. Plant height, number of leaflets, number of leaves, number of branches, leaf area, main stem diameter and root length were considered as growth parameters while dried weight of leaves (shade drying at 30-35°C - 7 days) was chosen as the yield component. Results revealed that significant interactions of fertilizer (p = 0.001), irrigation (p = 0.001) and 50% shade (p = 0.000) with the yield while spacing was non-significant (p = 0.664). The maximum yield was reported in the plot P2 (organic × 100 cm space × irrigated × non-shade) and there was a significant difference (p = 0.016) between the yields of P2 and control. However, considerable reduction of growth and yield of *S. alata* were observed due to the larval stage of a butterfly *Eurema hecabe* (Common grass yellow). Therefore, it can be concluded that, organic fertilizer, irrigation and non-shade environment have a great impact on the yield of *S. alata*. Finally, importance of analyzing active ingredients of *S. alata* under different growing conditions and identifying proper pest controlling methods for commercial cultivations are highlighted.

**Keywords:** Dry yield, Emperor's candlesticks, Eththora, Growing conditions, *Senna alata*
Several species of the genus *Dioscorea* are consumed as a staple food crop in many countries. Nevertheless, few are studied in detail in many countries. The present study is a preliminary attempt to determine genetic diversity among seventeen (17) *Dioscorea* spp. accessions comprising eleven (11) *D. alata*, two (2) *D. bulbifera*, two (2) *D. esculenta*, one (01) *D. pentaphylla* and one (01) *D. spicata* conserved at the Plant Genetic Resources Centre (PGRC), Sri Lanka, using both morphological and Simple Sequence Repeats (SSR) markers. Morphological characterization was carried out scoring 55 morphological characters. Data analyzed with Minitab 16 statistical software showed a higher variation among the morphological characters: mature and young stem color; twining habit; absence and presence of “wings”; leaf color; and shape. Among the two main resulting clusters one separated the *D. pentaphylla* accession from the *D. esculenta* accessions. All other *D. alata* accessions except Kodolala, cluster together showing similar phenotypic characters. Molecular characterization was carried out using 15 selected SSR markers. Statistically analyzed data revealed considerable genetic variation among the selected accessions and generated a total of 55 alleles with polymorphism in 13 SSR markers. A phylogenetic tree constructed based on Nei’s (1983) genetic distance and UPGMA algorithm consisted of four major clusters separating *D. bulbifera*, *D. pentaphylla*, *D. spicata* accessions into one cluster and all *D. alata* accessions together in three different clusters. The study revealed no duplicates and the findings are useful for conservation and improvement of the crop since the categorization should not solely be based on morphological data, but molecular techniques can also be utilized for the proper identification and categorization of germplasm.

**Keywords:** *Dioscorea* spp, Genetic diversity, Morphological markers, SSR markers
ETHNOBOTANICAL SURVEY OF UNDERUTILIZED EDIBLE PLANT SPECIES IN THREE SELECTED VILLAGES IN THE WET, INTERMEDIATE AND DRY ZONES IN SRI LANKA
Abeywickrama KGTAK1, Samarasinghe WLG1, Wijerathna RMS2, Ranil RGH2, Hunter D3
1Biodiversity for Food and Nutrition project, Plant Genetic Resources Center, Sri Lanka
2Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka
3Bioversity International, via dei Tre Denari, 472/a, 0057 Maccarese, Rome, Italy
thiliniayeshak@gmail.com

Underutilized edible plant species have an immense potential to contribute to food and nutrition security because they are often rich in nutritional and medicinal properties. Though Sri Lanka has a rich diversity of underutilized edible plants, their associated ethnobotanical information have not been adequately studied and documented. Most of the information on underutilized edible plants is still in the hands of local communities. However, with socio-economic shifts and transitions to modern lifestyles & food habits these important plants and associated traditional knowledge face the threat of being gradually eroded and neglected from the food systems. The collection and documentation of ethnobotanical information of underutilized edible plants is therefore a timely requirement. The objective of this study was to identify and document the underutilized edible plants including leafy vegetables, vegetables, fruits and edible flowers, in three selected villages Niunhella, Udukumbura and Gampola belonging to the Wet, Intermediate and Dry Zones of Sri Lanka. Field visits were conducted to each village and data were collected through a semi-structured interview scheduled from 20 randomly selected households of each village. Plant specimens were collected, and species were identified in consultation with taxonomists and using the reference specimens at the National Herbarium Peradeniya. A total number of 112 underutilized edible plants including 56 leafy vegetables, 17 vegetables, 38 fruits and 3 edible flowers belonging to 46 families were identified. The highest number of species diversity (56%) was recorded from Udukumbura (Intermediate Zone) village. The family Fabaceae represented the highest diversity of edible plant species. A species inventory list was developed including traditional knowledge on identified underutilized edible plant species with edible and medicinal uses, socio cultural, environmental and economic benefits.

Keywords: Depletion, Diversity, Sri Lanka, Underutilized species
VALUING AGROBIODIVERSITY FOR MAINSTREAMING INTO BLUEGREEN VILLAGE PROGRAMME: “FOOD MANDALA” AS A TOOL OF RECIPROCITY FOR ENHANCING RESILIENCE

Perera HAKI\textsuperscript{1}, Herath HMLK\textsuperscript{1}, Randeni RPLC\textsuperscript{2}

\textsuperscript{1}Department of Agribusiness Management, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonavila (NWP), 60170

\textsuperscript{2}Environmental Planning and Economic Affairs Division, Ministry of Mahaweli Development and Environment

leelrandeni@gmail.com

As an obligation to Paris Climate Agreement Sri Lanka pledged to develop 10,000 Bluegreen Villages by 2025, characterized by diverse landscapes and resilient communities to adverse climate change impacts. Mainstreaming agrobiodiversity is of high priority for meeting the programme outcome. However, with changing lifestyles locally available agrobiodiversity and its reciprocal sharing is often ignored making people more dependent on food being marketed. This research was conducted in a model blue green village to introduce food mandala as a tool of reciprocity for collective social action and participatory agrobiodiversity valuation. A discrete choice experiment was conducted to estimate the Marginal Willingness to Accept (MWTA) along with a questionnaire survey. Eight attribute levels were identified with three food mandala alternatives and nine choice cards were generated using SPSS software. Data analyzed in STATA econometric software using conditional logistic approach. Total of 207 households were interviewed. According to the results; 3 food items, from home garden, cultivated & uncultivated lands, 2 ½ Hours, 2 per month, 10 families, underutilized foods, supported by community based organization & a government institute and the monitory attribute imposed in to the logistic model were statistically significant with positive coefficients. Thereby community is interested in having diverse food items as well as highly interested in underutilized foods (Highest value: Rs. 1540.00). Statistically significant monitory attribute indicated that they assumed a cost reduction and 97.1% stated their willingness to engage in food mandala. As per the findings, introducing food mandala as a tool of reciprocity for mainstreaming agrobiodiversity proved a success. It was concluded that food mandala is an ideal participatory tool for popularizing locally available agro biodiversity, a useful event to motivate people on agro biodiversity conservation and benefit sharing including awareness creation on lesser-known, rare and underutilized agro biodiversity with culinary uses and recipes. Recommendations were made in the bluegreen village strategic guidelines for villages to apply tool by innovative ways.

\textbf{Keywords:} Agrobiodiversity valuating, Choice modeling, Food mandala, Reciprocity
AGROBIODIVERSITY FOR HUMAN HEALTH AND LIVELIHOOD DEVELOPMENT
Sri Lanka accommodate a wide array of edible roots and tubers which help to fulfill the carbohydrate needs of people. Popularization of underutilized root and tuber species (indigenous yams) would be a feasible contribution to overcoming malnutrition due to their versatility and low cost of production. For creating awareness among public, screening of nutritional properties in indigenous yams is essential.

This study estimated the antioxidant capacity, phenolics, and ascorbic acid contents of roots and tubers using the extracts of 80% methanol, absolute methanol and 3% Meta phosphoric acid respectively. Fifteen root and tuber crop varieties were used namely, *Amorphophallus campanulatus* (Kidaram), *Canna indica* (Buthsara; 2 Selections), *Dioscorea alata* (6 varieties; Guru ala, Kahata ala, Raja ala, Dandila, Jaffana Rasawalli and Hingurala), *D. bulbifera* (Udala; Aerial yam), *D. esculenta* (Kukulala), *Maranta arundinacea* (Arukka; Arrowroot) and *Xanthosoma sagittifolium* (3 varieties; Kiri ala, Variety Isuru, Kaha kiri ala). Yams were tested both in raw and boiled forms. Antioxidant capacity (AOC) of yams was determined by Ferrie Reducing Antioxidant Power Assay and 2,2-diphenyl-1-picryl hydrazyl Radical Scavenging Assay. Total Phenolic Content (TPC) and Ascorbic Acid content (AAC) were determined by Folin-Ciocalteu method and 2,6-dichlorophenol indophenol visual titration, respectively.

*Dioscorea bulbifera* and *A. campanulatus* showed higher AOC of 55.67 and 47.74 mg TE/g DW, respectively. *Dioscorea bulbifera* also had the highest TPC of 190.54 GAE; mg/100 g. Ascorbic acid content was highest in *X. sagittifolium* var. Isuru (12.12 mg/100 mg). The levels of AOC, TPC and AAC of yams generally decreased after boiling. *Dioscorea bulbifera* and *X. sagittifolium* - Kaha kiri ala retained relatively higher levels of antioxidants after boiling. It is suggested to popularize *D. bulbifera* (Udala) as an alternative to potato. Novel processing and value addition techniques are essential to popularize indigenous roots and tubers without deteriorating their important bioactive compounds.

**Keywords:** Antioxidants, Ascorbic acid, Indigenous yams, Phenolics, Root and tubers
Long grain non-pigmented Basmati rice varieties are very popular in the international market. However, due to increasing rates of non-communicable diseases the demand for pigmented rice varieties (RV) have increased. This study evaluated antioxidant properties (AP) of pigmented and white long grain RV of Sri Lanka at market available polishing rates. Locally developed long grain red and white pericarp basmati type two RV and a black pericarp RV obtained from CIC Agri Businesses (Pvt) Ltd, Sri Lanka were used in the study. Further, Pakistan White Basmati (PWB) obtained from the local market was used for comparison. Seventy percent ethanolic extracts of selected RV were tested for AP in terms of total phenolic content (TPC), ferric reducing antioxidant power (FRAP), oxygen radical absorbance capacity (ORAC) and DPPH and ABTS radical scavenging activities (n=3) at market available polishing rates (100%, 40% and 0% or whole grains). Results showed that whole grains of black rice had significantly higher (P<0.05) FRAP (38.58±1.03 mg Trolox Equivalents/g extract) while whole grains of both black and red RV exhibited significantly higher (P<0.05) TPC (Black: 27.67±1.26 and Red: 26.00±3.12 mg Gallic/g extract respectively) compared to the other rice samples studied. For ORAC, whole grains of black rice (107.58±4.60 mg Trolox Equivalents/g extract) and 40% polished red rice (89.99±8.93 mg Trolox Equivalents/g extract) showed significantly higher (P<0.05) activity compared to the other tested rice samples. DPPH (Black IC_{50}: 207.35±0.90 μg/mL; Red IC_{50}: 173.00±7.60 μg/mL) and ABTS (Black IC_{50}: 43.43±2.99 μg/mL; Red IC_{50}: 50.27±6.21 μg/mL) radical scavenging activities were also significantly higher (P<0.05) for whole grains of black and red rice. Results clearly show that PWB had the lowest activities for all the AP tested in this study. In conclusion, whole grains of black and red RV of Sri Lanka had the highest AP.

**Keywords:** Antioxidants, Long-grain rice varieties, Sri Lankan rice, Polished rice, Whole grains
EFFICIENCY OF FREEZE-DRIED BITTER GOURD POWDER AS A FAT REPLACER ON THE QUALITY ATTRIBUTES OF CHICKEN MEAT PASTE

Karunarathne ADR, Wijesinghe SKD and Jayasena DD

Department of Animal Science, Uva Wellassa University, Badulla 90000, Sri Lanka

dineshjayasena@yahoo.co.uk

Chicken meat paste is one of the value-added meat products popular among consumers mainly due to the convenience. However, considerable number of consumers in Sri Lanka believes that meat products cause harmful effects on human health mainly due to the fat content. Hence, the aim of this study was to incorporation of bitter gourd powder to improve biological/functional/health benefits of chicken meat paste. Chicken meat from cheap cuts was boiled to an internal temperature of 70 °C, minced and mixed with other ingredients to make the meat paste according to a recipe developed through preliminary trials. Treatments were prepared by incorporating FDBGP prepared using freeze drying method (-40 °C/36 hrs) at 1.0, 1.5, 2.0, 2.5 and 3.0% (w/w). Meat paste with no FDBGP was used as the control and all treatments were pasteurized at 85 °C for 15 minutes. A sensory evaluation was conducted to select the two best concentration of FDBGP to be added. Selected treatments and control were vacuum packed separately. Proximate composition, physicochemical parameters, TBARS value, microbial quality, and antioxidant capacity were determined over a one-month storage period under refrigerated condition (4 °C). Meat paste with 1% and 1.5% FDBGP (w/w) had the best sensory qualities (p<0.05). Meat paste with 1.5% FDBGP (w/w) contained the highest ash content (4.71%) and water holding capacity (81.62%), and the lowest fat content (2.17%), pH value (6.45) and color parameters (L*, a*, b*) (p<0.05). Meat paste with 1.5% FDBGP (w/w) showed the highest antioxidant capacity (41.82%) (p<0.05). According to TBARS value and microbial counts, FDBGP 1.5% (w/w) incorporated meat paste can be kept for 30 days at 4°C without quality deterioration. 1.5% FDBGP (w/w) can be recommended to produce low fat meat paste with better sensory properties.

Keywords: Antioxidant capacity, Bitter gourd, Chicken, Freeze drying, Meat paste
IN VITRO STUDY ON THE ALLERGENIC EFFECTS OF SELECTED AGRO FOODS, GREEN TEA (*Camellia sinensis* (L) Kuntze) AND SEAFOOD IN CAUSING IgE INDEPENDENT BASOPHIL DEGRANULATION

Wijerathna DMCK¹, Handunnetti SM², Fernando N², Premawansa S¹

¹Department of Zoology and Environment Sciences, Faculty of Science, University of Colombo, Colombo 03
²Institute of Biochemistry, Molecular Biology and Biotechnology, University of Colombo, Colombo 03

chaamila@gmail.com

Food allergy is a rising health problem worldwide. As opposed to the most common IgE antibody-dependent (indirect) basophil or mast cell degranulation in an allergy, pseudo-allergies occur with an IgE independent (direct) manner. Food, a main cause for pseudo-allergies, cause allergy-like reactions with normal IgE levels. Thus, patients are treated the same way, the general allergy patients are treated. Since food allergy can be fatal, appropriate diagnosis is essential. However, the causes and mechanisms of pseudo-allergies are not well understood. The current study focused on the IgE independent basophil degranulation caused by four common allergenic foods including skipjack tuna (*Katsuwonus pelamis*, Balaya in Sinhala), pineapple (*Ananas comosus*), Asian tiger shrimp (*Penaeus monodon*) and peanut (*Arachis Hypogaea L.*). The concentration of crude food protein extracts was determined by Bradford assay. Cytotoxicity of Rat basophil cell line (RBL-2H3) towards the food extracts was optimized by Sulforhodamine B (SRB) assay. Degranulation of basophils after treatment with 500 µg/ml of crude protein extracts was quantified microscopically using Toluidine blue dye. Significant induction (p<0.05) of IgE independent basophil degranulation was shown by tuna (Mean percentage±SD, 73.51±6.75), peanut (57.92±22.12), pineapple (54.36±6.90) and shrimp (50.50±21.46) with reference to the untreated controls. In addition, green tea (*Camellia sinensis*) with 200 µg/ml concentration of crude proteins significantly inhibited compound 48/80 (positive control) induced degranulation (p<0.05). Certain known allergenic proteins in tuna and peanut crude extracts were determined by SDS-PAGE. These proteins may lead to IgE independent pathway as well for basophil degranulation by binding with IgE like surface molecules or other receptors on basophils. In conclusion, food can cause IgE independent basophil degranulation to cause allergies whilst green tea has the potential of basophil stabilizing and anti-allergic activity. Further researches in this area would reduce the prevalence of food allergies by identifying food allergens, causes, mechanisms, clinical treatments for pseudo-allergies and also recommendations of native plants to treat food allergies.

**Keywords:** Anti-allergic activity, IgE-independent basophil degranulation, Food allergy, Pseudo-allergy
INCORPORATION OF HERBAL PLANT EXTRACTS; Zingiber officinale Roscoe AND Phyllanthus emblica L TO SUPPRESS GLYCEAMIC IMPACT OF CANE SUGAR

Samarasinghe CH1, Jayasinghe MA1, Senadheera SPAS2, Wijesekara I1, Ranaweera KKDS1

1Department of Food Science and Technology, Faculty of Applied Sciences, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka
2Department of Biochemistry, Faculty of Medicine and Allied Sciences, Rajarata University of Sri Lanka, Saliyapura, Sri Lanka.

hasithivvas@gmail.com

In Ayurvedic medicine herbal extracts have been used to reduce blood glucose responses for thousands of years. Addition of selected extracts to normal cane sugar and determining its glycaemic indices were main objectives of this study. Ginger (Zingiber officinale) and Gooseberry (Phyllanthus emblica) extracts were chosen to incorporate considering their reputation in traditional diet therapies and the cost effectiveness. By adding extracts at specific temperatures in a particular ratio, a novel sugar product was made from normal Cane sugar. Then the GI value of this product was determined using a standardized methodology. In this study, 12 healthy volunteers randomly underwent 2 sets of food challenges involving glucose (reference) and novel sugar (test food), both providing 50 g available carbohydrates. Serum glucose was monitored at various time-points i.e., at 0 (fasting), 15, 30, 45, 60, 90 and 120 minutes after ingestion and GI values were calculated by dividing the incremental area under the curve (IAUC) for the tested food by that for the standard food (IAUCS). Enzymatic colorimetric method (GOD/POD/PAP) was used to measure biochemical variables. Data analysis was done using MS Excel and the statistical programme Minitab 17. This trial is registered with the Ethical Review Committee, Faculty of Medical Sciences, University of Sri Jayewardenepura as 21/18. The mean GI value (95% CI) for novel sugar product was 38 ±9 with a percentage GI reduction of 40.84%, compared to normal cane sugar (GI = 65). The results of the study indicated that incorporating selected herbal plant extracts; significantly (p<0.05) lowers the GI of normal cane sugar. According to the above, Incorporation of suitable herbal extracts to food like rice and wheat flour may be a suitable option to reduce their glyceamic impact. Consuming few Gooseberries or few drops of Ginger after a starchy meal may reduce its glyceamic impact significantly.

Keywords: Cane sugar, Ginger, Glycemic index, Gooseberry
The poverty line within the village of Aranayaka Divisional Secretary's Division was considerably high where 70 families were reported with low income levels. Sub project “Establishment of small holder growers for root and tuber crops and home garden diversification in Aranayake area” initiated with the support of Biodiversity for Food and Nutrition project (BFN) in 2017. Main objectives were to increase the household food security level, income and nutritional status while conserving the diversity of existing yams within the area. Introduction of high nutritional yam cultivars, Equipments and inputs, protective fences supplied to the farmers. All the yams cultivations were promoting organic cultivation methods with zero damage to the environment. The project was successful where farmers of the yam cultivating community were able to bring the Community Development Center (CDC) in to an organized foundation. The creation of new leaders in the village has made a great difference in the village. Women’s contribution towards improving the economic status of households was increased. Women empowerment through decision-making, income generation, maintaining self employment programs has made the program gain much popularity within the village. Through this project, the family has been able to increase the familiarity within the family unit. The community development center launched the new yam products through this project as bites chips snacks and many other value added products derived through yams. Dedicated marketing outlet was also established as “Poshana Mandapaya” in Aranayake for selling value added products of yams as well as various tuber types for the consumers. The sub project aided by BFN project has opened up many opportunities for the rural farmer community in Aranayake area towards generating better livelihood and increased food and nutritional security within the villagers.

**Keywords:** Diversity, Food security, Household, Local yams, Poverty
α-AMYLASE AND α-GLUCOSIDASE ENZYME INHIBITORY ACTIVITIES OF SELECTED MILLET TYPES AND SORGHUM VARIETIES OF SRI LANKA
Senevirathne IGNH, Abeysekera WPKM, Abeysekera WKSM, Jayanath NY, Premakumara GAS, Wijewardana DCMSI

1Department of Food Science & Technology, Faculty of Agriculture, University of Peradeniya
2Herbal Technology Section, Industrial Technology Institute, Colombo 07
3Department of Agricultural Technology, Faculty of Technology, University of Colombo
4Department of Basic Science & Social Science, Faculty of Nursing, University of Colombo
5Field Crops Research and Development Institute, Mahailuppallama, Department of Agriculture

kanchana@at.cmb.ac.lk

Diabetes mellitus is a chronic disease characterized by an elevated level of blood glucose. α-Amylase and α-glucosidase are key enzymes involved in glucose metabolism. The present study was carried out to investigate the inhibitory effect of selected millet types and sorghum varieties on the activities of α-amylase and α-glucosidase enzymes. Range of selected millet types [Proso millet, Kodo millet, Foxtail millet, Finger millet (White finger millet, Oshada and Rawana)] and two sorghum varieties (sweet sorghum and sorghum ICSV 112) were used in this study. Methanolic extracts of selected samples were analyzed for α-amylase and α-glucosidase inhibitory activities in vitro. Further, total proanthocyanidins (TP) of both millet and sorghum samples were quantified. The results showed that selected millet types and sorghum varieties had α-amylase inhibitory activity with varying degrees of potentials (IC_{50}: 33.34 ± 1.11 - 1446.70 ± 54.06 µg/mL) while none of the millet and sorghum samples showed α-glucosidase inhibitory activity. Among the samples tested, sweet sorghum showed the highest α-amylase inhibitory activity (IC_{50}: 33.34 ± 1.11 µg/mL) and it was nearly four times more powerful than the reference drug Acarbose (IC_{50}: 111.98 ± 2.68 µg/mL). The next highest inhibitory activity was shown by Oshadha and Rawana and the inhibitory activities were moderate compared to the reference drug used. TP were also highest in sweet sorghum (12.87 ± 0.21 mg cyanidin/g of sample) followed by Oshadha and Rawana. It is concluded that selected millet types and sorghum varieties of Sri Lanka possess α-amylase inhibitory activity. Sweet sorghum showed the highest α-amylase inhibitory activity followed by Oshadha and Rawana. Furthermore, TP may have a role in mediating α-amylase inhibitory activity of selected millet types and sorghum varieties of Sri Lanka. Thus, selected millet types and sorghum varieties may be useful in managing diabetes and related complications.

Keywords: α-amylase and α-glucosidase enzyme inhibitory activity, Diabetes mellitus, Millet types and sorghum varieties of Sri Lanka
PHENOLIC CONTENT AND PANCREATIC LIPASE AND CHOLESTEROL ESTERASE INHIBITORY ACTIVITIES OF SELECTED MILLET TYPES AND SORGHUM VARIETIES OF SRI LANKA

Jayathilaka SI1, Abeysekera WPKM2, Abeysekera WKSM3, Jayanath NY1, Premakumara GAS4, Wijewardana DCMSI5

1Department of Food Science & Technology, Faculty of Agriculture, University of Peradeniya
2Herbal Technology Section, Industrial Technology Institute, Colombo 07
3Department of Agricultural Technology, Faculty of Technology, University of Colombo
4Department of Basic Science & Social Science, Faculty of Nursing, University of Colombo
5Field Crops Research and Development Institute, Mahailuppallama, Department of Agriculture

Hyperlipidaemia, a disorder of lipid metabolism is characterized by the elevated levels of serum triglycerides and cholesterol, is increasing rapidly throughout the world. Hence, there is an imperative need to search for novel anti-lipidemic agents preferably from natural sources. This study was carried out to determine the phenolic content and anti-lipidemic potential (pancreatic lipase and cholesterol esterase inhibitory activities) of selected millet types and sorghum varieties of Sri Lanka. The methanolic extracts of whole grains of selected millet types [Proso millet, Kodo millet, Foxtail millet, Finger millet (White, Oshadha and Rawana)] and two sorghum varieties (sweet sorghum and sorghum ICSV 112) were studied for total polyphenolic content (TPC), total flavonoid content (TFC) and pancreatic lipase (PL) and cholesterol esterase (CE) inhibitory activities in vitro. Gallic acid, quercetin, orlistat and simvastatin were used as the reference standards respectively in each assay. The results showed TPC and TFC of selected samples in the range of 2.82±0.16 - 122.26±8.47 mg Gallic Acid Equivalent/g of extract, 0.78±0.00 -15.44±0.07 mg Quercetin equivalent/g of extract respectively. Pancreatic lipase and cholesterol esterase inhibitory activities of selected samples ranged from 21.16±1.58 - 66.65±3.30 and 17.43±0.60 - 52.09±1.61% (at 2 mg/ml) respectively. All the observed activities were moderate compared to the reference standards used in this study. Among the studied types, sweet sorghum exhibited the highest phenolic content and highest pancreatic lipase and cholesterol esterase inhibitory activities. The second and third highest TPC, TFC and PL and CE inhibitory activities were observed for Oshadha, Rawana; Kodo millet, Foxtail Millet; Kodo Millet, Oshadha and Oshadha, Sorghum ICSV112 respectively. It is concluded that sweet sorghum had the highest phenolic content and pancreatic lipase and cholesterol esterase inhibitory activities among investigated millet types and sorghum varieties. Consumption of these cereals as whole grains may play an important role in prevention and dietary management of variety of chronic diseases including hyperlipidaemia.

Keywords: Millet types and sorghum varieties of Sri Lanka, Pancreatic lipase and cholesterol esterase inhibitory activities, Phenolic content
DETERMINATION OF VIABILITY OF *Bifidobacterium animalis* subsp. *lactis* IN GARLIC (*Allium sativum* L.) INCORPORATED SYNBIOTIC BUTTER

Premerathne JMNH\(^1\) Mudannayake DC\(^1\)

\(^1\)Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka

nimashaheshani2014@gmail.com

Butter is one of the nutritive and popular dairy products all around the world. At present, people are looking for health beneficial synbiotic food products which contain probiotics and prebiotics in order to prevent non-communicable diseases. Fermented foods consist of viable microbes that beneficially effect health of host by improving microbial balance in the gastrointestinal tract. Inulin is a prebiotic naturally and abundantly occurs in garlic. Synbiotic butter with garlic should be a new value-added product concept to the Sri Lankan market. This study was conducted to develop garlic incorporated synbiotic butter and investigate the effect of garlic incorporation on survival of *Bifidobacterium animalis* subspecies *lactis* (Bb12) probiotic strain in butter during long term refrigerated storage. Lyophilized garlic powder (LGP) was prepared using garlic bulbs and analyzed for its chemical composition. FTIR analysis was conducted for LGP and commercial chicory inulin to identify the presence of inulin. LGP was incorporated to butter at levels of 0\%, 2\%, 4\%, 8\% and 10\% (w/w) while 5\% (w/w) commercial chicory inulin incorporated butter was used as positive control. *B. animalis* 6\% (v/v) was inoculated to cream (40\% fat) before churning to ensure final count of \(>10^6\) cfu/g. Viability of Bifidobacteria during 28 days of storage at 6\ºC was assessed at 7-day intervals. Bifidobacteria enumeration was carried out by pour plating on MRS media supplemented with 0.05\% L-cysteine followed by anaerobic incubation. Probiotic viability of *Bifidobacterium animalis* subspecies *lactis* (Bb12) were analyzed in all six butter samples. In all sample’s viability of Bifidobacteria was increased up to 14 days of storage, and then reduced during 28 days of shelf life. The Bifidobacteria count (cfu/g) was increased with increasing garlic percentage compared to negative control sample (0\% garlic), indicating that the prebiotic compounds in garlic such as inulin, fructooligosaccharides and crude fibers may have enhanced the growth of probiotic bacteria.

**Keywords:** *Bifidobacterium*, Butter, Inulin, Synbiotic
ASSESSMENT OF AGRO-BIODIVERSITY IN KANDYAN HOME GARDENS: A CASE STUDY

Warnaasoriya PGAS\(^1\), Weerakkody WAP\(^2\) and Bandaranayake PRSD\(^2\)

\(^1\)Postgraduate Institute of Agriculture, University of Peradeniya
\(^2\)Department of Crop Science, Faculty of Agriculture, University of Peradeniya

ayeshasw21@gmail.com

Agro-biodiversity, the diversity of edible species, has direct relevance to rural livelihoods and the food and nutritional sovereignty of the nation. Kandyan home (forest) garden (KFG) is considered as one of the most diverse and productive farming systems which is predominant in several districts of the central highlands of Sri Lanka (i.e. Kandy, Kegalle, Matale and Kurunegala districts). It is composed of multistory canopy structure, number of natural and cultivated plant species and household livestock production. However, recent changes in the socio-economic structure of the village setup have dramatically influenced the sustainability of this farming system. Hence, this research was conducted to assess the agro-biodiversity associated with KFG system of a sample village, in comparison with similar assessments reported earlier. A field survey on 98KFGs was assessed in a selected village in Yatinuwara DS division in Kandy district for their biodiversity in 2017. According to the results, mean land holding of KFGs is 0.4 acres. Crop biodiversity in the KFGs was mainly composed of spices, fruits and timber. The highest density was occupied by clove (*Syzygium aromaticum*) (108.3 trees/ha), pepper (*Piper nigrum*) (28.4 trees/ha) and nutmeg (*Myristica fragrans*) (17.8 trees/ha) as economically important crop species. Regarding the natural biodiversity, 83.8% of terrestrial plants, 1.6% of epiphytes and 14.6% aquatic/semi aquatic spp. that belong to 77 plant families were found in the entire village area. Nearly a half of these plant species were native to Sri Lanka while the remaining were exotic species, either endemic or invasive. Land degradation and fragmentation could be identified as major factors leading into environmental issues in this farming system. The results indicated that there is no significant variation in agro-biodiversity level in the area with respect to the previous records and the study is being continuing on the overall biodiversity of the village.

**Keywords:** Agro-biodiversity, Kandyan (Forest) home garden, Exotic species, Invasive plant species
A COMPARATIVE STUDY TO DEVELOP CALCIUM, ZINC AND ANTIOXIDANT RICH DRINKING YOGHURTS USING PLANT AND PHARMACEUTICAL SOURCES

Samarathunga RMJN1, Jayasinghe MA1, Edirisinghe MP2, Wijesekara I1, Abeysundara De AP1, Senadheera SPAS3

1Department of Food Science and Technology, Faculty of Applied Sciences, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.
2MILCO (Pvt) Ltd, No.45, Nawala road, Narahenpita, Colombo 05, Sri Lanka
3Department of Biochemistry, Faculty of Medicine and Allied Sciences, Rajarata University of Sri Lanka, Saliyapura, Sri Lanka

jnsamarathunga@gmail.com

In this study, the effect of fortification of aqueous extracts of Moringa oleifera dried leaf powder and Phyllanthus emblica fresh fruit as plant ingredients and calcium carbonate and zinc aspartate from Unizink® 50 capsule as pharmaceutical ingredients in drinking yoghurts was investigated. The aim was to manufacture drinking yoghurts, which fulfill 1/3, 1/2 and 2/3 of Recommended Dietary Intake of calcium and zinc in humans and enriched with antioxidant activity. Minerals analysis and sensory evaluations of the products were carried out to select the best product from both plant and pharmaceutical product series. As analysed, calcium content of Moringa leaf extract prepared from unblanched leaf powder (25.27± 0.25mg/ml) was higher than from blanched leaf powder (17.14± 0.01mg/ml). In the mineral analysis, calcium contents of the drinking yoghurts analysed using wet ashing method were comparatively higher than the values obtained from dry ashing method. Sensory evaluation provided that drinking yoghurt fortified with plant ingredients at 50% RDI of calcium was the best sample (p<0.05). The total phenolic content of the best product was 3.17 mg GAE/g and ascorbic acid content was 55.5mg/100g. The DPPH radical scavenging activity (Antioxidant activity) was higher in plant ingredient fortified drinking yoghurts than with pharmaceutical ingredients (p<0.05). During the shelf life evaluation, there was no significant difference in total plate count of both fortified drinking yoghurt categories compared to the plain drinking yoghurt (control) but drinking yoghurt fortified with pharmaceutical sources showed higher pH values than the plain and plant ingredient fortified drinking yoghurts. Whey syneresis was higher in drinking yoghurts fortified with plant extracts and the viscosity decreased with the incorporation of plant extracts. The above plant ingredients can be successfully fortified at the level of 50% RDI of calcium while pharmaceutical ingredients at 33% RDI of calcium and zinc in drinking yoghurts.

Keywords: Antioxidant activity, ascorbic acid content, calcium, total phenolic content, zinc
FORMULATION OF NON-ANIMAL BASED STABILIZER COMBINATION TO REPLACE GELATIN IN SET-YOGHURT

Kuruppu KAYR, Abeysundara PDA
University of Sri Jayewardenepura
yanukakuruppu46@gmail.com

Gelatin is frequently used as a stabilizer in set-yoghurt nowadays. However, consumers concern about the source of gelatin due to various dietary habits, religious belief like reasons. The main objective of this study was to develop a gelatin free set-yoghurt by using non-animal-based stabilizer/s. First, Agar-Agar and κ-Carrageenan were separately used at 0.05%, 0.5% or 1% (w/w) concentration to produce set-yoghurt and the best concentrations (0.05% for both stabilizers) were selected based on organoleptic properties and pH of yoghurts. Then, the selected stabilizer concentrations were combined with Guar Gum (GG), Xanthum Gum (XG), or Locust Bean Gum (LBG) at 0.005%, 0.01% or 0.02% concentrations to produce set-yoghurt. Sensory analysis revealed that the yoghurt containing Agar + GG or LBG have acceptable organoleptic properties. Selected yoghurts were then subjected to descriptive sensory, physiochemical, proximate and microbiological analysis for 21 days at 4 °C using Gelatin 0.5% (w/w) added yogurt as the control. In all yoghurts, the microbial quality remained acceptable, the pH decreased, and the titratable acidity increased (P<0.05) during the storage period. The water holding capacity of LBG containing yoghurt was significantly lesser than the GG containing or control yoghurt samples. No significant difference in proximate composition among yoghurt samples observed. According to the descriptive sensory analysis, Agar + GG resulted greater taste, mouth feel, and texture compared to Agar + LBG in yoghurt. Finally, this study suggested that Agar + Guar Gum stabilizer combination is a good non-animal-based option to replace gelatin in set-yoghurt with sufficient overall properties.

Keywords: Gelatin, Non-animal, Set-Yoghurt, Stabilizer
AGROBIODIVERSITY FOR ECO SYSTEM SERVICES AND CLIMATE CHANGE ADAPTATION
Traditional crop varieties with higher genetic diversity are recognized as climate smart crops that can provide food security in tropical countries like Sri Lanka. A series of field experiments were conducted during four consecutive seasons (2 yala and 2 maha) from 2016 to 2018 to evaluate the adaptability of a Lablab (*Lablab purpurens*) bean variety (HORDI Ac. 001) and a traditional winged bean (*Psophocarpus tetragonolobus*) variety (HORDI Ac.023) in three diverse environments in Sri Lanka namely Gampola, Udukumbura and Milleniya representing; Cascade, Kandyean home garden and Owita ecosystems respectively. Trials were established in six farmer fields in the selected locations. The experiment was conducted as a Randomized Complete Block Design considering each farmer field as a replicate. Seeds were sown with a pacing of 75 X 60 cm in 11 m² plots. Farmer practices were adopted in crop maintenance. Adaptability of the crops was analyzed over seasons and locations. Number of days for first and 50% of flowering and pod yield per plant were taken from six randomly selected plants in addition to total plot yield. Data were analyzed to determine the effects of season, location and location into seasonal interaction. In addition, consumer acceptability in terms of taste, aroma and appearance of the pods was assessed for culinary use. Location into season interaction was not significant for number of days taken for flowering and the number of pods per plant separately for these two crops. The traits studied did not show any significant variation among the tested locations and seasons indicating higher adaptability of the crops. An average yield of 4.7 and 5.6 kg/plant/season was recorded in lablab and winged bean respectively. Both crops possessed good culinary value owing to their appearance, texture and taste making them suitable for home garden and for mixed cropping in the said ecosystems in Sri Lanka.

**Keywords:** Adaptability, Climate, Ecosystem, Lablab bean, Winged bean
Agrobiodiversity is a subcomponent of biodiversity where greater attention has been given for conservation all over the world in order to mitigate and resilient the adverse impact of climate change. In-situ conservation is the best way of conservation. Therefore, attempts should be taken to conserve agrobiodiversity in the farmer fields while they are encouraged to utilize agrobiodiversity by realization of agrobiodiversity products. However, the benefits arising from conservation of agrobiodiversity is not clear by the farming community in Sri Lanka and thus they do not compel to conserve it. Therefore, there should be such a devoted mechanism that supports realizing the benefit rising from conservation of agrobiodiversity in Sri Lanka. This research was carried out to identify the prospects for realization of the benefits arising from conservation of agrobiodiversity in three diverse environments in Sri Lanka, namely, Gampola, Udukumbura and Milleniya representing; Cascade, Kandyan home garden and Owita ecosystems respectively. Choice Experiment followed by a semi structured questionnaire administered in three sites to collect the data meeting the objectives of the study. Moreover, a participatory approach was taken to collect supporting data from other stakeholders relevant to the study. It was found that although there are several mechanisms to support farmers, none of them do not support conservation of agrobiodiversity. Farmers in study areas expect some devoted mechanisms supporting production of identified agrobiodiversity products. A support worth of Rs 80,000.00 is expected annually by the farmers for an acre of land where agrobiodiversity is fully conserved. They mostly value material support, extension support, entering into contracts and certification in a mechanism that support production of agrobiodiversity products. This can be taken into consideration forming policies towards conservation of agrobiodiversity.

Keywords: Agrobiodiversity, In situ conservation, Kandyan home garden, Owita Village tank based agriculture
 CONSTRAINTS FACED BY FARMERS OF MINOR IRRIGATION SYSTEMS IN MITIGATING THE IMPACT OF CLIMATE CHANGE: CASE STUDY FROM ANURADHAPURA DISTRICT, SRI LANKA
Premsiri PMSS, Dissanayake SP and Ginigaddara GAS
Department of Agricultural Systems, Faculty of Agriculture, Rajarata University of Sri Lanka, Anuradhapura
sspsakunthala@gmail.com

Minor irrigation systems are highly vulnerable to climate change affecting agricultural productivity, food security, ecosystem functions and services and livelihood of the farming community. Lack of knowledge on climate change projections has badly affected the minor irrigation farmers in Anuradhapura district causing frequent crop losses. This study attempted to identify gaps in knowledge of perceived climate risks and the challenges of adaptation to climate change faced by minor irrigation paddy farmers in Anuradhapura district. The Stratified random sampling method was used for selecting the sample. A questionnaire survey, interviewing 200 minor irrigation paddy farmers was completed in Anuradhapura district in 2019. Descriptively analyzed data revealed that although the farmers are concerned on climate change impacts on their cultivations, there is an information gap for mitigating the climate change impacts. Moreover, most of the farmers stressed the information needs of the extension services (75%), rain water harvesting methods (74%), climate and weather forecasting (65%), newly improved varieties (59%), weed control techniques (57%) and paddy storage and paddy marketing plans (57%). Few farmers stressed the information need on crop insurance (15%), agriculture policies (12%), irrigation techniques and methods (11%), and new information and communication technologies (6%). Results further revealed that, lack of awareness on information sources (69%), lack of finance (60%), lack of infrastructure (50%), high cost of adaptation measures (50%) and language barrier (42%) severely affected the mitigation process while poor knowledge sharing mechanism (68%), poor public relations of extension workers (54%) and high management cost (55%) were not significantly influenced on mitigating the efforts of climate change. Hence the study highlighted the need of effective agro-advisory services with improved technologies, practices and strategies to assist farmers in mitigating the impact of climate change in minor irrigation paddy farming systems in the Anuradhapura district.

Keywords: Climate change, Constraints, Information gaps, Minor irrigation
Wetland farming system is considered as one of the most significant farming systems in the world in achieving food security and as a climate change adaptation strategy. Uneven rainfall distribution pattern, high water table, low elevation and the unplanned building complexes in nearest cities have affected the unique wetland eco system in urban Kaduwela area. This study attempted to identify various constraints faced by farmers when adapting wetland agriculture as a climate change adaptation strategy. Simple random sampling method was occupied to select the sample of 120 farmers and questionnaire survey (2019) was conducted to collect data and information. Qualitative analysis was occupied in data analyse process. Results revealed that, many smallholder farmers in Kaduwela wetland area are facing water scarcity during Maha season (30%), flooding during Yala season (21%), continuous soil fertility decline (50%), pests and disease outbreaks (93%), weed infestation (96%), lack of extension services (85%), physical irrigation issues (56%), crop failure (94%), lack of market accessibility (38%), lack of finance (92%), lack of information and assistance on proper land use (87%). Only few farmers have been adapted to cropping patterns like mixed cropping (23%), intercropping (11%) and crop rotation (27%) to bear the prevailing production risks. The evidence proved that, there is a need in sustainable intensification to promote utilization of wetlands for agriculture to combat with climate change and subsistence farming for community. Therefore, assessment of bio-physical and socioeconomic suitability of Kaduwela wetland farming system is essential in order to promote climate smart agriculture, crop diversification and rain fed farming in the area.

Keywords: Agriculture, Climate change, Production constraints, Wetland
Agro tourism can be recognized as a strategy that can enhance rural agricultural livelihoods. Sri Lanka as an agricultural country has many potentials to promote agro tourism aiming sustainable rural agricultural development. The ‘village tank system’ is defined as a connected series of tanks organized within a meso-catchment of the dry zone landscape. This is mainly used for storing, conveying, and utilizing water from an ephemeral rivulet. There is a high biodiversity, agricultural lands and aesthetic beauty around the tank system. Irrespective of the huge opportunities prevailing in the area for involving in Agro - tourism activities in these areas, villagers do not seem to practice this strategy. Thus, the objective of this research is to study the potential advantages and constraints of agro tourism towards sustainable livelihood upliftment in Palugaswewa tank system, which was recently nominated as a world heritage. 200 respondents were selected through simple random sampling method. Data were collected through field survey and key personnel interviews were analysed qualitatively. Results revealed that, creation of job opportunities (20.2%), generating extra income (45%) and development of public services (26.7%) are potential advantages as perceived by villagers for introducing agro-tourism for cascade. Consequently, deterioration of village culture and society (53%), disturbing calmness of the village and quiet environment (22.2%), waste generation (7.4%) and invasion of drugs (11.1%) were perceived as disadvantages of introducing agro-tourism activities to cascade. Hence, development of agro tourism program for Palugaswewa tank system should take these perceived advantages and disadvantages by the villagers into consideration for its sustainability.

**Keywords:** Advantages, Agro-tourism, Cascade system, Disadvantages, Perception
SMALLHOLDER VEGETABLE FARMERS’ CHOICES FOR ADAPTATION TO CLIMATE CHANGE IN ANURADHAPURA DISTRICT, SRI LANKA

Kopiyawattage KPP, Ariyadasa WGS
Department of Agricultural Systems, Faculty of Agriculture, Rajarata University of Sri Lanka, Puliyankulama Anuradhapura

kumudupdn@gmail.com

Sri Lanka is an agriculture based developing country and about 70% of the rural population’s main livelihood is directly or indirectly related to agriculture. Changes in the climate such as increasing temperature, changing rainfall patterns and extreme weather events severely influence the smallholder farmers as they have low adaptive capacity. The majority of smallholder vegetable farmers depend on rainfall for their irrigation needs, hence are vulnerable to climate change. Due to adverse weather conditions, vegetable production of the country dropped by 9.1 % in 2017. Adaptation to the climate is the most appropriate strategy to minimize the adverse effects of climate change. Therefore, this study explored the factors affecting smallholder vegetable farmers’ choices of adapting to climate change. Multi stage random sampling technique was employed to select 150 small scale vegetable farmers from three divisional secretariat divisions in the North Central Province (NCP). Individual interviews were conducted with respondents using a pre-tested structured questionnaire. Descriptive and multinomial logistic regression analysis was done along with an adaptation strategy index (ASI) and problem confrontation index (PCI) to identify choices of adaptation and barriers for adaptation. According to the results, the most adapted strategy was crop rotation (84%) followed by more irrigation (77%) and use of drought tolerant varieties (57%) while the least adapted strategies were building trenches (11%), use of organic fertilizer (13%) and planting cover crops (15%). Results of PCI indicated that the high cost of farm input, lack of irrigation water, poor awareness of adaptation practices and less profit as the most critical limitation to adaptation. The study recommends strengthening agricultural extension services, providing irrigation facilities and promoting rural micro-finance institutions to facilitate choosing appropriate adaptation strategies, climate change. Moreover, analysis of adaptation practices and constraints at farmer level will help to facilitate government policy implementation.

Keywords: Adaptation, Climate, Smart agriculture
Paddy is the staple food crop in Sri Lanka. The productivity of most of the paddy lands in the coastal zone of Sri Lanka declines every year due to salinization caused by tidal waves and sea water, which are linked to climate change-induced sea level rise. This study focused primarily on the problem of salinity in the coastal paddy fields due to salt water intrusion in the wet zone of Sri Lanka. Soil samples were collected from salinity-affected paddy fields in 5 districts of the wet zone. The soil samples were collected in time gaps and checked for electrical conductivity and pH. Monthly rainfall data of these districts for the study period (May-September 2018) were collected from the Meteorological Department. The rainfall data and salinity data were analyzed using regression analyses. Two sample t-tests were carried out between the mean salinities of the site/s assumed to be of high salinity and a referral site with no salinity impact within a district. The mean salinities between the wet and dry periods of each salinity-affected site were compared. Farmer surveys were conducted to gather information on socioeconomic aspects related to the salinity problem in the wet zone. There was a statistically significant correlation between the rainfall and the salinity levels. It was observed that in certain areas there was a statistically significant difference between the means of the salinity in the wet period and dry period, whereas in some areas there was no statistically significant difference between them. The overall results indicated that most of the sites have salinity levels (1-3 dSm\(^{-1}\)) which can threaten the productivity of those lands. Therefore, it is recommended to the responsible authorities to take long term actions for the optimal control of salinity in the coastal paddy fields before it gets worse with time.

**Keywords:** Coastal paddy, Productivity, Salinity, Salt water intrusion
EFFECTS OF CLIMATIC VARIATION ON YIELD OF UPCOUNTRY TEA: A CASE STUDY BASED ON UPCOUNTRY TEA ESTATES OF KELANI VALLEY PLANTATIONS PLC IN SRI LANKA

Manawasinghe KS1, Abeyesinghe DC1, Weerakoon A2, Thennakoon TMNS3

1 Department of Plantation Management, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), 60170, Sri Lanka
2 Kelani Valley Plantations PLC, Dickoya, Hatton
3 Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka

ksmanawasingha@gmail.com

‘Ceylon tea’ industry plays a vital role in relation to the economic sustainability in Sri Lanka. Low productivity of tea growing areas in the country has been attributed to climatic changes, aging of tea fields, low replanting rate, land degradation, worker shortages and high input cost. Climatic variability has direct and indirect impacts on tea production in Sri Lanka. This study was conducted to identify the impact of rainfall variation in productivity of upcountry tea lands managed by Kelani Valley Plantations PLC in Sri Lanka. Data of tea estates from 2004 to 2015 was used to analyze the effects of rainfall on yield using equation of Pearson’s co-efficient correlation. The annual rainfall is highly fluctuated and Positive correlation is visualized between annual rainfall and yield. There is 0.12 and 0.15 Coefficient Correlation (r) in Hatton Region and Nuwaraeliya Region. The Standard Precipitation index is used to identify a climatic condition within a year in the regions. One extremely wet, one mild wet, three normal wet, one normal dry, one mild dry and two moderate dry months were identified within a year in the Hatton region. One severely wet, one moderate wet, one mild wet, two normal dry, one mild dry and three moderate dry months were identified within a year in the Nuwaraeliya region. Tea plants are very sensitive for monthly rainfall variation. A Significant positive correlation has shown between previous month rainfall and following month yield. There is a 0.62 and 0.70 Co-efficient Correlation (r) in Hatton region and Nuwaraeliya Region. Vagaries in climate are a critical factor for yield variability of the upcountry tea industry. Maintaining good agricultural practices (GAP) and choosing tea cultivars more adaptable to varying climatic condition will mitigate the effects of climatic variation in productivity of tea lands.

Keywords: Private tea estates, Rainfall fluctuation, Upcountry tea, Yield variation
AGROBIODIVERSITY - POLICIES, ECONOMICS, MARKETING AND VALUE CHAINS AND INDUSTRIAL OPPORTUNITIES
This study reviews the policy and regulatory framework of the government of Sri Lanka to examine the extent to which they contribute for conservation and sustainable utilization of its agro-biodiversity. A content analysis of national policies (17), ordinances (4) and acts (17), regulations/orders (8), programmes (20) and projects (14), action/strategic/master plans (11) and, performance and progress reports (47) was carried out to ascertain the policy directions and incentives promoting agro-biodiversity conservation and utilization. Policy statements that promote the conservation and utilization of traditional plant varieties and indigenous livestock vis-à-vis those of their exotic counterparts were identified. Of the policy documents reviewed, national policy on wild life conservation, national environmental policies, and national land use policy promote conservation whereas national policy and strategy on cleaner production for agriculture sector, national policy for primary industries promote sustainable utilization. National forest policies and national policy on sustainable consumption and production promote conservation and sustainable utilization. Home Gardening Promotion Programme, “Gamdora” Programme, Commercial Farm Programme, Community Based Seed Production Village Programme and kithul Development Project are good examples for activities that promote sustainable utilization of traditional varieties and animal breeds. However, some dis-incentives to promote traditional varieties and breeds are provided by the national policies on agriculture, plantation industry, livestock and the connected programmes, i.e., National Food Production Programme, “Divi-Neguma” National Development Programme. Re-visiting of policy goals and policy instruments will be required to minimize incentives provided to promote environmentally unsustainable farming systems

**Keywords:** Agro-biodiversity, Conservation, Policy & regulation, Sri Lanka, Utilization
Tea is consumed worldwide, with its popularity second only to water as a beverage. Although tea extracts are investigated for medicinal effects, there is no evidence available on a herbal tea with the following composition having such effects. Glycation is a process accelerated with hyperglycaemia leading to chronic diabetic complications. The study was conducted to investigate the phytochemicals present and anti-glycation effects of a developed herbal tea with *Phyllanthus embilica* (Gooseberry) fruit (50%), *Zingiber officinale* (Ginger) rhizome (25%) and *Coriander sativum* (Coriander) seeds (25%). Standard methods were used to screen for the presence of a number of phytochemicals. Anti-glycation effects of the herbal tea were analyzed through investigation of glycation induced protein cross-linking inhibitory effects. Lysozyme was incubated with fructose at 37°C and pH 7.4 for 7 days in the presence or absence of herbal tea at different concentrations. Standard inhibitor aminoguanidine and other controls were included. Sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE) was used to detect products of protein cross-linking in the incubation mixtures. Phytochemical analysis showed the presence of glycosides, flavonoids, alkaloids, terpenoids, saponins and tannins. These bioactive components serve as a set of valuable starting materials for drug development. SDS-PAGE revealed appearance of high molecular weight products such as dimer, trimer and tetramer in the negative control which is formed as a result of cross-linking. These products were absent in the presence of aminoguanidine and also in the presence of the herbal tea at all concentrations. These findings provide evidence that this new developed product can be used as a healthy drink as well as a remedy for patients suffering from diabetes.

**Keywords:** Anti-glycation, Coriander, Gooseberry, Ginger, Phytochemical
The Biodiversity for Food and Nutrition (BFN) project in Sri Lanka has established field sites as a strategy of on-farm conservation and utilization of biodiversity. Through this project it preserves not only the crop-genetic resources but also the relevant human knowledge and behavioral practices. The in-situ conservation of agricultural biodiversity should be coupled with proper utilization plan to realize the intended outcomes of BFN programme. In this context, there should be a marketing mechanism for the farmers at the BFN sites to safeguard their livelihoods. With this background, a study was conducted with the objective of developing marketing strategies to increase the utilization of BFN products in the sites. A questionnaire survey followed by focus group discussions with the farmers at BFN sites (Gampola-Giribawa, Udukumbura and Neunhalla) and key informant interviews with sellers were conducted. Low yields associated with crop failures due to lack of water and quality planting material, biotic constraints including wild animal damages and diseases were reported as production constraints while land fragmentation and alternative usage of lands have dropped the motivation of farmers towards cultivation. Sales have been hindered due to the existing marketing constraints such as low surplus, lack of buyers and consumers, low quality of end products, low price, transport difficulties, unavailability of proper storage facilities and influence of the middlemen. To overcome these issues some recommendations are proposed. Providing quality planting materials, conducting awareness programs on successful agronomic practices and quality of end products through workshops, exhibitions, seminars etc., holding competition among small farmer groups and establishing model home gardens, while granting low or no interest loans to farmers and providing fencing materials and electric fences at concessionary rates are recommended. Furthermore, government or industrial partners should be involved in contract farming and collection of produce at reasonable prices.

**Keywords:** Biodiversity, Constraints, Food, Nutrition, Marketing strategies
PUBLIC AWARENESS AND PERCEPTION ON GOVERNMENT INTERVENTIONS TO CONSERVE AND PROMOTE AGRO-BIODIVERSITY IN SRI LANKA
Swarnathilake UK, C, Pushpakumara, DKNG, Weerahewa, J
Faculty of Agriculture, University of Peradeniya
udani19910807@gmail.com

It is evident that a variety of policies and programmes have been implemented to conserve and promote traditional crop varieties and animal breeds in Sri Lanka even though such species are not predominant in present day farming systems in Sri Lanka. This study examines level of awareness, perceptions and suggestions of different communities on the existing government initiatives. A sample of 127 farmers, 144 school teachers and 220 school students were interviewed using structured questionnaires to obtain necessary information. A convenience sampling method, i.e., snowballing, was adopted to select respondents from 43 geographical locations in 16 districts. Data was analysed using descriptive statistics. It was evident that a greater majority of farmers use improved local varieties or imported varieties in farming. Poor access to markets, poor knowledge on farming practices, lack of quality planting materials and wild animal attacks were identified as main constraints that prevent use of traditional varieties. Awareness on traditional varieties and animals among the teachers and children was found to be poor. Over 90% of respondents in each group expect government support to promote traditional crop varieties and animal breeds. In particular, school teachers indicate a need of updating prevailing government interventions. Provision of fertilizer subsidy, credit facilities, high quality inputs and extension services have identified as key measures that should adopted by the government agencies. It was revealed that (i) the degree of awareness on the government programs is low and incomplete, (ii) adoption of traditional varieties/breeds is perceived to be cumbersome, and (iii) certain suggestions provided are not pragmatic. Revisiting of school curriculum related to traditional agriculture, creation of awareness of the benefits of traditional varieties and breeds among consumers, development of new marketing structures and improving of accessibility to planting materials will be required to promote conservation and sustainable utilization of traditional varieties/breeds.

Keywords: Agro biodiversity, Awareness, Conservation, Government, Perception
Being rich in biodiversity, Sri Lanka possesses a high potential for the production of BFN food items. Yet, there exists a clear gap in respect of having a proper certification system for BFN food items to ensure that they will be produced in conformity with a set of quality standards. Even though certain third-party certifications exist, it is not practical for small scale producers to avail themselves of those services due to the high operational and transaction costs involved. In the light of this, the Participatory Guarantee System (PGS) that principally involves certification of organic produce through the active participation of stakeholders can be considered a viable alternative option for BFN certification. PGSs are based on mutual trust, social networks, knowledge building and exchange. The major objective of the present study is to set up guidelines for a participatory guarantee system to provide quality assurance services for BFN products in order to ensure the sustainability of production and utilization. This study held a series of Key Informant Interviews and Focus Group Discussions in three BFN pilot sites (Gampola, Neunhella and Udukumbura) and with other stakeholders, all of which helped to identify the required set of components for a PGS. According to the findings, it is first necessary to identify the key stakeholders. Next, clear-cut guidelines must be set by organizations like the Department of Agriculture and NGOs. Finally, mechanisms should be put in place for the implementation and continuation of the programme, supported by strong monitoring, evaluation, awareness raising and knowledge sharing activities to provide official recognition for PGS. While implementing this process, the managers should address any major shortcomings related to inconsistent supply of raw materials, poor quality of products, high cost of production, poor relationship between raw material suppliers and processors, poor market demand for specialty products and low level of awareness among consumers.

**Keywords:** BFN crops, BFN product quality, Participatory guarantee system (PGS)
EFFECT OF COMMERCIAL LIQUID SMOKE FLAVORING ON PHYSICO-CHEMICAL PROPERTIES IN TILAPIA (*Oreochromis niloticus*)

Lelwela GKTN\(^1\), Wijesinghe SKD\(^1\), Himali SMC\(^2\), Abeyrathne EDNS\(^1\)

\(^1\)Department of Animal Science, Uva Wellassa University, Badulla 90000, Sri Lanka
\(^2\)Department of Animal Science, University of Peradeniya, Peradeniya 20400, Sri Lanka

sandun@uwu.ac.lk

Fish is a highly nutritious food which deteriorates rapidly. Smoking is quite important as a preservation method for fish while improving color, texture, flavor and shelf life. This study was conducted to ascertain physico-chemical properties of smoked Tilapia using a commercial liquid smoke flavoring. Frozen Tilapia were received and thawed in air at 0-5°C for 17 hours. Liquid smoked Tilapia were produced by immersing fillets for 1 hour in a liquid smoked brining solution containing 5% (v/v) liquid smoke and 3% (w/v) NaCl followed by drying at 80°C for 3 hours in an electrical oven. Final products were vacuum packed and stored at 4°C for analysis. Proximate composition was measured for moisture, ash, crude fat and crude protein just after smoking. Microbial quality (*Salmonella, Escherichia coli* and Total Plate Count), TBARS, pH, color and texture were detected during 21 days of chilled storage (4°C). Collected data were analyzed using one-way ANOVA and Complete Randomized Design was used. It was observed 49.78±3.89% moisture, 7.01±0.09% ash, 11.92±0.18% crude fat and 26.62±0.54% crude protein in smoked fillets. Microbial counts were gradually increased from 4.84±0.06 to 5.67±0.09 log cfu/g while TBARS values were ranged between 0.075±0.00 to 0.037±0.02 mg malondialdehyde per kg of fish (p<0.05). pH ranged between 6.87±0.07 to 6.79±0.10. Both of lightness (44.48±1.97 to 35.11±2.67) and yellowness (20.43±1.94 to 17.54±1.36) indicated a significant (p<0.05) decrease whereas the increase of redness (7.07±1.53 to 9.88±1.19) was insignificant (p>0.05).

In conclusion, microbial counts and lipid oxidation of liquid smoked Tilapia were within the permitted levels under the chilled storage for 21 days. Hence, the Tilapia fillets incorporated 5% liquid smoke flavoring can be safely stored at 4°C for 21 days under the vacuum package. Therefore, it is recommended to incorporate liquid smoke flavoring to inland fish.

**Keywords:** Liquid smoke, Microbial quality, Physico-chemical quality, Tilapia
Women’s care role is the shouldering duties and responsibilities in the domestic sphere. Under that women perform different roles in the household and farm, which are important for the existing economy though it is not valued in the current economic indicators. Women’s involvement in home gardening for household consumption is one of the care role dimensions that attempted to value in this study. The research was operationalized in Kandyan Home Gardens. The sample size was 120 female home gardeners selected from Medadumbara Divisional Secretariat in Kandy district. The multistage sampling was used for sample selection. Data collection was done by administering a pre-tested questionnaire. This study interpreted the economic value in terms of labour saving by women in the sample. The opportunity cost method was adapted for the valuation. It contained steps of (1) selecting six home gardening activities of women in the sample, (2) calculating labor-days she spends for those activities, and (3) calculating value of those labour-days using labour wages in the study area. The most common six home gardening activities selected were (a) land preparation, (b) crop management, (c) collecting planting materials, (d) livestock rearing, (e) watering and (f) common post-harvest activities. The mean saving of labour cost per month was interpreted in this study as care economic value of women’s role through home gardening, and for considered set of home gardening activities it was 4488.00 LKR. Even though, a majority (70%) of the sample were part-time home gardeners, their contribution to labour saving is a value (4488.00 LKR) that cannot be undermined in the rural households’ context. This is the most important finding of the study, which lead to recommendations that policies should address specific needs of women in home gardening and offering ways to improve labour productivity of the home gardeners enhancing technology and extension.

**Keywords:** Domestic Sphere, Economic Value, Kandyan home gardening, Labour Saving, Women’s care role
BIO-DIVERSITY FOR FOOD AND NUTRITION (BFN) VALUE CHAINS IN SRI LANKA: CONSTRAINTS AND OPPORTUNITIES FOR VALUE CHAIN UPGRADING

Samarasinghe KP, Senevirathne NDSL, Hemachandra SD, Samarasinghe WLG

1 Agribusiness Centre, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka
2 Department of Agricultural Economics and Business Management, University of Peradeniya, Peradeniya, Sri Lanka
3 Biodiversity for Food and Nutrition project, Plant Genetic resources Centre, Gannoruwa, Peradeniya

kalanipetronia@yahoo.com

There are mainly 9 BFN crop categories and more than 100 high-nutritious biodiversity for food and nutrition (BFN) crop varieties identified in Sri Lanka by Department of Agriculture (DoA). However, at present they do not contribute significantly to the diet of Sri Lankan consumers. Popularizing BFN crops among consumers will have health benefits to the consumers as well as economic benefits to the rural farmers. This study aimed at mapping the value chains of selected BFN crops (i.e. gotukola, dandila, isuru deshi kiri ala, soursop, nelli, moringa leaves and sesbania) with high market potential while identifying strengths, weaknesses, opportunities and threats for value chain upgrading. Structured interviews and focus-group-discussions were carried out with 155 consumers in Kandy district, 91 farmers, 4 food manufacturers, middlemen, and officers at National Food Promotion Board (NFPB) and DoA. It was found that production up-scaling is possible by identifying farmers in different geographical areas to cultivate BFN crops with market potential. This study concludes that farmers’ willingness to cultivate BFN crops and selling high quality BFN crop added food for consumers through Helebojun outlets and through outlets led by NFPB are strengths to BFN crop value chains in Sri Lanka. Nevertheless, farmers lack adequate knowledge of growing plants organically and new technologies suitable for planting and harvesting yield. Further, intermittent supply (seasonality), poor quality BFN crop production compared to imported products and, higher pricing are other highlighted constraints. Potential of promoting BFN crop (i.e. moringa, soursop) added food into both local and export market and niche market by giants in food and beverage manufacturing industry and their involvement in research and development create new opportunities for value addition for BFN crops. However, importing higher quality BFN raw materials for lower prices is still a threat to upgrade local BFN value chains.

Keywords: Biodiversity for Food and Nutrition-BFN, Opportunities and Constraints, Sri Lanka, Value Chain Upgrading
Frozen yoghurt is a unique dairy product with physical properties related to ice cream while nutritional and sensory characteristics are similar to fermented dairy products. Incorporation of fruit pulp into frozen yoghurt is a new approach which further improves its nutritional and sensory properties. Therefore, this study was conducted to develop and evaluate frozen yoghurt with different jackfruit pulp concentrations. Ice cream mixture, yoghurt mixture and ripen jackfruit pulp were prepared separately and they were mixed together in correct proportions to prepare three frozen yoghurts containing different levels of jackfruit pulp (10, 15, and 20%) and they were packed in plastic cups. Plain frozen yoghurt was used as the control. Colour, aroma, texture, taste, meltability, and overall acceptability were evaluated using nine-point hedonic scale. Then all formulations along with the control were analysed for moisture, protein, fat, fibre, ash, and total solids. Shelf-life was tested for six weeks at frozen storage using titratable acidity (TA), pH and microbiological qualities. The frozen yoghurt containing 15% of jackfruit pulp scored best for overall acceptability. It contained 69.13 ± 1.12% moisture, 5.84 ± 0.12% protein, 3.59 ± 0.39% fat, 9.83 ± 0.98% fibre, 2.55 ± 0.26% ash, and 30.87 ± 1.12% total solids. Moreover, the protein, fibre, and ash content of the frozen yoghurt containing 15% jackfruit pulp were significantly higher compared to the control whereas, its fat content was significantly lower compared to the control ($p<0.05$). Total plate count and TA of all frozen yoghurts increased gradually while their pH decreased. Yeast and mould, coliform was not detected and no layer separation was observed during storage. Therefore, it can be concluded that addition of 15% jackfruit pulp into frozen yoghurt improved its physicochemical, microbiological, and sensory properties significantly and it can be introduced as a value added healthy dairy product.

**Keywords:** Frozen yoghurt, Jackfruit, Value added
LIST OF REVIEWERS

Dr. Pradeepa Bandaranayake
Director, Agriculture Biotechnology Centre, Faculty of Agriculture, University of Peradeniya, Peradeniya

Mr. P.B Dharmasena
Agriculture Expert, Mahaweli Water Security Investment Project, Mahaweli Authority of Sri Lanka

Mr. Sarath Ekanayake
Flora ecologist, International Union for Conservation of Nature, Colombo

Mr. Nalin Ekanayake
Director (Retired), Seed Certification & Plant Protection Centre, Department of Agriculture, Gannoruwa

Prof. L.H.P.Gunararthne
Agribusiness Centre, Faculty of Agriculture, University of Peradeniya, Peradeniya

Mrs. Roshni Hafeel
Deputy Director, Rice Research Station, Ambalanthota

Dr. R. M. Herath
Director, Socio Economic & Planning Centre, Department of Agriculture, Peradeniya

Mrs. Janakie Hettiarachchi
Director, Seed Certification & Plant protection Centre, Department of Agriculture, Peradeniya

Dr. A.H.M. Jayasooriya
Senior Consultant, EML Consultants (PVT) Ltd

Dr. H.K.Kadupitiya
Head (Land Use Planning & Geo Informatics Division) Natural resources Management Centre, Department of Agriculture, Peradeniya

Dr. R. Karawita
Chairman, National Food Promotion Board, Narahenpita

Mr.J.A.K.M.A. Kedaragama
Natural Resources Management Centre, Department of Agriculture, Peradeniya

Dr.R.S.K. Keerthisena
Additional Director General (Research) Department of Agriculture, Peradeniya

Ms.Kethakie Kulapala
Department of Ayurveda, Nawinna, Maharagama
Dr. Madurage  
Faculty of Veterinary Medicine & Animal Science, University of Peradeniya, Peradeniya

Prof. Terrence Madhujith  
Department of Food Science & Technology, Faculty of Agriculture, University of Peradeniya, Peradeniya

Ms. P. Malathie  
Additional Director (Research), Horticultural crop Research & Development Institute, Department of Agriculture, Gannoruwa

Prof. Buddi Marambe  
Department of Crop Science, Faculty of Agriculture, University of Peradeniya, Peradeniya

Dr. Malaviarachchi  
Assistant Director of Agriculture, Field Crop research & development Institute, Mahailuppallama

Dr. Piyal Marasinghe  
Botanist, Department of Ayurveda, Nawinna, Maharagama

Dr. Eresha Mendis  
Department of Food Science & Technology, Faculty of Agriculture, University of Peradeniya, Peradeniya

Prof. Udith Jayasinghe Mudalige  
Faculty of Agriculture & Plantation Management, Wayamba University of Sri Lanka, Makandura

Dr. C. Perera  
Department of Agricultural Biology, Faculty of Agriculture, University of Peradeniya, Peradeniya

Dr. Niranjala Perera  
Faculty of Livestock, Fisheries & Nutrition, Wayamba University of Sri Lanka, Makandura

Mr. Periyasamy  
Director, National Agriculture Information & Communication Centre, Department of Agriculture, Gannoruwa

Prof. G.Pushpakumara  
Dean, Faculty of Agriculture, University of Peradeniya, Peradeniya

Mrs. Disna Rathnasinghe  
Principal Scientist (Food & Nutrition), Extension & Training Centre, Department of Agriculture, Peradeniya
Dr. N. Rajapaksha
Head, Department of Food Science & Technology, Faculty of Agriculture, University of Peradeniya, Peradeniya

Prof (Ms) R.M.C.P. Rajapaksha
Department of Soil Science, Faculty of Agriculture, University of Peradeniya, Peradeniya

Mrs. Kanthi Ribera
Assistant Director of Agriculture, Food Research Unit, Department of Agriculture, Peradeniya

Dr. Rohitha
Department of Food Science & Technology, Faculty of Agriculture, University of Peradeniya, Peradeniya

Dr. W.L.G. Samarasinghe
Additional Director, Plant Genetic Resources Centre, Department of Agriculture, Gannoruwa

Dr. Subhani
Deputy Director, National Herbarium, Department of National Botanic Gardens, Peradeniya

Dr. K.H. Sarananda
Faculty of Agriculture & Plantation Management, Wayamba University of Sri Lanka, Makandura

Dr. Jayantha Senanayake
Director (Actn), Rice Research & Development Institute, Bathalagoda

Mr. D.N. Sirisena
No 11, 4th Stage, Uyandana state, Kurunegala

Dr. Renuka Silva
Faculty of Livestock, Fisheries & Nutrition, Wayamba University of Sri Lanka, Makandura

Dr. Ajantha Silva
Director, Natural resources Management Centre, Department of Agriculture, Peradeniya

Dr. Kapilasiri Udawela
Assistant Director of Agriculture, Rice Research & Development Institute, Bathalagoda

Dr. Samanthi Wasala
Additional Director (Development), Horticultural crop Research & Development Institute, Department of Agriculture, Gannoruwa

Dr. Priyantha Weerasinghe
Director, Horticultural crop Research & Development Institute, Department of Agriculture, Gannoruwa
Prof. Syril Wijesundara  
National Institute of Fundament Studies, Hanthana  

Dr. Rohan Wijekoon  
Director, Agriculture Modernization Project, Ministry Of Agriculture, Rajagiriya  

Prof. Swarna Wimalasiri  
Department of Food Science & Technology, Faculty of Agriculture, University of Peradeniya, Peradeniya  

Dr. D.B.T Wijeratne  
Assistant FAO Representative, Food and Agriculture Organization of the United Nations, Colombo