ANNUAL RESEARCH REVIEW 2019

NATIONAL INSTITUTE OF FUNDAMENTAL STUDIES

www.nifs.ac.lk info@nifs.ac.lk +94 81 2 232 002 +94 81 2 232 131

Vision and Mission

Vision

To be a renowned center of excellence for research in fundamental studies

Mission

Initiate, promote and engage in advanced research in fundamental studies for the enhancement of scientific knowledge and development of human resources contributing to national development

Message from the Chairman

I am writing this message to the Annual Research Review of the NIFS with great pleasure and enthusiasm. Even though I hold the position of the Chairman of the Board of Governors of this prestigious institution for a very short period, that was adequate for me to get an insight into the high-quality research carried out by the Scientists attached to the NIFS. The NIFS is the only research institute in the country dedicated to doing fundamental research, and Scientists have done high-quality research that can lead to high impact. Based on some review sessions I had with the Scientists, I was looking forward to seeing the projects such as 'Red clay-based water filter', 'Carbon-based nutrition management mobile App', 'Bio-absorbents to absorb textile dyes for SMEs', 'Geothermal resource mapping', 'Graphite based rechargeable batteries', etc. to go beyond the research stage to developments. I am sure these projects and many other projects which I haven't had time to explore have a potential to make a real contribution to our economy and awaiting to see collaborations that will trigger such economic activities strive from NIFS.

I congratulate the Scientists who have contributed to the Annual Research Review for their achievements and high-impact work and wish them all the best for their future endeavors.

Prof. Janaka Ekanayake (BSc, PhD, FIEEE, FIET, FIESL, CEng)
Chairman of the Board of Governors, National Institute of Fundamental Studies

Message from the Director

It is with immense pleasure I write this message on the occasion of the 2019 Annual Review of the National Institute of Fundamental Studies (NIFS), Kandy. We are a national institute mandated to conduct fundamental research to improve knowledge and find solutions to burning national problems. Despite the challenges we have faced in the past year, we have made tremendous progress in our research outcomes, institutional development and knowledge dissemination while engaging in nationally important programs.

The Annual Research Review provides an opportunity to showcase the quality of the work carried out at the institute and also helps to highlight its impact on society. In this process, our scientists' work is critically evaluated, and the reviewers identify deficiencies and shortcomings and make suggestions to improve overall research outcomes. Last year alone, our scientists published over 75 research papers in international and local journals. In addition, 145 research articles were published as conference proceedings and abstracts. They have also attracted funding to the tune of Rs. 19 million and formed 55 strong research collaborations and networks both nationally and internationally.

Currently, our Institute is equipped with state-of-the-art facilities for advanced research. All research activities are led by an internationally qualified expert pool of scientists. For the first time, we have also brought over 18 adjunct professors to NIFS from across the world, and they work with NIFS scientists to find solutions to broad scientific problems. Our motto is: even with limited facilities, produce the highest quality research outputs, gain international recognition and inspire the whole nation by developing the country economically and socially.

One of the core objectives of the NIFS is to train high-quality postgraduate students to support national development. Over the past 40 years, we have trained about 1,500 high-quality MPhil and PhD level postgraduates; through this process, we have minimized brain drain and lifted the academic vigor of our national universities. Presently, we are closely working with the Ministry of Higher Education, Technology and Innovation to establish the first NIFS affiliated postgraduate university in the country. This ties in with one of our core objectives: train postgraduates within the country to a standard commensurate with training in any world class institution. Presently, there are around 20 PhD, 50 MPhil, 10 Masters and 45 undergraduate students training at NIFS

NIFS is also extensively involved in science dissemination for school students, by conducting the School Science Program - one of the oldest programs in the country. We continue to strengthen the program to meet the needs of budding scientists in the country. We also extended our dissemination activities to the general public through participation in 3 exhibitions and the first Open Day last year.

Our researchers are primarily focused on addressing burning national issues like, COVID-19, human-animal conflicts, chronic kidney disease, food and nutrient security, water quality, etc generating fundamental knowledge required to address these issues. NIFS is on a fascinating path of growth and development in the coming years, and I wish all the scientists and staff of the NIFS every success during this annual review.

Professor Saman Seneweera
Director, National Institute of Fundamental Studies

Contents

National Institute of Fundamental Studies
Hantana Road
Kandy 20000
Sri Lanka

Tel: +94 812 232 002
Fax: +94 812 232 131
E-mail: info@nifs.ac.lk
Web site: www.nifs.ac.lk

SECTION I – RESEARCH UNITS

Project Leaders are responsible for authenticity of reports they have Submitted

Energy & Advanced Materials

Energy and Advanced Materials unit at the National Institute of Fundamental Studies covers several ambitious projects dealing with technologically important novel materials and devices. These are being investigated under four broad themes: The Condensed Matter Physics and Solid State Chemistry project mainly deals with the synthesis and characterization of novel polymeric electrolytes for dye sensitized solar cells, rechargeable batteries and electrochromic display devices, the Nanotechnology and Advanced Materials project covers target oriented fundamental and advanced investigations leading to the development Sri Lankan minerals and related materials for nano-technological and advanced materials based applications.

The Energy and Advanced Materials Chemistry project focuses on the chemistry and physics of novel materials for the conversion of solar energy into chemical and electrical energies. The Material Processing and Device Fabrication project involves experimentation and basic studies in Materials Processing and Device Fabrication with an emphasis on graphite, graphite based devices and carbon supercapacitors.

- Condensed Matter Physics & Solid State Chemistry
- Energy & Advanced Material Chemistry
- Material Processing & Device Fabrication
- Nanotechnology & Advanced Materials

Vidya Nidhi Prof. M.A.K.L. Dissanayake

B.Sc. M.S.,Ph.D.(Indiana, USA), D.Sc. (Wayamba, Sri Lanka), Recipient of Presidential awards for scientific publications 2018, National Science Foundation Life Time Award (2018), National Science Foundation SUSRED Award for Ph.D. Training (2018), SLAAS General Research Committee (GRC) Award (2015) for research excellence and the Committee of Vice Chancellors & Directors' (CVCD) Award (2010) for research excellence (Physical Science), "Vidya Nidhi" National Award (2005).

Served the University of Peradeniya, Sri Lanka as Director of the Postgraduate Institute of Science (PGIS) and as Senior Professor of Physics prior to joining the NIFS in 2011. Visiting Professor, University of Illinois at Chicago (UIC)(2009), Visiting Post Doctoral Fellow, University of Oklahoma, USA (1994), Visiting Professor, University of Aberdeen, UK (1993), Visiting Postdoctoral Fellow, Chalmers University of Technology, Sweden (1985-2019).

Title: **Research Professor**
E-mail: **lakshman.di@nifs.ac.lk**
Tel: **0777 130667**
ORCID ID: **0000-0001-5488-9384**

Condensed Matter Physics & Solid State Chemistry

Research in condensed matter physics and solid state chemistry is important because it often uncovers novel phenomena which are scientifically intriguing and technologically important. Fabrication of solid state devices such as solar cells, solid state lasers, LEDs, numerous consumer semiconductor electronic devices, and solid state batteries are few such examples. `Soft' condensed matter systems such as solid state and quasi-solid (or gel) state polymers, also find many applications.

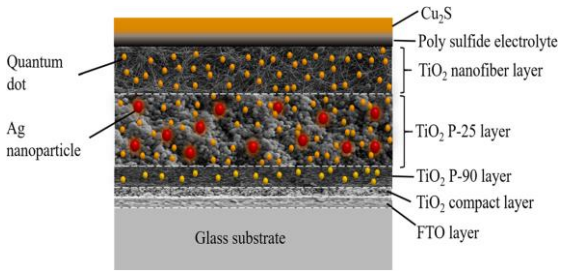
Research under the Condensed Matter Physics & Solid State Chemistry programme at the NIFS deals with the synthesis and characterization of technologically important novel solid state and quasi-solid state (gel) materials and devices for energy generation and utilization. The main emphasis is on dye sensitized solar cells (DSSCs).

Dye-sensitized solar cells (DSSCs) offer an efficient and easily implemented technology for environmentally friendly energy generation. Compared to conventional silicon solar cells, a DSSC provides comparable power conversion efficiency (PCE) at low material and manufacturing costs. DSSC materials such as titanium oxide (TiO_2) are inexpensive, abundant and innocuous to the environment, DSSC materials are less prone to contamination and are processable at ambient temperature. They perform better under lower light intensities, which makes them an excellent choice for indoor applications as well.

During 2019, several projects under the DSSCs have been completed successfully by our group. These are (a) Efficiency enhancement in PbS/CdS quantum dot-sensitized solar cells by plasmonic Ag nanoparticles, (b) Efficiency enhancement in dye-sensitized solar cells using hierarchical TiO_2 microspheres as a light scattering layer and (c) Effect of polyaniline on the performance of dye sensitized solar cells fabricated with poly (ethylene oxide) based gel polymer electrolytes.

Ag colloidal nanoparticle-incorporated plasmonic TiO_2 (nanofiber/nanoparticle) double-layer electrodes for Quantum dot sensitized solar cells

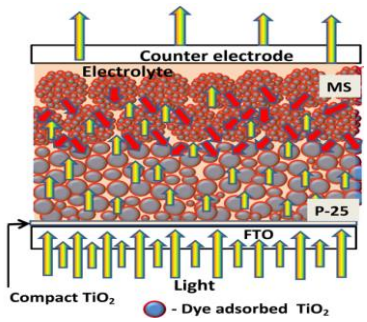
TiO_2 electrodes were sensitized with PbS/CdS core-shell quantum dots by successive ionic layer adsorption and reaction (SILAR) technique, and QDSSCs were fabricated with polysulfide electrolyte. Cu_2S formed on a brass plate was used as the counter electrode of the QDSSC. A higher power conversion efficiency of 4.09% was been obtained due to the plasmonic effect under the simulated light of 100 mW cm^{-2} with AM 1.5 spectral filter. The overall efficiency and short-circuit current density of the plasmonic QDSSC was enhanced by 15% and 23%, respectively, with respect to the QDSSC without Ag nanoparticles.



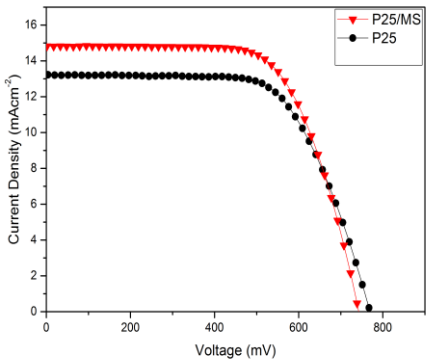
The enhanced performance of the plasmonic QDSSC is evidently due to the enhanced optical absorption by localized surface Plasmon resonance effect by the Ag nanoparticles in the TiO_2 double layer photoanode and the resulting increase in the short-circuit photocurrent.

Hierarchically structured TiO_2 microspheres (MS) for efficiency enhancement in Dye Sensitized Solar Cells

Generally, enhanced light absorption in DSSC is achieved through light scattering in the device by employing a double layered TiO_2 photo anode consisting of an active layer of smaller (~ 20 nm) P25 particles and a scattering layer consisting of larger (~ 300 nm) particles. However, due to the smaller effective surface area of the larger particle layer, dye adsorption in the second layer is very poor and therefore, the efficiency enhancement due to the usage of thicker photo anode is hindered. Therefore, in this study, investigations were carried out to replace the conventional, larger particle scattering layer by a morphologically different structure of TiO_2. Here, the DSSC performance between two different types of scattering layers, one consisting of TiO_2 nanorods (NR) and the other consisting of hierarchically structured TiO_2 microspheres (MS) are compared. DSSC fabricated with P25/MS double layered photoanode outperformed the DSSC fabricated with P25/NR double layered photoanode. P25/MS based DSSC delivered a highest short circuit current density of 14.80 $mAcm^{-2}$ with an efficiency of 7.38%, while the efficiency of DSSC fabricated with P25/NR photoanode exhibited a 7.03% efficiency. The DSSC fabricated without a scattering layer showed an efficiency of only 6.68%. The diffuse reflectance and dye adsorption measurements revealed that the better performance of P25/MS double layered DSSC is largely due to the improved photon absorption facilitated by superior light scattering as well as higher dye loading by TiO_2 microspheres.



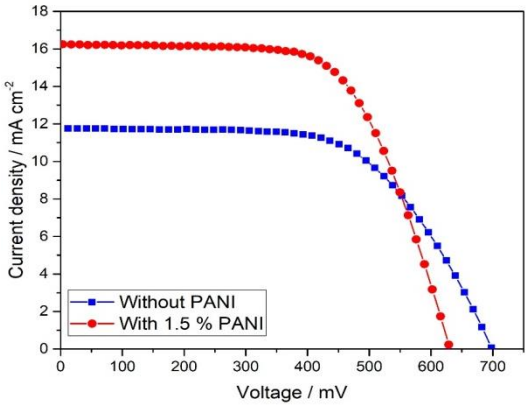
The figure depicts increased light absorption by scattering by TiO_2 double layer photoanode consisting of a layer of hierarchically structured TiO_2 microspheres (MS) on a layer of P25 TiO_2.



Effect of polyaniline on the performance of dye sensitized solar cells fabricated with poly (ethylene oxide) based gel polymer electrolytes.

Ionically conducting gel polymer electrolytes are promising materials for improving the power conversion efficiency of DSSCs. In this study, polymer electrolytes containing poly (ethylene oxide) (PEO), LiI and I_2 are used as the redox electrolyte and different amounts of polyaniline (PANI) conducting polymer are introduced as an additive to the PEO based electrolytes. The gel polymer electrolyte without PANI showed a conductivity of $1.32x10^{-2}$ S cm^{-1} at room

temperature and with the incorporation of 1.5 wt% PANI, the conductivity increased up to of 1.75×10^{-2} S cm^{-1}. The DSSCs fabricated with 1.5% PANI incorporated polymer electrolyte showed an efficiency of 6.56% while the DSSCs without PANI in the electrolytes showed an efficiency of 5.00% under the illumination of 100 mW cm^{-2} (AM 1.5) simulated sunlight. Possible formation of interconnected channels within the host polymer matrix due to the incorporation of PANI providing additional conducting pathways for better electron transfer between the redox mediator and the dye cation might be one of the reasons for this enhancement in the efficiency as it is reflected from the enhancement in the short circuit current density of these devices.



Photocurrent density vs voltage curves of the DSSCs fabricated with polymer electrolytes without PANI and 1.5 wt% PANI added to the gel polymer electrolyte.

Ph.D. & M.Phil. Students

Ms. Kohila Paramanathan*, completed M.Phil. in December 2019
Mr. T. Jaseetharan*, Ph.D. student
Ms. J.M.K.W. Kumari, Ph.D. student
Mr. S. Senthuran*, M.Phil. student
Mr. K. Umair, M.Phil. student
Ms. W. Ishara Sandamali*, Ph.D. student
(*Externally funded RAs)

Key publications

Highly efficient plasmonic dye-sensitized solar cells with silver nanowires and TiO_2 nanofibres incorporated multi-layered photoanode
M.G.C.M. Kumari, C.S. Perera, B.S. Dassanayake, M.A.K.L. Dissanayake, G.K.R. Senadeera
Electrochimica Acta 298 (2019) 330-338

Highly efficient, PbS:Hg quantum dot–sensitized, plasmonic solar cells with TiO_2 triple-layer photoanode.
M.A.K.L. Dissanayake, T. Jaseetharan, G.K.R. Senadeera, J.M.K.W. Kumari, C.A. Thotawatthage, B-E. Mellander, I. Albinson and M. Furlani
Journal of Solid State Electrochemistry (2019)23 (6)1787–1794.

Low cost quasi solid state electrochromic devices based on F-doped tin oxide and TiO_2
H.N.M. Sarangika , M.A.K.L. Dissanayake, G.K.R. Senadeera , W.G.M.D. Karunarathne
Materials Today: Proceedings (2019)
https://doi.org/10.1016/j.matpr.2019.07.585

From Left: Ms. Ishara Sadamali, MrHKHD. Kankanamge, Mr. S. Senthuran, Prof. GKR. Senadeera, Prof. MAKL. Dissanayake, Mr. T. Jaseetharan, Mr. K. Umair, Ms. KW. Kumari

G.K.R. Senadeera

Professor in Physics at OUSL, B.Sc. (Sp) Physics 1991, (Perad), Ph.D. (Solid State Physics, 1996, Perad, (sandwiched with DTU-Denmark), Post Doc. Dip.(Chemistry and Chemical Engineering, TIT, Japan (1998). M.Sc. (Medical Physics, Reading), Google Scholar h-index: 22. Fellow, Institute of Physics, Sri Lanka. Sri Lanka patent No. 11982, Japanese Patent by Nippon Kayaku Co, Ltd, Japan – NKS (JP2005135656) / Portuguese Patent by Y-Dreams – Portugal, PT 104634A, Presidential Research Awards for years 1999 to 2005,2007, 2008, 2010, 2013, & 2014, NRC Merit Awards in 2012 & 2015. OUSL Research Awards from 2012 to 2018, SUSRED award by NSF 2018. Google scholar *h* index: 23

Title: **Visiting Research Professor (NIFS)**
Email: **gksen@ou.ac.lk**
Tel: **081-2494083**
ORCID ID: **0000-0002-9202-9008**

Performance Enhancement of Dye Sensitized Solar Cells by Co-sensitization of Triple Layered TiO_2 Photo anode with Natural Dyes

Dye sensitized solar cells convert visible light into electricity usin sensitization of the cell. The Performance of dye sensitized solar cells is mainly based on the dye used as a sensitizer. The present study, Dyes extracted from natural resources is one of the main research areas under dye sensitized solar cells. The use of natural dyes as sensitizers can cut down the high cost of metal complex sensitizers and also replace expensive chemical synthesis processes by simple extraction process. Natural dyes are abundant, easily extractable, and are safe materials with no environment threats. These can be extracted from flower petals, leaves, roots and barks in the form of anthocyanin, carotenoid, flavonoid and chlorophyll pigments.

During 2019, underthe NIFS solar energy programme, we achieved efficiency enhancement of dye sensitized solar cells by increasing the light harvesting rate of the photoanode by structurally modifying the TiO_2 photoanode and by co-sensitizing with two natural dyes Eosin-Y and Rose Bengal. A Nanoparticle (NP)/Nanofibre (NF)/Nanoparticle (NP) triple layered structure of TiO_2 was formed by incorporation of electrospun TiO_2 nanofibres in between two TiO_2 nanoparticle layers. Characteristics of DSSCs comprising this triple layered structure were compared with the performances of DSSCs fabricated with conventional nanoparticle (NP) TiO_2 photanodes under identical conditions by using inexpensive Eosin-Y dye and electrolyte solution consisting of tetra propyl ammonium iodide and iodine dissolved in acetonitrile and ethylene carbonate. Dramatic enhancement in the efficiency of DSSC was obtained due to the incoperation of the nanofibre layer in to the structure of conventional photoanode. DSSCs fabricated with Eosin–Y dye sensitized triple layered structure of NP/NF/NP showed an overall efficiency of 1.77% whilst. Solar cells without the nanofibre layer but having the same thickness showed an efficiency of 0.89% giving an increase of efficiency by ~ 98% under irradiance at 1000 W m^{-2} (AM 1.5). DSSCs sensitized with Rose Bengal dye showed 0.25% and 0.76% efficiencies with conventional and triple layered structures of photoanodes respectively. Photocurrent density and UV-Visible absorptions measurements revealed that the main cause for this improvement might be due to enhanced light harvesting by the scattering effect within the electro spun TiO_2 nanofiber layer.

It was observed that the co-sensitization process optimized the devices performance considerably. DSSCs sensitized sequentially twice the efficiency of those of the cells sensitized with any of the single dyes incorporated with a conventional photoanode. DSSC fabricated with TiO_2 NP/NF/NP composite three-layer photo anode cosensitized with the above dyes showed an average energy conversion efficiency of 2.09% whilst the DSSCs fabricated with co sensitized conventional photoanode showed an efficiency of 1.04% giving an increase in efficiency of 100%.

Kalpani Wasana Kumari

Kalpani Wasana Kumari is currently a Ph.D. Research Assistant in the Condensed Matter Physics and Solid-State Chemistry project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc (Hons) from *the* University of Peradeniya in 2013 and M.Phil from the Postgraduate Institute of Science, University of Peradeniya in 2017. She re-joined NIFS in 2018. Her current research focuses on dye/quantum dot sensitized solar cells and graphite based counter electrodes. Her research interests include polymers, conducting polymer based electrolytes, graphite-based nanomaterials for counter electrodes for solar cells.

Mobile: +94(0)717574072
E-mail: kalpani.ku@nifs.ac.lk
https://www.researchgate.net/profile/Kalpani_Kumari
https://scholar.google.com/citations?user=wXk2W-8AAAAJ&hl=en

Thillainathan Jaseetharan

Jaseetharan is currently a Ph.D. Research Assistant with the Condensed Matter Physics project at the National Institute of Fundamental Studies (NIFS). He received his B.Sc (Hons.) in Physics from the University of Jaffna in 2008, M.Sc. from the Postgraduate Institute of Science, University of Peradeniya in 2015 and joined the NIFS in 2016. His research focuses on Semiconductor quantum dots for solar cells and Infrared detectors. Jaseetharan's research interests include colloidal quantum dot sensitized plasmonic solar cells, polymer-based gel & solid electrolytes for photovoltaic application and IR detectors.

Mobile: +94 (0)772 852 827
E-mail: jaseetharan@seu.ac.lk | jaseetharan.th@nifs.ac.lk
https://scholar.google.com/citations?hl=en&user=h9yCVf0AAAAJ
https://www.researchgate.net/profile/Thillainathan_Jaseetharan2
https://orcid.org/0000-0001-6718-4762

Sivasubramaniam Senthuran

Sivasubramaniam Senthuran is currently an M.Phil. student with the Condensed Matter Physics and Solid State Chemistry group at the National Institute of Fundamental Studies (NIFS) Since2018. He received a B.Sc (Hons) in Physics from the University of Jaffna, Sri Lanka and M.Sc. in Plasma Physics from the Queen's University of Belfast, United Kingdom. His research mainly focuses on nanostructural modifications of photoanodes for Dye-Sensitized Solar Cells. Senthuran's research interests include numerical simulation of nanophotonics for solar cell applications, and energy storage devices.

Mobile: +94 (0)766 695 189
E-mail: senthuran.si@nifs.ac.lk
https://scholar.google.co.nz/citations?user=-N51ePkAAAAJ&hl=en
https://www.researchgate.net/profile/Senthuran_Sivasubramaniam

Umair Khaleelullah

Umair Khaleelullah is currently a M.Phil. Research Assistant with the Condensed Matter Physics and Solid State Chemistry project at the National Institute of Fundamental Studies (NIFS). He received his B.Sc (Hons), from the University of Sri Jayewardenepura, Sri Lanka and joined NIFS in 2018. His research focuses on efficiency enhancement of Dye-Sensitized Solar Cells by developing novel electrolytes and novel photo anodes. His research interests include efficiency enhancement in dye sensitized solar cells by modifying the TiO2 photoanode, Polymer electrolytes, Conducting polymers and Nanofillers.

Mobile: +94 (0)76 707 4707
E-mail: umair.ka@nifs.ac.lk **|** umair.usjp@gmail.com
https://www.researchgate.net/profile/Umair_Khaleelullah2

Ishara Sandamali

Ishara Sandamali is currently a M.Phil. Research Assistant attached to the Condensed Matter Physics and Solid State Chemistry project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc (Hons) from the University of Sri Jayewardenepura, Sri Lanka and joined NIFS in 2019. Her research focuses on the development of engineering nanomaterials for photovoltaic applications. She has a full time Research Assistantship from AHEAD Operations administered through the Open University of Sri Lanka.

Mobile: +94 (0)0768649214
E-mail: sandamali.ish@gmail.com

Jayasundera Bandara

Jayasundera Bandara, is a Senior Research Professor in NIFS. His research is focused on novel materials and nanostructures for the application indye/q-dot sensitized solar cells and solar fuels production. Professor Bandara has 86 research publications in SCI journals (5479 citations, h-index 37) and he was honored by UNESCO/Japan fellowship (1991-1992), Tokyo Institute of Technology; Swiss Government Fellowship (1994-1998), postdoctoral Fellow (2000-2001), Tufts University, USA; Visiting Professor (Oct 2004-Feb 2005), Switzerland, Geroge Foster Fellowship (2007-2008), Germany; Visiting Scientist (2009), Germany; Humboldt Fellowship (August-Oct 2013), Frie University, Germany; Tubitak Fellowship (August-oct, 2014), Turkey; Humboldt Fellowship (July-September 2016), Max-Plank institute, Awards: Young Scientist Award, NASTEC (2005), Presidential Awards (2000-2016);.CAS President's international fellowship initiative(pifi) award (2017-2018), Chinese Academy of science, China.

Title: **Senior Research Professor**
E-mail : **jayasundera.ba@nifs.ac.lk**
T.P.: **0812232002 (ext 172)**
ORCID ID: **0000-0001-8530-5679**

Energy & Advanced Material Chemistry

The research theme of the Energy & Advanced Material Chemistry Group is renewable energy. Under this broad theme, the chemistry and physics of new materials for the conversion of solar energy into chemical and electrical energies is investigated. Research projects such as extending and adapting current photovoltaic technology mainly dye-sensitized, Q-dot and polymer solar cells to generate electricity directly from solar radiation; constructing artificial chemical devices mimicking photosynthesis to collect, direct, and apply solar radiation, for example to split water, convert atmospheric carbon dioxide to produce various forms of environmentally clean fuels, Chemical, electrochemical and photochemical methods for the purification of air and water are the main research topics of the group. Additionally, the group actively carries out research on environment remediation where we investigate novel, low cost water and air purification methods for abatement of industrial pollutants by using sunlight.

Under the research topic of conversion of solar energy into electrical energy, our research is mainly focused on understanding and improving the of fundamental requirements (efficient harvesting of sun light and efficient separation of excited charge carriers) of different types of solar cells such as dye-sensitized, polymer and q-dot sensitized solar cells. In this project, novel light harvesting materials are synthesized and their charge separation as well as charge recombination properties are investigated in order to fabricate solar cell devices. The main objective of this research is to fabricate a low-cost solar cell by enhancing light absorption and charge carrier separation.

Water splitting reaction is still one of the unresolved problems in physical chemistry and we are trying to understand how an electromagnetic energy can be efficiently converted to chemical energy i.e can water be efficiently split in hydrogen and oxygen using solar energy? Can we convert CO_2 into useful chemicals?

Hydrogen production by water splitting reaction

Hydrogen production by photocatalytic water splitting is considered one of the most important renewable paths, however a reliable hydrogen production system is yet to be achieved. The biggest problems encountered in photocatalytic water splitting systems is the poor response of most of the stable photocatalyts to visible light. It is challenging to achieve an efficient separation of excited charge carriers, i.e electrons and holes. Introduction of defects in high bandgap materials is one of the promising strategies to simultaneously tailor the band gap and control the life time of photoexcited electron–hole pairs. A strategy was developed to induce oxygen vacancy defects in $SrTiO_3$ powders *via* the reaction of $NaBH_4$ at high temperature (550^oC) in the presence of a mixture of Ar:H_2 gases. The high temperature treatment of $SrTiO_3$ powders resulted in electron doping of $SrTiO_3$ due to oxygen vacancies triggering the development of a highly visible active $SrTiO_3$ photocatalyst with a remarkable 10-fold enhancement of H_2 evolution activity.

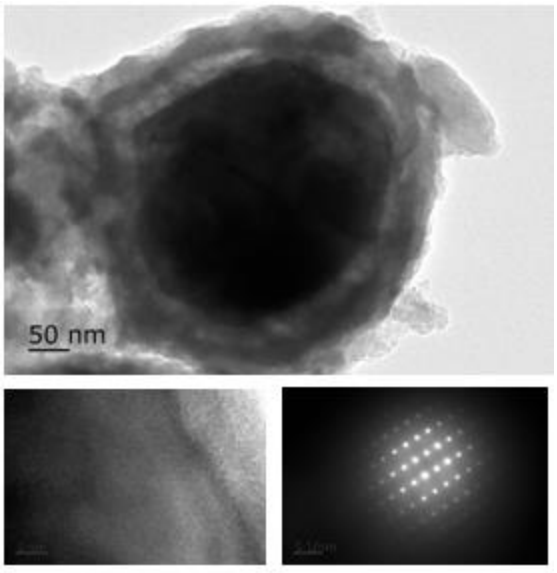


Figure 1: (a) HRTEM image of highly reduced black $SrTiO_3$ powder, (b) Fringe patterns and (c) SAED patterns of reduced black $SrTiO_3$ powder.

The TEM images and corresponding SAED patterns clearly indicate the formation of core-shell crystalline $SrTiO_3$ and reduced $SrTiO_3$. The visible light response of the highly reduced $SrTiO_3$ is evident by the IPCE spectra shown in Figure 2 in which it was clearly demonstrated that the light response of reduced $SrTiO_3$ extends till 600 nm with a weak response even at 800 nm.

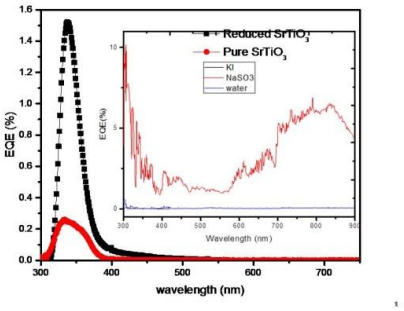


Figure 2: IPCE response of reduced $SrTiO_3$ and $SrTiO_3$ powders and insert shows the magnify image of IPCE in Near IR region.

Based on the properties of non-reduced and reduced $SrTiO_3$ together with the experimental evidence, the following mechanism can be proposed for the higher visible light activity of the reduced $SrTiO_3$ catalyst. It is known that the non-reduced $SrTiO_3$ contained a large number of deeply trapped states and upon band gap excitation of $SrTiO_3$, most of the photoexcited electrons in non-reduced $SrTiO_3$ can be deeply trapped in the intrinsic defects. However, in highly reduced $SrTiO_3$, deeply trapped stated are filled by electrons *via* reduction treatment (or electron doping).

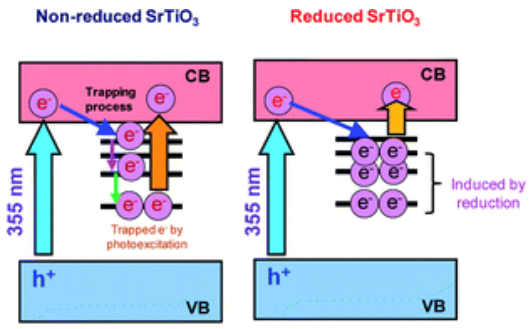


Figure 3: Proposed electron excitation and separation mechanism in (a) non reduced and (b) reduced $SrTiO_3$ catalysts.

The findings can be easily adapted to other high-band gap semiconductors to enhance the visible light photocatalytic H_2 generation reaction.

THIN FILM solar cell

Thin-film solar cells technology is one of the solutions for expensive silicon solar cells. Antimony sulfide (Sb_2S_3) solar cells have demonstrated an efficiency exceeding 7% with a liquid electrolyte when assembled in an extremely thin absorber configuration deposited via chemical bath deposition. We developed solid type Sb_2S_3 solar cells with P3HT as hole conductor material.

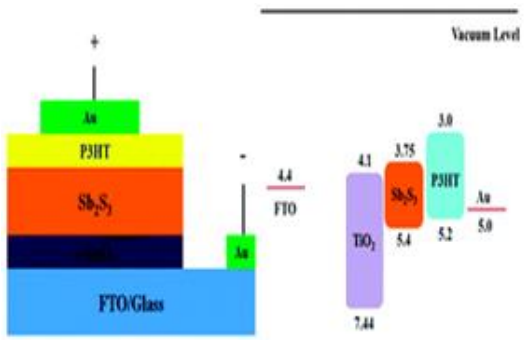


Figure 4: Schematic diagram of Sb2S3 and P3HT solid state solar cell.

As shown in Figure 5, the IPCE spectra show a broad response from 350 to 750 nm which is better than the normal dye-sensitized solar cells.

The efficiency of the Sb_2S_3/P3HT based solar cell is ~4.0% and exhibit high stability under ambient conditions. Investigations are being carried out to enhance the solar cell efficiency of these solid state solar cells.

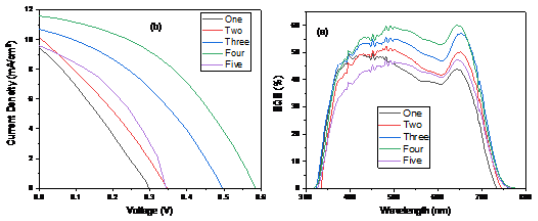


Figure 5: IV and IPCE response of Sb2S3 and P3HT solid state solar cell.

M.Phil Students: H. G. D. P. Ubeysekara, K.M.De S. Subasheela, F. Aliyer
M.Sc. Students: S.A.D.A.V. Sumithraarchi, C. Rajapaksha
Undergraduate students: K. Bandaranayake

Key publication:

Piezoelectric materials for catalytic/ photocatalytic removal of pollutants: Recent advances and outlook, Z Liang, CF Yan, S Rtimi, J Bandara, Applied Catalysis B: Environmental 241, 256-269, 2019 (IF 14.229)

Removal of groundwater nitrates by heterogeneous supramolecular complexes-like photocatalytic system based on in-situ generated and highly active Ti^{3+}/Ti^{2+} states in the reduced TiO_2, DS Dharmagunawardhane, NL De Silva, UB Gunatilake, CF Yan, J Bandara, Molecular Catalysis 470, 89-96, 2019 (IF 2.938)

From left: Ms. HGDP. Ubesekara, Ms. KMDS. Subaseela, Mr. SADAV. Sumithraarachchi, Prof. JMS. Bandara, Ms. D. Aluthpatapandi, Ms. MA. Farhana

Mohaiyadeen Aliyar Farhana

Mohaiyadeen Aliyar Farhana is currently an M.Phil Research Assistant in the Energy and Advanced Material Chemistry project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc from the South Eastern University of Sri Lanka in 2017 and joined NIFS in 2018. Her research focuses on thin film solar cells. Her research interests include Solar Energy, cost effective and environment friendly Chalcogenide thin film solar cells.

Mobile: 075 5529049;
E-mail: farhana.al@nifs.ac.lk

Darsha Prabhashini Ubeysekara

Darsha Prabhashini Ubeysekara is currently working as a research assistant in the Energy and Advanced Material Chemistry project at the National Institute of Fundamental Studies (NIFS) and reading for a M.Phil. at the University of Peradeniya. She is awarded a special degree in Physics from the University of Jaffna, Sri Lanka in 2018 and joined the NIFS in 2019. Her research focusses on environmentally friendly chalcogenide thin film solar cells and her research interests include Solar Energy, material development and cost effective solar cells.

Mobile: 0703300748
E-mail: darsha.ub@nifs.ac.lk

Koshila Subaseela

Koshila Subaseela is currently a Research Assistant in the Energy and Advanced Material Chemistry project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc. (special) degree in Chemistry from the University of Peradeniya in 2018. She joined NIFS in 2019 and is currently reading for her M.Phil. Koshila's research focuses on developing efficient photocatalysts for hydrogen generation from water splitting. Her research interests include solar energy, renewable energy, photocatalysis, green catalysis and carbon-based nanomaterials.

Mobile: 0715890410
E-mail: koshila.su@nifs.ac.lk

Ashoka Kumara

Professor Kumara obtained his B.Sc.(1993) from the University of Peradeniya, M. Phil.(1997) from the University of Sri Jayewardenepura, and Ph.D.(2001) from Shizuoka University, Japan. He has published over 100 papers in highly indexed international journals and 8 patents. Prof. Kumara's Research Publications received over 5000 citations with a h-index of36. He has served in many institutions in Japan in various capacities, such as a Visiting Professor at Shizuoka University and Toyota Technological University, and as a Senior Scientist at SPD Laboratory. He is an Honorary Professor the Research Institute of Electronics, Shizuoka University, Japan. He has been awarded MONBUSHO, JST and JSPS Japanese Government Fellowships. He is a recipient of many recognized awards in Sri Lanka, namely Young Scientist Award (NSF) President's Research Awards, NRC Merit Award and NSF SUSRED Awards.

Title: **Research Professor**
E-mail: **kumara.as@nifs.ac.lk**
T.P.: **0812232002**
ORCID ID: **0000-0001-9804-2652**

Material Processing and Device Fabrication

The above project conducts experiments and basic studies in the areas of material processing and device fabrication, emphasizing on energy conversion and storage, attempting to utilize locally available raw materials, whenever possible. Coconut charcoal and graphite are being innovatively developed as electrodes for solar cells and supercapacitors. Exfoliation and purification of Sri Lankan graphite will be continued with a view to producing oil absorbents and graphene. Furthermore, the project plans to conduct research in the area of extremely thin absorber solar cells (perovskites as well as other absorbers) and develop hole conducting materials to be used in these solar cells and other opto-electronic devices. The project ideas are currently trending and are geared to issues in energy and materials. The objective is to adopt an unconventional approach to compete in the international arena. This project will promote local and international collaboration and support student research achievement.

Dye-sensitized Solar Cells Based on Tin and Zinc Oxide Composite Films Using Ionic Liquid Electrolytes

After decades of research, long term stability of dye-sensitized solar cells (DSCs) continues to remain a questionable issue. The observed instability is caused by dye and electrolytic degradation and gradual evaporative elimination of the volatile components of the electrolyte via unavoidable faults in the sealing. Degradation of the dye and the electrolyte is mainly due to photocatalytic reactions mediated by titanium dioxide. Of familiar high-band gap oxide materials, short wavelength (< 300 nm) radiation initiated by photo-catalytic activity originating free radical generated by hole transfer to water molecules is strongest in titanium dioxide. Although DSCs made from less photo-catalytically active tin and zinc oxides are inefficient, composite tin-zinc oxide films yield efficiencies comparable to those fabricated out of titanium dioxide films. Studies conducted reveal that DSCs based tin-zinc oxide films are highly stable when high boiling point solvents are incorporated to solubilize the conventional iodide/tri-iodide redox system.

The IV characteristics of DSCs made of SnO_2, ZnO and SnO_2/ZnO films with high boiling point ionic liquid electrolyte are shown in Figure 1 and the IV parameters are summarized in Table 1 clearly conspicuous improvements in Jsc, Voc and FF are also seen in the SnO_2 / ZnO cell.

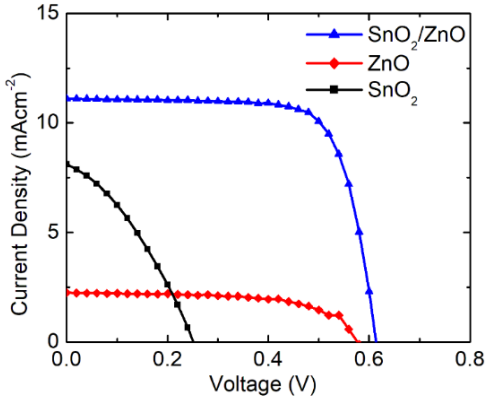


Figure 1. IV characteristics of the DSCs based on SnO_2, ZnO and SnO_2/ZnO composite films.

Table 1. IV parameters of DSCs with ionic liquid electrolyte

Working Electrode	J_{sc} (mA cm^{-2})	V_{oc} (V)	FF	η (%)
SnO_2	8.11	0.251	0.34	0.69
ZnO	2.25	0.577	0.64	0.83
SnO_2/ZnO	11.1	0.614	0.74	5.04

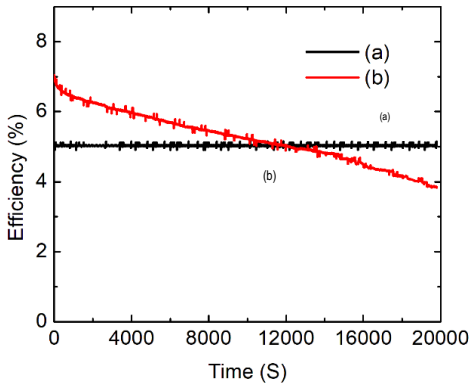


Figure 2. Comparison of the time variation of the efficiencies of SnO_2/ZnO DSCs based (a) on ionic liquid electrolyte and (b) volatile electrolyte

Figure 2 compares the time variation of the efficiencies of SnO_2/ZnO cell that utilizes the high boiling point ionic liquid and volatile electrolytes. The less viscous volatile electrolyte yields higher initial efficiency, but the electrolyte loss causes a rapid decline of the efficiency. A detectable decrease in the efficiency of ionic liquid system was not observed in the ionic liquid system during the period of illumination.

Results indicate that the SnO_2/ZnO cell, yields nearly an order of magnitude higher efficiency compared to the efficiencies of systems based on individual oxides. More importantly, findings demonstrate that the DSCs made of SnO_2/ ZnO films and the ionic liquid electrolyte are highly stable and resistant to degradation during prolonged illumination.

Fabrication of Supercapacitors using Jack Fruit Latex as the Binder

Development of supercapacitors attracts a great deal of attention as they are more environmentally friendly than batteries and admit extraordinarily large number of charge- discharge cycles, without an appreciable decrease in the performance. Almost all commercial supercapacitors are based on coconut shell charcoal, which possess many advantages compared to carbons derived from other forms of biomass.

The conventional procedure for making a supercapacitor from coconut charcoal involves a number of steps. Burning coconut shells, washing with water and acids to eliminate minerals and activation. To fabricate a supercapacitor, activated charcoal is pulverized to a suitable mesh size, blended with a binder and pressed onto a conducting planer substrate to form a compacted film. Two such components moistened with an electrolyte and sandwiching an ion permeable membrane forms the supercapacitor. Use of a binder is crucial as in its absence, grains are not held together and loosening of grains generally forbids

setting-up of the film. In this study, Jack fruit latex was used as the binder of activated charcoal. Jack fruit latex was mixed with charcoal in a suitable ratio to obtain a charcoal paste. The prepared charcoal paste was used to fabricate capacitor electrodes.

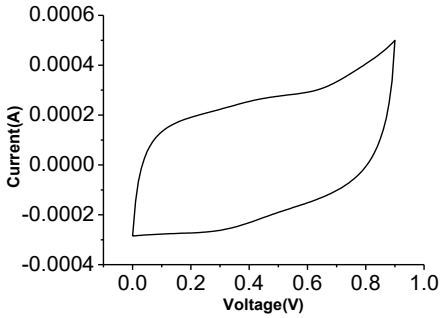


Figure 3. cyclic voltammetry curve

Cyclic Voltammetry plots were used to calculate specific capacity (Figure 3). In this study 0.1M KSCN was used as the electrolyte. Supercapacitors fabricated using the above procedure gave maximum capacitance of 44F/g. Since the jack fruit latex binder is insoluble in aqueous solution, durability of the capacitor is high.

Research Students: K.D.M.S.P.K. Kumarasinghe
P.N. Dissanayake
D.G.B.C. Karunarathne

Key publications:

Activated coconut shell charcoal based counter electrode for dye-sensitized solar cells. K.D.M.S.P.K. Kumarasinghe, G.R.A. Kumara, R.M.G. Rajapakse, D.N. Liyanage and K. Tennakone, Organic Electronics (2019) 71, 93-97.

Investigations on the photo catalytic activity of calcium doped TiO_2 photo electrode for enhanced efficiency of anthocyanins based dye-sensitized solar cells. N. Prabavathy, R. Balasundaraprabhu, G. Balaji, A.U. Malikaramage, S. Prasanna, K. Sivakumaran, G.R.A. Kumara, R.M.G. Rajapakse, Dhayalan Velauthapillai, Journal of Photochemistry and Photobiology A: Chemistry (2019) 377, 43-57.

Powder Pressed Cuprous Iodide (CuI) as A Hole Transporting Material for Perovskite Solar Cells, S.Uthayaraj, D.G.B.C.Karunarathne, G.R.A. Kumara, T. Murugathas, S.Rasalingam, R.M.G.Rajapakse, P.Ravirajan, D. Velauthapillai, Materials (2019) 12, 2037.

From left: KDMSPK Kumarasinghe, Mr. PN Dissanayake, Mr. SMB Dissanayake, Mr. DGBC Karunarathne, Mr. JGKJ Wimalasena, Seating: Prof. G.R.A. Kumara

Pubudu Kumarasinghe

Pubudu Kumarasinghe is currently working as a Research Assistant in Material Processing and Device Fabrication project at the National Institute of Fundamental Studies (NIFS) while reading for a Ph.D. on dye-sensitized solar cells. Before joining NIFS, she received her M.Phil from the University of Kelaniya and B.Sc from the University of Peradeniya. Her research concentrates on fabrication and characterization of solar energy materials and devices.

Mobile: +94 779 066 916
E-mail: pubudu.ku@nifs.ac.lk
https://www.researchgate.net/profile/Kdm_Kumarasinghe

Pubudu Nuwan Dissanayake

Pubudu Nuwan Dissanayake is currently an M.Phil Research Assistant in the Material Processing and device fabrication project at the National Institute of Fundamental Studies (NIFS). He received his B.Tech from the Uva Wellassa University of Sri Lanka in 2017 and joined NIFS in 2018. His research focuses on dye sensitized solar cells, perovskite solar cells and super capacitors. His research interests include photochemistry, material chemistry and solar energy.

Mobile: +94 713874353
E-mail: pubudu.ka@nifs.ac.lk

Buddhika Karunarathne

Buddhika Karunarathne is currently working as a M.Phil. Research Assistant in the Material Processing and Device Fabrication Project at the National Institute of Fundamental Studies (NIFS). He received his B.Sc. from the University of Peradeniya, Sri Lanka in 2017 and joined NIFS in 2018. His research focuses on the development of highly efficient and environmentally stable perovskite solar cells and perovskite solar panels using industrially viable methods for power generation. His research interests include solar energy and supercapacitors.

Mobile: +94 716 192 340
Email: buddhika.ka@nifs.ac.lk

Athula Wijayasinghe

Athula Wijayasinghe obtained his B. Sc. (Sp.) (1994) from University of Peradeniya in Sri Lanka, LIC (Eng.) and Ph.D. (2004) in Mat. Sci. and Eng. from KTH (Royal Institute of Technology) in Sweden. He is a Senior Research Fellow (Nanotechnology & Advanced Materials and Electrochemical Materials)/ National Institute of Fundamental Studies, Sri Lanka (2005-2009, 2013 to date); Senior Lecturer/Course Coordinator (Materials Sci. and Tech.) (2009-2013)/Uwa Wellassa University, Visiting Lecturer for Postgraduate/Undergraduate courses in Minerals Development; Assi.Professor/Visiting Assi. Professor/ Doktorander in Materials Engineering (1999-2007)/KTH, Sweden. Awards: Precedential Awards; NRC awards for Research publications, SUSRED awards for Postgraduate supervision. His research publications have received 317 citations; Google scholar h-index of 10.

Title: **Senior Research Fellow**
E-mail: **athula.wi@nifs.ac.lk**
T.P.: **0812232002**

Nanotechnology and Advanced Materials

Nanotechnology and Advanced Materials are the most progressive branches in the Materials Science and Technology field and play a key role in improving economic performance and quality of life. Nanotechnology has already created many novel, advanced materials and devices for a vast range of applications. These technological applications are mostly dependent on material resources, mainly developed by upgrading minerals resources. Sri Lanka possesses a large variety of economically useful minerals that are still exported as cheap raw materials. Though they have the potential to play a major role in global nano-tech and other high-tech industrial applications, proper value addition to our minerals, by upgrading for these applications, is lacking.

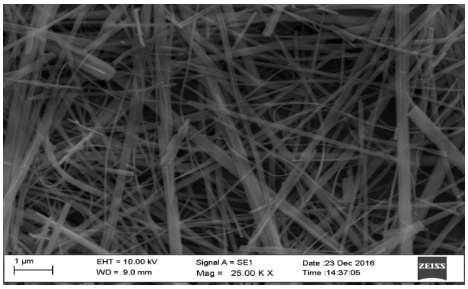
This project seriously considers these factors inherent to our country, when adapting or contributing to scientific or technological advances in Nanotechnology and Advanced Materials. Therefore, performing fundamental, but target oriented, advanced scientific investigations by developing our mineral resources for highly profitable industrial applications is essential. Investigation on novel, advanced semiconductors for energy conversion and storage applications, mainly for novel rechargeable batteries, is another important research area carried out by this project. here, a number of research investigations are performed to develop transition metal based semiconductors by introducing modern nano technological techniques and processes.

Commencing its work in 2013, this project has already produced three Sri Lankan Patents on the development of Sri Lankan graphite together with a number of processes and prototypes of products, having high commercial potential. Furthermore, based on our promising performance achieved through true intervention on higher value addition to local graphite resources, a Major Research Grant (Rs. 49.8 Millions) was given to us from the General Treasury through the Cabinet Memorandum (No. 17/1907/ 16/038 on 2017-08-09) of the Government of Sri Lanka. The ‘’National Center for Advanced Battery Research (NCABR)’’ has now been established and is attached to our project at NIFS. NCABR is a laboratory facility open for all research groups working in the country for developing local minerals for battery and energy related applications.

Development of low-cost and performance enhanced advanced materials for energy conversion using low-cost and nano material synthesis techniques

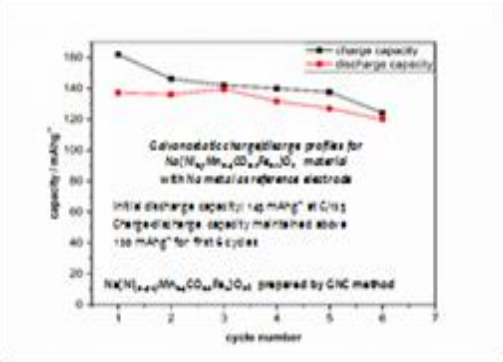
1.1. Study of mechanism and effect of dopants in advanced transition metal semiconductors

In order to understand the mechanisms controlling the morphology and size of particles from micron to nano scales, the effect of the precursor on crystal growth in nano particle formation was investigated under this sub-activity.



The knowledge gained through these investigations has been extended to prepare advanced transition metal semiconducting materials with appropriate particle size and morphology. Moreover, advanced fundamental scientific investigations have been carried out to study the mechanism and the effect of dopants on electrical and electrochemical behavior of explored transition metal semiconducting materials with an ultimate objective of developing performance enhanced transition metal semiconductors for the electrode application of electrochemical energy conversion applications, specially in rechargeable batteries.

1.2. Development of materials for the electrolyte and electrode applications in upcoming Na-ion and Mg-ion batteries.



Under this, the laboratory cells assembled with our developed Na-Ni-Mn-Co oxides doped with cheaper transition metals as the cathode material and our developed $Na_2Ti_3O_7$ nano structured anode material resulted in promising performance for electrode application in Na-ion rechargeable batteries.

1.3. Electrochemical performance investigations of Li-ion rechargeable batteries

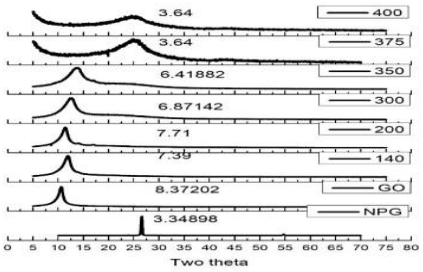
A dedicated laboratory facility for testing laboratory scale batteries has been established under this project at NIFS using a mega research grant received from the General Treasury, Government of Sri Lanka. This ''National Center for Advanced Battery Research'', is a common facility open to all local research groups working on developing local minerals for battery and energy related applications.

At this center, investigations were carried out on locally fabricating of full Li-ion rechargeable coin cell with developed Sri Lankan graphite as the anode material and our invented nanostructured transition metal oxides as cathode materials. This resulted in very promising performance with higher capacity and durability but at a lower cost. Further investigations are being carried out on the fabrication of bigger battery types such as pouch cells.

Value addition to Sri Lankan minerals and related materials for advanced/high tech/nano-tech applications.

2.1. Structural modification and ion intercalation investigations on Sri Lankan minerals.

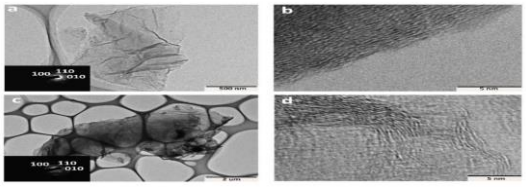
Deriving advanced materials out of abundant Sri Lankan minerals having layered or other suitable crystalline structures for ion intercalation were carried out under this sub-activity. After subjecting to thorough purification process, the selected minerals were subjected to fundamental investigations on structural/surface modification in atomic/ nano scale in order to facilitate ion intercalation. Sri Lankan vein graphite, vein quartz and clay types are presently being investigated.



Out of them, our structurally modified vein graphite showed high potentiality for anode application of Na-ion battery with its promising Na-ion intercalation/de-intercalation capability. A significant outcome; a novel, important invention capable of engineering the inter-layer space of expanded graphite, through a chemical process, will be patented.

2.1 Deriving nano-materials, nano-structured entities and composites from vein graphite.

Deriving nano-materials having diverse characteristics and performance out of Sri Lankan vein graphite structural varieties were investigated under this sub-activity. As each of these four structurally distinct morphological varieties of Sri Lankan vein graphite inherites its own unique morphological behavior, they can result in different characteristics and performance in the materials derived from these structurally different varieties of cheaper vein graphite.



Currently, investigations are underlay in deriving nano-graphene powder from all these four structural vein graphite varieties. It has been further extended to fabricate vein graphite based nano-structured composites aiming for diverse range of advanced industrial and nano-technological applications.

M. Phil / Ph.D. Students:

Mr. Kamalagith Heshan
Miss. Niruba Kanagaratnam
Miss. Himashi Narampananwa
Mr. Indika Samarakoon

Key Publications;

Synthesis of Li(Ni1/3Mn1/3Co1/3-xBax)O2 cathode materials for lithium-ion rechargeable battery by glycine-nitrate combustion process, T.H.N.G. Amaraweera, H.W.M.A.C. Wijayasinghe*, B.-E.Mellander, Ionics, (2019) 25:2501–2507.

From left: Ms. H. Narampanawa, Mr. I.B. Samarakoon, Dr. H.W.M.A.C. Wijayasinghe, Mr. W. G. Jayasekara

Galagedarage Don Kamaljith Heshan

G. D. K. Heshan is currently a Research Assistant in the Nano Technology and Advanced materials project at NIFS. He received his B.Tech in Materials Science and Technology from the Uva Wellassa University of Sri Lanka in 2013 and joined NIFS in 2015. He has registered for a M.Phil Degree at the Postgraduate Institute of Science in University of Peradeniya. His research focuses on the development of local minerals and related materials for water purification. His research interests include nanotechnology, nanomaterial synthesis, analytical chemistry, computational chemistry, information technology and microcomputer programming.

Mobile: +94 715955056
E-mail: heshan.ge@nifs.ac.lk

Jael Nirubha Kanagaratnam

Jael Nirubha Kanagaratnam is currently a M.Phil Research Assistant in the Nanotechnology and Advanced Materials project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc from Uva Wellassa University of Sri Lanka in 2015 and joined NIFS in 2016. Her research focuses on developing Sri Lankan graphite for future batteries. Her research interests include energy storage systems, sustainable energy, geo-physics, mineral processing and Nano-technology for mineral value addition.

Mobile: +94 777 824 666
E-mail: jaelnirubha@gmail.com
https://www.researchgate.net/profile/

Himashee Naranpanawa

Himashee Naranpanawa is currently a M.Phil Research Assistant in the Nanotechnology and Advanced Materials project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc from the Uva Wellassa University of Sri Lanka in 2017 and joined NIFS at 2018. Her research focuses on purification and surface modification of natural vein graphite in Sri Lanka for lithium ion battery. Her research interests include mineral processing, mineral extracting, mineralogy and petrology, petroleum, gemology, battery development

Mobile: +94 717 900 148
E-mail: himashee.na@nifs.ac.lk
https://www.researchgate.net/profile/Himashee_Naranpanawa

Indika Samarakoon

Indika Samarakoon is currently a Research Assistant attached to the Nanotechnology and Advanced Materials project at the National Institute of Fundamental Studies (NIFS). He obtained his first degree from the Institute of Chemistry, Ceylon in 2013 and MSc in Nuclear Science from the University of Colombo in 2018. He joined the NIFS in 2019 and is now reading for his M. Phil. Degree from the Postgraduate Institute of Science, University of Peradeniya. His research focuses on purification and modification of natural vein quartz in Sri Lanka for energy conversion applications and modeling and simulation of research able batteries. His research interests include value addition of minerals, synthesis of nano materials, modeling and simulation of materials and chemistry of energy conversion applications.

Mobile: +94 717 699 049
E-mail:indika.sa@nifs.ac.lk
https://www.researchgate.net/profile/Ymib_Samarakoon

Theoretical Physics & Computational Studies

At the Theoretical Physics and Computational Studies Research Unit at NIFS, we use the tools of theoretical and computational physics to address, explain and understand the physical world surrounding us. This research unit consists of projects under the areas of Foundations of quantum mechanics and Single Bubble sonoluminescence (Mysteries of Energy Focusing Phenomena). Specifically, the Quantum Physics Research Group is currently engaged in investigating the fundamental aspects of Quantum to Classical Transition, Quantum chaos, Quantum Computing and Quantum non-locality.

- Quantum Physics & Applied Electronics

Asiri Nanayakkara

Prof. Nanayakkara received his BSc in Mathematics (University of Colombo); MS in Physics (Ohio University USA); PhD in Physics (Iowa State University, USA). He has been a postdoctoral researcher at University of Bristol (UK), Ames Laboratory (USA) and Supercomputer Computations Research Institute (USA). He worked as a computational scientist at CRAY Research inc. (USA) before joining NIFS. His research publications have received nearly 140,000 citations; Google scholar h-index of 51.

Title : **Senior Research Professor**
E-mail: **asiri.na@nifs.ac.lk**
T.P.: **0812232002**
ORCID ID: **0000-0002-3042-6227**

Quantum Physics and Single bubble Sonoluminescence

Quantum mechanics, quantum field theory and relativity together form the theoretical foundations of modern Physics. Even 100 years after its inception the fundamental aspect of quantum mechanics is one of the most dynamic areas of current physics research. In particular, fundamental research on Quantum Non-locality, Quantum Entanglement and Quantum to Classical Transition is not only very important in understanding the true nature of the quantum reality but also their existence has practical consequences, enabling much stronger forms of information processing, communication and quantum computing. The Quantum physics research Group at NIFS was initiated in January 2016 and is currently engaged in investigating fundamental aspects of Quantum to Classical Transition, Quantum chaos, Quantum Computing and Quantum non-locality. Some collaborative research on quantum physics is carried out with the departments of Physics and Mathematics, at the University of Colombo.

In sonoluminescence research, we are mainly interested in understanding the light emission phenomenon using computational and theoretical techniques. We are currently developing software for realistic simulations of single bubble sonoluminescence and investigating light emission mechanisms using quantum mechanics.

Quantum Physics:

One of the unique features of quantum systems is quantum non-locality due to entanglement. On the other hand, the processes of quantum decoherence can provide clues about the mechanism of wave function collapse and quantum to classical transition. Quantum decoherence and entanglement can be investigated both theoretically as well as numerically by means of quantum random walks that are the quantum counterpart of classical random walks. Further, quantum walks provide a testing ground for various aspects of decoherence, wave function collapse and quantum to classical transition.

In this research area, many investigations were carried out for generation and utilization of entanglement in multidimensional quantum random walks as well as multiparticle random walks. The multidimensional coin operators constructed by taking direct tensor products of one dimensional unitary operators usually preserves entanglement if the initial coin state is entangled. Nevertheless, they do not generate entanglement unless the initial coin state is entangled.

Recurrence in quantum walks is termed when the walker returns to the origin with a nonzero probability and if the original coin state is also the same as the initial coin state then the quantum walk is said to have a full revival. In this research, with the aid of 2-D non-local coins, we were able to show that some four-state quantum walks can have full revivals with any even period and periodicity can be controlled with a slight change of a single parameter within the coin operator. We introduced a quantum scheme which can generate recurrence in n-dimensional. Under this scheme, a walker exhibits a periodic motion by returning to the initial position in equal time gaps. Periodic motion is maintained by launching interventions on the coin space during each cycle of the motion.

Further, we showed that for any given number of spatial dimensions, a coin operator can be constructed to generate a quantum walk having full revivals with any desired period. From the point of view of quantum computation and simulations, these coin operators can be useful in implementing quantum walks which oscillate between any two states with a finite periodicity.

Dechoherence in quantum systems was investigated using quantum walks. We introduced an analytically treatable spin decoherence model for quantum walk on a line that yields the exact position probability distribution of an unbiased classical random walk at all-time scales. This spin decoherence model depicts a quantum channel in which simultaneous bit and phase flip operator is applied at random on the coin state. Based on this result, we claim that there exists certain quantum channels that can produce exact classical statistical properties for a given one-dimensional quantum walk. Moreover, from the perspective of quantum computing, decoherence model introduced in this study may have useful algorithmic applications when applied on quantum walks with non-local initial states.

Single Bubble Sonoluminescence:

Single-Bubble Sonoluminescence (SBSL) is observed when a single gas bubble, which is acoustically levitated in a liquid, undergoes nonlinear oscillations in synchrony with the applied sound field and emits sub-nanosecond flashes of light at the point of maximum implosion. As the bubble collapses, vibrational energy gets concentrated by at least a factor of 4×10^4 to produce flashes of light in the UV range. At the latter stages of the collapse, both the temperature and the pressure inside the bubble reach extreme values such as 20,000K and 3,500 atm respectively. Also the bubble wall reaches acceleration over 10^{11}g near the maximum implosion.

In water, the spectrum of SBSL fits blackbody radiation with surface temperatures in the range of 6000K–20 000 K for sound frequencies between 10 and 50 kHz. On the other hand, spectrum of SBSL of an isolated bubble driven at 1MHz sound frequency agrees well with thermal bremsstrahlung from a 10^6 K plasma.

Although stable SBSL was discovered over twenty-five years ago, the exact mechanism of light emission still eludes the scientific community. Many experimental investigations reveal that the spectrum of long-time stable water based SBSL is continuous and best fit by an ideal Planck blackbody spectrum. Puzzlingly, the reason behind the observation that SBSL emissions follow this Planck's law behavior is still not clear. Nevertheless, ideal blackbody models suffer from some serious inconsistencies. Especially, it has been experimentally observed that the pulse width of Sonoluminescence radiation is only weakly dependent on wavelength, contrary to what we would expect from an ideal blackbody which would result in much longer pulses at long wavelengths than in the short wavelength region. Further, the pulse widths predicted by blackbody models are usually much larger than the experimental values. Moreover, the derivation of Planck's formula assumes that many wavelengths of light fit into the blackbody. This condition is not satisfied by the SBSL bubbles as the hot spot is smaller than the wavelength of light that we measure.

Therefore, it is now widely believed that light emission region of SL bubble cannot be an ideal blackbody and it is nearly transparent to its own emission. The SBSL spectrum is now assumed to be the result of volume emission mainly due to thermal bremsstrahlung. However, bremsstrahlung view is baffled by the previously mentioned observation that SL is in many cases accurately matched by a blackbody spectrum, which implies an opaque emitter.

In order to investigate aforementioned inconsistencies, we first developed a computer simulation software based on hydro-dynamical model which assumes gas distribution in the interior of the bubble is uniform throughout the cycle. Based on the simulation, we developed a new surface emission model (NSEM) based on blackbody radiation. It was found that NSEM can accurately predict experimental SBSL intensities, pulse widths, pulse shapes, and nearly independent nature of pulse widths on the wave length. Our results further show that experimentally observed behavior of SBSL radiation on driving pressure and the expansion ratio can only be reproduced by NSEM and predictions made by models based on volume emission due to thermal bremsstrahlung contradicts the experimental results. Our results strongly suggest that the SBSL emission is mainly due to surface emission from a blackbody but not the currently accepted thermal bremsstrahlung.

This is a very significant result. However, the referees of the journal Physical review letters (highest ranking journal in physics) pointed out that we need to do realistic computer simulations based on non-uniform gas models by solving Navier-Stokes equations numerically to remove any possible loop holes. Currently new software is being developed and is expected to be completed in 2020.

M. Phil students
Mr. Manoj Wijesingha
Mr. Prabhat Herath
Mr. Mahesh Jayakody
Mr. Kanishka Palihakkara

Key Publications

(1) Mahesh N Jayakody and Asiri Nanayakkara (2019). “Full state revivals in higher dimensional quantum walks” Phys. Scr. 94. 045101

(2) Randika Dodangodage and Asiri Nanayakkara (2018) “Maneuvering periods of 2D quantum walks with the coin operator” Eur. Phys. J. Plus 133, 389

(3) V. Bandara, P. Herath, A. Nanayakkara (2015). “Temperature dependence of singlebubble Sonoluminescence threshold in sulfuric acid: An Experimental study” Physical Review E 91, 06301

Natural Products & Food Chemistry

Many types of plants, plant products (fruits and vegetables) and microorganisms such as fungi contain bioactive components which are of benefit to humans. These have been consumed as food and some have been used for medicinal purposes for centuries. The scope of Natural Products and Food Chemistry unit of the NIFS is to study medicinal plants, natural products and functional food science. In the natural products project, studies are mainly focused on identifying bioactive secondary metabolites present in plant and fungal extracts, and in medicinal preparations. The preventive/therapeutic effects of these compounds are evaluated against chronic diseases such as diabetes and cardiovascular diseases. Nutritional Biochemistry project focuses on various aspects of functional and nutritional properties of foods and cover a wide area like functional and nutritional properties of food, food safety, and bioavailability of food to improve health and well-being of people. Food chemistry project focuses on exploring the application of food chemistry to add value to under-utilized plant resources to address national food security. Knowledge gained from these projects will eventually be used in the development of novel food products, food supplements and healthy foods with enhanced nutritional and functional properties.

- Food Chemistry
- Natural Products
- Nutritional Biochemistry

J.M. Nazrim Marikkar

B.Sc. (Hons) (Chemistry), University of Colombo, Sri Lanka in 1995; Ph.D. (Food Chemistry) Universiti Putra Malaysia in 2004; Post-Doctoral Researcher at Universiti Putra, Malaysia (2008-2009), Research Fellow at Universiti Putra, Malaysia (2009-2010), Senior Lecturer at Universiti Putra Malaysia (2011-2015); Assistant Professor at International Islamic University, Malaysia (2016-2017).

Title: **Associate Research Professor**
E-mail: **nazrim.ma@nifs.ac.lk**
Tel: **0773285820**
ORCID ID: **0000–0002–0133–5852**

Food Chemistry

Food chemistry studies and understands the physicochemical properties of carbohydrates, lipids, proteins and other biomolecules present in food systems. Thefood chemistry project at NIFS focuses on exploring the application of food chemistry to add value to under-utilized plant resources and address the national food security. Food security is an area of national importance for Sri Lanka in the context of challenges arising from climate change. In this backdrop, adding value to the underutilized resources could be a viable strategy. Sri Lanka is a tropical country with a rich biodiversity and has several underutilized plant resources; some of them are edible plants, fruits, seeds in the wild forest. In the agricultural sector of the country, there are several byproducts, which are wasted or underutilized due to lack of research on their commercial exploitation. However, through systematic studies, these byproducts can be used to formulate novel food products or ingredients. These novel products formulated through value addition can not only address the food and nutritional needs of the society but also as a functional food to mitigate the risk of developing chronic diseases such as diabetes. We investigate nutritional composition, bioactivity, and functional properties of raw materials coming from these under-utilized plant resources. Generally, the nutritional composition, bioactivities, and functional properties of raw food items undergo changes during the application of different food processing methods such as freezing, thawing, drying, frying, etc. For instance, industrial frying could cause several chemical reactions that may produce toxic compounds, which are absorbed into food products. Research on the changes caused by food processing are of considerable importance for human nutrition, food safety and wellness.

Research on food authentication is also a sub objective of this project. In recent years, studies on food authentication has received much attention from researchers working in different parts of the world. This will ensure the quality and authenticity of food products to safeguard consumers from fraudulent practices. In this regard, we pay attention to the use of various chromatographic, spectroscopic and thermo-analytical techniques to classify genuine food from fraudulent materials. Although in some instances, the fraud can be detected easily, on in many occasions the task of authentication is a challenge to the analyst. This has compelled us to use statistical tools to explore subtle differences in the analytical data of food samples to draw conclusions.

Characterization of Coconut Testa Flour and Its Lipid Component by FT-IR Spectroscopy

FT-IR Spectroscopy has received much attention due to its multiple uses in food analysis. Mid infrared characterization of coconut testa flour (CTF) and coconut testa oil (CTO) can give important information about the organic functional groups present in them for authentication purposes. In this study, FT-IR spectra of CTF and CTO from five different coconut cultivars namely, Gon Thembili (RT), Ran Thembili (RT), San Raman Tall (SR), Tall x Tall (TT) and Commercial (COM) hybrid were recorded within the range of 4,000–650 cm^{-1}. According to the results, CTF and CTO displayed remarkable differences to distinguish each other with several spectral features. For CTF, the contour of spectra were roughly similar irrespective of the cultivars, but slight variations in intensities were noticed in some frequency regions (Fig. 1).

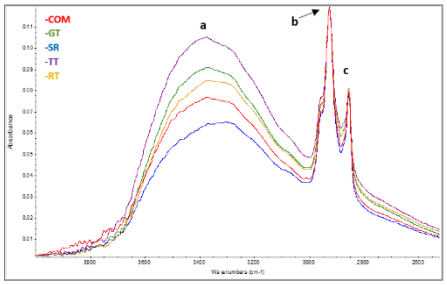


Fig. 1: Spectral overlay of CTF in the frequency range 3800 to 2600 cm^{-1}

The spectral bands present in CTF spectra were indicative of organic functional groups associated with moisture, fat, protein and carbohydrates. Based on the band frequency and intensities of the absorption peaks, all CTF samples were rich in proteins but low in fats. In the case of CTO, spectra of all cultivars showed characteristic vibrational bands corresponding to organic functional groups present in tri-acylglycerols molecules. Although certain spectral regions exhibited few dissimilarities, the chemical groups representative of those spectral features were same. Particularly, the variability of the degree of unsaturation of the oil of different cultivars was responsible for intensity variations noticed in these absorption peaks. Results of these spectra would stimulate further studies and benefit the authentication of CTF, CTO and other macro-food constituents present in CTF.

Characterization of Oils and Fats by DSC

Differential scanning calorimetry (DSC) has been one of the most useful instrumental techniques for authentication of oils and fats. As DSC can provide well-defined curves for unadulterated neat oils, they can serve as fingerprints for authentication and quality assurance. In this study, usefulness of the DSC heating and cooling profiles was investigated for authentication of virgin coconut Oil (VCO). As DSC curves are sensitive to compositional changes caused by adulteration, deviations in DSC curve and its associated parameters such as ON (onset temperature), OF (offset temperature), EN (enthalpy change), PT (peak temperature) and PH (peak height) were found to be useful. The overlay of DSC heating curves presented in Fig 2 showed significant deviations in DSC features caused by adulteration.

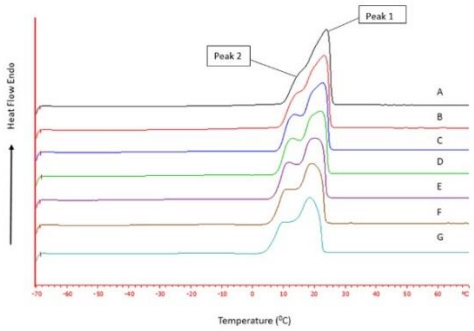


Fig. 2: DSC heating curves of (A) virgin coconut oil (VCO), (B) VCO adulterated with 5% palm olein (PO), (C) 10% PO, (D) 15% PO, (E) 20% PO, (F) 25% PO, and (G) 30% PO.

This study showed that all DSC parameters of Peak-1 and Peak-2 were significantly affected by adulteration as low as 5%; strong correlations found in these parameters helped develop predictive models for quantification.

Anti-oxidative Properties of Coconut Testa Flour

Often times, phenolic constituents are attributed for antioxidant capacity of plant-extracts. According to our inter-varietal study of local coconut cultivars, the highest total phenolic content was recorded in TXT (62.58±5.99 mg GAE/g of extract), followed by RT (58.15 ± 1.68 mg GAE/g of extract) and SR (47.30 ± 11.09 mg GAE/g of extract). DPPH radical scavenging activity for CTF extracts were ranged from 217.86 to 472.32 ppm. Highest DPPH radical scavenging activity was observed in SR (IC50 = 217.86±8.50 ppm) followed by RT (IC50 =225.47±15.16 ppm) and GT (IC50 =252.87±3.35 ppm)

Ferric reducing antioxidant power (FRAP) values for CTF extracts of local coconut cultivars ranged from 0.26 to 0.67 mmol FeSO4/g of the extract. Lowest FRAP value was reported for SR (0.26 ± 0.02 mmol FeSO4/g of extract) which was significantly lower ($p<0.05$) than those of all other varieties. FRAP values of RT (0.53 ±0.02 mmol FeSO4/g of extract), GT (0.58±0.03 mmol FeSO4/g of extract), TXT (0.6±0.05 mmol FeSO4/g of extract) were statistically similar ($p>0.05$). FRAP values of COM (0.67±0.00 mmol FeSO4/g of extract) and TXT (0.6±0.05 mmol FeSO4/g of extract) were significantly ($p<0.05$) higher than those of other cultivars.

MPhil Students

Ms. S.S.K. Marasinghe
Ms. R. Gunarathne

Key Publications

Marasinghe, S.S.K., J.M.N. Marikkar, C. Yalegama, S. Wimalasiri, G. Seneviratne, R. Weerasooriya and R. Liyanage (2019). Comparison of inter varietal differences in chemical composition and nutritional properties of coconut testa flour. *J Nat Sci Found Sri L.* 47: 351–358.

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Marikkar, J.M.N., Nisa Kamil and A.R. Raihana (2019). Differential scanning calorimetric analysis of virgin coconut oil, palm olein and their adulterated blends**.** *Int. J. Coco Res. Dev.* 35 (1): 34–42.

From left: Ms. R. Gunaratne, Prof. JMN. Marikkar, Ms. SSK. Marasinghe

Sanjila Marasinghe

Sanjila Marasinghe is currently a M.Phil Research Assistant in the Food Chemistry project at the National Institute of Fundamental Studies (NIFS). She received her MSc(Clinical Biochemistry) from the University of Peradeniya and BSc (Food Science & Technology) from Sabaragamuwa University of Sri Lanka in 2017 and 2012 respectively. Sanjila joined NIFS in 2018. Her research focuses on antioxidative and anti-diabetic activity of partially defatted coconut pairings of indigenous coconut varieties of Sri Lanka. Sanjila's research interests include development of functional foods, phytochemical constituents and bioactivities of underutilized fruits of Sri Lanka, value addition to by-products of food industry, genetic polymorphisms of human serum PON1 enzyme.

Mobile: +94718948746
E-mail: sanjila.ma@nifs.ac.lk
https://www.researchgate.net/profile/Sanjila_Marasinghe2

Rasika Gunarathne

Rasika Gunarathne is a M. Phil research assistant in the Food Chemistry project at the National Institute of Fundamental Studies. She received her B.Sc. (special) degree in Food Science and Technology from the University of Peradeniya in 2019. After 4 months of experience as a temporary demonstrator in the Faculty of Agriculture, University of Peradeniya, she joined NIFS in 2019. Her research focuses on the bioactivity studies and prebiotic potential of partially defatted coconut testa flour of Sri Lankan coconut cultivars. Her research interests include functional foods, nutraceuticals, food chemistry, biochemistry and food nutrition.

Mobile: 071-6865088

E-mail: rasika.gu@nifs.ac.lk

Lalith Jayasinghe

BSc (Hons) (Chemistry) University of Peradeniya, 1985;, Ph.D. (Natural Products Chemistry) University of Peradeniya, 1992; Diploma in Natural Products Chemistry, TIT Japan 1994; Alexander von Humboldt Research Fellow, University of Hohenheim (1999/2000) & Jacobs University Bremen (2011, 2015 & 2019) Germany; IPICS Fellowship in 1988 to University of Karachi; Kandiah Memorial Award, Institute of Chemistry Ceylon (1992); TWAS - NARASA Young Scientist Award in 1992; UNESCO – Mombusho Research Fellowship 1993; Visiting Scientist, TIT Japan (2004); University of Mississippi, USA (2004 - 2005); University of Milan, Italy (2006); Visiting Professor, TIT, Japan (2009); Fellow of the National Academy of Science of Sri Lanka (2012); Presidential Award for Scientific Publication (for 8 Years), H-index of 22 for 83 Scientific Publications, 3 Book Chapters and 264 communications.

Title: **Senior Research Professor**
E-mail: **lalith.ja@nifs.ac.lk**
Tel: **0812232002**
ORCID ID: **0000-0003-1703-4154**

Natural Products

Natural Products are compounds produced by plants, fungi, marine organisms etc. These compounds can be used to improve the quality of human life. Although there are over 3500 flowering plants inhabiting Sri Lanka, including ~800 endemics, relatively low numbers of plants have been chemically and biologically investigated. Of these 3500 plant species, about 750 are claimed to have uses in the indigenous system of medicine. The fungal flora native to Sri Lanka is around 25,000 and a vast majority of them remains to be studied for the presence of bioactive metabolites. The use of natural products in the management and treatment of diseases and disorders in humans and plants is more acceptable and offers lesser risk than use of synthetic compounds. The overall objective of the Natural Products Project of the NIFS is the identification of bioactive extracts and compounds from natural resources, as potential sources for control of human and plant diseases. Research activities have been focused on the chemistry and bioactivity of secondary metabolites from plants, fungi (including endophytic fungi) and edible fruits of Sri Lanka. Another area of research has been the identification of polyphenols in tea, medicinal plants, edible fruits and spices using Liquid Chromatography - Mass Spectrometry (LC-MS) and also studies on the cause and control of postharvest fungal diseases and disorders, including one *hitherto* unknown disorder, of edible and export-oriented fruit crops. These research activities are very wide and represent basic research in the field of natural products chemistry, pharmaceutical research and new materials.

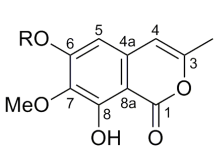
In our studies, the bioactivities of extracts and compounds are assessed using bioassays; [DPPH (2,2'-diphenyl-1-picrylhydrazyl) radical scavenging assay to detect the presence of natural antioxidants; the brine shrimp (*Artemia salina*) lethality assay to detect cytotoxicity; the lettuce (*Lactuca sativa*) seed germination assay to detect the presence of phytotoxic and allelopathic compounds, the TLC bioautography method to detect the presence of antifungal compounds; α-amylase, α-glucosidase and lipase enzyme inhibitory activity assays to detect drug targets for the treatment of diabetes, obesity and hyperlipidemia. Bioactive extracts are subjected to activity guided fractionation using chromatographic techniques to isolate bioactive compounds. Structures of isolates are determined by detailed analysis NMR, MS spectral data. Partial syntheses of isolates are carried out to enhance the bioactivity of isolates.

Research activities of the Natural Products Project of the NIFS are mainly in the following areas:

(1) Investigation of extracts from plant sources and epiphytic and endophytic fungi for use in agriculture and human health
(2) Chemistry and bioactivity of edible fruits
(3) Plant secondary metabolites and LC-MS profiling of bioactive extracts
(4) Cause and control of postharvest fungal diseases and disorders of edible and export-oriented fruits

Endophytes that reside in the tissues of living plants have been attracting a growing interest as potential sources of novel natural products for exploitation in medicine, agriculture, and industry. In a continuation of our search for bioactive compounds from endophytic fungi from Sri Lankan flora, we investigated the secondary metabolites produced by an endophytic fungi *Biscogniauxia capnodes* (Family: Xylariaceae), isolated from the fruits of *Averrhoa carambola* (Oxalidaceae), commonly called starfruit. We previously reported chemistry and phytotoxic activity of the constituents of *A. carambola* fruits. An endophytic fungus isolated from *A. carambola* fruits was identified as *Biscogniauxia capnodes* by morphological studies and sequence analysis of ITS regions of rDNA. This is the first report of the isolation of *B. capnodes* from *A. carambola* fruits. *B. capnodes* was cultured in potato dextrose broth (PDB). EtOAc extract of the broth and mycelium showed antifungal activity against *Cladosporium cladosporiodies,* antioxidant activity against 2,2′-diphenyl-1-picrylhydrazyl (DPPH) radicals (42.5% inhibition at 25 ppm), high brine shrimp lethality (96.7% at 125 ppm) and phytotoxicity in lettuce (*Lactuca sativa*) seed germination assay (shoot inhibition 45.3% and root inhibition 55.3% at 200 ppm). Chromatographic separation of the EtOAc extract furnished two isocoumarins, reticulol (**1**) and 6-*O*-methylreticulol (**2**), and two dihydroisocoumarins, 5-methylmellein (**3**) and 7-hydroxy-5-methylmellein (**4**). The structures of compounds **1**–**4** were elucidated by analysis of NMR spectroscopic data and by comparison with reported data as well as MS data.

Among these secondary metabolites compound **3** was most abundant. Compounds **3** and **4** were found to have (3*R*)-absolute configuration on the basis of their negative optical rotations (**3**): $[\alpha]_D^{25}$ -98.9 (*c*, 1.87, $CHCl_3$) and **4**: $[\alpha]_D^{25}$ -88.9 (*c*, 0.18, $CHCl_3$). It seems likely that fungi biosynthesize preferentially (3*R*)-enantiomers of **3** and **4**, since the (3*S*)-antipodes have not been reported from natural sources thus far. Compounds **1**-**4** were subjected to the above-mentioned bioassays, but no significant activities were observed except for reticulol (**1**), which exhibited a moderate DPPH radical scavenging activity with an IC_{50} value of 58 μg/mL (IC_{50} of a positive control BHA was 5.5 μg/mL).



1: R = H
2: R = Me

3: R = H
4: R = OH

Compounds **1**–**4** possess all isocoumarin skeleton and have been isolated as rather popular fungal metabolites except for compound **4**. Reticulol (**1**) has been reported as an inhibitor of cyclic adenosine 3',5'-monophosphate phosphor diesterase. Further, reticulol was suggested to inactivate Topo I, which is involved in tumor metastasis and exhibit excellent cytotoxicity against B16F10 melanoma when combined with adriamycin. Recntly reticulol has been reported to decrease degranulation and histamine release significantly. 6-*O*-methylreticulol (**2**) were previously isolated from *Streptomyces mobaraensis*, liverwort *Wettsteinia schusterana*, and so on. α-Glucosidase inhibitory activity of **2** has been reported recently. 5-Methylmellein (**3**), isolated from the endophytic fungi *Biscogniauxia mediterranea* from the medicinal cactus *Opuntia humifusa*, was shown to have antifungal activity against the plant pathogen *Phomopsis obscurans*. 7-Hydroxy-5-methylmellein (**4**) was previously reported only from the marine derived fungi *Acremonium* sp. and *Nodulisporium* sp.. This report represents the second isolation of this rare dihydroisocoumarin.

Further the NSF and NRC funded research projects titles (1) Chemistry and bioactivity of endophytic fungi from four popular condiment plants *Curcuma longa*, *Myristica fragrance*, *Syzygium aromaticum* and *Zingiber officinale* used in indigenous system of medicine in Sri Lanka: Possible application in health and agriculture (II) Bioactive metabolites of endophytic fungi from the medicinal plants *Coccinia grandis, Costus speciosus* and *Gymnema sylevestre* used in indigenous medicine for treatment of

diabetes mellitus and possible commercial applications (iii) Microbial Metabolites - a source for development of eco-friendly new weedicides are in progress.

Plant secondary metabolites and LC-MS profiling of bioactive extracts is another research project. Under this project, bioactive extracts from the following plants were identified: *Aerva lanata, Basella alba, Hemidesmus indicus, Ipomea batatas, Moringa olefere, Murraya koengii, Persia americana, Solanum nigrum*. The LC-MS studies on the extracts showed the presence of chlorogenic acid.

Ph.D / M.Phil. Students

Sumudu Bandara - Ph.D. Student
Dilhara Dissanayake - Ph.D. Student
Sathya Sambawathas - M.Phil. Student
Kaushalya Hettiarachchi - M.Phil. Student
Amanda Perera - M.Phil. Student
Surekha Balasooriya - M.Phil. Student
Lakshika Manawadu - M.Phil. Student
Chamali Amarasinghe - M. Phil. Student
Mayantha Kurera - M.Sc. Student

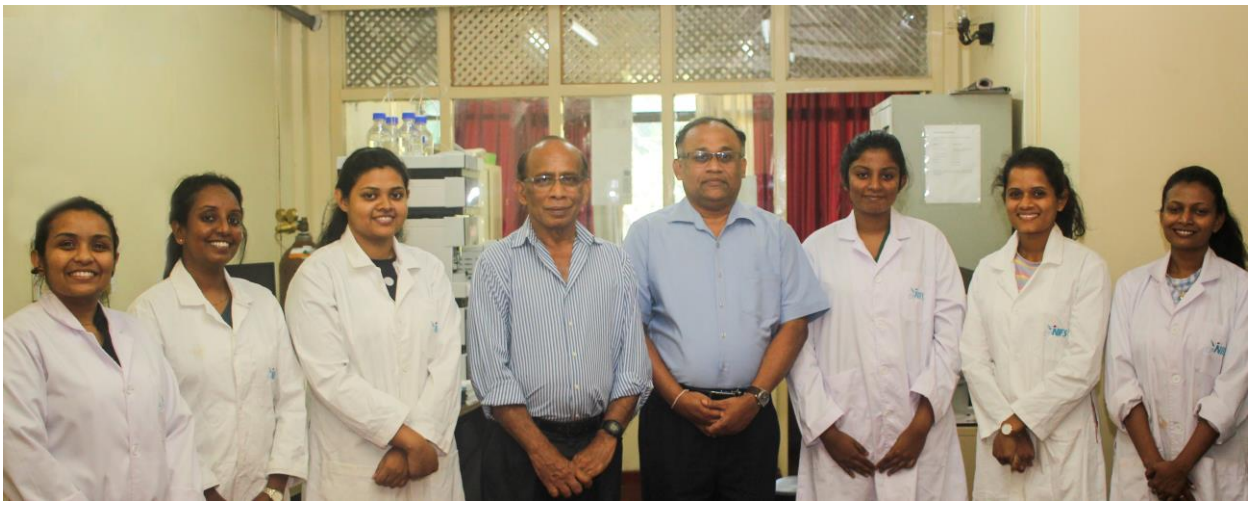
Chief Technical Officer – D.S. Jayaweera

Key Publications

Sathya, S., Amarasinghe, N.R., **Jayasinghe, L.,** Araya, H., Fujimoto, Y. (2020) Enzyme inhibitors from the aril of *Myristica fragrance*, *South African Journal of Botany*, **130**, 172-176.

Sritharan, T., **Kumar, N.S., Jayasinghe, L.**, Araya, H., Fujimoto, Y. (2019). Isocoumarins and dihydro isocoumarins from the endophytic fungus *Biscogniauxia capnodes* isolated from the fruits of *Averrhoa carambola*, *Natural Product Communications*, **14**, https://doi.org/10.1177/1934578X19851969.

Fernando, W.I.T., Attanayake, A., Perera, H.K.I., Sivakanesan, R., **Jayasinghe, L.** (2019) Isolation, identification and characterization of pancreatic lipase inhibitors from *Trigonella foenum-graecum* seeds, *South African Journal of Botany*, **121**, 418-421.



From left: Ms. DMDM. Dissanayake, Ms. EAIA. Perera, Ms. J Weerasinghe, Prof. NKB. Adikaram, Prof. ULB. Jayasinghe, Ms. SMKT. Samarakoon, Ms. BMS. Balasooriya, Ms. HST. Kaushalya

Nimal Adikaram

Ph.D Queen's University of Belfast (1981); BSc. University of Colombo (1974). Emeritus Professor and Visiting Research Professor at the NIFS (2017–2018); Fellow (Elect), National Academy of Sciences of SL, Honorary Fellow, Indian Mycological Society. Served as the Head, Dept. of Botany, Univ. of Peradeniya (1999-2000, 2002 – 2009), Chairman, Board of Study in Plant Sciences, PGIS, 2003 – 2009; Editor-in Chief, Ceylon. J. Science (Bio. Sci.) (1998 –2007). Currently a Member of the Editorial Board of CJS, Journal of National Science Foundation, Journal of Mycopathological Research and J Indian Phytopathology. Recipient of the TWAS Young Scientist Award in Biology (1988), King Baudouin Award, International Foundation for Science (IFS)(1990), General Research Council (SLAAS) Award (1993), Silver Jubilee Award for research, IFS, Sweden (1997), NSF Merit Award for research in bioactive lichen substances (2004), CVCD award for outstanding researcher in 2012, Presidential Awards for Research (2003–2005, 2007-2009 & 2012). International Consultant in Postharvest Technology for Food & Agriculture Organization, UN in Bangladesh (2003), Functioned as an international Consultant in Plant Health, Asian Development Bank (ADB) in Cambodia in 2015, 2018. Published over 90 scientific articles, 4 books, 6 book chapters, 134 communications. Earned 1210 citations, *h*-index 20, *i*10 index 38, Citations 1210.

Postharvest pathology of horticultural fresh produce

Postharvest diseases constitute a major cause of postharvest losses of freshly harvested horticultural produce. Fruit loss amounts to 20 – 40% of the total harvest in Sri Lanka.

Project 1: *Study of postharvest diseases and disorders adversely affecting the export potential of mango var. TomEJC and their management.*

The project, funded by the National Research Council (NRC) Public Private Partnership (PPP) program, investigated several disorders and fungal diseases, mainly the stem-end browning, SEB) in ripe mango variety TomEJC lowering the fruit market quality. The aim of the research is to understand the cause, and the factors affecting and the mechanism of their development to formulate appropriate management practices finally. A postgraduate research student is working in the project.

Fruit pitting is a physiological disorder that was diagnosed in 2018 prior to which a loss of 13–15% of harvested fruit var. TomEJC was experienced by the Industrial Partner. The disorder has not been recorded or studied before in any Sri Lankan mango varieties or other fruit species. Pitting appears as small (1–1.5 cm diameter), circular or irregular, concave, depressed and isolated areas in the peel of harvested fruit.

Microscopical studies, using microtome tissue sections, revealed that the pitting symptoms develop as a result of some weaker tissue layers below the epidermis which collapse soon after harvest, forming depressed areas on the surface of fruit peel. Weakening of these tissue layers was thought to be due to their weaker cell walls, that lacked Ca/Mg cross linkages among the pectin molecules.

Extensive fruit tissue and soil samples from the mango plantations with affected plants analysis, using EDX (Energy Dispersive X-ray analysis) and ICP (Inductively Coupled Plasma-Mass Spectrom- etry), indicated involvement of two elements, macro- and micro- in the development of pitting disorder. The mechanism of pitting development at tissue level and the main factors that determine pitting incidence were understood.

Supplementing the soil with a nutrient mixture containing a macro- and a micronutrient as a fertilizer, after flowering, reduced the incidence of pitting significantly to >0.01% in the previous seasons, from September 2018–2019. Pitting was first detected in this variety in 2016 and continued to occur. Percentage of

harvested fruits affected during 2017/2018 was 13%.

Lenticel Darkening (LD) is a disorder that results from entry of water in to lenticels, tiny pores on the fruit peel for gaseous exchange during or after harvest, followed by oxidation of phenolic compounds. Spilling latex on the fruit surface during harvest and handling, washing harvested fruits for longer periods or using detergents were found to aggravate lenticel darkening. Postharvest practices that are likely to induce LD were identified and corrected.

Internal Pulp Browning (IPB) is a new disorder, first encountered in 2012 in ripe mango var. *TomEJC*. The condition has not been reported before from mango anywhere in the world and the cause is not known. IPB symptoms generally appear in the pulp, just outside the seed, as dark brown areas on either side of the seed. Externally, the affected fruits do not show any sign of IPB and the disorder is detected only when the internal pulp is exposed by cutting through the fruit pulp.

The present study established that the development of IPB was associated with germination of the seed while within the fruit and prolonged and heavy rainfall is a pre-requisite for its development. A bacterium was also isolated from affected tissue and identified using selective media and DNA sequence analyses. The role of the bacterium in IPB is, however, not clear.

Subsequent experiments revealed that in-fruit seed germination begins when the fruits are left on the tree more than certain number of weeks, till they are slightly over matured. We were able to avoid IPB by harvesting fruits slightly earlier than a the stage presently practiced without affecting the ripening process, flavor development or eating quality. This was subsequently recommended as a management practice for the var. TomEJC. Since then IPB was not a problem in this variety and was not observed in any of the fruit seasons that followed. Only a few fruits with IPB symptoms were encountered in December 2018 January 2019 and December 2019. Weather data collected since 2012 were compared with the IPB incidence and the outcome showed a direct correlation between heavy rain fall and IPB incidence. Not every fruit that is exposed to heavy rain prior to harvest developed IPB symptoms showing that in-fruit seed germination is essential for IPB. Only a small percentage of harvested fruits with IPB (<1%) were encountered in the 2018/19 and 2019/20 seasons.

Among fungal diseases, stem-end browning (SEB) was found to be a new and most problematic disease that adversely affects the marketing of fruits. Symptoms of stem-end browning appear during ripening. Browning appears first around the stalk which spreads further with the advancement of ripening, covering the upper one-third to half the fruit skin. In different fruit seasons, the stem-end browning appeared in different colors, dark brown, light greyish brown or pale brown color. In affected fruits, the superficial pulp tissue also became affected. SEB was found to be a disease complex, caused by a number of pathogenic fungi. These fungi were isolated from the SEB affected tissue, the stalk and also from younger fruits. They were identified and the pathogenicity of some of them was tested. Eight fungi isolated from fruits showing SEB are being identified to species level using DNA sequence analyses.

Field hygiene by removal and destruction of diseased leaves, twigs and peduncles from the previous season helps in reducing fungal inoculum and lowers disease incidence. Concurrent field application of a fungicide, especially immediately after flowering, and postharvest dips with a safer fungicide reduced the occurrence of SEB.

Other disease management practices tested but not effective enough were, (i) removal of stalk after harvest, since all SEB fungi could be isolated from the stalk tissue, (ii) application of papaya latex

Several other fungal diseases were also observed and are being studied. These include the mango scab, *Glomerella cingulata* spotting and the *Pestalotiopsis* spot and crusty leaf disease.

Mango var. *TomEJC* is presently cultivated in the dry and arid zones of Sri Lanka and with the current expansion of cultivation, future fruit production, on hence export is expected to be doubled by 2020. Development of proper management practices to combat these disorders and diseases is important to sustain

the availability of good quality fruits of this variety for export.

Project 2: Molecular identification of *Colletotrichum* causing anthracnose disease

Molecular identification of *Colletotrichum* species associated with anthracnose disease was continued as collaborative project with Prof. Deepthi Yakandawala, Department of Botany, University of Peradeniya. Anthracnose is a common and destructive postharvest disease in fruits, vegetables, foliage plants and cut-flowers lowering their quality and marketability. The plants studied during 2019 included *Begonia* species (foliage plant), anthurium (cut-flower) and banana fruits. Accurate identification of pathogens is crucial for formulation of appropriate management practices and biosecurity purposes.

Mycology work

Preparation of, (i) checklist of Plant Pathogenic fungi in Sri Lanka, (ii) Lists of plants-associated fungi recorded in Sri Lanka, Agaric flora of Sri Lanka, for the Red list.

Collection, identification and recording of new fungal species as addition to the Mycoflora of Sri Lanka. A basidiomycota fungus (Agaricales), collected 100 years after its first record in Ceylon, was collected and identified as *Leucocoprinus birnbaumii*

Sathya Sambavathas

Sathya Sambavathas is currently an M.Phil Research Assistant in the Natural Product Chemistry project at the National Institute of Fundamental Studies (NIFS). She received her B.Pharm degree from the University of Peradeniya, Sri Lanka in 2016 and joined NIFS the same year. Her research focuses on Anticholinesterases from Sri Lankan Spices. Sathya's research interests include natural product chemistry, pharmaceutical sciences, medicinal chemistry, and formulation development.

Mobile: +94 770293901

E-mail: sathya.sa@nifs.ac.lk

https://www.researchgate.net/profile/Samba_Sathya

Dilhara Dissanayake

Dilhara Dissanayake is currently a Ph.D Research Assistant in the Natural Products project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc from the University of Kelaniya, Sri Lanka in 2014 and joined NIFS the same year and obtained her M.Phil in natural products chemistry from the University of Peradeniya in 2019. Her research focuses on chemistry and bioactivity of endophytic fungi associated with Sri Lankan medicinal plants and edible fruits. Her research interests include natural products chemistry, medicinal chemistry, biochemistry and organic chemistry.

Mobile: +94 71 3880255

E-mail: dilhara.di@nifs.ac.lk

*https://www.researchgate.net/profile/Dilhara_Dissanayak*e

Lakshika Manawadu

Lakshika Manawadu is currently a Research Assistant, reading for her M.Phil. Degree, at the National Institute of Fundamental Studies (NIFS; Natural Products division), under a NRC Public Private Partnership (PPP) project. She obtained her B.Sc. Special Degree in Plant Biotechnology from the University of Colombo, Sri Lanka in 2016 and joined the NIFS in 2017. Her research focuses mainly on "Postharvest disorders adversely affecting the export potential of mango var. TomEJC and their management". Her research interests include Biotechnology, Postharvest Pathology/Technology, Molecular Phylogeny and Bioinformatics.

Mobile: +94 712153560

E-mail: lakshika.ma@nifs.ac.lk

https://www.researchgate.net/profile/Lakshika_Manawadu

Surekha Balasooriya

Surekha Balasooriya is currently a M.Phil Research Assistant in the Natural Product Chemistry project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc from the Peradeniya University of Sri Lanka in 2017 and joined NIFS in 2018. Her research focuses on the Chemistry and Bio-activity of secondary metabolites of endophytic fungi, isolated from selected antidiabetic medicinal plants in Sri Lanka. Her research interests include Chemistry and Microbiology

Mobile: +94719632661;
E-mail: surekha.ba@nifs.ac.lk
https://www.researchgate.net/profile/Surekha Balasooriya

H. S. T. Kaushalya

H. S. T. Kaushalya is currently a M.Phil Research Assistant in the Natural products project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc from the University of Ruhuna in 2017and joined NIFS in 2018. Her research focuses on the Isolation of enzyme inhibitors and other bioactive compounds from some selected medicinal plants in Sri Lanka. Her research interests include Natural product chemistry, Organic synthesis, Organic chemistry and Spectrometry.

E-mail: shilpika.he@nifs.ac.lk
https://www.researchgate.net/profile/Kaushalya_T

Chamali Poornima Amarasinghe

Chamali Poornima Amarasinghe is currently a M.Phil Research Assistant in the Natural Products Chemistry project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc from the Ruhuna University of Sri Lanka in 2016 and joined NIFS in 2017. Her research focuses on Post-harvest diseases observed in mango variety TomEJC . Her research interests include Microbiology, Mycology, Plant Pathology, Molecular Biology, Tissue culture, Environmental Science, Plant Anatomy.

Amanda Perera

Amanda Perera is currently a M.Phil Research Assistant in the Natural Products Chemistry project group at the National Institute of Fundamental Studies (NIFS). She received her B.Sc from the Rajarata University of Sri Lanka in 2016 and joined NIFS in 2018. Her research focuses on the Chemistry and bioactivity of endophytic fungi from popular condiment plants which are highly used in indigenous system of medicine in Sri Lanka. Her research interests include natural products chemistry, organic chemistry, microbiology, biochemistry and medicinal chemistry.

Mobile: +94 71 3729497 ;
E-mail: indeewari.pe@nifs.ac.lk
https://www.researchgate.net/profile/Indeewari_Perera

Sumudu Bandara

Sumudu Bandara is currently a PhD Research Student in the Natural Products project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc from the University of Peradeniya in 2009 and M.Phil in 2015. She joined NIFS in 2018. Her research focuses on the search for natural enzyme inhibitors from some Sri Lankan medicinal plants. Her research interests include natural products chemistry and biochemistry.

Mobile: +94 779062261;
E-mail: sumudu82@gmail.com

Dr. N.L.B.R Liyanage

B.Sc. (2000), University of Peradeniya, Sri Lanka; M.Sc.(by research)(2005), Ph.D. (2009),Postdoctoral Research Fellow(2009-2010) Obihiro University of Agriculture and Veterinary Medicine, Japan; Research Fellow, Laboratory of Nutritional Biochemistry, National Institute of Fundamental Studies, Sri Lanka (Jan 2011 to April 2018); Senior Research Fellow (April 2018 to date); Scientific Officer, National Science Foundation, Sri Lanka (2001-2003).

Title: **Senior Research Fellow**
E-mail: **ruvini.li@nifs.ac.lk**
T.P: **0718675609/0812322002**
ORCID ID: **0000-0002-6349-0284**

Nutritional Biochemistry

Nutritional Biochemistry project focuses on various aspects of functional and nutritional properties of foods and covers a wide area including like functional and nutritional properties of food, food safety, and bioavailability of food to improve health and well-being of people.

Functional and nutritional properties of food: Under this research theme, studies are conducted to assess the antioxidant, enzyme inhibition (amylase, glucosidase, and lipase), radical induced DNA damage prevention and identification of active compounds. In addition, *in vivo* and cell culture studies are also done for further confirmation of functional properties. At present, we are focusing on the assessment of functional properties of selected starches and commonly consumed Ayurvedic plants in Sri Lanka, we are also investigating the nutritional and physicochemical properties of raw and processed *Artocarpus nobilis* seeds native to Sri Lanka.

Bioavailability of food: Bioavailability is the degree to which food nutrients are available for absorption and utilization in the body. It is a critical issue for many nutritional concerns. In this study, bioavailability of nutrients and antioxidant compounds in legumes were studied. Further, the effect of boiling and simulated digestion on prebiotic activity of legumes were also studied.

Effect of biofilm-bio fertilizer on nutritional and other functional properties of rice: Biofilm biofertilizer was developed at NIFS with the aim of reducing chemical fertilizer usage to minimize the environmental pollution and to reduce the cost of agriculture. Although this fertilizer has already been introduced to various crops, its effect on the nutritional and functional properties of crop harvest has not been undertaken previously. Thus, a study was initiated in collaboration with the biofilm biofertilizer project of NIFS to investigate the effect of biofilm biofertilizer on the nutritional and biochemical properties of selected rice varieties grown in Sri Lanka.

Screening some Ayurvedic plants for antidiabetic property During the last few years there has been a tremendous growth in the field of herbal medicine. Herbal medicine is gaining popularity both in the developing and developed world because of its natural origin and less side effects. As a result, the public has turned towards medicinal plants for the treatment of chronic ailments such as diabetes. Identification of the active components and their molecular interaction is essential to analyze the therapeutic efficacy of the products and to standardize them. Although, over 400 plants are used for treatments of diabetes, only a small number of them have received scientific and medical evaluation to assess their efficacy. This study aims to screen popular Sri Lankan Ayurvedic plants for their anti-diabetic property and identify the active ingredients responsible for their therapeutic effects. Out of the 10 studied plants, three plants have been identified with high anti-diabetic properties and further studied are being carried out to identify active compounds in those plants.

Nutritional and biochemical properties of raw and processed *Artocarpus nobilis* (Badi Del/ Wal Del) seeds

Current knowledge on the effect of nut consumption on the prevention of diet related non-communicable diseases is a well-established factor. It is mainly associated with lowering the risk of coronary heart disease and prevention of type 2 diabetes. Although many countries produce specific local brands of nut-based products at a competitive price, Sri Lanka is yet to explore the physicochemical properties of naturally available nuts,popularize them and find suitable market opportunities. The present study investigated the nutritional and biochemical properties of raw and processed *Artocarpus nobilis* (Badi Del/wal Del) seeds using *in-vitro* and *in-vivo* assays. Seeds were subjected to three different processing methods; roasting, microwaving and boiling. Initial screening was conducted to assess the phenolic content and antioxidant capacity of raw and processed *A. nobilis* seeds in comparison with almond and pistachio. Significantly higher ($p \leq 0.05$) total phenolic content (TPC) and total flavonoid content (TFC) were reported in raw *A. nobilis* seeds than raw almond. Moreover, heat processing; microwaving and pan roasting significantly ($p \leq 0.05$) improved the TPC, TFC and reported higher antioxidant activity in DPPH, ABTS and FRAP assays compared to raw almond and pistachio nuts. However, boiling didn't significantly ($p \leq 0.05$) improve the antioxidant activity.

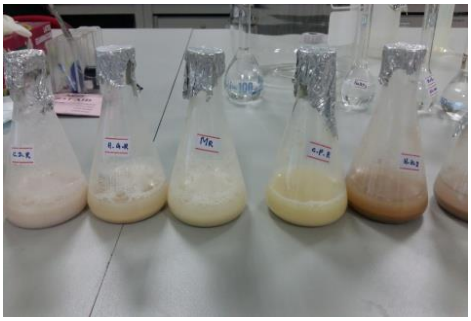
Boiling and *in-vitro* digestion on the bio-accessibility and bioavailability of phenolic compounds and antioxidant capacities in legumes

Different processing methods and gastrointestinal digestion are known to modulate the bio-accessibility and bioavailability of bioactive compounds in food. This study focuses on the effect of processing (boiling) and simulated gastrointestinal digestion on antioxidant capacity, phenolic and flavonoid content of chickpea, mung (MI6), red cowpea (waruni), cowpea (dawala) and horse gram (kollu). According to the results, boiling and *in-vitro* digestion modulate the bioavailability of antioxidants and their activity. Among the raw samples, horse gram (Kollu) was found to contain the highest ($p \leq 0.05$) amount of phenolics (20.66±1.58 mg GAE/g) with highest ($p \leq 0.05$) Fe^{3+} reduction, ABTS and DPPH radical scavenging activity while cowpea (dawala) had the lowest amount of phenolics (13.59±0.1 mg GAE/g)with lowest($p \leq 0.05$) antioxidant capacity. However, upon boiling, legumes showed significant ($p<0.05$) decreases in total phenolic, flavonoid contents and antioxidant capacity. When these samples were subjected to *in-vitro* digestion, boiled legumes showed a significant increase ($p \leq 0.05$) in total phenolic, total flavonoid and antioxidant activity compared to raw samples. *In-vitro* digested, boiled mung and horse gram had the highest Fe^{3+} reducing activity (233.90±13.10 mM / $Fe^{2+}.g^{-1}$/ 233.68 ±37.82 mM / $Fe^{2+}.g^{-1}$) and ABTS radical scavenging activity (621.83±16.77 µmolTE /g/ 363.34 ± 10.34 µmolTE / g). Hence, the overall results revealed that processing and simulated digestion modulate the bioavailability of total phenolic, total flavonoid and the antioxidant activity of above five selected legumes. Bioavailability of phenols and flavonoids was high ($p \leq 0.05$) in horse gram and mung bean compared to other legumes. These two legumes will be subjected to a dialysis bag model and a LC/MS study will be carried out to understand the actual bioavailability of different phenolic acids.

Prebiotic activity of legumes after *in-vitro* digestion

Legumes are identified as potential prebiotics that stimulate the growth of certain gastrointestinal microbes such as *Bifidobacteria* and *Lactobacilli*, leading to the formation of (short chain fatty acids) SCFAs. Processing and *in vitro* digestion may modulate the prebiotic potential of legumes. In this

study, fermentative properties of raw and boiled legumes before and after simulated digestion using synthetic enzymes (pepsin, pancreatin and bile extract) were studied. Boiling and *in-vitro* digestion showed differential effect on the growth of colonic bacteria depending on the legume.



A significant differential growth of *Bifidobacterium* and *Lactobacilli* was observed for tested legumes upon boiling and *in-vitro* digestion. Among tested samples, horse gram showed the highest ($p \leq 0.05$) growth of *Lactobacilli* and boiled digested chickpea and raw digested mung beans had the highest ($p \leq 0.05$) growth of *Bifidobacterium.*

The optical density and the pH of the fermented media further confirmed the above observation. In addition, boiled, digested chickpea ($p \leq 0.05$) suppressed the growth of E. coli compared to other legume samples. Overall, the study shows that simulated digestion and boiling modulate the fermentative property of studied legumes and chickpea showed the highest prebiotic potential compared to other legumes.

Current M.Phil/M.Sc. students

Ms. Afka Deen
Ms. S.M.V.K. Sewwandhi
Ms. R.J. Bangamuwage
Ms. W.A.P.M.M. Ariyarathna
Ms. Uditha Premarathne

Key Publications

R Visvanathan, C Jayathilake, R Liyanage, R Sivakanesan(2019) Applicability and reliability of the glucose oxidase method in assessing α-amylase activity Food chemistry 275, 265-272.

R Liyanage, C Kiramage, R Visvanathan, C Jayathilake, P Weththasinghe, R Bangamuwage, B C Jayawardana, J Vidanarachchi (2018) Hypolipidemic and hypoglycemic potential of raw, boiled, and sprouted mung beans (*Vigna radiata* L. Wilczek) in rats Journal of Food Biochemistry 42 (1), e12457.

BC Jayawardana, VB Warnasooriya, GH Thotawattage, V Dharmasena, R Liyanage(2019) Black and green tea (*Camellia sinensis* L.) extracts as natural antioxidants in uncured pork sausages Journal of food processing and preservation 43 (2), e13870.

From left: Ms. SDH. Kaushalya, Ms. FA. Deen, Dr. NLBR. Liyanage, Ms. RHWMIC. Rathnayake, Ms. SMVK. Sewwandi

Fathima Afka Deen

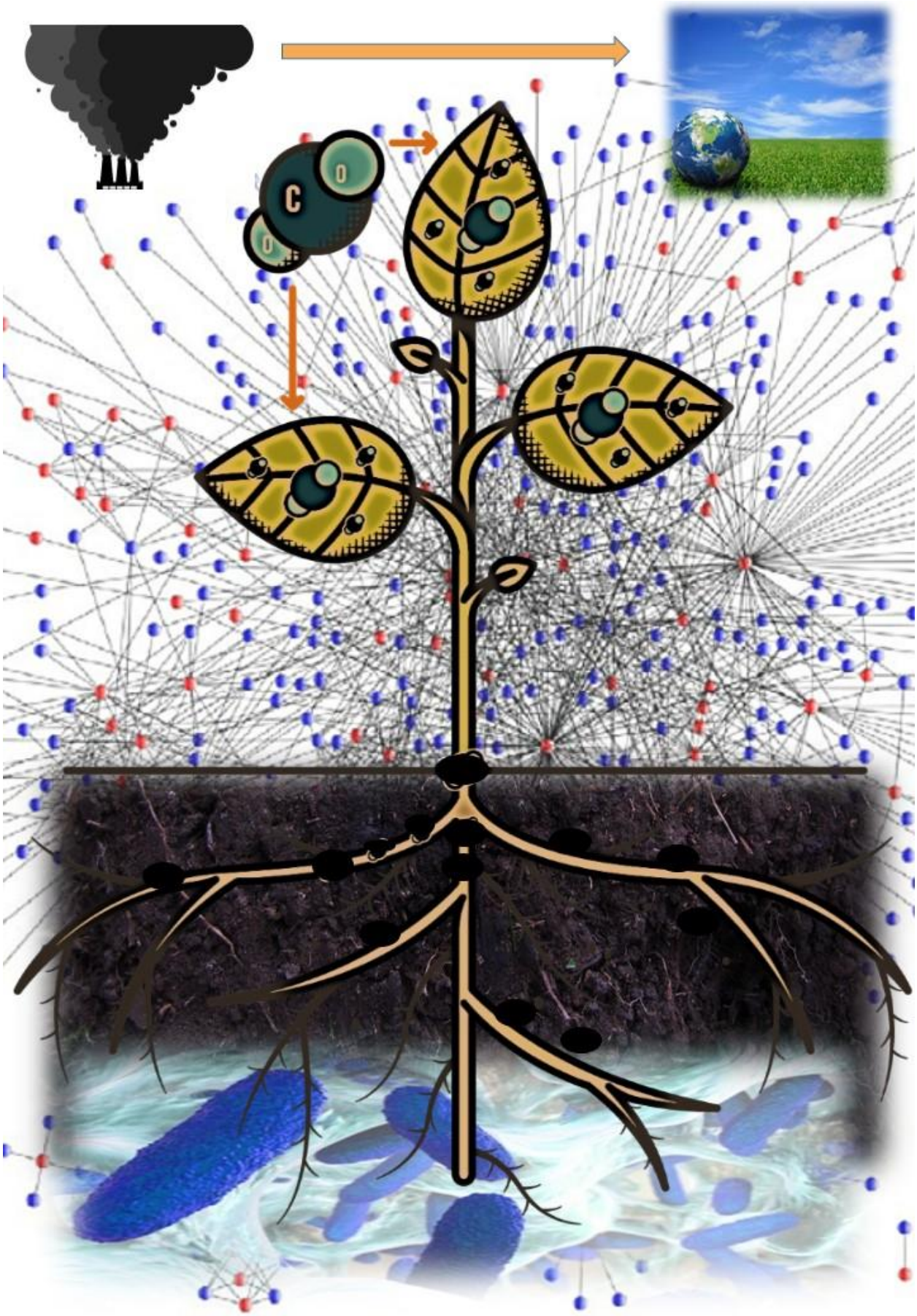
Fathima Afka Deen is currently a M.Phil Research Assistant in the Nutritional Biochemistry project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc from University of Peradeniya Sri Lanka in 2016 and joined NIFS in 2017. Her research focuses on Bioavailability of bioactive compounds in commonly consumed legumes in Sri Lanka. Her research interests include Food Biochemistry, Molecular Biology and Biochemistry, Chemistry, Analytical Chemistry, Organic Chemistry.

Mobile: +94 762622262;
E-mail: afka.de@nifs.ac.lk
https://www.researchgate.net/profile/Fathima_Deen

Kaushalya Sewwandi

Kaushalya Sewwandi is currently an M. Phil Research Assistant with the Nutritional Biochemistry project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc from the University of Peradeniya Sri Lanka in 2019 and joined NIFS the same year. Her research focuses on evaluating nutritional properties and biochemical properties of Sri Lankan underutilized nut types. Her research interests include Food Biochemistry, Molecular Biology and Biochemistry, Chemistry.

E-mail: vindyani.su@nifs.ac.lk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Microbiology & Carbon Sequestration

In the evolution of the Earth, formation of the lithosphere preceded that of the biosphere and even today the existence of plants depends largely upon soil which provides the substrate for anchorage and most of their nutrients. Soil nutrient supply is sustained by cycling of water, carbon, nitrogen, sulfur etc. and these processes are mediated by soil microorganisms. Studies carried out by this cluster are aimed first at understanding the complex network interactions among the variables, and then applying the knowledge gained to sustaining and improving soil fertility by manipulating the role of microorganisms in nitrogen fixation, carbon sequestration and enhancing root growth and nutrient uptake through the introduction of beneficial microbial communities in biofilm mode. Research is also directed towards microbial generation of bioenergy to circumvent the use of environmentally damaging fossil fuels.

- Microbiology & Soil Ecosystems
- Microbial Biotechnology
- Rhizobium Project

Renuka Ratnayake

Dr. Renuka Ratnayake, Senior Research Fellow at NIFS, obtained her B.Sc. (Sp) Botany in (1992), M.Phil. (by research) in (1997) and Ph.D.(2006) from the University of Peradeniya and joined the NIFS in 2009. She worked as a Postdoctoral researcher at the World Forestry Center, USA and Murdoch University, Australia. Dr. Ratnayake is a recipient of Endeavour Research Fellowship, Presidential Research Awards and SUSRED award for post graduate supervision. She worked as a Lecturer in the Faculty of Applied Sciences at the Rajarata University of Sri Lanka before joining the NIFS.

Title: **Senior Research Fellow**
Email: **renuka.ra@nifs.ac.lk**
Tel: **0773175850**
ORCID ID: **0000-0002-7667-1447**

Microbiology and Soil Ecosystems

Global warming has progressed to an injurious level that a thriving need lies in mitigating carbon dioxide build up in the atmosphere. Soil carbon sequestration is the process of removing atmospheric CO_2 via plant photosynthesis; atmospheric CO_2 is captured and diverted to the
soil as soil organic carbon where it becomes stable for thousands of years. Soils contain more carbon than all terrestrial vegetation and the atmosphere combined and is one of the most active carbon sinks on Earth, second only to oceans. The main objective of the Soil Ecosystems project is to determine soil C sequestration potential, its dynamics and the method of improvement in different major vegetation types of Sri Lanka such as natural and plantation forests, wetlands, agricultural plantations, farm lands, home gardens, small holder cultivations etc. The potentiality of coastal ecosystems such as mangroves and intertidal salt marshes will be studied for capturing and storing of atmospheric carbon as aboveground and belowground biomass and in sediments. As the first step, mangroves and saltmarsh ecosystems located in Northern Sri Lanka are under investigation. A study has also been initiated to develop a baseline soil information system for soil C and other nutrients for paddy growing soils in Sri Lanka. Estimation of C stocks in soil and preparation of GIS based maps are the main outcomes of this project. Kandyan home garden systems have also been studied for soil C sequestration potential.

Microbial cellulases have shown potential application in a wide range of industries including biofuel, pulp and paper, textile, laundry, food and feed industry, agriculture etc. The present project focused on studying the potential applications of enzyme extracts obtained from locally isolated cellulolytic microorganisms in different value added products and processes. Research conducted so far indicated that locally isolated microorganisms and their enzymes can be effectively used in industrial processes to replace commercially available, high cost enzymes. Another study has been initiated to investigate the genetic diversity of cyanobacteria in different water bodies of Sri Lanka with their taxonomical identification, nutrient profiling and toxin analysis. The project also focuses on the establishment and maintenance of cyanobacteria culture collection which facilitates the preservation and conservation of pure cyanobacteria strains present in different types of water bodies and stress conditions in Sri Lanka not only for academic and industrial research but also for future reference.

Microbial cellulases: application in biofuel production and other value-added products and processes

The study evaluated potential uses of cellulolytic microbes and their enzymes in different industrial applications. *Trichodermaviridae* recorded the highest total cellulase activity (0.94 FPU/ml). Anaerobic consortium, RF5 showed 0.55 FPU/ml of total cellulase activity. *Candida tropicalis* was the best ethanologenic yeast with 9.59% ethanol. In bioethanol production, *T.viridae-C.parapsilosis* co-culture gave the highest ethanol yield (5.32%). The highest laccase (0.76 U/ml) and total cellulase (0.57 FPU/ml) activities in pretreatment and saccharification of sugarcane bagasse were produced by *Earliellascabrosa and Aspergillusniger,* respectively. 50% vinasse + bagasse facilitated the growth of fungi confirming the use of vinasse in low cost culture media. Cellulases from *Aspergillus* sp. showed the potential of formulating superactive cellulase blends to remove denim dye. The growth of damping-off causative *Phytophthora* was suppressed by antifungal effect of *Trichoderma* and *Aspergillus* enzyme extracts. The findings open up new areas of research for future industrial developments.

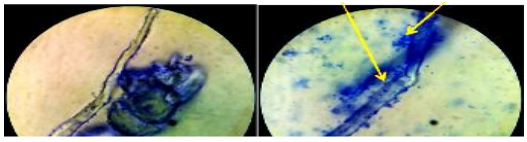


Figure 01: The microscopic observations of fermented broth of *Trichoderma* and yeast co-culture. Yeast cells attached to fungal filaments could be observed in each picture.

Investigation of genetic diversity of cyanobacteria in different water bodies of Sri Lanka with their taxonomical identification, nutrient profiling and toxin analysis

This study has been initiated for broad taxonomical evaluation along with morphological and molecular identification of cyanobacteria isolated from different ecosystems in Sri Lanka. More than 100 monocultures have been isolated and morphologically identified so far from different extreme ecosystems. Their molecular characterization, taxonomical evaluation and value addition are in progress. Most importantly, establishment of a cyanobacteria culture collection adds a global and national significance to the study in the sense of conservation of genetic resources of Sri Lankan cyanobacteria. Culture collection is composed of 200 strains from freshwater and different extreme ecosystems; saltmarshes, mangroves and hot water springs and maintained under laboratory conditions with regular sub culturing and cryopreservation. Some isolates have been molecularly characterized while others are in progress. Overall, this study provides a strong baseline as a step forward for the improvement of cyanobacteria conservation and natural resources based science and technology.

Figure 02: Cyanobacteria culture collection established and maintained by Bioenergy and Soil Ecosystems Research Project at National Institute of Fundamental Studies, Sri Lanka

Figure 03: Microscopic images obtained from monocultures for morphological identification

Estimation and Mapping of Soil Nutrients and Carbon Stock in Mangrove and Salt Marsh

Blue Carbon ecosystems such as mangrove, saltmarsh and seagrass, are known as one of the most effective biological carbon sequester in the long term. The main objective of this research is to study soil C sequestration capacity of two major coastal Blue C ecosystems i.e. mangroves and saltmarsh ecosystems in Mannar Region, Sri Lanka. This ecosystem's services neither has been measured nor marketed yet. Therefore, quantifying the carbon stocks and setting the baselines is a necessity. Mannar region was a war zone until 2009 and was hard to reach and at present major development processes are taking place in the region. Therefore, the blue carbon ecosystems at the region have been understudied. Soil samples have been collected from Vankalai, Naravilikulam, Achchankulam, Erukulampiddy, Kaladi, Vidatalativu, Mannar (Southbar), Vellankulam, Illuppakadavil and along A32 road until Punarin, and have been analyzed for their nutrient status and carbon stocks. The data will be processed to a Geographical Information System (GIS) based map digitally visualizing the soil C stock at these ecosystems.

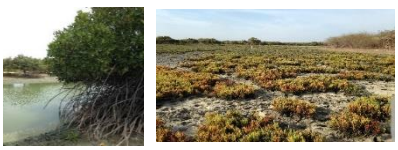


Figure 04: The Mangrove and saltmarsh ecosystems at Mannar region

At some sites, the microbial activity has been restricted. Those sites could be identified as areas with no vegetation or sites where water has been retained in the rainy season, and for a considerable time after that. Considerably low available nitrate concentration and phosphate concentration could be observed at the sites. The availability of

phosphate is limited at calcareous soil as it precipitates with Ca^{+2} in alkaline medium. Available ammonium concentration is high as deposited ammonium washes away from higher grounds. This could be a budding step for identifying the blue C in C trading in the future, and need for rehabilitation of degraded mangrove and saltmarsh sites could be emphasized.

Development of baseline soil information system for soil carbon and other nutrients for paddy growing soils in Sri Lanka

Organic carbon accumulation in paddy ecosystems was faster and more pronounced than in other arable ecosystems. In this study, soil organic carbon and its fractions in paddy soils and their links to nutrient availability will be determined. Outputs generated from this study will provide information on current status of soil organic C stocks and other nutrient cations in the paddy soils of Sri Lanka. The study will provide firsthand information vital to the establishment of a national carbon accounting system in the future. Conditional Latin Hyper Cube Sampling Design was employed in the study for the purpose of spatial determination of carbon stocks in all paddy growing districts in Sri Lanka. So far, more than 1600 soil samples have been collected and analyzed for their carbon fractions and nutrient availability. Soil sampling, their analyses and spatial modelling are in progress. Up to now the findings reveal that, as more productive croplands, paddy lands contain higher SOC content and the amount increased under water logged conditions. further, variations of soil carbon stocks of paddy soils in different agro ecological zones were estimated.

Figure 05: Soil sampling and background data collection in paddy growing soils of Sri Lanka

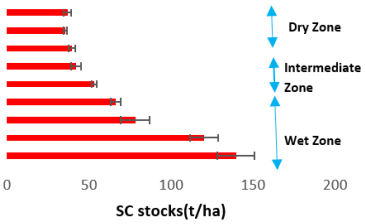


Figure 06: Variation of soil carbon (SC) stocks in paddy growing soils of some selected Districts in different agro ecological zones of Sri Lanka.

From left: Ms. DDMO. Dissanayake, Ms. EMD. Perera, Mr. DMBA. Chathuranga, Mr. EPD. Wijetunga, Mr. IMDB Idisooriya, Ms. ULRW. Premathilake, Ms. T. Paranavithana
Seating: Ms. TK. Bowange, Dr. RR. Ratnayake, Ms. SK. Jayasekara

Sandhya Jayasekara

Sandhya Jayasekara is currently attached to the Bioenergy & Soil Ecosystems Research Project at NIFS as a Research Assistant. She received her B.Sc. (Special) in Microbiology with a first class from the Faculty of Science, University of Kelaniya. Before moving to NIFS in 2016, she worked as a Teaching Assistant at the Department of Microbiology, University of Kelaniya. Currently she is reading for her M.Phil. at the Post Graduate Institute of Science, University of Peradeniya. Her research titled "Microbial cellulases: The application in biofuel production and other value added products and processes" focuses on isolation and characterization of cellulolytic microorganisms from natural environment of Sri Lanka and studying the possible applications of cellulase enzyme extracts obtained from efficient cellulolytic microorganisms.

Mobile: +940777846444

E-mail: sandhya.ja@nifs.ac.lk

Ovini Dissanayake

Ovini Dissanayake is currently an M.Phil. Research Assistant in the Bioenergy and Soil Ecosystem project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc. from the University of Peradeniya, Sri Lanka in 2018 and joined NIFS the same year. Her study at NIFS focuses on Soil Carbon Sequestration in Blue Carbon Ecosystems of Sri Lanka. Her research interests include Environmental Sciences, Soil Chemistry, Geographic Information Systems (GIS) mapping and Biostatistics.

Mobile: +94 768886918

E-mail: ovini.di@nifs.ac.lk

Thilakshi Paranavithana

Thilakshi Paranavithana is currently an M.Phil Research Assistant in the Bioenergy and Soil Ecosystem project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc from the Sabaragamuwa University of Sri Lanka in 2018 and joined NIFS the same year. Her study at NIFS focuses on Development of baseline soil information system for soil Carbon and other nutrients for paddy growing soils in Sri Lanka. Her research interests include Environmental Sciences, Soil Chemistry, Remote sensing and Geographic Information Systems(GIS) mapping.

Mobile: +94 712 253 625

E-mail: thilakshi.pa@nifs.ac.lk

Gamini Seneviratne

Senior Research Professor, National Institute of Fundamental Studies; Postdoctoral Fellow, Katholieke Universiteit Leuven, Belgium (1994);Visiting Collaborative Research Fellow, University of Sydney, Australia (April-June 2007); Visiting Professor, University of Sydney, Australia (January-May 2009); Member, Soil Science Society of America/American Society of Agronomy, American Society for Microbiology; Former Editor, Agriculture, Ecosystems & Environment (Elsevier); Research publications have received 1929 citations (December 2019); Google Scholar h-index of 24; Elected Fellow of the National Academy of Sciences (2011 to date). **Awards:** Presidential Research Awards (1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006); Listed as a top researcher in Sri Lanka by the University Grant Commission (UGC), Sri Lanka & one of the most productive scientists in Sri Lanka in the Third World Academy of Sciences, Italy.

Title:	**Senior Research Professor**
E-mail:	**gamini.se@nifs.ac.lk**
T.P.:	**0812232002**
ORCID ID:	**0000-0003-1562-4097**

Microbial Biotechnology

The research program focuses on investigations on the role of developed microbial biofilms in agriculture, plantations and the environment. With the development of microbial biofilms [fungal-bacterial biofilms (FBBs) in particular] in vitro in 2002, several basic research studies were conducted to evaluate their potential as microbial ameliorators in the soil and also in the environment. The studies yielded very promising results. Consequently, biofilm-based biofertilizers called Biofilm biofertilizers (BFBFs) were developed for agriculture and plantation crops (especially non-legumes, e.g. tea, rice, vegetables etc.), tested extensively under field conditions, and were commercialized in 2014. So far, BFBFs have been used in over 20,000 acres of rice in the country with chemical fertilizers (NPK) cut down by up to 50%, while increasing crop yields between 10-40%. It is also used in organic agriculture. Research on BFBFs have also been started in Canada, India, Indonesia, Brazil and Iraq with promising results.

Current studies are centered on agriculture, health and environmental benefits of the use of BFBFs, and also industrial applications of FBBs. We recently started a research study on Biofilm medicines for next-generation drug discovery.

Effect of Biofilm Biofertilizer on Tea Cultivation

Biofilm is an assemblage of microbes adherent to each other and/or biotic/abiotic surfaces and embedded in a self-produced extracellular matrix of polymers (EPS). Such biofilms can also be developed *in vitro* using beneficial microbes, and can be used as Biofilm biofertilizers (BFBFs). In tea (*Camellia sinensis* L.) cultivation, decreased soil quality can be seen where tea has been grown for a long time, especially when the soil biodiversity and nutrient content become depleted. Use of chemical fertilizers (CF) in the growers' practice causes leaching out of CF, thus polluting water basins, depleting beneficial micro-organisms and insects, decreasing plant immunity and reducing soil fertility, which accompany a huge damage to the overall ecosystem. Once applied, the BFBFs break the dormancy of microbial forms in the soil seed bank and enhance biodiversity, nutrient availability for crop growth as well as biocontrol of pests and pathogens, thus improving crop productivity and soil fertility.

This study was designed to analyze soil, plant and microbial parameters of the growers' CF practice and BFBF practice using two comparable tea fields. Results indicated that the selected parameters varied among the two treatments. Moreover, the application of BFBF improved the nutrient utilization efficiency of plants and led to increased tea yield over CF alone application in the growers' practice (Fig. 1) while cutting down CF usage up to ca. 60%. Therefore, it is concluded that the BFBF is an eco-friendly and economically viable method to replace growers' current practice of CF alone application.

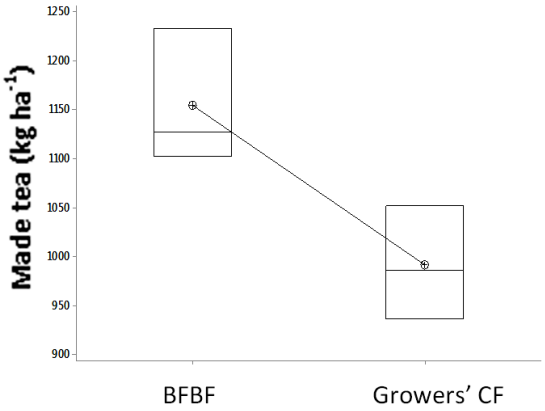


Figure 1: Total quantity of made tea after seven months of the two fields where the two treatments were applied.

Potential of Biofilm biofertilizer application in Paddy Soil Carbon Sequestration in Sri Lanka: an Economical Analysis

Carbon is an essential element for every living organism on Earth. After the industrial revolution, emission of carbon to the atmosphere at higher rates has led to global warming and climate change. Currently, photosynthesis is the most effective way of withdrawing carbon from the atmosphere. However, Soil carbon sequestration (SCS) is the most important phenomenon to store that carbon for prolonged periods without escaping back to the atmosphere. Globally, expanding agricultural lands have the potential to play a major role in SCS in the phase of degradation of natural ecosystems like forests. Thus, contribution of agriculture to mitigate climate change is becoming more and more important. In this context, in the present study, the potential of Biofilm biofertilizer (BFBF) practice, being a soil organic matter accumulation process for carbon sequestration was analyzed in rice (*Oryza sativa* L.) cultivation in Sri Lanka. The land extent of annual rice cultivation in Sri Lanka is ca. 2.5 million acres. Therefore, there is a noteworthy potential of the BFBF practice to mitigate climate change via SCS in rice cultivation while earning foreign exchange from carbon trading. The present study was designed to evaluate this potential over farmers' current chemical fertilizers (CF) alone practice to estimate how much the BFBF practice can contribute to boost the economy of the country. Results showed that BFBF can significantly increase SCS over farmers' current CF alone practice (Fig. 2).

Is it an organic leafy vegetable? A simple method of detectection

In the last decade, the demand for organic food has increased steadily worldwide. Indeed, the population accredits healthier and beneficial properties to organic foods.

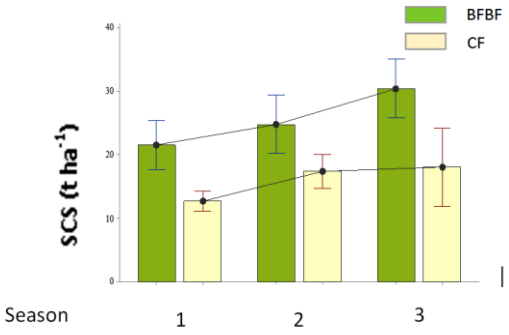


Figure 2: SCS of the two treatments, CF and BFBF practices in respective season (1. Yala 2018, 2. Maha 2018/2019, 3. Yala 2019).

It is believed that organic agriculture is contributing to reduction in the risk of developing chronic diseases like CKDu. Organic foods have a higher content of bioactive compounds and sometimes low levels of unhealthy substances such as heavy metals and are free of synthetic fertilizers and pesticides compared to conventional agricultural produces. However, there are no methods to determine whether a harvested produce is organic or not.

Furthermore, no standards exist that define the product-oriented quality aspects of organic food. Being the most widely used organic food, which has a risk of containing unhealthy factors, leafy vegetables play a major role in our diet. In fact, it is the main input to the plate of the majority of people, next to rice. Therefore, finding a reliable way to determine the organicity of leafy vegetables is the need of the hour.

In this study, a simple lab culturing of leaf disk microbes of *Centella asiatica* L. (Gotukola), as the test plant was used as an indicator to detect whether the leafy vegetable was organic or not. Results showed that there was a marked difference in

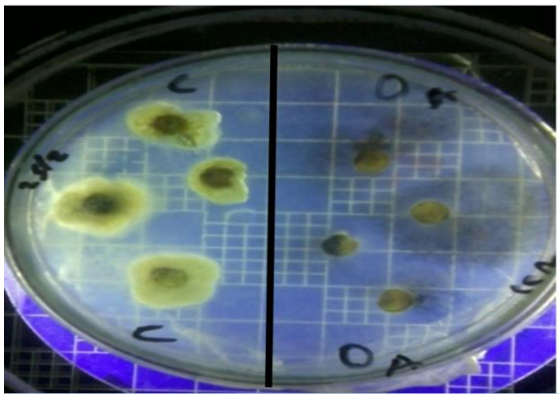


Figure 3: Endophytic diazotrphs and non diazotrophs growing from organic and non-organic leaf disks *(Organic – right side, non organic – left side of the Petri-dish).*

microbial colony morphology of the leaf disks between organic and non-organic crops. This study opens a new avenue for a healthier world by regulating such foods using this simple method.

M.Phil Students: Ms. S.W. Meepegamage, Ms. A.T.D. Rathnathilaka, Mr. M. Premarathna, Ms. H. K. S. N. S. Gunarathne.

Key publications:

Profitability of strawberry (*Fragaria ananassa*) production with biofilmed biofertilizer application. Singhalagea, I.D., Seneviratne, G., Madawala, H.M.S.P., and Wijepala, P.C. *Scientia Horticulturae*, 234, 411-413, 2019, [SCI, IF : 1.961]

Biofilm mediated synergistic degradation of hexadecane by a naturally formed community comprising *Aspergillus flavus* complex and *Bacillus cereus* group. Perera, M., Wijayarathna, D., Wijesundera, S., Chinthaka, M., Seneviratne, G. and Jayasena, S . *BMC Microbiology*, 19, 84, 2019, [SCI Exp, IF : 3.287]

From left: T. Rathnathilake, Ms. RCK. Karunarathne, Mr. UMB. Premaratne, Mr. A. Pathirana, Prof. G. Seneviratne, Mr. S. Ekanayake, Mr. WMKDS. Warnakulasooriya, Ms. Varuni Seneviratne, Ms. S. Meepegamage

Sachini Meepegamage

Sachini Meepegamage is currently an M.Phil Research Assistant in the Microbial Biotechnology project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc from the University of Peradeniya, Sri Lanka in 2016 and joined NIFS in 2017. Her research's focuses on soil microbial community analysis in Sri Lanka. Sachni's research interests include Microbiology, Molecular Biology and Biotechnology, Recombinant DNA technology, Genetics, Genetic engineering of crop plant and Plant tissue culture.

Mobile: +94 772 351 100
E-mail: sachini.me@nifs.ac.lk

Thilini Rathnathilaka

Thilini Rathnathilaka is currently an M.Phil Research Assistant in the Microbial Biotechnology project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc from the Wayamba University of Sri Lanka in 2018 and joined NIFS the same year. Her research interests include environmental biotechnology, molecular biology and Biostatistics.

Mobile: +94 772484703;
E-mail;thilini.ra@nifs.ac.lk

Mahesh Premarathna

Mahesh Premarathna is currently an M.Phil Research Assistant with the Microbial Biotechnology project at the National Institute of Fundamental Studies (NIFS). He received his B.Sc. from Wayamba University of Sri Lanka in 2019 and joined NIFS the same year. His research focuses on Microbial Biofilms and their Network Interactions. His research interests include Microbiology, Molecular Biology and Biochemistry, Biotechnology, Recombinant DNA technology, Genetic Engineering, Microfluidics, Soil carbon sequestration and mitigation of climate change, Astrobiology, and Philosophy.

Email: mahesh.pr@nifs.ac.lk
https://scholar.google.com/citations?user=2Kw6GKoAAAAJ&hl=en
https://www.researchgate.net/profile/Mahesh_Premarathna
https://orcid.org/0000-0002-6127-3956

Dilan Warnakulasooriya

Dilan Warnakulasooriya is currently a Research Assistant with the Ministry Biofertilizer project at the National Institute of Fundamental Studies (NIFS). He received his B.Sc. from Wayamba University of Sri Lanka in 2019 and joined NIFS the same year. His research interests include soil science, environmental impact assessment, and water quality on agriculture and environment.
E-mail: dilan.wa@nifs.ac.lk

S. A. Kulasooriya.

B. Sc. (Hons) Ceylon 1966,; Ph. D. London 1971, D. Sc. (*Honoriscausa* Sabaragamuwa University) 2012, Emeritus Professor, University of Peradeniya (since 2006); Dean, Faculty of Science (2000 – 2003), Chair of Microbiology (1981) UoP; Research Fellow (1978/79) International Rice Research Institute, Philippines; Visiting Consultant (1982/83/84) International Atomic Energy Agency, Austria; Visiting Scientist (1987/88) Weizmann Institute of Science, Israel; Visiting Professor, Washington State University, USA (1999/2000); Senior Fellow, Global Studies Institute, San Jose State University, USA (2003/04); Fellow, Institute of Biology (since 1982); Fellow National Academy of Science (since 1986); Titular National Honor, *VidyaNidhi* (1986)

Title: **Visiting Research Professor**
E-mail: **ananda@kulasooriya.com**
T.P.: **0812232002, 077-600-4940**
ORCID ID: **0000-0002-3309-1311**

Rhizobium Project

Development and distribution of rhizobial inoculants continued throughout the year. Demand for inoculants for vegetable beans increased. A chemical N-fertilizer response curve done in a field trial with vegetable bean (*Phaseolus vulgaris*) at Ankumbura confirmed that urea fertilizer can be replaced completely by inoculation. Assessment of weed growth in this experiment showed that a 60% reduction in weed biomass could be obtained by replacing urea application with rhizobial inoculation.

All the rhizobial strains used for field inoculation of different crop legumes were subjected to molecular characterization. Results showed ten clusters at 70% molecular similarity coefficient and four clusters with 100% similarity. Based upon the Maximum Likelihood Tree search conducted using 16S rRNA gene sequences on the most commonly used 5 strains, isolates were identified as *Bradyrhizobium* sp. (Green Gram), *Rhizobium* sp. (Soybean, Vegetable bean and Clover) and *Sinorhizobium* sp. (Groundnut). This is the first record of *Sinorhizobium* in Sri Lanka.

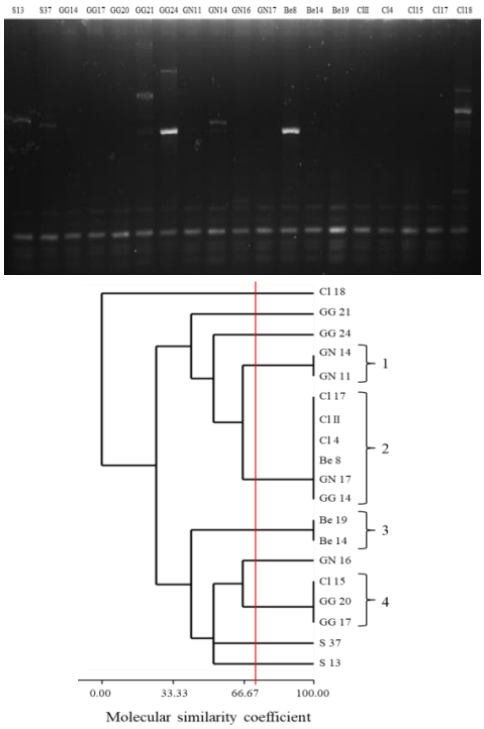
Yet another study was done as part of a M.Sc. research project by a student of the University of Peradeniya. This was on isolation of phosphate solubilizing microorganisms associated with legume plants and evaluating their P-solubilizing abilities using Azolla as a bioassay plant.

Extension work for demonstrating and popularizing rhizobial inoculation continued. Field trials were initiated to test the efficacy of rhizobial inoculation of groundnut in collaboration with officers of the Wayamba Provincial Agriculture Department.

Molecular characterization of *Rhizobium* isolates from selected food legumes in Sri Lanka

Ishanthi Nawanjana, R. K. G. Kumara, R.G. S. C. Rajapakse* and S. A. Kulasooriya
*University of Peradeniya

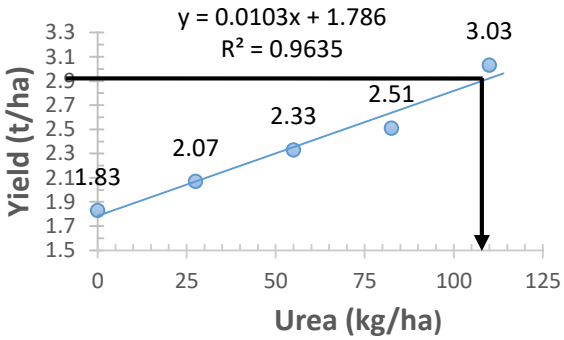
Genetic diversity of 19 Rhizobial strains isolated from legume crops like soy bean, ground nut, green gram, vegetable bean and clover were analyzed. DNA fingerprinting using ERIC primers was applied for the initial characterization. Having done a cluster analysis of the DNA fingerprinted isolates, sequencing of the 16S rRNA gene was performed on the five isolates that are commonly applied as inoculants. ERIC fingerprinting gave a polymorphic banding pattern. The dendogram constructed showed ten clusters with 70% similarity and four clusters having 100% similarity. Based on the Maximum Likelihood Tree search conducted using 16S rRNA gene sequences, the five selected isolates were identified as *Bradyrhizobium* sp. (GG 21), *Rhizobium* sp. (S 13, Be 8 and Cl 15)and *Sinorhizobium* sp.(GN 11) which is the 1st record in Sri Lanka.



Yield response curve of vegetable bean for N-fertilizer (urea) in comparison to rhizobial inoculation

H. I. G. K. Anuruddi*, E. M. H. G. S. Ekanayake, R. K. G. K. Kumara, K. L. C. KumariFonseka* and S. A. Kulasooriya
*University of Ruhuna

A field trial was conducted in a farmer's field in Amkumbura, Kandy, to develop a yield response curve to urea fertilizer by vegetable bean (*Phaseoulus vulgaris*). Six treatments comprised of 100%, 75%, 50%, 25% and 0% of the recommended level (220 kg/ha) of urea compared with rhizobium inoculation. The total pod yields, weed biomass under different treatments, along with nodule and growth parameters were assessed.



The highest pod yield 3.03 t/ha recorded with 100% urea application was not significantly different ($p<0.05$) from the inoculation treatment. A 60% reduction in weed growth was observed between the highest urea application for this rhizobial inoculation.

Field trial in progress

These results confirmed that rhizobial inoculation could completely replace urea application to this crop.

Isolation, characterization and sequencing of phosphorus solubilizing microorganisms associated with crop legumes

Ishara Bandara*, R. G. S. C. Rajapakse* and S. A. Kulasooriya
*University of Peradeniya

P-solubilizing microorganisms were isolated from soil samples from Balangoda associated with beans Avara and Ma (long bean). Serial dilutions of these soils were plated onto MPVK selective medium. Colonies showing clearing zones after 3 to 5 days were isolated by sub-culturing. Few bacterial colonies and two fungal colonies with P-solubilizing abilities were isolated. The ability of these isolates to solubilize Eppawala Rock Phosphate (ERP) in comparison to TSP was tested in small containers, using Azolla as a bioassay plant.

Results showed highest P-soulbilization with fungal isolates and these were not significantly different from TSP soulbilization.

Extension work

(a) Farmer familiarization

Six programs were conducted in collaboration with Mahaweli Authority at Huruluwewa area and with Plenty Foods (PVT) at Tissa area for 500 farmers.

Huruluwewa: Mahaweli Authority farmers

Tissa: Plenty Foods officers and farmers

(b) Field Demonstrations

Twenty five field demonstrations were conducted for vegetable bean cultivators in collaboration with the Mahaweli Authority and the Wayamba and Kandy Provincial Agriculture Departments.

Marassana: With Kandy Provincial Agriculture Department officials and farmers

(c) Supply of inoculants

Inoculants were supplied to 4000 acres of soybean (Plenty Foods), 1639 packets for vegetable beans (Central Provincial Council) and 580 acres of green gram (Central and Wyamba Provincial Councils).

Ph.D. Student

Mr. K. Mohanan – Ph.D. Degree completed

Key Publications

S. A. Kulasooriya (2019). The amazing world of microorganisms.(A review article). *Ceylon Journal of Science* ***48****(4): 303 – 310. DOI:* http://doi.org/10.4038/cjs.v48i4.7669.

S. A. Kulasooriya (2019) Current status of algal toxins in Sri Lanka.Invited speech.Proc 7thInternatl.Symp. Water quality and Human Health: Challenges Ahead. 6 && December 2019, PGIS, University of Peradeniya, Sri Lanka: 5 – 6.

Shamala T, Thilini AP, Anuradha S, **Kulasooriya SA**, Seneviratne G (2018) The Effect of FlavanoidNarigennin coupled with the development of biofilm *Azorhizobiumcaulinodans-Aspergillus* spp. on increase in rice yields in conventionally and organically grown rice. International Journal of Plant Studies **1** (1):

From left: Mr. MIB. Noor, Ms. AHMCD. Aberathna, Mr. EMHGS. Ekanayake, Prof. SA. Kulasooriya, Mr. RKGK. Kumara, Mr. AHMAK. Tennakoone

Earth, Environment & Biodiversity

The main focus of research in this cluster is the discovery, evaluation, and development of the islands bountiful biotic and abiotic natural resources. Research activities are also focused on efficient use of existing resources and maintaining a cleaner environment. A team of scientists in this cluster work on monitoring and modelling terrestrial and aquatic systems that provide scientific support for restoration and management. They conduct laboratory and field experiments on geothermal resources, toxic metal release from soil and water, their removal and modelling using low cost material. Research is also done on environmental remediation

Another important line of research in this cluster deals with the investigation of natural forest degradation and their restoration through natural regeneration, particularly in the dry zone of Sri Lanka. Biogeography, factors affecting biodiversity, such as Invasive Alien Plants, and conservation status of flora of Sri Lanka are also studied by the scientists attached to this cluster.

Another group of scientists in this cluster focus their research studies on understanding how ecosystems are modified by the loss of biodiversity. These studies are based on plants and animals in terrestrial and aquatic ecosystems with a special focus on the Sri Lanka–Western Ghats biodiversity hotspot. Scientists of this cluster are involved in many taxonomic and ecological research activities ranging from arthropods, such as spiders and scorpions, to primates and higher plants.

- Earth Resources and Renewable Energy
- Environmental Science Research Programme
- Evolution, Ecology & Environmental Biology
- Plant & Environmental Sciences
- Plant Taxonomy & Conservation
- Primate Biology

N. Deepal Subasinghe

BSc and MPhil University of Peradeniya, Sri Lanka.
Ph.D. University of Reading, England, 1999.
Senior Lecturer in Physics at the Open University of Sri Lanka 2000-2003.
Postdoctoral Researcher at the RMIT University, Australia from 2003 to 2009.
Visiting lecturer at University of Kelaniya, University of Peradeniya, Macquarie University, Sydney, RMIT University , Melbourne, and University of Reading, UK.
Immediate Past President - Geological Society of Sri Lanka (GSSL),
Member - Board of Earth Sciences, Postgraduate Inst. of Science, Univ. Peradeniya,
Life Member & Exec. Comm. Member: Geological Society of Sri Lanka
Life Member: Sri Lanka Assoc. for Advancement of Science (SLAAS)

Title: **Associate Research Professor**
Email: **deepal.su@nifs.ac.lk**
Tel: **0812232002**
http://www.ifs.ac.lk

Earth Resources & Renewable Energy

Main aims of the ER & RE project are to find and develop new energy and earth resources as well as to improve the efficiency of selected existing resources.

Despite its size, Sri Lanka has several economic mineral resources, as well as potential geothermal resources. Understanding the origin of minerals and rocks in Sri Lanka as well as the geothermal resources will not only help to identify new resources, but also help to understand the origins of lithological complexes in Sri Lanka and contribute to the advancement of knowledge.

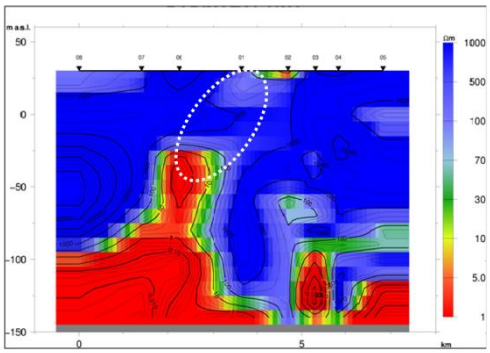
Sustainable utilization of known deposits as well as finding hitherto unknown mineral deposits will contribute to the economic development of the country. Sub project on geothermal resources of Sri Lanka has both fundamental and applied aims. Geothermal energy can be used as a renewable energy source. Understanding the nature of mineral resources and rocks as well as the geothermal resources in Sri Lanka will shed more light on the origin of lithological zones of Sri Lanka. Evaluation of mineral resources, with a focus on their origin and economic potential are also carried out as sub projects.

First ever radon map of Sri Lanka was prepared jointly with the Atomic Energy Board, to establish the baseline of the background radiation levels and to find mineral resources. This will also help to understand the distribution of natural radiation in Sri Lanka.

Research on thermoelectricity is relatively new to Sri Lanka. A pioneering research project on thermoelectricity was introduced. While thermoelectricity can generate electricity directly from heat, and can be used as a renewable source, one of the major advantages is its unique ability to increase the overall efficiency of an existing system by ‘scavenging’ and converting waste heat to electricity through co-generation.

Geothermal Resource Mapping Project:
The first ever comprehensive study of Sri Lankan geothermal resources was initiated at the NIFS in collaboration with few other institutes. Geological, geochemical and geophysical techniques were employed to investigate the nature of the geothermal resources. One of the non-invasive, passive geophysical techniques used in the survey was Magneto-Telluric (MT) technique. Time-Domain Electromagnetic (TDEM) is an active technique used in the survey. Without the need for drilling, the above techniques can provide information on geological structures, heat sources and water resources hidden under several meters to several kilometers of the earth, if necessary. Processed data is used to produce resistivity profiles that represent the sub-surface structures. Recently, focus was on the geochemical, petrological and mineralogical aspects of the areas around the geothermal belt.

Although not located in a volcanic region, Sri Lanka has some geothermal resources as evidenced from a number of thermal springs. Some of the thermal springs may have a potential for generating electricity and contributing to the energy needs of the country. Developing our own renewable energy sources will not only reduce the our dependence on imported fossil fuel, it will also help to reduce the polution.



Resistivity profile of Padiyathalawa hot spring area, modelled using TDEM data.

Mineralogy & Economic Geology Project:
Studying mineral deposits using modern geophysical, geochemical and mineralogical techniques will help to find new economic mineral resources, and understand the fundamental processes of nature.

Some projects are conducted in collaboration with the Department of Geology, University of Sri Lanka. One of the sub projects conducted is “Probing the provenance & distribution of heavy mineral placer deposits in coastal areas of Southern India and SW Sri Lanka”, which is funded by the Ministry of Science & Technology.

Another subproject started recently is “Petrogenesis, geochemistry and potential of economic mineralization of granitic pegmatite in Sri Lanka”. This is funded by NRC.

Results from a recently completed research project on Eppawala phosphate deposit indicated a possible extension of the ore, beyond hitherto known areas. We are working on the confirmation of these possible extensions of the Eppawala phosphate deposit.

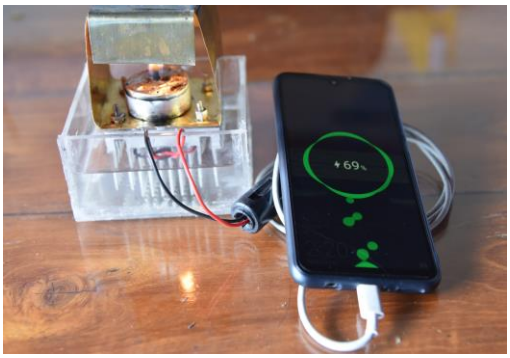

Current mining area of Eppawala phosphate deposit.

Radon Mapping Project: Radon is the single most contributor of natural radiation in our world. While all 39 isotopes of radon are unstable and have very short half-lives, two of the naturally occurring isotopes have special significance, as they are emitted by uranium and thorium. NIFS is conducting a radon monitoring programme with a view to producing a radon map of the country, in collaboration with the Atomic Energy Board of Sri Lanka. Passive and active methods are used in this exercise. Indoor and outdoor radon levels, as well as the parent radio nuclides are mapped around the country.

Radon mapping helps to identify the health hazards as well as the mineral deposits with radioactive minerals.

Thermoelectricity (TE) Research: Reasearch on TE is a fast growing field globally, although no serious research was happening in Sri Lanka, prior to this pioneering project at NIFS. TE can not only be used as a source of renewable energy, it can also be used

as a co-generation technique, to improve the overall energy efficiency of existing systems. In TE, heat is directly converted to electricity using the *Seebeck* effect. Unlike other methods, TE can utilise heat energy from multiple sources, for example, solar energy, geothermal energy, waste energy from factories or automibile engines, or even body heat.



A thermoelectric generator developed at the NIFS, charging a mobile phone, using heat of a candle.

NIFS TE research group focusses on developing low-cost TE material from locally available raw materials such as graphite and its derivatives. Graphene Thin Films produced at NIFS using Sri Lankan natural graphite show promising thermoelectric properties. These thin films may be used in niche applications such as extracting waste heat to power-up portable electronic devices and bionic devices.

Theoretical modelling is also carried out to enhance the thermoelectric properties as well as the power output of TE modules.

This project was funded by the NRC Grant 15-119.

Research Students in 2019:

H.M.D.A.H.Banadara- MPhil Thesis submitted
D.R. Charles (NSF) – MPhil Thesis submitted
W.M.H.S. Wijekoon (NRC) - MPhil Thesis submitted
A.R. Ratnayake - MPhil candidate
N.B. Suriyaarachchi (PhD candidate-left)
D.W.M. Samadhi Dissanyaka (NRC - MPhil candidate
G. Wijeratne – (Ministry Grant – M.Phil)

Recent Publications:

1. Bandara, H.M.D.A.H.,. Sooriyarachchi, N.B., Subasinghe, N.D. (2019). Near surface resistivity and geostructural study of the mahapelessa hot spring field, Sri lanka. *Journal of Geological Society of Sri Lanka*, 20(1), p.33-40.
2. Bandara, H.M.D.A.H. Sooriyarachchi, N.B. Dissanayake, C.B. Subasinghe, N.D. (2019). Geothermal Energy - Potential Applications in Sri Lanka. *Peer Reviewed Journal on Vidulka National Energy Symposium*, 5(1), p.161-173.
3. Jayawardena, S.B.A.D.Y. and **Subasinghe, N.D.** (2018) Fractal Analysis of River Networks Based on Remote Sensing Data: An Example from Kelani River Basin, Sri Lanka. *Jour. Geol. Soc. Sri Lanka*. 19(2). P.69-86.

From left: DWMSSK. Dissanayake, Mr. OKS. Opatha, Mr. RA. Ratnayake, Mr. HS. Wijekoon, Prof. ND. Subasinghe, Mr. HMDA. Bandara, Mr. KKS. Kumara, Ms. DRTL. Harischandra

Dilshan Anuranga Bandara

Dilshan Anuranga Bandara is currently a M.Phil Research Assistant in the Earth Resources and Renewable Energy project at the National Institute of Fundamental Studies (NIFS). He received his B.Sc. special degree in Geology from the University of Peradeniya in 2017, and joined NIFS the same year. His research focuses on geophysical and petrological studies in Sri Lankan Hot springs. His research interests include Exploration Geophysics, Metamorphic Petrology, Structural Geology, Geochemistry and Seismic studies.

Mobile: +94 776597480
E-mail: dilshan.ba@nifs.ac.lk
https://www.researchgate.net/profile/Dilshan_Bandara2

Anjana Rathnayake

Anjana Rathnayake is currently an MPhil Research Assistant with the Earth Resources and Renewable Energy project at the National Institute of Fundamental Studies (NIFS). He received his B.Sc. (Special) degree in Physics from the University of Sri Jayewardenepura in 2018, and joined NIFS in 2019. His research focuses on thermoelectric device modeling. His research interests include Thermoelectricity, Computational Physics, Theoretical Modeling, Simulation Modeling, Computer-Assisted Numerical Analysis, and Parallel Computing.

Mobile: +94 711329457
E-mail: anjana.ra@nifs.ac.lk
https://www.researchgate.net/profile/Anjana_Rathnayake2

Himal Wijekoon

Himal Wijekoon is currently an MPhil Research Assistant with the Earth Resources and Renewable Energy project at the National Institute of Fundamental Studies (NIFS). He received his B.Sc from the University of Peradeniya, Sri Lanka in 2017 and joined NIFS the same year. His research focuses on development of low-cost thermoelectric materials for energy harvesting and co-generation. His research interests include using Sri Lankan Graphite as an efficient thermoelectric material, Synthesis of Graphene thin films, Development of thermoelectric devices to use in aviation industry, and materials synthesis/characterization.

Mobile: +94 711 585 654
E-mail: himal.shankana@gmail.com
https://www.researchgate.net/profile/Himal_Wijekoon

Rohan Weerasooriya, Fellow NASS

Received PhD from University of Peradeniya. Distinguished Professor, Hefei University of Technology. He Served as DAAD Guest Professor at Institute of Applied Geology, the University of Erlangen, Germany, Professor in Soil Chemistry, University of Peradeniya, Fulbright-Hayes Senior Fellow, University of Maryland at College Park, and a Post-doctorate Research Affiliate Stanford University, USA. Member of the National Steering Committee of Sri Lanka China Bilateral Program on China-Sri Lanka Joint Research and Demonstration Center for Water Technology. He is a member of visiting Faculty of many universities.
Field of expertise: Water Chemistry and modeling

Title: **Research Professor**
E-mail: **rohan.we@nifs.ac.lk**

Environmental Science Program: Water Research

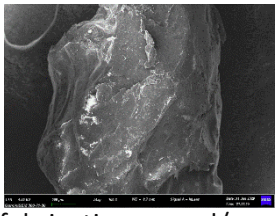
Most researchers often consider environmental science as an applied discipline. What underlying fundamental level of understanding does environmental research need to attain to evaluate the delicate processes that control nature? In consonance with the National Environmental Action Plan of Sri Lanka, we have a different perspective in executing environmental research at NIFS. The NIFS Environmental Science Research Program addresses of hitherto date unsolved Sri Lankan environmental problems that have no or ambiguous solution in the world at a molecular level. The NIFS Environmental Science Program research focuses on the atmospheric, water, and soil environmental processes to elucidate intrinsic factors that control them.

The researchers from the University of Peradeniya, Rajarata University, University of Jayawardhanapura, Uva Wellassa University, National Water Supply and Drainage Board, Water Resources Board, Hefei University of Technology, Chinese Academy of Sciences, Karlsruhe Institute of Technology, Lublin University of Poland, National Chung Hsing University, University of Manitoba collaborate with NIFS Environmental Science Group. The National Research Council of Sri Lanka, Natural National Research Foundation of China, Taiwan, DAAD, Germany, Program on Belt and Road Countries, China, and the industrial sector funds most of the NIFS environmental projects. We report the progress achieved by the NIFS Water Research Group during 2019.

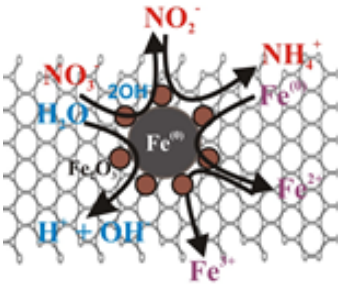
Turn Key Water Treatment Plant: In compliance with UN Sustainable Development Goals, the provision of safe water to the entire nation by 2030 is a priority of the development plan of the Government of Sri Lanka. Presently over 1.4 million people mostly living in the dry zone experiences acute water stress. Most of the drinking water resources in the dry zone are unpalatable due to high salinity. However, little attention is explicitly paid to mitigate high salinity, rendering water palatable. We have developed a turn-key treatment solution using nano and reverse osmosis membranes to combat salinity issues. Our plant operates at near-zero wastewater generation. The concentrates blend to reach natural water chemistry before disposal. Based on reaction paths of the major ion pairs, we controlled cations in the water so that anions like fluoride will be removed simultaneously while restoring ion balance. The facility is now commissioned to a village community. Besides, we developed a mobile phone application for plant automation. The facility is now operational at a laboratory scale level.

Electrochemical Water Treatment: In collaboration with the Chinese Academy of Sciences, we developed a new electrodialysis self-reversal (EDR)process to mitigate the salinity of water. The construction of the pilot plant is completed, however, the installation at the Rajarata University of Sri Lanka has been delayed.

Reactivity Enhanced Sand: In drinking water treatment, sand filters are conventionally used to control turbidity. We enhanced the performance of sand fabricating sand/graphite composite. In addition to turbidity, the reactivity improved sand and fluoride in water. A Sri Lankan patent is pending.

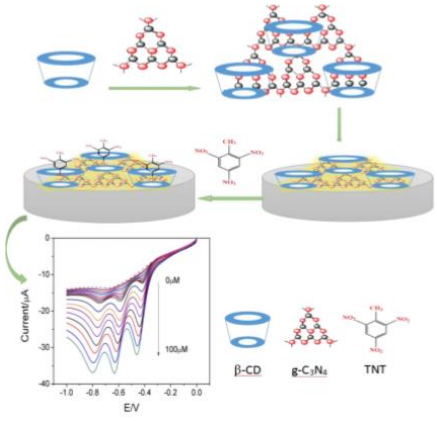


Nitrate Reduction in Water: In compliance with green technology, we fabricated zero-valent iron – reduced graphene oxide nanocomposites (nZVI-rGO-P) using polyphenols derived from green tea both as a reductant and binder. When compared with nZVI -BH, the nZVI-rGO-P reduces 70 % per 100 mg/L nitrate in solution.



Water Quality Standards introduced by regulatory agencies like WHO or US EPA consider total concentrations of chemical species in water. However, the synergy among these species requires consideration. At the same time, particular attention should be paid to identify feasible chemical species present in natural waters. Hitherto date, different species were predicted using thermodynamics models, which do not guarantee their actual presence. We developed the potential energy surfaces of ion pairs and tried identifying their presence in natural waters using EXAFS measurements.

Electrochemical sensors for pollutant control in water is carried out in collaboration with Hefei University of Technology (Prof. Xing CHEN GL). A novel method using mesoporous g-



C_3N_4 and β-cyclodextrin nanocomposite (mpg-C_3N_4/β-CD) for electrochemical detection of 2,4,6-trinitrotoluene (TNT) was developed. The unique structure of the mesoporous g-C3N4/β-CD nanocomposite facilitates both mpg-C_3N_4 electrocatalysis and β-CD inclusion-complexation of the analytes. The results illustrate the potential for using g-C3N4/β-CD modified GCE sensors in monitoring TNT and other nitroaromatic compounds in environmental analysis.

Selected Publications

Zhi-Qiang Wang, Hongjin Liu, Chun-yang Li, Xiaoyuan Chen, **Rohan Weerasooriya**, Juan Wei, Jinmei Lv, Pin Lv, Yucheng Wu (2020) Mesoporous g-C3N4/β-CD nanocomposites modified glassy carbon electrode for electrochemical determination of 2,4,6-trinitrotoluene, Talanta (in Press)

M. Makehelwala, Y. Wei,,S.K. **Weragoda,., R. Weerasooriya (2020)** Ca^{2+} and $SO4^{2-}$ interactions with dissolved organic matter: Implications of groundwater quality for CKDu incidence in Sri Lanka. Journal of Environmental Science (In Press).

Titus Cooray, Yuansong Wei, Junya Zhang, Libing Zheng, Hui Zhong , Sujithra K. Weragoda and **Rohan Weerasooriya** (2019) Drinking Water Supply for CKDu Affected Areas of Sri Lanka Using Nano-Filtration Membrane Technology: From Laboratory to Practice. *Water* 11, 2512 -2526.

T. Cooray;Y. Wei; H. Zhong; L. Zheng.;S.K. Weragoda,; **R**.**Weerasooriya** (2019) Assessment of groundwater quality in CKDu Affected areas of Sri Lanka: Implications for drinking water treatment. *Int. J. Environ. Res. Public Health*, *16*, 1–16.

Core Research Group

Dr. SK Weragoda, NWSDB, Prof. Y. Wei, Adjunct Professor, NIFS, Director, RCEES, CAS, Prof. Xing CHEN, Group Leader Sensors development, Hefei University of Technology, Dr. Atula Bandara, UoP, Prof Gamini Kumarasinghe, UoJProf. Ajith Herath, RUSL.,

Graduate Research Candidates

Wu Zhigo, M.Phil./ PhD Candidate PGIS, University of Peradneiya

Rukshani Padmanandan/ Jayani Bandara/Upeksha Halpegama

From Left: Ms. WADK. Senavinanda, Ms. AMD. Rajapakshe, Ms. TKS. Priyangani, Prof. Nora, Mr. DS. Rajapakshe, Prof. R. Weerasooriya, Dr. IPL. Jayarathne, Mr. HANHB. Senanayake, Ms. JU. Halpegama, Ms. E. Munasinghe, Ms. PMCJ. Bandara, Ms. P. Rukshagini

Jayani Upeksha Halpegama

Upeksha Halpegama is a Research Assistant in the Environmental Science Research Program at the National Institute of Fundamental Studies (NRC TO 16-015 research grant). She received her B.Sc. from the Rajarata University of Sri Lanka in 2017 and joined NIFS in 2018. Her research focuses on the comparative electrochemical methods for treatment of drinking water: Design and construction of continuous flow reactor and optimization. Her research interests include Electrochemistry and material chemistry.

Mobile: +94 0718570110
E-mail: jhalpegama@gmail.com
Jayani.ha@nifs.ac.lk

Rukshagini Pathmanathan

Rukshagini Pathmanathan is a research assistant in Environmental modelling research group at the National Institute of Fundamental Studies (NRC TO 16-015 research grant). She has recently completed her MSc in Soil and Environment at the Postgraduate Institute of Agriculture, University of Peradeniya. She obtained her basic degree in Agricultural Technology and Management, specializing in Soil Science from the University of Peradeniya. Her research focus is on Identification of fluoride genesis in groundwater and development of groundwater protection plan for source water in Dry zone regions of Sri Lanka. She has research experience related to nano Zero Valent Iron in reduction of nitrate in the drinking water.

Mobile: 075 040 6646;
E-mail: ruks2007@gmail.com

Lakmal Jayarathna

BSc (Sp) Chemistry 2006, PhD 2013 (UOP). Research Fellow (Environmental Science Research program), NIFS, Sri Lanka, Research Scientist, Material Technology Section, Industrial Technology Institute (2013-2017).

Title: **Research Fellow**
Email: **lakmalipj@yahoo.co.uk**
Tel: **0718016717**
ORCID ID: **0000-0002-9592-9183**

Environmental Science Research Program: Materials Development and Fabrication

Materials development and fabrication program under the Environmental Science research project has to been considered as an area of fundamental and applied science. The **NIFS Environmental Science Research Program** focused on addressing the fundamental scientific aspects of pressing environmental problems in Sri Lanka with global interest. Environmental pollution is one of the major results of modern development. Remediation of pollutant materials from water, soil, and the air is the most focused. Monitoring and understanding of the basic and fundamental mechanisms of the pollutant materials in nature are much more important. Advanced materials such as nanomaterials and composite materials play a vital role in various applications. Nanomaterials functioning as adsorbents and catalysts and their composites are used for the detection and removal of gases, contaminated chemicals, organic pollutants, and biological substances.

Nanomaterials show a better performance in environmental remediation than other conventional techniques because of their high surface area (surface-to-volume ratio) and their associated high reactivity. Synthesis of advanced materials using locally available materials such as zeolite from kaolin, contribute the national development. Nano and composite materials show higher efficiency in remediation of pollutant in the environment.

Synthesis of zeolite

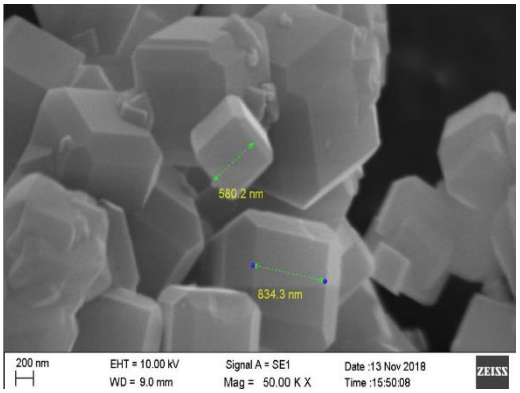
1. Water treatment
2. Catalytic applications
3. Adsorption, purification and separations process
4. Hydrogen storage
5. Nano-composites for optoelectronics
6. Sensors
7. Drug delivery application
8. Size control synthesis of materials
9. Membrane seperation

Synthesis of Nano- zeolite-A (LTA) with aid of SDS as particle size-controlling Agent

Conventional synthetic zeolites historically known as molecular sieves are crystalline aluminosilicates with well-defined pore structures. Nano-crystalline zeolite synthesis has received considerable attention in the past decade and has today turned essential in commercial materials. Zeolite-A (LTA zeolite) is a type of synthetic zeolite, which is known as one of the most commercially successful zeolites having wide applications such as air separation.

Usually, nano-LTA zeolites are synthesized via low-temperature hydrothermal crystallization in the presence of 'organic templates'. Generally, Tetramethylammonium-hydroxide (TMAOH) is used as a template. However, these templates are expensive and non-recyclable. Therefore, from the green chemistry point of view, numerous efforts have been devoted to synthesize template free nano-zeolites. In this work, nano- zeolite-A was synthesized via both conventional hydrothermal and microwave method in the absence of mineralizers and organic templates. As a size controlling agent, an anionic surfactant Sodium dodecyl sulfate (SDS) was used. The effect of different crystallization conditions including aging time, synthesis time and synthesis temperature were studied under both methods. In addition, the influence of surfactant amounts for particle size-controll was investigated.

Hydrothermal and microwave methods have produced pure LTA zeolites crystals with a 300-500 nm range in size with a high degree of crystallinity. Compared to hydrothermal method, microwave heating required much less time and no considerable change was found in crystal size and crystallinity.



Synthesis, characterization and determination of the catalytic activity of Fe and Cu modified zeolite catalysts.

Zeolite is a crystalline aluminosilicate framework which comprises a tetrahedral arrangement of Si^{4+} and Al^{3+} that are surrounded by O^{2-} . Zeolites are used in various applications in solving environmental, scientific, industrial and day to day problems due to their flexibility and adaptability. Some of major applications of zeolites are purification of water, formation of sludge, medicinal uses and catalysis. In this study, zeolite was modified with $FeSO_4$ and $CuSO_4$ using the solid state ion exchange method to produce modified Fe-zeolite and Cu-zeolite catalysts respectively. The modified catalysts were characterized using FTIR, XRD and particle size analysis. Catalytic isomerization of glucose to levulinic acid and benzylation of toluene and benzyl alcohol reaction were used to determine the catalytic activity of the modified Fe-zeolite and Cu-zeolite catalysts.

Zeolite based catalyst for NOx, SOx reduction

Zeolites have been known for about 250 years, though their employment in science and industry started only in the early 1960s. Zeolites are typically synthesized under hydrothermal or solvothermal conditions with Al and Si sources or organic amines/ ammonium cations as a template. Indeed, of using chemical as starting materials, alumino-silicate sources, such as kaolin clay, were used for this study. However, traditional methods are not environmental friendly. Therefore, in this project a greener synthesis method will be developed to synthesize zeolite from locally available kaolin clay. It has been reported that the zeolite obtained through such routes can further be modified for some selective reactions. The development of zeolite based selective catalytic reduction (SCR) system for the reduction/removal of emission of harmful gasses, is a major goal of this research project.

When considering the methodology for this project, locally available kaolin clay will be collected, and full chemical analysis will be conducted. Then kaolin clay will be used for synthesis of zeolite by hydrothermal or microwave method. Fine tuning, such as ion ratio, temperature, time, etc., will be

tested to obtain the required morphology of zeolite. A new method will be developed for the synthesis of specific types of zeolite (zeolite Y, beta and mordenite) from local kaolin clay. Synthesized zeolite will be intercalated with some metal cataions to obtain catalytic type zeolite with different experimental conditions, such as solid state ion exchange method, wet ion exchange, etc. Some zeolites will be modified to increase gas adsorption performance. Materials will be fully characterized by using advanced material characterization techniques. Catalytic reduction of exhaust gases such as NO_x and SO_2 will be tested under different experimental conditions. Effect of temperature, loading, concentrations and other physical and chemical parameters will be tested. Adsorption behavior of the gases with physical and chemical parameters will also be tested. Finally, conditions will be optimized, and the method will be extended to field studies.

Surface modification of super-paramagnetic Magnetite nanoparticles for bio-conjugation

Unique structural and functional properties of iron oxide nanoparticles (IONP) have become important in most biomedical applications such as laboratory diagnostics, therapeutics and targeted drug delivery. These applications require magnetic IONP to be essentially non-toxic and bio compatible. In order to achieve biocompatibility, these magnetic IONP are required to be coated with appropriate polymers or inorganic materials.

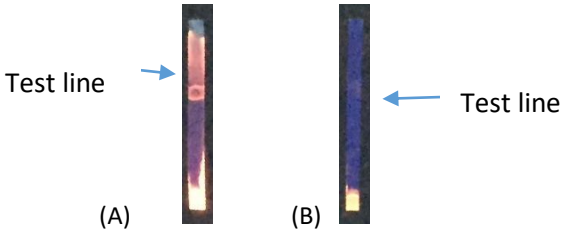
Magnetite (Fe_3O_4) nanoparticles were synthesized by co-precipitation of Iron (II) chloride tetrahydrate and Iron (III) chloride in the presences of a basic solution. The XRD pattern of the sample matches well with the standard XRD graph. Reduced particle size can be observed by the increased intensity of the peaks due to prevention of aggregation of nanoparticles. Acquired FTIR spectrums suggested PEG- Fe_3O_4 via its carbonyl groups and conjugated aromatic ring of rhodamine (Rh). Thus, surface modification of PEG coated Fe_3O_4 nanoparticles with fluorescent material; Rh was confirmed by XRD and FTIR was successful.

Bio-conjugation of Rh-PEG- Fe_3O_4 nanoparticles can be achieved by making use of the functional groups of the polymer surface. These bio-conjugated super-paramagnetic iron oxide nanoparticles can be further improved as florescent detection probes.

Development of rapid lateral flow diagnostic kit for Dengue

Dengue Fever is considered as one of the most important arthropod borne viral diseases. Diagnosis of the disease as early as possible will improve the patient management, vector controll and lower the fatality rate. Therefore, there is a need to develop a low cost, rapid diagnostic test that could be used easily in field settings such as home or rural clinics where such facilities are limited. The objective of this study is to develop a rapid, user friendly diagnostic test to detect dengue NS1 protein, using nanotechnology. To develop the assay, highly fluorescent, L-cysteine capped CdTe quantum dot nanoparticles were synthesised. A lateral flow immunoassay (LFIA) was be developed using in house produced anti-dengue NS1 monoclonal antibodies which are conjugated to fluorescent CdTe quantum dot nanoparticles.

Figure shows Test pad of the lateral flow immunoassay strip. (A): positive control (B): negative control.



Ph.D/M.Phil/MSc Students: Ms. M.M.E. Munasinghe, Mr. B.A.Y.B. Jayawardhana, Ms. Gimhani Perera, Ms. Anuradha Rajapakse

Key Publications:

Lakmal Jayarathna, Nelum Karunathilake, Athula Bandara and Rohan Weerasooriya, Adsorption Configurations of 2-Chlorophenols on Colloidal Silica, DOI: 10.5772/intechopen.88113

Erandi Munasinghe, Maheshi Aththapaththu and **Lakmal Jayarathne**, Magnetic and Quantum Dot Nanoparticles for Drug Delivery and Diagnostic Systems**,** DOI: 10.5772/intechopen.88611

Anuradha Rajapakshe

Anuradha Rajapakshe is currently an M.Phil Research Assistant in the Environmental Science Research project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc. special degree in Chemistry from the University of Peradeniya in 2018, and joined NIFS in 2019. Her research focuses on Material Science and carrying out experiments to develop modified materials for removal of harmful gases from vehicle exhaust. Her research interests include Exploration of newer inorganic materials as catalysts which can be used in a variety of applications.

Mobile: 0769153514

E-mail: anuradha.ra@nifs.ac.lk

https://www.researchgate.net/profile/Anuradha_Rajapakshe

Gayan Bowatte

Gayan Bowatte completed BSc (Hons) degree in 2009, from the Faculty of Science, University of Peradeniya. He was awarded his PhD in 2016 in epidemiology and biostatistics from the Faculty of Medicine, the University of Melbourne, Australia. After completion of PhD he worked as a Research Fellow at the Melbourne School of Population and Global Health at the University of Melbourne.
Publications: 55 peer reviewed journal articles; 40 conference abstracts.

Title: **Research Fellow**
E-mail: **gayan.bo@nifs.ac.lk**
ORCHID ID: **0000-0002-9577-9752**

Air pollution modelling and health effects estimate

Air pollution is a global public health issue which is linked with adverse health outcomes throughout the globe. It poses a great burden of disease, annually contributing to 7 million deaths in the world, making it the top environmental risk factor associated with burden of disease. In Sri Lanka, air pollution exposure is a neglected health risk for humans. Air pollution is ubiquitous in nature that makes the whole population in a given area exposed. Therefore, even a small increase may pose a high risk at the population level. Exposure to air pollution leads to development and exacerbations of respiratory and cardiovascular diseases. The health burden posed on the Sri Lankan economy by air pollution has significant consequences by affecting economic growth as well as welfare of its citizens.

Air pollution modelling is used to estimate population/individual level exposures which are important in health risk assessments. The research project at the “Air Pollution Modelling and Health Risk Assessment” group aimed at modelling air pollution in Sri Lankan urban and rural areas, estimating health risk associated with air pollution and evaluating performance of air pollution control methods. Hence, the information generated can be utilized to identify vulnerable groups, high risk areas, provide recommendations to implement policies to reduce pollution. The research of this group will provide evidence targeted at controlling air pollution by implementing policies.

Air pollution monitoring network using smart sensors: Air pollution monitoring in the country has been limited to a few specific locations that do not represent actual levels that Sri Lankans are exposed to. Hence, it is impossible to evaluate health risk associated with air pollution in Sri Lanka using the few existing ground monitoring stations. Air pollution monitoring using standard fixed site monitors are expensive in terms of equipment cost, maintenance and labour. Recent technological advances in the development of smart sensors to monitor air pollution has opened an opportunity to establish low cost air pollution monitoring networks. These sensors are able to measure pollutants at high spatial and temporal resolutions, which is a notable advantage in assessment of exposure to environmental contaminants. These solar powered sensor units (Figure 1) are capable of measuring Particulate Matter (PM) < 1 µm in diameter (PM_1), PM <2.5 µm in diameter ($PM_{2.5}$) and PM <10 µm in diameter (PM_{10}) continuously. These data are uploaded to a cloud-based server and pollution levels can be observed real time.

We deployed these sensors in locations of Colombo and Kandy to measure air pollution in both urban and semi-urban areas.

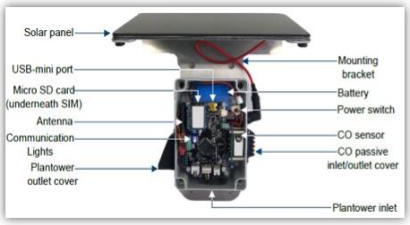


FIG1: KOALA (Knowing Our Ambient Local Air quality) smart sensor

The average $PM_{2.5}$ in Colombo was 60 µg/m^3 while in Kandy during the same time period the average $PM_{2.5}$ was 32 µg/m^3 (during two weeks of continuous monitoring). This indicates that in selected urban locations the levels of $PM_{2.5}$ in Colombo is relatively high compared to Kandy (FIGs 2 & 3).

FIG 2: Daily average $PM_{2.5}$ variation in Colombo

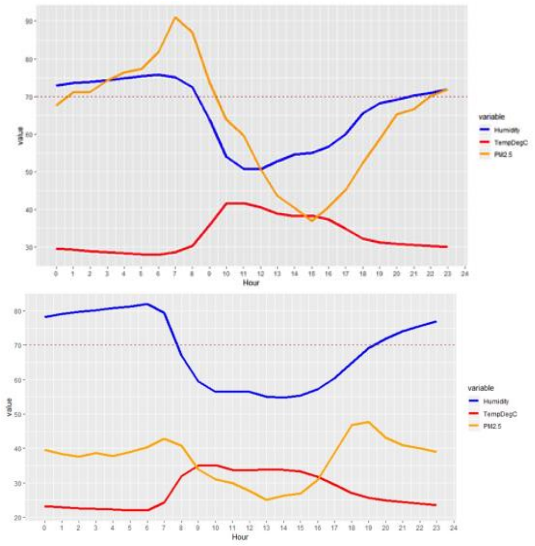


FIG 3: Daily average $PM_{2.5}$ variation in Kandy

Figures 4 and 5 shows the weekly pattern of $PM_{2.5}$ in both Colombo and Kandy.

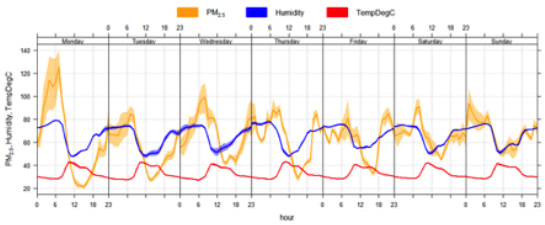


FIG4: Weekly variation of $PM_{2.5}$ in Colombo

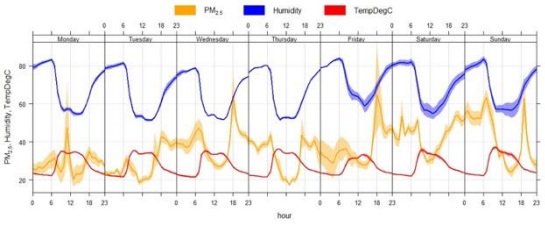


FIG5: Weekly variation of $PM_{2.5}$ in Kandy

The collected data over one-year period in 120 locations of Kandy will be used to develop a Land Use Regression model to predict air pollution in unmeasured locations of the Kandy area.

Measuring air pollution during adverse events: The levels of air pollution was very high in November 2019 in Sri Lanka. In most of the places, smog was visible. These high levels were suspected to be wind transported of pollutants from India. Our air pollution sensors were able to detect this high level of pollution. Figure 6 shows that $PM_{2.5}$ levels started to rise after the first week of November 2019.

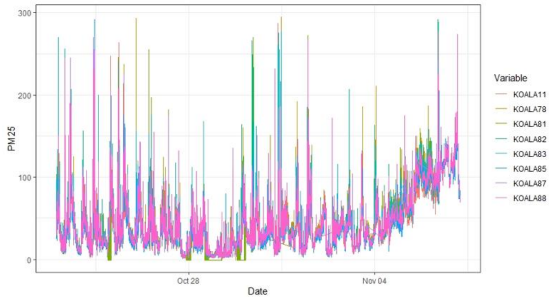


FIG6: High air pollution in November 2019 in Kandy-results of 9 sensor readings

Indoor air pollution, respiratory diseases and birth outcomes in rural Sri Lankan communities: In rural areas of Sri Lanka the effect of indoor air pollution is higher compared to outdoor. We conducted a research project to investigate the effect of fuel used for cooking on respiratory health and birth outcomes of rural communities. The results indicate children living in households primarily using biomass fuel were twice as likely to have wheezing than those living in households primarily using clean fuels (LPG stoves) (OR 2.38; 95%CI 1.08-5.27). Children were at higher risk of allergic rhinitis and eczema in households that used a traditional biomass stove compared with a clean stove OR3.08; 95%CI 1.34-7.04 and OR7.96; 95%CI 2.35-26.93, respectively.

Biomass fuel use had 2.7 times higher risk of having a low-birthweight baby compared to households used LPG for cooking, OR 2.74 95%CI 1.08-6.96. Similarly, biomass fuel had a higher risk of small for gestational age (OR1.87 95%CI 1.03, 3.41). A trend of increased risk was observed for these birth outcomes with the type of stove used (LPG stove, improved traditional stove and traditional stove) (FIGs 7 & 8).

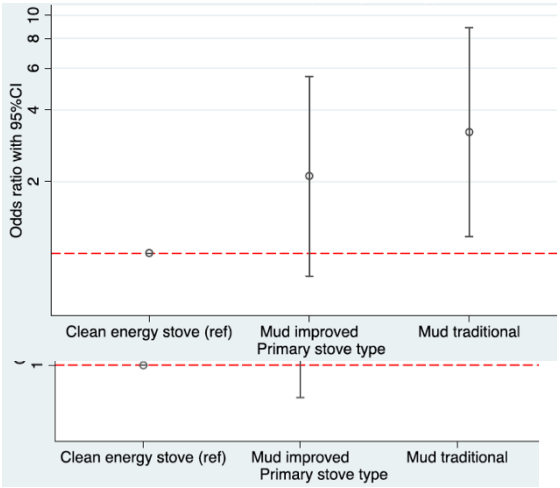


FIG7: Adjusted Odds Ratios for the association between stove type and low birthweight

FIG8: Adjusted Odds Ratios for the association between stove type and small for gestation

Research Students: Mr Mahesh Senarathna.

Key Publications:

Perret JL, **Bowatte G,** Knibbs LD, et al. Residential exposure to outdoor air pollution and post-bronchodilator lung function deficits in mid-adult life. Am J Respir Crit Care Med. 2019 1;200(1):110-4.

Yang BY, Guo Y, Markevych I, Qian ZM, Bloom MS, Heinrich J, Dharmage SC, Rolling CA, Jordan SS, Komppula M, Leskinen A, **Bowatte G**, et al. Association of long-term exposure to ambient air pollutants with risk factors for cardiovascular disease in China. JAMA Netw Open. 2019 8;2(3):e190318–e190318.

Suresh P. Benjamin

Suresh Benjamin obtained his Ph.D. from the University of Basel, Switzerland. Prior to joining the NIFS he was a Postdoctoral Researcher at the University of California (Berkeley), The George Washington University and the Smithsonian Institution. He is also an Alexander von Humboldt Research Fellow.

Title: **Associate Research Professor**
E-mail: **Suresh.be@nifs.ac.lk**
T.P.: **0812232002**
ORCID ID: **-**
www.nifs.ac.lk/research/evolution-ecology-and-biodiversity

Ecology and Environmental Biology

Basic research in biodiversity covers every aspect of ecosystem function. Research in Ecology and Environmental Biology laboratory focuses on understanding how ecosystems are modified by the loss of biodiversity. Ecosystems sustain human lives and diversity of species is fundamental to healthy ecosystems. We believe that biodiversity loss, through the ecosystem services it supports, is the single most significant challenge facing not only Sri Lanka but also the entire planet. Biodiversity loss is also a hindrance to achieving sustainable development.

Biodiversity is negatively impacted by climate change, with negative consequences for human wellbeing. Biodiversity, can also be an important contributing factor in climate-change mitigation and adaptation. Biodiversity estimates can be used as indirect assays of ecosystem function or productivity or as direct estimators of ecosystem responses to human induced climate change. Thus, the study and conservation of biodiversity is critical to addressing climate change.

Studies are currently on terrestrial and freshwater ecosystems worldwide, with a special focus on the Western Ghats-Sri Lanka biodiversity hotspot. The primary focus is the largely unchartered fields of invertebrate biodiversity. Our findings are shared through papers published in international, peer reviewed journals.

Molecular Phylogeny of cobweb spiders with a Revision of Selected Genera (Araneae: Theridiidae) of Sri Lanka based on morphology and target gene analysis

Theridiidae is one of the largest spider families consisting of 2300 described species placed in 109 genera. They are worldwide in distribution. Many common spiders throughout the world are members of this family. Cobweb spiders are highly diverse from the perspective of species richness, morphological diversity, variety of web architecture, and behavioral repertoires. Our literature review suggests that cobweb spiders are not a well-studied taxonomic group in Sri Lanka. As many species were described almost a century ago. In this new project we plan to study the Theridiidae genera *Argyrodes*, *Chikunia*, *Coleosoma*, *Meotipa*. Perhaps the most beautiful of all the Theridiidae belong to the genus *Argyrodes*. It is a part of the subfamily Argyrodinae. They are mostly very small, but their bodies are spangled with brilliant silver, so that when hanging in webs of other spiders, they shine like drops of water in the sunlight. Hence, they are called dewdrop spiders. A resemblance which doubtless serves them as a protection against their enemies. Spiders of the genus *Argyrodes* (Theridiidae) are generally known to be kleptoparasitic. Some species can regularly be found in the webs of other spiders (Web sharing). These kinds of Kleptoparasitic spiders occupy heterospecific webs to steal prey or silk.

Overall aims of this project which began in early 2019 is:

To revise taxonomy and study the phylogenetic relationships of selected cobweb spider genera of Sri Lanka.

2. Specific objectives:

i. To revise the taxonomy of selected cobweb spider genera in Sri Lanka.

ii. To study the phylogenetic relationships of the selected cobweb spider genera in a cladistic/phylogenetic framework using target gene analysis.

Taxonomic revisions and descriptions of jumping spiders of Sri Lanka based on morphology and target gene analysis (Araneae: Salticidae) from Sri Lanka

Salticidae is the largest family of spiders and currently includes around 6183 species placed in 646 genera, distributed worldwide. Majority of salticid genera lack proper descriptions and revisions. Phylogenetic relationships of Sri Lankan jumping spiders are still unknown due to lack of morphological and molecular based studies.

The objectives of the current study are to provide taxonomic revisions of the jumping spider genera *Ballus*, *Colaxes* and *Marengo* and placement of these genera in the salticid tree of life, description of new species of these three genera, phylogenetic placement and taxonomic description of the Sri Lankan endemic genus *Flacillula* with provisional descriptions of new species including notes on their distribution and provision of distributional records of Sri Lankan species of the Jumping spider genera *Brettus*, *Cocalus*, *Cyrba*, *Gelotia*, *Phaeacius* and *Portia*.

Molecular phylogeny of *Ballus*, *Marengo* and *Colaxes* was based on a combined molecular data set of H3+CO1+28S target gene fragments. The phylogenetic analyses were conducted separately for *Ballus* + *Marengo* + *Colaxes* and *Flacillula*.

According to maximum likelihood analysis and Bayesian analysis, Sri Lankan *Ballus* appeared as sister to *Peplometus*, a genus only known from Africa. *Marengo* appeared as a paraphyletic taxon: *C. wanlessi*, *M. crassipes*, *M. nitida* and *Marengo* sp. B appeared within a well-supported clade. In maximum likelihood analysis and Bayesian analysis, *Flacillula* species of Sri Lanka are in a well-supported clade, distinct from *F. minuta* of the Pacific Islands. Twenty-one species (12 of them endemic) are described based on the material from Sri Lanka. *C. wanlessi*, *M. crassipes*, *M. nitida*, *M. striatipes*, *F. lubrica*, *Brettus adonis*, *Cocalus lacinia*, *Cyrba ocellata*, *Gelotia lanka*, *Phaeacius wanlessi*, *Portia labiata* and *Spartaeus spinimanus* are re-described. One species of *Marengo* and seven species of *Flacillula* are named provisionally pending formal description. The presence of a large number of endemic species and their localised distribution in the country highlights the urgent need of conserving their habitats.

Taxonomic revisions and descriptions of jumping spiders of the genera *Carrhotus*, *Epidelaxia*, *Telamonia* and *Thyene* (Araneae: Salticidae) in Sri Lanka.

This is a subproject of the project mentioned above. The aim of this project, which began in early 2019, is revision of selected genera and placement in the salticid tree of life.

To revise the taxonomy and study phylogenetic relationships of Jumping Spider Genera (Family: Salticidae) from Sri Lanka.

Specific objectives

I. To revise the taxonomy of species of jumping spiders of the genera *Carrhotus*, *Epidelaxia*, *Telamonia* and *Thyene* in Sri Lanka.

II. To study the phylogenetic position of the selected jumping spider genera within a phylogeny of the family and outgroups.

Molecular phylogenetic relationships of selected crab spider genera (Araneae: Thomisidae) from Sri Lanka

Crab spiders of the family Thomisidae are medium sized, cryptic dwellers in habitats ranging from foliage, flowers, tree barks to soil. They possess a variety of morphological, behavioural and ecological traits which make them special. Majority of thomisid genera lack proper descriptions and revisions, and molecular data. Still more important to us, phylogenetic relationships of Sri Lankan crab spiders are still unknown due to lack of morphological and molecular studies.

The objectives of the current study are to gain a comprehensive understanding of the crab spider biodiversity of the island, re-circumscribe genera in phylogenetic terms and placement of these genera in the thomisid tree of life using molecular phylogenetics.

M.Phil Students: Miss Dilini Prabhashini Bopearachchi, Miss. Mathura Tharmarajan and Miss. Abira Satkunanathan.

Key Publications:

Gillespie, R.G., Benjamin, S.P., Brewer, M.S., Rivera, M.A.J. and George R.K. 2018. Repeated diversification of ecomorphs in Hawaiian stick spiders. Current biology 28: 941-947.

Ranasinghe, U.G.S.L. and Benjamin, S.P. 2018. Three new species of *Aprusia* (Araneae: Oonopidae) from Sri Lanka with a phylogenetic analysis of the genus. Journal of Natural History 52: 713-738.

Ileperuma Arachchi, IS. and Benjamin, S.P. 2019. Twigs that are not twigs: phylogenetic placement of crab spiders of the genus Tmarus of Sri Lanka with comments on the higher-level phylogeny of Thomisidae. Invertebrate Systematics 33: 575-595.

Kanesharatnam, N. and Benjamin, S.P. 2019. Multilocus genetic and morphological Phylogenetic analysis reveals a radiation of shiny South Asian jumping spiders (Araneae, Salticidae). Zookeys. 839: 1-81.

From Left: Ms. M. Tharmarajan, Ms. A. Satkunanathan, Mr. N Rathnasiri, Prof. S. Benjamin Mr. NP. Athukorala, Ms. D. Bopearachchi

Dilini Bopearachchi

Dilini Bopearachchi is currently a M.Phil. Research Assistant in the Evolution, Ecology and Biodiversity project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc from the Rajarata University of Sri Lanka in 2015 and joined NIFS in 2017. Her research focuses on Biodiversity of jumping spiders in Sri Lanka. Her research interests include Biodiversity Molecular Ecology, Systematics, and Evolutionary biology.

Mobile: +94 774 455 441;
E-mail: dilini.bo@nifs.ac.lk
https://www.researchgate.net/profile/Dilini_Bopearachchi

Abira Satkunanathan

Abira Satkunanathan is currently a M Phil Research Assistant in the Evolution, Ecology and Biodiversity project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc. from the University of Ruhuna in 2017 and joined NIFS in 2019. Her research focuses on the Biodiversity of jumping spiders in Sri Lanka. Her research interests include Biodiversity and Conservation, Molecular Ecology, Systematics, Evolutionary Biology, Arachnology, DNA barcoding and Molecular Phylogeny.

Mobile: +94 774 942 521;
E-mail: abirasatkuna11@gmail.com
https://www.researchgate.net/profile/Abira_Satkunanathan

Mathura Tharmarajan

Mathura Tharmarajan is a M.Phil Research Assistant in the Evolution, Ecology and Biodiversity project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc from the Ruhuna University of Sri Lanka in 2017 and joined NIFS in 2019. Her research focuses on the Biodiversity of cobweb spiders in Sri Lanka. Her research interests include Biodiversity and Conservation, Molecular Ecology, Systematics, Evolutionary Biology, Arachnology, DNA barcoding and Molecular Phylogeny.

Mobile: +94 770 877 743
Email :- mathura.th.nifs.ac.lk
https://www.researchgate.net/profile/Mathura_Tharmarajan

M.C.M. Iqbal

B.Sc (Agric.) from the University of Peradeniya in 1980, Dipl. Ing_Agron. from the Swiss Federal Institute of Technology in Zurich (ETH) and a Ph.D from the University of Göttingen. Served as a Senior Lecturer in Agriculture Biology at the Eastern University, Sri Lanka and joined the NIFS in 1996. Received research fellowships from the German Academic Exchange Service and the Erasmus Mundus programme of the EU received Presidential Research Awards on many occasions. Council member of the Royal Asiatic Society, the Institute of Biology, Chairman of the General Research Committee (SLAAS), and a member of the Ethics Committee (SLAAS). Also a member of the Board of Governors of the NIFS

Title: **Associate Research Professor**
E-mail: **iqbal.mo@nifs.ac.lk**
T.P.: **0812232002**
ORCID ID: **0000-0002-4862-5099**

Plant and Environmental Sciences

Contamination of our environment by hazardous materials such as heavy metals, textile dyes, fertilizers (nitrates, phosphates) and organic and inorganic wastes is a concerning environmental issue in Sri Lanka. One of the causes is discharge of effluents, particularly from small and medium scale industries into waterways. These small industries are unable to invest in high tech, expensive waste water treatment systems. A cost-effective simple decontamination method is therefore needed for use in these industries. Further, it is necessary to decontaminate the contaminated water bodies to provide a safe environment for all living beings. Our research group, has developed and synthesised adsorbent materials and identified plant species to use in water bodies to absorb these pollutants. Some plant species are capable of breaking down textile dyes through their metabolic pathways.

We continued the development of polymer layer silicate composites (PLS) and Metal Organic Frameworks (MOFs) to remediate these pollutants. MOFs are crystalline structures used in the separation and storage of toxic gases, catalytic reactions and electrochemistry. Using a green synthesis method (microwave-assisted hydrothermal method), MOFs, were developed to remove chromium and capture carbon-dioxide. Plant species capable of increased capacity to absorb phosphates and nitrates, which can be recycled as bio fertilizers, particularly with animal farm effluents, which have high levels of these nutrients are being investigated.

The plant tissue culture laboratory has developed a protocol for micropropagation of Stevia, is a natural sweetener, now in demand from the industry to replace sugar in confectionery and beverages. Experiments are in progress to break seed dormancy of difficult to propagate tree species and their micropropagation for forest restoration.

Investigations on Climate Change showed changes in the pattern of extreme rainfall and temperature in Sri Lanka. There was a significant decrease in rainfall in 15% of the meteorological stations, possibly due to the delayed onset of the southwest monsoon. The annual average minimum and maximum temperature also increased in 70% and 55% of the stations, respectively.

Environmental Remediation

Improper discharge of effluents from industries such as batik, textile dyeing, metal plating and leather tanning contaminate the environment with organic dyes and heavy metals. Most of these industries are small and medium scale and are unable to invest in high tech expensive wastewater treatment systems. A cost-effective simple decontamination method (i.e. end pipe treatment system) is needed for these industries. Further, it is necessary to decontaminate the contaminated water bodies to provide a safe environment for all living beings. To provide a solution, we have developed and synthesized adsorbent filter materials and identified plant species to use in contaminated water bodies as phytoremediators.

We are also using phytoremediation techniques and adsorption processes to recover phosphates and nitrates from the aquatic environment. Phosphate absorbed aquatic plants can subsequently be used as bio-fertilizers.

Metal Organic Frameworks (MOFs) were synthesised to remediate textile dyes and heavy metals. MOFs are crystalline structures used in the separation and storage of toxic gases, catalytic reactions, and electrochemistry. There are a few studies reporting the use of MOFs as a sorbent for heavy metals and textile dyes. We used a green synthesis method (microwave-assisted hydrothermal method) to synthesize the MOFs.

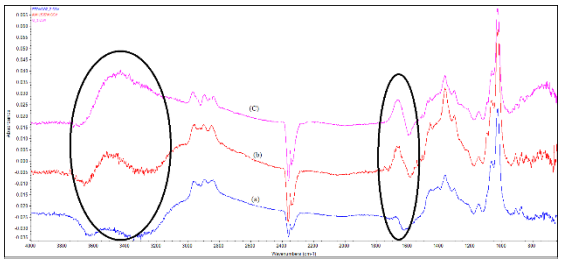


Figure 1. FT-IR spectra of reaction mixture for CO_2 experiment

Under a collaborative project with the Institute of Physical Chemistry of the University of Goettingen, Germany we are attempting the conversion of atmospheric carbon dioxide to useful organic compounds. We were initially able to convert CO_2 to formic acid using the MOFs, NH2-MIL 53 and MIL 53.

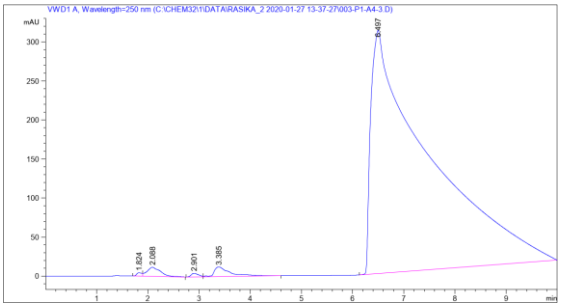


Figure 2. HPLC spectra of reaction mixture for CO_2 experiment

Phosphate remediation

Phosphorus, is an essential component of DNA, and necessary for all life forms. It is globally a limited resource. Globally, phosphate rock deposits are the major source of fertilizers; it is a finite resource and the deposits are estimated to be exhausted in 150 years. With no artificial substitute and increasing demand from food crops, recovery of phosphorus is essential. In addition, phosphorus containing effluents is an environmental issue causing eutrophication, algal blooms, and reduced drinking water quality. We investigated the ability of the invasive aquatic plant, *Salvinia molesta*, to recover phosphorus from effluent wastewater. In a greenhouse experiment, *S. molesta* removed 87% of the phosphate after 48 hrs. Of this, 79% of the phosphorus was recovered from the dried and powdered plant tissues. Using the powdered *S. molesta* as a phosphorus source, we conducted a hydroponic experiment to test the growth and yield attributes of a rice cultivar. Our results showed the dual ability of Salvinia to remove phosphorus from water with high levels of phosphorus, and to use these plants as a source of phosphorus fertilizer for rice. We are further investigating the phosphorous uptake and accumulation in plants growing on the Eppawela rock phosphate deposit.

Figure 3. Use of *Salvinia molesta* to recover phosphorus from effluent wastewater.

Plant tissue culture

To mitigate extensive deforestation of dry forests, restoration requires replanting. Natural seed propagation of these trees is limited due to seed dormancy, seasonal, slow, and seedlings not available in the numbers required. The objective of this project is to micropropagate the species Mee (*Madhuca longifolia*), Palu (*Manilkara hexandra*) and Kumbuk (*Terminalia arjuna*), which have high economic value as timber due to their strength and durability.

Figure 3. a. "Mee" *(Madhuca longifolia)* plant b. "Palu" plant *(Manilkara hexandra)*

Woody plant species are difficult to micropropagate due to their recalcitrant nature, internal contaminants, phenolic exudates and slow growth rate. In addition to direct organogenesis and indirect embryogenesis, we are investigating in vitro germination as a new path to overcome physical dormancy of the recalcitrant seeds. Seed treatments were applied to break seed dormancy and promote germination, which include, pre-chilling, treatment with glibberelic acid and potassium nitrate and changing light conditions.

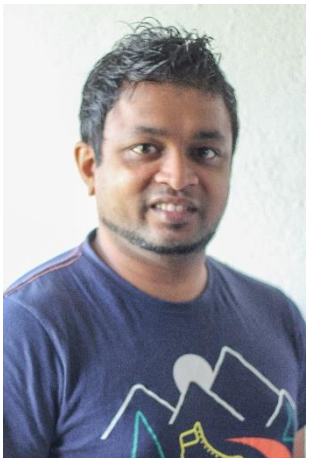
a b c d

Figure 3. a. Matured "Palu" seeds b. Matured "Mee" Seeds c. In vitro seed germination of "Palu" d. In vitro seed germination of "Mee"

A protocol was developed to micropropagate Stevia, a plant producing zero-calorie diterpene glycosides in its leaves. This is a natural substitute for sugar since they are about 300 times sweeter than sucrose. With the incorporation of natural growth enhancer (coconut water) to the growing media, plants were micropropagated and the results showed that Stevia can be mass propagated with a little amount of nutrients in a short period of time. This plant is important for food technologists and the confectionery industry to replace sugar in their products for consumption by people affected by diabetes mellitus.

Figure 3. a. *In vitro* grown Stevia b. Acclimatized Stevia on soil

From left: Ms. L. Jayathilaka, Ms. S. Perera, Ms. M. Karunarathna, Prof. Mohamad Iqbal, Mr. Ranjith Hapukotuwa, Dr. Rasika Dissanayaka



Rasika Dissanayake

Rasika Dissanayake is currently a Ph D Research Assistant in the Plant and Environmental Sciences project at the National Institute of Fundamental Studies (NIFS). He received his B.Sc. from the University of Peradeniya Sri Lanka in 2011, M.Sc. in 2013 and joined the NIFS in 2017. His research focuses on Development of adsorbent materials for wastewater treatment. His research interests include Environmental remediation, Material chemistry, Physical chemistry, Polymer chemistry and Metal Organic Frameworks and organometallic chemistry.

Mobile: +94 773 440 479
E-mail: rasika.di@nifs.ac.lk
https://www.researchgate.net/profile/Rasika_Dissanayake2

Manjula Karunarathna

Manjula Karunarathna is currently a M Phil Research Assistant in the Plant and Environmental Science project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc from the Uva Wellassa University Sri Lanka in 2017 and joined the NIFS in 2018. Her research focuses on Micro propagation of Woody plant Species grown in Dry Forest of Sri Lanka. Her research interests include Tissue culture of Endemic plants in Sri Lanka, Medicinal Plants and woody plant species, and Plant Secondary metabolite analysis.

Mobile: +94 713578747
E-mail: manjuca.ka@nifs.ac.lk
https://www.researchgate.net/profile/Manjula_Karunarathna

D.S.A. Wijesundara

Ph.D (Biology), City University of New York,1998: B. Sc. Botany, (1978) and M.Phil in Botany (1991), University of Peradeniya; Curator, Hakgala Botanic Gardens (1980-1989), Curator Royal Botanic Gardens Peradeniya and Curator, National Herbarium (1989-1998); Director, National Botanic Gardens, (1998-2006), Director General, Department of National Botanic Gardens (2006-2015); Research Professor NIFS, Kandy (January 2016 – to date); Presidential awards for Scientific Research. (2001, 2002, 2007, 2008, 2009, 2011 and 2012). Chairman National UNESCO Man and Biosphere Committee, Chairman National Species Conservation Advisory Committee. Elected Fellow of the National Academy of Sciences 2006. Council Member of University of Peradeniya.

Title: **Research Professor**
E-mail: **siril.wi@nifs.ac.lk**
Tel: **0718133155**
Orchid address: **0000-0002-6754-8201**

Plant Taxonomy and conservation

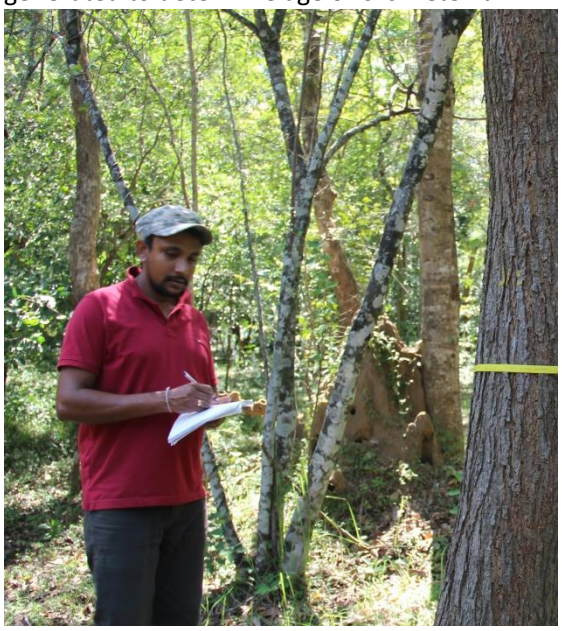
The Plant Taxonomy and Conservation project focusses primarily on, a) Taxonomic and Biogeographical Studies of flora of Sri Lanka, b) Restoration Ecology, c) Sustainable Use of Sri Lankan Plants, d) Factors affecting the conservation of flora of Sri Lanka including Invasive Alien Species, and e) Preparation of the National Red List for flora.

Conserving the natural forest ecosystems is vital for the wellbeing of both flora and fauna and the conservation of floral wealth has become an important national priority. The government of Sri Lanka is planning to increase the natural forest cover from the current 29.7% up to 32%. Assisted natural regeneration (ANR) is one of the important methods selected for restoring forest cover in degraded areas. NIFS-Sam Popham Arboretum (NIFS-SPA) is considered the best site in Sri Lanka for ANR. On account of its significance as a bench mark site for Assisted Natural Regeneration, many forest ecologists and botanists use NIFS-SPA as a research site. It is also a popular tourist destination owing to the presence of unique fauna with a rich bird life and some unique animals such as Slender Loris and Pangolin. NIFS-SPA also has a dry evergreen rich vegetation consisting of over 200 species of trees. One of the main tasks of this project is to develop this important arboretum. The woody vegetation was mapped on a GIS map for one third of the arboretum and research on regeneration is continuing. The interpretative signage including maps and informative panels on both flora and fauna within the arboretum were established.

Research activities on natural products from medicinal and invasive plants were carried out in collaboration with Universities of Peradeniya and Jayawardenapura. Work related to the compilation of National Red list for flora was continued with the assistance of expert teams conducting meetings at the National Herbarium.

Floristic Survey of IFS-Popham Arboretum, Dambulla

13.5 (5.5 ha) acres out of 36 (14.5 ha) acres of land within the NIFS-Popham Arboretum, Dambulla was selected for floristic study. The land selected was divided into 10 x 10 m grids (Plots) and the girth and species name of woody individuals above 10cm within each grid were recorded. The data were entered into a GIS (Arc View) database. The total area (36 acres) was completely surveyed and a total of 369 species (287 Genera's in 83 Families) were observed and identified. *Chloroxylon swietenia* was selected for age determination study since it has been identified as positive growth ring species in Sri Lanka and the most abundant species in the selected 13.5 acres land. To analyse, 10 increment cores samples and 10 stem discs sample were collected. Growth index was generated to determine age of *C. swietenia*.



Soil Microbial Biomass Carbon (MBC) determination was initiated to compare soil status among the three sub-vegetation and determine the improvement of soil along the succession. Nine soil samples were taken from each sub-vegetation and analysed using Chloroform fumigation-incubation method.

DNA Barcoding, Morphological Taxonomy and Phylogeny of *Syzygium* spp. of family Myrtaceae in Sri Lanka - Implications for conservation and sustainable exploitation.

During the field visits, 30 species out of 31 recorded so far in Sri Lanka were collected. The collection is ca. 250 specimens which contained voucher specimens, DNA samples and reproductive material collected in FAA for dissection. Specimens were collected from Adams Peak, Hakgala SNR, Horton Plains NP, Knuckles conservation area (Riverstone, Dik Pathana, Ilukkumbura, Thangappuwa), Sinharaja (Pitadeniya, Kudawa, Morning side, Gongala, Enasal Watta), Sitha Eliya, Kanneliya, Piduruthalagala, Queensberry Estate, Royal botanic gardens: Peradeniya, Hakgala botanic gardens, Yatihena, Kelanigama, Udu Dumbara, Hantana, Pattipola, Batamandiya, Thalagune, Sabaragamuwa University of Sri Lanka, Kalthota, Anamaduwa

All the collected specimens were prepared as voucher specimens and deposited in the National Herbarium – Peradeniya. A one-month training on molecular lab work was gained at Singapore Botanic gardens. Eight species of Sri Lankan *Syzygium* were DNA extracted during this session for whole genome sequencing. Voucher specimens of related Asian *Syzygium* species were accessed in the Singapore herbarium and compared with Sri Lankan species. All the Myrtaceae specimens from Sri Lanka were annotated. Nomenclature issues of Sri Lankan Syzygium species were discussed.

Diversity distribution pattern of genus *Strobilanthes* in Sri Lanka and their implications for conservation planning

Locations of all thirty-three species of *Strobilanthes* species were mapped on floristic zones in Sri Lanka. Among the floristic zones, foothills of Adam's Peak and Ambagamuwa had the highest species richness, whereas dry zone had the lowest compared to *Strobilanthes* recorded zones. Furthermore, the diversity and distribution of plants were affected by altitude.

The pollen morphology of Genus *Strobilanthes* from Sri Lanka were investigated using scanning electron microscope. The objective of this study was to assess the taxonomic value of pollen morphological characteristics. Findings in this study have shown some variations in the pollen morphology that can be used in species identification and classification. Pollen description includes pollen class, shape, apertures, exine thickness and ornamentation. The results have demonstrated that pollen morphology characteristics have taxonomic significance and are useful as additional data especially in species identification and classification.

M.Phil Students:

Chanaka Lekamge and Himesh Jayasinghe

Selected Publications

1. Ranil Rajapaksha, Nadeeka Gunawardena, Upul Garasin, Gamini Pushpakumara, Tilak Premakantha, **Siril Wijesundara** and Leonid Averyanov. 2019. Elatostema rigidiusculum (Urticaceae), a new species endemic to Sri Lanka. Phytotaxa. 404 (2): 085–090
   DOI: https://doi.org/10.11646/phytotaxa.404.2.4
2. Gothamie Weerakoon, André Aptroot, Robert Lücking, Omal Arachchige, **and Siril Wijesundara** 2019. *Graphis* and *Allographa* (li chenized Ascomycota: *Graphidaceae*) in Sri Lanka, with six new species and a biogeographical comparison investigating a potential signature of the 'biotic ferry' species interchange. The Lichenologist. **Volume 51, Issue 6.** pp. 515-559
3. T. Wijewickrama, I. Karunaratne, **S. Wijesundara** and S. Madawala. 2019. Community perceptions and responses on bamboo spread in native forests: a case study from Sri Lanka, International Journal of Sustainable Development & World Ecology, DOI: 10.1080/13504509.2019.1706057

From left: Mr. C. Lekamge, Prof. DSA. Wijesundara, Mr. HD. Jayasinghe

Himesh Dilruvan Jayasinghe

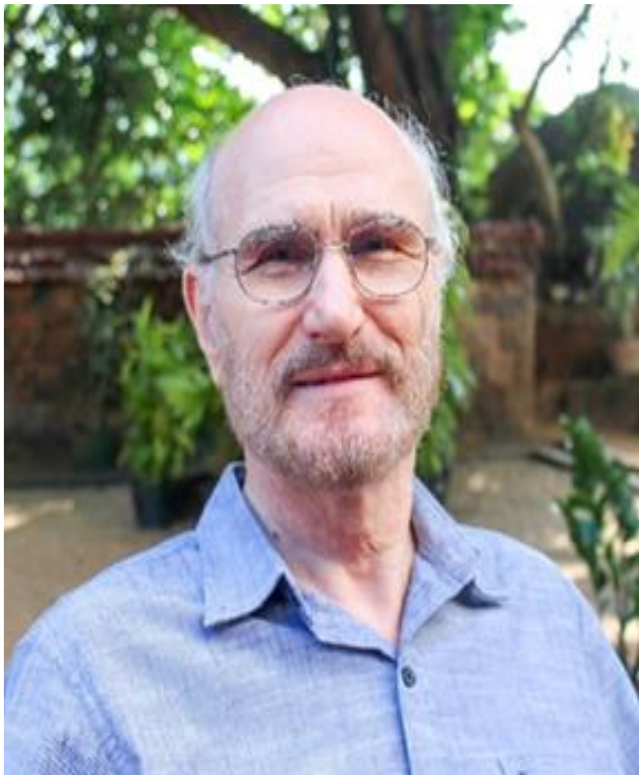
Himesh Jayasinghe is currently an M.Phil Research Assistant in the Plant Taxonomy and Conservation Research project at the National Institute of Fundamental Studies (NIFS). He received his B.Sc from the University of Moratuwa, Sri Lanka and joined NIFS in 2018. His research focuses on Taxonomy and Molecular systematics of Genus *Syzygium i*n Sri Lanka. His research interests include Plant taxonomy, Biodiversity Conservation, and Taxonomy and Ecology of Lepidoptera.

Mobile: +94 718 181 225;
E-mail:Himesh.ja@nifs.ac.lk
https://www.researchgate.net/profile/

Chanaka Lekamge

Chanaka Lekamge is currently an M.Phil Research Assistant in the Plant Taxonomy and Conservation Research project at the National Institute of Fundamental Studies (NIFS). He received his B.Sc from the University of Ruhuna, Sri Lanka and joined NIFS in 2016. His research focuses on Forest Restoration in Sri Lanka. His research interests include Biodiversity conservation, Invasive Alien Plants, Dendrochronology, Plant taxonomy, Forestry and wood science.

Mobile: +94 712 411 131;
E-mail: chanaka.le@nifs.ac.lk
https://www.researchgate.net/profile/Chanaka_Lekamge



Wolfgang Dittus

PhD (Zoology) Univ. Maryland, USA; MSc (Zoology) McGill University, Canada; BSc (Science) McGill University, Canada. Prof. Dittus Conducts multidisciplinary research on wild populations of primates in Sri Lanka under the Smithsonian Institution: 1968-2020. He is an Associate Editor Am J. Primatology (past) & J. Primatology (present), IUCN Primate Specialist for Asia, Chairman, Association for the Conservation of Primate Diversity. www.primates.lk

Title: **Research Professor (Visiting)**
Email: **Wolfgang.di@nifs.ac.lk**
Tel: **0777 282 700**
ORCID ID: **0000-0001-7981-3968**

Primate Biology

The research involves observational studies of monkeys (primates) in their natural forest habitats. Our aims are to: (1) establish new knowledge concerning the evolution of social behavior in primates; (2) provide a scientific basis for nature conservation; and (3) disseminate new knowledge through scientific publications and professionally produced documentary films. These popular media serve not only to educate and entertain, but also to gain public support for conservation in the local and international communities. To date, more than 35 such documentaries have been produced, and more are planned in 2020. The films advertise a positive image promoting tourism in Sri Lanka.

We test scientific hypotheses of social evolution and behavioral ecology through an interdisciplinary approach that examines the Darwinian outcomes (in terms of survival and reproductive success) of the various inter-relationships among parameters involving population genetics, genealogy, anatomy, epidemiology, physiology, environment and behavior. In practice, at our study site at Polonnaruwa (Sri Lanka), we have identified several thousand individual monkeys. For each macaque (*Macaca sinica sinica* Linnaeus 1771) we have monitored its behavioral, genealogical, ecological and demographic history. To this end, we require large samples over an extended period to assure statistical soundness (longevity on wild monkeys may exceed 35 years).

Key publications among n=5 (2015-2019)

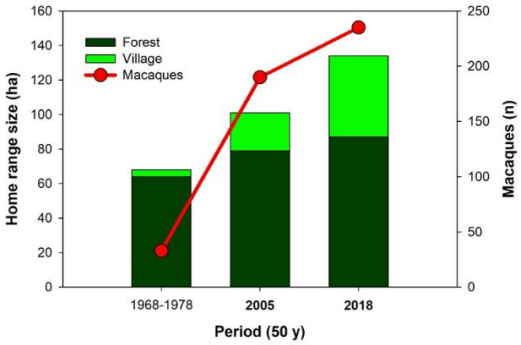
Dittus, Gunathilake & Felder (2019). Assessing public perceptions and solutions to human-monkey conflict from 50 years in Sri Lanka. *Folia primatologica* 90:89–108. DOI: 10.1159/000496025

Dittus (2018). Nearly sixty percent of Sri Lanka's mammals inhabiting the rain forests face extinction: time is short to conserve these forests and their diverse dependents. *Sri Lanka Forester* 39:49-76

Dittus (2017). The biogeography and ecology of Sri Lankan mammals point to conservation priorities. *Ceylon Journal of Science* 46 (*Special Issue*):33-64. DOI: 10.4038/cjs.v46i5.7453

Lessons from long-term (50 y) observations of human-monkey conflict (HMC) at Polonnaruwa.

Historically, Sri Lankan villages always have had to contend with raids from monkeys. But the level of conflict was under control, villagers chased monkey raiders: monkeys respected humans and vice-versa as monkeys benefited from benign traditions. Most importantly, the amount of food waste from village households was low; there was little to attract monkeys to human habitation. This balance changed, however, with the development of better living standards, the proliferation of guest houses and visitation to tourist hotspots – all of which contributed to an increase in human produce littered in the environment and the purposeful feeding of monkeys. Basic biology dictates that food stimulates survival and reproduction, i.e., population growth. Our study over 50 years shows precisely this pattern. Natural monkey habitat, which supports only a low population of monkeys (see 1968 in figure) has been progressively encroached upon by human settlements and an increasing flow of visitors littering food. Expanding food-rich human settlements drew monkeys out of their traditional forest territories, monkey populations grew and HMC increased far above historical levels. The solution to decrease HMC is not to capture and release problem monkeys into other rural areas but to take steps to decrease food made accessible to monkeys and in this way control their population growth.

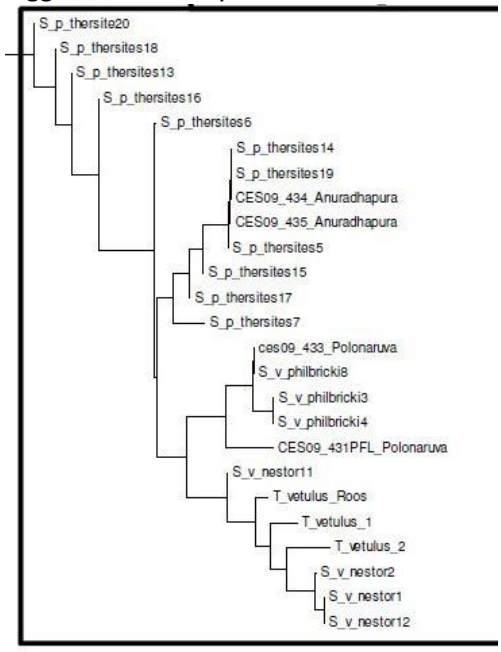


The phylogenetics of langur species; Semnopithecus vetulus, S. priam and their hybrids. A collaboration established in 2017 between W. Dittus (WD), Suresh Benjamin (SB) of the NIFS and Praveen Karanth (PK) of the Indian Institute of Science. We aim to define the genetic differences among these populations as it pertains to the evolution of primate species. To date, we have identified hybrids, collected DNA samples in the field (WD) and initiated genetic analyses (SB & PK).

Female hybrid (Gray X Purple-faced langur)

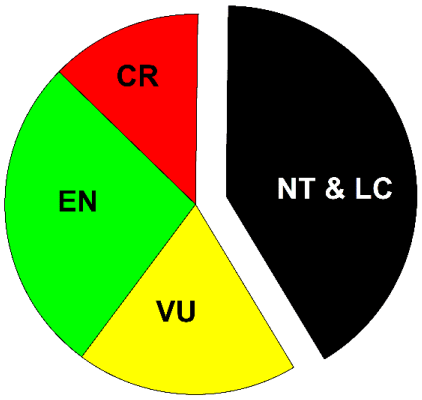
The tree shows phylogenetic clusters of DNA samples from geographically distant

populations of *S. priam* and *S. vetulus.* A closer relation between these populations is suggested in the hybrid zone at Polonnaruwa.



Demography, range use and behavior of the purple-faced langur, *Semnopithecus vetulus philbrickii*. Routine monthly census of 14 groups of PFL langurs to monitor rates of birth, reproductive seasonality, sex ratios at birth, change in age-sex composition of groups with time, mortality and transfer between social groups. Range use changes according to month and year. Comparative summaries of long-term demographic and ecological changes clarify the life-history of this species in the dry zone forests.

Sunil Rathnayake rescues an infant PFL victim of infanticide.



Rainforest mammals of Sri Lanka threatened with extinction; CR=critically endangered; EN= endangered; VU=Vulnerable; LC=Lest concern; NT=Not threatened.

Threat of extinction of mammals in the lowland wet zone rainforests of Sri Lanka.

Comparative analyses between IUCN and Ministry of Environment Red Lists combined with historical records of the geographic distribution of mammals among different phyto-climatic zones of Sri Lanka indicate that nearly sixty percent of rainforest mammals are threatened; including all endemic genera (n=2) and species (n=8), nearly half of endemic subspecies (48%) and many (48%) of non-endemic native taxa. Habitat loss and unabated encroachment of people into protected areas are the main threat. Effective political will is needed to safeguard this natural heritage of Sri Lanka.

A Critically Endangered endemic rainforest primate confined to north of the Kalu Ganga with virtually no remaining natural habitat and no protected area.

Primate researchers at Polonnaruwa

(Left to right: Chameeera Pathirathne, Wolfgang Dittus and Sunil Rathnayake.)

Molecular Biology & Biotechnology

Molecular biology is the study of the chemical structures and processes of biological phenomena that involve the basic units of life, the molecules while in biotechnology biological processes, organisms, or systems are used to manufacture products to improve the quality of human life. The cluster consists of three projects Molecular Microbiology & Human Diseases, Medical Entomology and Plant Stress Biology & Molecular Genetics.

Molecular Microbiology & Human Diseases project particularly seeks to understand the distribution of microbial communities in different environments; air, water and soil as well as within the human lung and the role of these microbes in disease pathogenesis and progression. In 2019, the project concentrated on three major sub projects which included studying the lung microbiota in lung cancer and bronchiectasis patients, to genetically characterize drug resistant *Mycobacterium tuberculosis* isolates and a study on thermophilic microorganisms in hot springs of Sri Lanka with a metagenomic approach.

The aim of the Plant Stress Biology & Molecular Genetics project is to gain a comprehensive understanding of the mechanisms of climate stress tolerance in plants in order to make informed decisions as to what is required to improve stress tolerance levels of crops. Current focuses of the project include improvement of rice yield gap by manipulating photosynthesis and bio fortification of rice with Zn and Fe.

- Molecular Microbiology & Human diseases
- Plant stress Biology and Molecular Genetics

D. N. Magana- Arachchi

B.Sc. (1994), Faculty of Science, University of Colombo, Sri Lanka; Ph.D. (2001), Faculty of Medicine, University of Colombo, Sri Lanka; Project Leader MM & HD [National Institute of Fundamental Studies (NIFS)], Sri Lanka (Joined IFS in December 2004 as an Academic and serving to date). Post-Doctoral Research Associate, University of Nebraska Medical Center, USA (2002-2004). Research Fellow, Institute of Fundamental Studies (IFS), Sri Lanka (2001 to 2002). Assessor for Laboratory Accreditation ISO 17025 & for Good Lab Practice (GLP)- Sri Lanka Accreditation Board for Conformity Assessment (SLAB).

Awards; Paul Ehrlich Foundation Fellowship, Presidential Awards; WPSC Young Investigators Award.

Title; **Associate Research Professor**
Email; **dhammika.ma@nifs.ac.lk, nayomam@yahoomail.com, dmaganaarachchi@gmail.com, cellbio@nifs.ac.lk**
T.P.; **0812232002**

ORCID ID; **0000-0001-5825-4626**

Molecular Microbiology & Human Diseases (MM&HD)

The research interests of the MM& HD project revolve around microbial ecology in different environments and the effect of microorganisms on human diseases. The environments we focus are air, water and soil. We also concentrated on the human lung and paid attention to both communicable (CD) and non-communicable diseases (NCDs) that affect humans globally. The major health issue which has been gripping Sri Lanka for the last three decades; Chronic Kidney Disease of unknown aetiology (CKDu) and pulmonary diseases are the two major areas being studied.

In pulmonary diseases, drug-resistance of *Mycobacterium tuberculosis* is being extensively investigated. We have on-going collaborative projects to genetically characterize drug resistant *Mycobacterium tuberculosis* isolates from Sri Lankan and Pakistani TB patients to identify associated biomarkers. Aside, human lung is being studied for its microbiome. In addition, we concluded the study on Beijing lineage *Mycobacterium tuberculosis* strains. We are in the process of identifying the variations in bacterial profiles in different respiratory diseases; namely, lung cancer and bronchiectasis. Our aim is to figure out how human-bacterial cellular interactions affect the disease progression in lung cancer and bronchiectasis patients. The aim of the CKDu research project is to determine the presence of cyanotoxins, electrolytes and fluoride in ground waters in CKDu endemic areas and uptake mechanism of these risk factors in plants. Thermophilic microorganisms in hot springs of Sri Lanka is an understudied area and the utility of the extremophiles in the biotechnology industry is immense. Currently, different hot water springs around the country are being sampled and being analyzed to identify these extremophiles.

In order to detect possible ingress of cometary microorganisms & particulate matter, we commenced a project with the founder of NIFS; Prof. Chandra Wickremasinghe and are awaiting permission to conduct Balloon flights over Sri Lanka for air sampling. We conduct epidemiological studies on Asbestos industry workers in Sri Lanka with the aim to determine the occupational health related issues due to chemical and physical properties of this roofing material during manufacturing.

Study of lung microbiota in lung cancer and bronchiectasis patients

The study focused on bacterial identification of the lung microbiota in lung cancer and bronchiectasis patients, compared to a healthy population. The total bacterial loads were detected using real-time PCR. Self-designed primers were used to identify the genera *Pseudomonas*, *Achromobacter*, *Streptococcus*, *Rothia* and, *Staphylococcus*. Except for *Rothia* sp., other genera were present in three study groups with the genus *Staphylococcus* and *Pseudomonas* being the most abundant. The highest bacterial load was observed in the lung cancer group (4.12 $x10^4$ cells/µL) whereas the lowest bacterial load was observed in bronchiectasis group (2.75 $x10^4$ cells/µL).

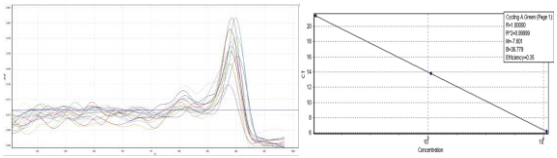


Figure 1. Melt peaks and standard curve for real-time PCR

Prevalence of Beijing lineage *Mycobacterium tuberculosis* strains in Sri Lanka

Beijing lineage is the most widespread *Mycobacterium tuberculosis* lineage owing to its links to high transmission rate, virulence and drug resistance. We undertook a study in Kandy, a popular tourist destination in Sri Lanka to explore this knowledge gap. Accordingly, 26% of pulmonary tuberculosis patients in Kandy reported during the period of February 2018 to July 2019 belong to the Beijing lineage and majority are young people, having a high sputum smear grade and an out-of-country travel history.

Genetic characterization of drug resistant *Mycobacterium tuberculosis* isolates from Sri Lankan and Pakistani TB patients and identification of associated biomarkers

Drug resistance is the key factor that challenges the control of tuberculosis (TB) in the world. In total 101 TB patients from Kandy and 15 patients from Welisara were recruited and 21 drug resistant isolates including one extensively drug resistant and three multi drug resistant strains were identified.

From sequencing, mutations in ser315thr in *kat*G gene and in *rpo*B gene were identified in a majority while most mutations lie outside the hotspot region.

Diversity and distribution of thermophilic microorganisms in hot springs of Sri Lanka: A metagenomics approach

Water and microbial mat samples were collected from six hot springs. Bacterial isolates obtained from Mahapelessa belonged to two bacterial phyla, Proteobacteria (84%) and Firmicutes (16%). According to the 16S metagenomics studies, 25 bacterial phyla were observed and among them Proteobacteria was abundant in all sampled hot springs. In Mahapelessa and Maha Oya, Firmicutes and Bacteroidetes were the most abundant phyla while in Wahawa and Nelumwewa, Chloroflexi was the most abundant phylum.

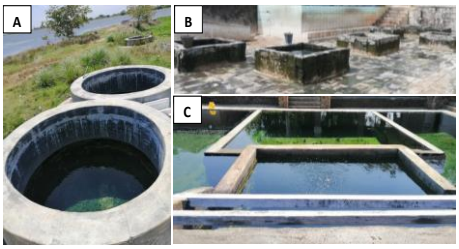


Figure 2. A; Nelumwewa hot springs, B; Kinniya hot springs, C; Mahapelessa hot springs

Enrichment mechanism of CKDu-risk factors in ground water, their uptake pathways and potential remedies

The study focuses on the ground waters of Girandurukotte, a CKDu endemic area in Sri Lanka. Water samples and edible plant materials are being analyzed from both CKDu endemic area and CKDu non endemic areas for comparison. In addition, an epidemiological survey will be conducted for more details. As a pilot study, water samples collected from different locations were cultured in cyanobacteria specific media. As per the PCR amplification with Hepf/Hepr primers, DNA extracted from Lyngbya sp. and Nostocales isolates that originated from drinking water project yielded the expected fragment of *mcy*E gene confirming the presence of potential microcystin producing cyanobacteria in drinking water sources in Girandurukotte.

Epidemiological study on Asbestos related occupational health problems among Asbestos industry workers in Sri Lanka

This project focuses on the impact of occupational asbestos exposure on the health of asbestos related industrial workers in Sri Lanka. An epidemiological study was conducted using data from 264 industrial workers in an asbestos manufacturing company in Sri Lanka. 63 cases of possible restrictive lung diseases were recorded with lung function test and the highest number of cases were from production workers. Air samples and deposition samples were also collected from the factory premises. The samples are being analyzed using Phase Contrast Microscopy, ICP-OES, XRD, FTIR, and particle size analyzer.

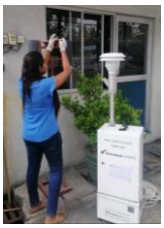


Figure 4. Sample collection by air sampler and sedimentation

Balloon flights over central Sri Lanka to detect possible ingress of cometary microorganisms & particulate matter

We are investigating the stratosphere up to 50 km above Sri Lanka for microorganisms and dust particles. The air sampler consists of a latex sounding balloon, a parachute, a micro controller unit, primary radio transmitter and a GPS unit. Assembly of GPS and SMS tracking system, sampler triggering system and all the programming parts were finalized and tested. Balloons and parachutes have been purchased for the test run and the preparation of sampler is finalized.

Figure 5. Trial balloon launch and bacterial isolates obtained at 50 ft

Junior Research Fellow:
Dr. CA Thotawatthage

M.Phil. Students: EMUA Ekanayake, DGSN Samarasinghe, JMPS Madamarandawala, WBCP Weerarathne, MATM Senevirathna
Research Student: SMNK Thilakarathne
MSc. Students: EGJ Jayanatha, T Nagendran, HAH Hiroshini

Key publications:

1. Liyanage, H., Magana-Arachchi, D., Abeysekara, T. and Guneratne, L. (2016). Toxicology of freshwater cyanobacteria. Journal of Environmental Science and Health, Part C, 34(3), pp.137-168.

2.Sayanthooran, S., Gunerathne, L., Abeysekera, T.D.J., Magana-Arachchi D.N.(2018). "Transcriptome analysis supports viral infection and fluoride toxicity as contributors to chronic kidney disease of unknown etiology (CKDu) in Sri Lanka" International Urology & Nephrology (50) pp. 1667-1677.

3. Weerasekera, D., Pathirane, H., Madegedara, D., Dissanayake, N.,Thevanesam, V. & Magana-Arachchi ,D.N. (2019) Evaluation of the 15 and 24-*loci* MIRU-VNTR genotyping tools with spoligotyping in the identification of *Mycobacterium tuberculosis* strains and their genetic diversity in molecular epidemiology studies, Infectious Diseases, 51:3, 206-215.

From left: Ms. MATM Senevirathna, Ms. WBCP Weerarathne, Dr. CA Thotawatthage, Ms. DGSN Samarasinghe, Ms. EMUA Ekanayake, Ms. HAHH Hettiarachchi
Seating: SMNK Thilakarathne, Prof. DN Magana-arachchi, Ms. JMPS Madamarandawala

Meththika Suharshini Vithanage

Dr. Meththika Vithanage is the Founder/Director of the Ecosphere Resilience Research Centre, University of Sri Jayewardenepura, Nugegoda. Her work has yielded important findings for successful application in the fields of agriculture, solid waste management, and environmental pollution remediation. Dr. Vithanage has contributed more than 120 SCI journal articles, 4 books and 25 book chapters. She has over 5800 citations and h-index of 35. Further, Dr. Vithanage is the leading scientist in the field of environmental sciences based on the scholarly output as stated in SCIVal, Elsevier.

Title:	**Visiting Associate Research Professor**
Email:	**Meththika@sjp.ac.lk**
Tel:	**0750279477**
ORCID ID:	**0000-0003-2923-4065**

Molecular Microbiology & Human Diseases (MM&HD)

Biochar-water Research

Biochar (BC) exhibits a great potential as an adsorbent in the decontamination of water. To improve the adsorption capabilities and impart the particular functionalities of BC, various methods (chemical, physical modification, impregnation with different materials, and magnetic modification) have been developed. We prepared BC composites in order to assess their adsorption potential for a wide range of aquatic contaminants. Nine SCI indexed articles were published in Q1 journals in 2019. We received a 35 million rupee grant from NSF to conduct research on CKDu risk factor removal where Prof. Dhammika Magana-Arachchi is a collaborator.

Climate Extreme Analysis

Climate change has pushed the natural limits of our environment, creating extreme weather events that are more frequent and more intense in certain locations around the globe. There is evidence of increasing trends in temperature extremes in most countries of South Asia, while in a few regions, temperature extremes have been decreasing. Overall changes in rainfall and temperature have led to alterations in water availability in this region. We studied the trends and extremes in temperature and rainfall in Sri Lanka for the last 50 years. Two SCI journal articles have been published from this research with the grant funding from NRC.

Asbestos Research

Many countries have prohibited the use of all forms of asbestos to limit exposure and so control, prevent and ultimately eliminate asbestos-related diseases, from which at least 107 000 people die each year globally. In Sri Lanka, there are no adequate studies conducted to assess the airborne Chrysotile fibre counts and hence do not have data available on its impacts to health. We conducted epidemiological and chemical research related to the workers and dust particles in the asbestos based industries in Sri Lanka with grant funds from the Ministry of Technology and Research.

Chemical and Microbial Characteristics of Dust from Upper Atmosphere

This ongoing project plans to sample dust from the upper atmosphere to find its chemical and microbial characteristics in order to assess their properties. We collaborate with Prof. Chandra Wickremasinghe, UK, Founding Director, NIFS.

Anuradha Ekanayake

Anuradha Ekanayake is currently a Research Assistant reading for MPhil. in the Molecular Microbiology & Human Diseases research group at the National Institute of Fundamental Studies (NIFS). She received her B.Sc. (Hons) from Northumbria University, United Kingdom in the same year and joined NIFS at 2015. Her research focuses on the human lung microbiome in chronic respiratory diseases. Her research interests include Molecular Microbiology, Metagenomics, Host-Microbe Biology and Cancer Biology.

Mobile: +94 769 379 310
E-mail: anuradha.ek@nifs.ac.lk
https://www.researchgate.net/profile/Anuradha_Ekanayake

Pavithra Madamarandawala

Pavithra Madamarandawala is currently an NSF Research Assistant reading for MSc in the Molecular Microbiology and Human Diseases project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc. degree from the University of Pune India in 2017 and joined NIFS at 2017. Her research focuses on drug resistance of *Mycobacterium tuberculosis*. Her research interests include Molecular Immunology, Biochemistry, Infectious Diseases and Microbiology.

Mobile: +94 771 316 984
E-mail: pavithra.ma@nifs.ac.lk
https://www.researchgate.net/profile/Pavithra_Madamarandawala

Nimanthika Samarasinghe

Nimanthika Samarasinghe is currently a MPhil Research Assistant in the Molecular Microbiology and Human Diseases project at the National Institute of Fundamental Studies (NIFS). She received her B.Sc. (Special) degree from the University of Kelaniya, Sri Lanka in the same year and joined NIFS at 2018. Her research focuses on diversity and distribution of thermophilic microorganisms in hot springs of Sri Lanka. Her research interests include Molecular Microbiology.

Mobile: +94 775 580 169
E-mail: nimanthika.sa@nifs.ac.lk

Nirmani Thilakarathne

Nirmani Thilakarathne is currently a Research Assistant in the Molecular Microbiology & Human Diseases research group at the National Institute of Fundamental Studies (NIFS). She received her B.Sc. (Special) from the University of Peradeniya, Sri Lanka in 2017 and joined NIFS in 2019. Her research focuses on the characterization of antibiotic resistance genes in environmental microorganisms. Her research interests include Molecular Microbiology, Genetic Engineering, Drug Designing, and Cancer Biology.

Mobile: +94713577364
E-mail: nirmani.th@nifs.ac.lk
https://www.researchgate.net/profile/Nirmani_Thilakarathne

Chameena Weerarathne

Chameena Weerarathne is currently an NRC Research Assistant reading for MPhil in the Molecular Microbiology & Human Diseases research group at the National Institute of Fundamental Studies (NIFS). She received her B.Sc. (Special) from Wayamba University of Sri Lanka in 2018 and joined NIFS in 2019. Her research focuses on Asbestos related occupational health and Epidemiology. Her research interests include Environmental Sciences, Epidemiology, Soil Microbiology and Agricultural Biotechnology.

Mobile: +94 717 443 260
E-mail: chameena.we@nifs.ac.lk
https://www.researchgate.net/profile/Chameena_Weerarathne

Saman Seneweera

Saman Seneweera is a Molecular Plant Physiologist, Director at National Institute of Fundamental Studies (NIFS) Sri Lanka, Professor, University of Southern Queensland, Adjunct Professor, University of Melbourne, Australia and Adjunct Professor at the Ruhuna University, Sri Lanka. He has also worked at the University of Western Sydney, Australia, Tohoku University, Japan and the University of Ilinois, Chicago, USA. He referees many journals and has supervised over 25 HDR students internationally. Prof Seneweera is on the editorial board of many journals and reviews a large number of journals. He has published more than 200 research articles in top ranking journals including Nature and Science, has been an invited speaker at international conferences and has presented many keynote addresses. Professor Seneweera is the recipient of multiple awards including the "MSLE Research Excellence Award-2011" from the University of Melbourne.

Title: **Professor/Director**
Email: **saman.se@nifs.ac.lk**
Tel.: **0812232002**
ORCID ID: **-**

Plant Stress Biology and Molecular Genetics

Creating global benchmark yields in paddy and minor crops

The current national average rice yield is close to 4.2 MT per hectare which increased from around 2 MT/HA in the 1970's to 4.2 MT/HA by the early 2000s. The current average yield remains stagnant despite 95 percent of the rice crop extent being brought under improved cultivars. Traditional cross hybridization and selection is still a widely used strategy for developing cultivars with a higher yield in Sri Lanka. The already low yield potential of Sri Lankan rice is further challenged by the following factors; increase in the cost of production, and inevitable climate change. A major knowledge gap in understanding key traits and genetic components contributing to rice yield and how physiological and molecular traits interact with the environment to maintain the yield potential in Sri Lankan cropping systems still remains. The root cause for the low yield potential of Sri Lankan rice is the decades of negligence in the adaptation of scientific technology in plant breeding. In the developed world, advanced plant breeding techniques like gene mapping, high throughput phenotyping, and gene editing based crop improvement are widely used, making significant progress in yield enhancement. However, in Sri Lanka, such genetic and molecular tools in plant breeding are not being used. In this project, we propose an innovative methodology to increase the yield potential of rice by designing a new ideotype. This will be achieved by identifying key physiological and biochemical traits associated with rice yield together with genome mapping and transcriptome comparison.

The proposed study will use multidisciplinary approaches including transcriptomics, bioinformatics, biotechnology and plant physiology and will provide fundamental knowledge and new concepts for plant breeders to develop high yielding rice varieties with improved tolerance to the adverse effects of climate change, which in turn will have immense socio-economic relevance.

Precision nitrogen management through environmental benign hybrid nanomaterial

Nitrogen is the element that plants require in the highest quantity. Availability of N is one of the key limiting factors in crop productivity in agricultural systems. Uptake, assimilation, translocation and remobilization are the main steps involved in the use of N by plants. Plant N uptake from the soil depends on environmental conditions, soil type and plant genotype. Nitrogen is utilized by plants mainly for the synthesis of organic compounds such as proteins, nucleic acids, storage and signaling molecules etc. The photosynthetic capacity of plants greatly depends on the leaf N content. Considerable amount of N in plants is invested in the leaf blades, especially in the chloroplasts, to be used in the synthesis of proteins such as Rubisco and thylakoid proteins. Approximately, 50-70% of N applied to the soil is lost, mainly due to surface run-off, leaching of nitrates and volatilization of ammonia. Extreme use and incomplete capture of N fertilizers result in excessive emission of N_2O which has been linked to ozone depletion and is also another cause of global warming. Currently, nanotechnology is being considered as a solution to improve nutrient use efficiency of plants. Emerging nanotechnology based strategies, due to their nanoscale size (1-100 nm) and high surface area to volume ratio can profoundly impact energy, economy, and the environment by reducing nutrient loss due to leaching, emissions, and long term incorporation by soil microorganisms. Nutrients encapsulated in nanoparticles can increase uptake efficiency by triggering release according to environmental conditions and plant demand. In addition, controlled release fertilizers may also improve the soil by decreasing adverse effects associated with over application of fertilizer. Fertilizers can be designed in such a way that they release nutrients in a controlled manner which synchronizes with the needs of plants. Therefore, in this research project, we aim to develop an environmentally friendly, cost effective, biodegradable, controlled release nano fertilizer system.

Aversive Geofencing Technology to Mitigate Human-elephant Conflict

Anthropogenic activities such as urbanization and agricultural expansion have affected wildlife populations in many different ways. While in some cases, species tend to adapt to the changing environments and subsequently thrive, in other instances it has led to loss of species. With habitat loss and fragmentation, wild animals compete with humans for limited resources, resulting in conflict. Asian Elephants (*Elephas maximus*) play a major role in human-wildlife conflict across their range. This conflict has resulted in the death of both elephants and humans and large scale damages to crops and property. Electric fences are the most commonly used method to mitigate this conflict. However, they are expensive to build and maintain, create undesirable non-target impacts, and can be ineffective given that elephants sometimes learn to break these fences. The rise in incidents of conflicts with elephants has triggered the need for alternative and more flexible options to mitigate this problem. Aversive Geofensing Devices (AGDs-Satellite linked warning collars) is a novel approach currently used on domestic farm animals for grazing management. This system allows farmers to create virtual fences using computer software, while the GPS collars are programmed to emit an aversive signal when the animal reaches virtually fenced boundaries automatically. This recent advance in virtual fencing technology has the potential to revolutionize the management of human elephant conflict, but requires field-testing and refinement. This project tests AGD technology on captive elephants at the Pinnawala Elephant Orphanage to determine its effectiveness in managing elephant movement. If successful, AGDs would then be tested on wild elephants to determine its effectiveness in managing elephant movement around human habitations.

From left: Ms. S.C. de Mel, Ms. M. Perera, Mr. A. Jayathissa, Prof. S. Seneweera, Ms. W. Welagedara, Ms. U. Nakandala

Maheshika Perera

Maheshika Perera is a MPhil Research Assistant in the Plant Stress Biology and Molecular Genetics Project. She obtained my BSc equivalent special degree from the Institute of Chemistry Ceylon in 2014. Maheshika's Her scientific career at the Sri Lanka Institute of Nanotechnology as a Research Scientist. After 5 years of research experiences she joined NIFS in June 2019. Currently her research is focused on Precision nitrogen management through environmental benign hybrid nanomaterial. Her research interests include Nanotechnology, Material Chemistry, Plant nutrients and Plant physiology.

Mobile: +94710778959
Email: *maheshika.pe@nifs.ac.lk*
https://www.researchgate.net/profile/Maheshika_Perera2
https://orcid.org/0000-0002-8419-8805
https://www.linkedin.com/in/maheshika-perera-4733108b/

Upuli Nakandala

Upuli Nakandala is a PhD Research Assistant with the Plant Stress Biology and Molecular Genetics project at the NIFS. She obtained her B Sc (Special) in Molecular Biology and Biotechnology from the University of Peradeniya in 2017 and joined NIFS in June 2019. Upuli's research focuses on creating benchmark yield in paddy and other minor crops. Her research interests include plant breeding and genetics, DNA fingerprinting, crop physiology and functional genomics.

Mobile: 0711828341
Email: upuli.na@nifs.ac.lk
Research Gate ID: https://www.researchgate.net/profile/Upuli_Nakandala2
https://orcid.org/0000-0003-3774-1972

Surendranie Cabral de Mel

Surendranie is a PhD student registered at the University of Southern Queensland (USQ), Australia, and based at the National Institute of Fundamental Studies (NIFS). Her research interests lie in behavioural ecology, physiology and wildlife conservation. Surendranie obtained her BSc (Special degree) in Zoology from the University of Colombo in 2013 and was awarded a Commonwealth Shared Scholarship in 2014 to study for her Master of Research (MRes) degree in Wildlife Conservation at the University of Southampton, UK. She is conducting her PhD research project on efficacy and welfare of Aversive Geofencing Devices for managing the movements of Asian elephants.

Email: surendranie.ca@nifs.ac.lk
https://www.researchgate.net/profile/Surendranie_Cabral_De_Mel
https://orcid.org/0000-0001-5045-2716

Adjunct Positions at NIFS 2019

Prof. Atula Sandanayake

Prof. Sandanayake, started his academic career at the University of Sri Jayewardenepura, Sri Lanka as an Assistant Lecturer (1996–1999); Sabaragamuwa University of Sri Lanka, Sri Lanka, as a Lecturer (1999–2007); Japan Advance institute of Science and Technology, Ishikawa, Japan, as a Research Fellow (2007–2014); Center for Organic Photonics and Electronics Research (OPERA), Kyushu University National University Corporation, Fukuoka, Japan, as an associate Professor (2016–2018) and Professor (2018–present).

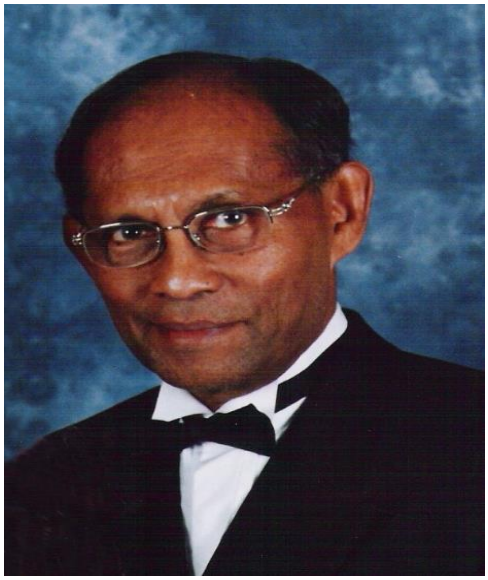
His postgraduate research experience lie in the area of photoinduced electron Transfer processes of chemically modified carbon nanomaterials and supramolecules for artificial solar energy harvesting systems composed of porphyrin nanoarchitectures and carbon nanomaterials. Currently he is working on organic semiconductor laser- an area of physical chemistry. He is also working on the exploratory research for advance technology (ERATO) program of the Japan science and technology agency (JST) as a Professor (research). Prof. Sadanayake, succeefully completed several research projects in Japan is Advance institute of Science and Technology (JAIST) under "Development of Advanced Evaluation Methods for Organic Light Emitting Materials and Development of Advanced Evaluation Methods for Next-generation Organic Electronics Materials", using research funding from the of JSPS Program. The successful results have been published in several high impact factor, international journals. The total number of publications in peer-reviewed journals, international book chapters, international conferences and national journals and conferences count over 200.

Dr. Chandana Herath

Dr. Herath, a hepatologist, is a Senior Research Fellow of the Department of Medicine of the University of Melbourne at Austin Health. Upon successful completion of his JSPS (Japan Society for the Promotion of Science) postdoctoral studies in the Department of Veterinary Medicine at the Tokyo University of Agriculture and Technology in Tokyo, Japan, Dr. Herath joined the Department of Medicine Faculty of Medicine, Dentistry and Health Sciences at the University of Melbourne in 2004.

As head of the hepatology laboratory Dr. Herath has made a significant contribution towards developing animal models of liver diseases to study and formulate therapies to treat patients with liver disease including cirrhosis. He was successful in securing nationally competitive grants, amounting to over AU$ 3 million from the National Health and Medical Research Council of Australia. Dr. Herath supervised and/or mentored a number of PhD and MD students to successful completion and currently has 10 PhD students working on a number of projects. Dr. Herath has contributed to over 52 scientific publications which include peer-reviewed papers, book chapters and abstracts, and has given a number of speeches at major scientific conferences.

Prof. Chandra Wickramasinghe



Prof Wickramasinghe obtained his PhD and ScD degrees from Trinity College and Jesus College, Cambridge respectively. His research interests include the interstellar medium, infrared astronomy, light scattering theory, applications of solid-state physics to astronomy, the early Solar System, comets, astrochemistry, the origin of life and astrobiology. As a student and collaborator of Fred Hoyle, Wickramasinghe further proposed a radical kind of panspermia that included the claim that extraterrestrial life forms enter the Earth's atmosphere and were possibly responsible for epidemic outbreaks, new diseases, and genetic novelty that Hoyle and Wickramasinghe contended was necessary for macroevolution. He published the first definitive book on Interstellar Grains in 1967. He has made many contributions to this field, publishing over 350 papers in peer-reviewed journals, over 75 of which are in Nature (Nature is the world's leading multidisciplinary science journal).

Asian Power 100 list (2005) named Prof Wickramasinghe as one of the 100 most influential Asians living in the UK. He is currently the Director of the Buckingham Centre for Astrobiology, Honorary Professor of the University of Buckingham, Editorial Board Member of Astrophysics and Space Science, Editorial Board Member of the Journal of Scientific Exploration, Editor of Astrobiology for the internet journal *Journal of Cosmology.com* and a Team member of the European Space Agency's Rosetta Mission.

Prof. Dilantha Fernando

Professor Dilantha Fernando is the Dean, Professor and Plant Pathologist at the University of Manitoba, Canada. He was recently elected a Fellow of the American Phytopathological Society in the USA, a rare honor bestowed on a Canadian scientist. Prof. Fernando also received the highest award for exemplary research towards sustainable agriculture from the International PGPR Community. Professor Fernando is a world renowned, plant scientist with focused research on Plant Pathology, Biotechnology and Microbiology. His program is world famous for its research contributions to host-pathogen interactions at the fundamental level, and understanding the mechanisms of biological control of plant pathogens with bacteria at the molecular level, understanding of the plant defense pathways and key genes expressed in defense against plant pathogens at the transcriptome level. Prof. Fernando's research also looks at Dual-RNASeq to understand the pathogenicity of genes and how they are expressed between avirulent and virulent isolates on a host crop. He is also world renowned in the study of toxins (myco-toxins) produced by plant pathogens on economically important crops (wheat, barley and corn) and how they cause disease.

Prof Fernando's research also focusses on climate change and its effects on crops and diseases. He is a leader in the field of plant pathology and is recognized around the world.

Prof. I.M. Dharmadasa

Professor I.M. Dharmadasa is a Senior Staff Grade Professor in Electronic Materials and Devices at Sheffield Hallam University, UK. His research is focused on solar energy conversion, and has over 38 years of experience in both industry and academia. He has published over 300 articles including 6 patents, a single authored book on "Advances in Thin Film Solar Cells- Pan Stanford Publishing" and a co-authored book on "Next Generation Solar Cells- Springer".

Prof. Dharmadasa graduated from the University of Peradeniya in Sri Lanka by completing the Special Degree in Physics in 1975. After winning an Open Commonwealth Scholarship in 1977, he completed his Ph.D. in 1980 at the University of Durham (UK). After a short period of serving the University of Peradeniya as a Lecturer in Physics, he joined the University College, Cardiff, UK and the British Petroleum Company (BP), before joining Sheffield Hallam University (SHU) in 1990. Prof. Dharmadasa is a promoter of renewable applications in society. The theme of his work is to use clean energy for sustainable development and poverty reduction. He pioneered a *'Solar-Village'* project in Sri Lanka in order to empower rural communities. This project is now in the replication stage in Sri Lanka with support from the Sri Lankan Government.

Prof. Keerthi S. Guruge

Professor Keerthi S. Guruge completed his BSc in General Science with a first class from in University of Peradeniya in 1985. He obtained his MSc from Kochi University, Japan in 1992. He then completed his PhD in Environmental Chemistry and Ecotoxicology at the United Graduate School of Agricultural Sciences Ehime University, Japan in 1997. Prof. Guruge completed a Post Doctorate under the JSPS fellowship in 1999. In 1999, he joined the National Institute of Animal Health, Tsukuba, Japan as the first foreign researcher (and Sri Lankan) and is now the head of the toxicology unit. He also serves as an Adjunct Professor at the Osaka Prefecture University, Osaka, Japan. Currently, Prof. Guruge has 2850 citations with h-index of 27 in Google Scholar.

Prof. Kirthi Tennakone

Kirthi Tennakone was born in the village of Metikotumulla, Gampha District, Sri Lanka and received his school education at the Government Central College, Veyangoda. He obtained a General Science Bachelor's Degree in Physics and Mathematics from the University of Colombo in 1964. After graduation, he served as an assistant teacher in the Education Department, when he was awarded an East-West Center Fellowship at the University of Hawaii, where he obtained a PhD in Theoretical Physics in 1972. He was an Associate Professor at the University of Sri Jayewardenepura and a Professor of Physics, University of Ruhuna, Sri Lanka. He was appointed to the Sumanasekara Endowed Chair in Natural Science at the Institute of Fundamental Studies 1988 and also served as its Director for more than a decade. He has held many research positions in the United States, Europe and Japan and is currently an Adjunct Professor of Physics at the Georgia State University. He has authored more than 300 publications and mentored the post -graduate research of a number of accomplished academics, researchers and executives.

Prof. Muhammad Iqbal Choudhary
(Hilal-i-Imtiaz, Sitara-i-Imtiaz, Tamgha-i-Imtiaz)

Dr. M. Iqbal Choudhary is Director and Professor of Bioorganic and Natural Product Chemistry at the International Center for Chemical and Biological Sciences (H. E. J. Research Institute of Chemistry and Dr. Panjwani Center for Molecular Medicine and Drug Research). He has discovered many potent bioactive compounds from indigenous medicinal plants that are under clinical trials. Prof. Muhammad's contributions to reverse bacterial resistance to antibiotics represent seminal contributions in this important field. His scientific, and capacity building contributions have been recognized by prestigious national and international awards, honors, and fellowships of several academies of science. Prof. Choudhary has 1,800 publications (Citations 27,970, *h* index 69) in the fields of organic and bioorganic chemistry, along with 57 international patents (51 US Patents), 68 books and 40 chapters in books, published by major U.S. and European presses and supervised 84 Ph.D. students.

Dr. Naoki Hirotsu

Dr. Naoki Hirotsu is a Professor at Toyo University, Japan. He is an expert in the field of molecular biology and molecular genetics in the area of Plant Physiology, has published 31papers and one book chapter. Most of his research articles are published in high impact journal including Nature Genetics.

Prof. Nikolai Kuhnert

Prof. Nikolai Kuhnert, Jacobs University Bremen, Germany is a world class scientist in the field of Natural Products, Food Chemistry, Analytical Chemistry and Organic Chemistry. He served as a host professor for the prestigious Alexander Humboldt Research Fellowship to Germany. Prof. Nikolai Kuhnert obtained his PhD in Inorganic Chemistry and Pharmaceutical Biology in 1995 from the Maximilians Universität Würzburg, Germany. Following postdoctoral stays at the Universities of Cambridge and Oxford, he accepted a position as member of the Faculty of Organic Chemistry at the University of Surrey. In 2006, he moved to Jacobs University Bremen, where he is now a Full Professor in Analytical and Organic Chemistry. He has been Visiting Professor at several Universities including Saarbrücken, Regensburg, Bremen, CSIC Rocasolano in Madrid, CEBAS in Murcia and KAUST, NIFS Kandy, Sri Lanka. Prof. Kuhnert's research interests are focused on the application of mass spectrometry in the analysis and structure elucidation of phenolic natural products from dietary and medicinal plants and the analysis of food processing products such as black tea, roasted coffee, Maillard reaction products and chocolate. (http://www.jacobs-university.de/ses/nkuhnert). His research publications received 6603 citations (June 2019); h-index of 42. In 2018 he published 17 peer reviewed publications.

Prof. Nor Hadiani Ismail

Professor Nor Hadiani Ismail obtained her B Sc (Honours Chemistry) from University of Waterloo, Canada and PhD in Natural Products Chemistry from University Putra Malaysia. Her PhD thesis won the Tan Sri Ong Kee Hui medal for the Best Thesis in 1999 awarded by the Institute Kimia Malaysia. She is a Professor in Chemistry at University Teknologi Mara (UiTM). Prof Nor Hadiani is the recipient of UiTM Excellence Service Award 2002, 2006 and 2015. Prof Nor Hadiani has published 164 peer reviewed scientific publications in internationally reputed journals. Her publications have received 3536 citations with h- index of 33. Prof Nor Hadiani is the Vice President of the Malaysian Natural Products Society and actively promotes natural products scientific research and activities in Malaysia and the surrounding region. She was an elected fellow of the Institute Kimia Malaysia during 2012. For her outstanding achievements in natural products chemistry research, Prof Nor Hadiani was recognized as a Top Research Scientist Malaysia (2017) by the Academy of Science Malaysia. Currently, she is the Director of 'Atta-ur-Rahman Institute for Natural Product Discovery', UiTM's research center dedicated to research in natural product science.

Prof. Sabrina Dallavalle

Prof. Sabrina Dallavalle is full professor in Medicinal Chemistry at the Università degli Studi di Milano. She has a background in organic and medicinal chemistry, with specific training and expertise in structural elucidation and synthesis of natural and biologically active organic substances. Prof. Dallavalle has developed and successfully completed several interdisciplinary research projects in the field of Biomedicine, in collaboration with academic research groups and pharmaceutical companies (e.g. Sigma-tau, GlaxoSmithKline, BIOGEM). Her most significant accomplishment has been the contribution to the development of new molecules, which have proved to be promising antitumor drugs, three of them having so far reached phase I/II of clinical trials. This achievement is documented by the filing of 12 international patents related to the discovery of new camptothecins, atypical retinoids as well as HDAC inhibitors. Prof. Dallavalle is scientific works are mainly documented by 116 publications in international leading journals in organic and medicinal chemistry.

Dr Srinivas Nammi

Dr Srinivas Nammi is a Senior Lecturer in Pharmacology and Academic Course Advisor (BMedSc) at the School of Science and Health, Western Sydney University, Australia. He has a doctorate in Pharmaceutical Sciences, specializing in Pharmacology. Before joining the Western Sydney University, Dr. Nammi worked at the Faculty of Pharmacy, University of Sydney after gaining years of postdoctoral experience as DAAD Fellow at the University of Tübingen, Germany and as University Postdoctoral Fellow at the University of Manitoba, Canada. He has a distinguished track record in Ayurvedic and Western herbal medicines research for over 20 years and has made significant contributions to both basic and applied research related to drug discovery, biological evaluation and mechanistic studies with a special focus on metabolic disorders. Dr. Nammi has attracted competitive research funds from national and international institutional and industrial bodies. He has 1 international patent and published over 80 scientific papers, 10 editorials and 3 book chapters. Dr. Nammi has also contributed over 40 research abstracts published in the proceedings of National and International Conferences, Symposia and Seminars. His research has been cited so far in over 3000 publications with an H-index of 28. He is serving as Secretary for the Australian DAAD Alumni Association and he sits on the editorial and review boards of a number of biomedical journals including *BMC Complementary & Alternative Medicine* and *Evidence-Based Complementary & Alternative Medicine*. He is an international expert reviewer of a number of national and international research grant bodies including NHMRC, Diabetes Australia, QNRF, TRC, and IF.

Prof. Vasantha Rupasinghe

Prof. Vasantha Rupasinghe is a Professor and Killam Chair of Functional Foods and Nutraceuticals at the Department of Plant, Food and Environmental Sciences of Dalhousie University. Prof. Rupasinghe's has made significant breakthrough discoveries in the interface of food bioactives and their health benefits. His major research contributions to food science and technology include elucidating the mechanism of actions of biologically active compounds present in plant-food especially fruits, vegetables and their processed products. For example, cancer chemopreventive, neuroprotective, cardio-protective and anti-inflammatory properties of plant-food flavonoids.

Prof. Rupasinghe's research program, has attracted over $7M (since 2004) in external funds, and resulted in five patent filings, one license agreement and contributions to the commercialization of over a dozen value-added food products. He has published over 175 peer-reviewed articles (Scopus author h-index 42 and total citations 5300; September 01, 2019) ,18 book chapters and over 200 abstracts in conference proceedings.

Prof. Rupasinghe has trained over 100 highly qualified personnel including M.Sc. and PhD students and Post-Doctoral Fellows who are now serving many different professional positions in the Canadian Food and Beverage sector. He has been serving as an Adjunct Professor of Food Science related Departments of many Universities worldwide.

Prof. Veranja Karunaratne

Professor Veranja Karunaratne graduated with a B.Sc. Chemistry (Special) from the University of Colombo, Colombo, Sri Lanka (First Class), followed by a Ph.D. in Synthetic Organic Chemistry - University of British Columbia, Vancouver, B.C. Canada. He has post-doctoral research experience from the University of British Columbia and University of Kansas.

Prof. Karunaratne was the former Head, Department of Chemistry, University of Peradeniya, (2005 -2008), Former Chairman, Senior Student Counsellor, University of Peradeniya (1997-2001), Former Science Team Leader, and Associate Director, Sri Lanka Institute of Nanotechnology) (2008 -2016) and currently is a Senior Professor, Department of Chemistry, University of Peradeniya and Vice Chancellor, SLINTEC ACADEMY. He was honoured by the government of France in 2012 with a Chevalier dansl'Ordre des Palmes Académiques (Knight of the *Order of Academic Palms*). Prof. Karunaratne is an elected Fellow of the National Academy of Sciences and a Fellow of the Royal Society of Chemistry and is a Visiting Professor, University of British Columbia from 2003 to date.

Professor Karunaratne has won many awards including Presidential Award for Research and Scientific Publication from 2001-2017. He has supervised 16 PhD and 10 MPhil students and published 157 publications in peer reviewed journals (h index: 31) and is the inventor of 53 patents and applications. Ten of his postgraduate students are employed in academia in a number of universities in Sri Lanka.

Prof. Yoshinori Fujimoto

After graduating from the Department of Chemistry, Tokyo Institute of Technology, Prof Fujimoto completed his PhD in 1978. Then, he spent three years as a Research Fellow at the School of Pharmacy, University of Wisconsin-Madison. Prof Fujimoto was appointed as Assistant Professor at the Department of Chemistry, of Tokyo Institute of Technology in 1982, Associate Professor in 1990, Professor in 1996, and joined the Department of Chemistry and Materials Science, Graduate School of Science and Engineering of the same university. Prof. Fujimoto retired from the University in 2015, and was appointed to Professor Emeritus. Now he serves as Visiting Professor, Organization for the Strategic Coordination of Research and Intellectual Properties and Lecturer, School of Agriculture, Meiji University (May 2015–to date). Prof. Fujimoto was appointed as Visiting Research Professor, NIFS, Kandy, Sri Lanka (June 2015–April 2019). His research achievement in natural product chemistry involves isolation and structure elucidation of nearly three hundred new bioactive secondary metabolites from plants, microbes and marine invertebrates as well as biosynthetic, enzymatic and genetic studies of steroidal and terpenoidal compounds. These results are reported in 283 peer-reviewed original research papers, 12 review articles, 12 books and book chapters and 11 patent applications.

Prof. Yuansong WEI

Yuansong Wei, is, Professor and, the Director of the Laboratory of Water Pollution Control, Research Center for Eco-Environmental Sciences (RCEES), Chinese Academy of Sciences (CAS). Deputy Director of CAS-TWAS Center of Excellence for Water and Environment (CEWE). Awarded Bachelor of Fine Chemical Engineering from Jiangxi Polytechnic University in July, 1990; Master of Environmental Engineering from Dalian University of Technology in July, 1995; PhD in Environmental Engineering from RCEES, CAS in July, 2000, respectively. He worked as Postdoctoral fellow in TNO Environment, Energy and Process Innovation, the Netherlands from March 2001 to March 2002, and as Visiting Scholar in EAWAG (Swiss Federal Institute of Aquatic Science and Technology) from March 2008 to March 2009. His research areas are focus on water; waste water treatment, organic solid wastes treatment and resource recovery, river restoration, and antibiotics pollution; control in the environment. He has supervised 18 PhD and 45 Master students and published over 280 papers in peer-reviewed journals.

SECTION 2-RESEARCH PERFORMANCE IN YEAR 2019

PUBLICATIONS IN JOURNALS 2019

SCI: Science citation index, SCI Exp: Science citation index Expanded, IF: Impact Factor,
*: joint paper with another NIFS research project

ENERGY & ADVANCED MATERIALS RESEARCH UNIT

Condensed Matter Physics & Solid State Chemistry

1. **Dissanayake, M.A.K.L.,** Jaseetharan, T., **Senadeera, G.K.R.,** and Kumari, J.M.K.W. (2019). Efficiency enhancement in PbS/CdS quantum dot-sensitized solar cells by plasmonic Ag nanoparticles. *Journal of Solid State Electrochemistry*, p.1-10. [SCI Exp, IF : 2.531]

2. **Dissanayake, M.A.K.L.,** Jaseetharan, T., **Senadeera, G.K.R.,** Kumari, J.M.K.W., Thotawatthage, C.A., Mellander, B.E., Albinsson, I., and Furlani, M. (2019). Highly efficient, PbS:Hg quantum dot–sensitized, plasmonic solar cells with TiO_2 triple-layer photoanode. *Journal of Solid State Electrochemistry*, 21(6), p.1787-1794. [SCI Exp, IF : 2.531]

3. Sarangika, H.N.M., **Dissanayake, M.A.K.L., Senadeera, G.K.R.,** and Karunarathne, W.G.M.D. (2019). Low cost quasi solid state electrochromic devices based on F-doped tin oxide and TiO_2. *Materials Today: Proceedings*, p.1-5.

Energy & Advanced Material Chemistry

1. **Bandara, J.,** Yan, C.F., Liang, Z., and Rtimi, S. (2019). Piezoelectric materials for catalytic/photocatalytic removal of pollutants: Recent advances and outlook. *Applied Catalysis B: Environmental*, 241, p.256-269. [SCI, IF : 14.229]

2. Dharmagunawardhane, D.S., De Silva, N.L., Gunatilake, U.B., Yan, C.F, and **Bandara, J.** (2019). Removal of groundwater nitrates by heterogeneous supramolecular complexes-like photocatalytic system based on in-situ generated and highly active Ti^{3+}/Ti^{2+} states in the reduced TiO_2. *Molecular Catalysis*, 470, p.89-96. [SCI, IF : 2.938]

Material Processing & Device Fabrication

1. Kumarasinghe, K.D.M.S.P.K., **Kumara, G.R.A.,** Rajapakse, R.M.G., Liyanage, D.N., and Tennakone, K. (2019). Activated coconut shell charcoal based counter electrode for dye-sensitized solar cells. *Organic Electronics*, 71, p.93-97. [SCI, IF : 3.495]

2. Liyanage, D.N., Kumarasinghe, K.D.M.S.P.K., **Kumara, G.R.A.,** Jayasundera, A.C.A., Tennakone, K., and Onwona-Agyeman, B. (2019). Donor-□-Conjugated Spacer-Acceptor Dye-Sensitized Solid-State Solar Cell Using CuI as the Hole Collector. *International Journal of Photoenergy*, 2019, p.1-5. [SCI Exp, IF : 2.026]

3. Prabavathy, N., Balasundaraprabhu, R., Balaji, G., Malikaramage, A.U., Prasanna, S., Sivakumaran, K., **Kumara, G.R.A.,** Rajapakse, R.M.G., and Dhayalan Velauthapillai (2019). Investigations on the photo catalytic activity of calcium doped TiO_2 photo electrode for enhanced efficiency of anthocyanins based dye sensitized solar cells. *Journal of Photochemistry and Photobiology A: Chemistry*, 377, p.43-57. [SCI, IF : 3.261]

4. Uthayaraj, S., Karunarathne, D.G.B.C., **Kumara, G.R.A.,** Murugathas, T., Rasalingam, S., Rajapakse, R.M.G., Ravirajan, P., and Velauthapillai, D. (2019). Powder pressed Cuprous Iodide (CuI) as a hole transporting material for perovskite solar cells. *Materials*, 12(13), p.2037. [SCI Exp, IF : 2.972]

Nanotechnology & Advanced Materials

1. Amaraweera, T.H.N.G., Pynthamil, S., **Wijayasinghe, H.W.M.A.C.,** and Balasooriya, N.W.B. (2019). Preparation of Vein Graphite Anode Materials by Eco-Friendly Mild Oxidation, for Lithium-Ion Rechargeable Batteries. *Journal of the Geological Science of Sri Lanka*, 20, p.37-43.

NATURAL PRODUCT & FOOD CHEMISTRY RESEARCH UNIT

Food Chemistry

1. Marasinghe, S.S.K., **Marikkar, J.M.N,** Yalegama, C., Wimalasiri, S., **Seneviratne, G., Weerasooriya, R.,** and **Liyanage, R.,** (2019). Comparison of inter-varietal differences in chemical composition and nutritional properties of coconut testa flour. *Journal of National Science Foundation Sri Lanka*, 47(3), p.351-358. [SCI Exp, IF : 0.419]*

2. **Marikkar, J.M.N.,** Kamil, N., and Raihana, A.R. (2019). Differential scanning calorimetric analysis of virgin coconut oil, palm olein, and their adulterated blends. *International Journal on Coconut Research and Development*, 35(1), p.34–42.

3. **Marikkar, J.M.N.,** Yanty, N.A.M., Mustafa, S., and Van Bockstaele, F. Nusantoro, K. (2019). Effect of Three Plant-Based Shortenings and Lard on Cookie Dough Properties and Cookies Quality. *International Food Research Journal*, 26(6), p.1795-1802. [SCI Exp, IF : 0.662]

4. Roslan, N. I. M, **Marikkar, J.M.N.,** Manaf, N. Y, Musthafa, S, and Miskandar, M. S (2019). Effect of enzymatic transesterification using Mucor miehei lipase on physicochemical properties of Engkabang (*Shorea macrophylla*) fat - canola oil blends. *International Food Research Journal*, 26(5), p.1427-1435. [SCI Exp, IF : 0.662]

Natural Products

1. Fernando, W. I. T, Perera, H. K. I., Athauda, S. B. P., Sivakanesan, R**., Kumar, N. S. K.,** and **Jayasinghe, L.** (2019). Heat stability of the in vitro inhibitory effect of spices on lipase, amylase and glucosidase enzymes. *Food Science and Nutrition*, 7(2), p.425-432. [SCI Exp, IF : 1.747]

2. Fernando, W. I. T., Attanayake, A. M. K. C., Perera, H. K. I., Sivakanesan, R., **Jayasinghe, L.,** Araya, H., and Fujimoo, Y. (2019). Isolation, Identification and Characterization of Pancreatic Lipase Inhibitors from *Trigonella foenum*-graecum Seeds. *South African Journal of Botany*, 121, p.418-421. [SCI Exp, IF : 1.504]

3. Kaliyadasa, E., **Jayasinghe, L.,** and Peiris, S. (2019). Tuber quality of Ashwagandha (Duanal) affected by different growth conditions. *Korean Journal of Agricultural Science*, 46(1), p.151-161.

4. Mahendranathan, C., and **Adikaram, N.K.B.** (2019). Potassium silicate treatment enhances natural disease resistance in *Capsicum annuum* L. and reduces anthracnose disease development. *Ceylon journal of science*, 48(3), p.251-259.

5. Rathnayake, G. R. N., **Kumar, N. S., Jayasinghe, L.,** Araya, H., and Fujimoto, Y. (2019). Secondary metabolites produced by an endophytic fungi pestalotiopsis microspore. *Natural products and bioprospecting*, 9, p.411-417.

6. Sritharan, T., **Kumar, N. S., Jayasinghe, L.,** Araya, H., and Fujimoto, Y. (2019). Isocoumarins and dihydroisocoumarins from endophytic fungus *Biscogniauxia capnodes*, isplated from the fruits of *Averrhoa carambola*. *Natural products communications*, 14(5), p.193-198. [SCI Exp, IF : 0.554]

Nutritional Biochemistry

1. Rizliya, V., Jayathilake, C., **Liyanage, R.,** and Sivakanesan, R. (2019). Applicability and reliability of the glucose oxidase method in assessing alpha -amylase activity. *Food Chemistry*, 275, p.265-272. [SCI, IF : 5.399]

2. Jayawardana, B. C., Warnasooriya, V. B., Thotawattage, G. H., Dharmasena, V. A. K. I., and **Liyanage, R.** (2019). Black and green tea (*Camellia sinensis* L.) extracts as natural antioxidants in uncured pork sausages. *Journal of Food Processing and Preservation*, 43(2), p.1-8. [SCI Exp, IF : 1.288]

3. Marasinghe, S.S.K., **Marikkar, J.M.N,** Yalegama, C., Wimalasiri, S., **Seneviratne, G., Weerasooriya, R.,** and **Liyanage, R.,** (2019). Comparison of inter-varietal differences in chemical composition and nutritional properties of coconut testa flour. *Journal of National Science Foundation Sri Lanka*, 47(3), p.351-358. [SCI Exp, IF : 0.419]*

4. Jayawardana, B. C., Chaturika, W. V. A. H., Vidanarachchi, J. K., Chandika, S. D. P. M. P. , and **Liyanage, R.** (2019). Onion (Allium cepa) suppresses the Lipid Oxidation and Improves the Sensory Quality of Cooked Pork Sausages. *International Journal of Livestock Research*, 9(3), p.41-48.

MICROBIOLOGY & CARBON SEQUESTRATION RESEARCH UNIT

Bioenergy & Soil Ecosystems

1. Premetilake, M.M.S.N., **Ratnayake, R.R.,** Perera, G.A.D., and **Kulasooriya, S.A.** (2019). Modelling Carbon Sequestration Potential of *Eucalyptus grandis* Forest Plantations in Intermediate Zone of Sri Lanka. *Pramana Research Journal*, 9(3), p.344-351.

2. **Ratnayake, R.R,** Chamari, D., Ekanayake, S., Rajapaksha, K., Karunaratne, S.B., and Kumara, K.L.W. (2019). Impact of the establishment of a botanical garden on soil carbon sequestration and nutrient availability in tropical soils. *Archives of Agronomy and Soil Science*, 64, p.1-12. [SCI Exp, IF : 1.681]

3. **Ratnayake, R.R.,** Roshanthan, T., Gnanavelrajah, N., and Karunaratne, S.B. (2019). Organic Carbon Fractions, Aggregate Stability, and Available Nutrients in Soil and Their Interrelationships in Tropical Cropping Systems: A Case Study. *Eurasian Soil Science*, 52(5), p.1542-1554. [SCI Exp, IF : 0.883]

Microbial Biotechnology

1. Buddhika, U.V.A., and **Seneviratne, G.** (2019). Media manipulation with in vitro developed biofilms to cultivate yet-unculturable bacteria from Soil. *International Journal of Scientific Research and Review*, 8(4), p.377-384.

2. Marasinghe, S.S.K., **Marikkar, J.M.N,** Yalegama, C., Wimalasiri, S., **Seneviratne, G., Weerasooriya, R.,** and **Liyanage, R.,** (2019). Comparison of inter-varietal differences in chemical composition and nutritional properties of coconut testa flour. *Journal of National Science Foundation Sri Lanka*, 47(3), p.351-358. [SCI Exp, IF : 0.419]*
3. Perera, M., Wijayarathna, D., Wijesundera, S., Chinthaka, M., **Seneviratne, G.,** and Jayasena, S . (2019). Biofilm mediated synergistic degradation of hexadecane by a naturally formed community comprising *Aspergillus flavus* complex and *Bacillus cereus* group. *BMC Microbiology*, 19, p.84. [SCI Exp, IF : 3.287]

4. Singhalage, I.D., **Seneviratne, G.,** and Madawala, H.M.S.P. (2019). Cultivated strawberry (*Fragaria x ananassa*) and wild strawberry (*Duchesnea indica*) rhizosphere associated microbes as inoculants to promote early vegetative growth of strawberry. *International Journal of Science and Research*, 8(4), p.862-867.

5. Singhalagea, I.D., **Seneviratne, G.,** Madawala, H.M.S.P., and Wijepala, P.C. (2019). Profitability of strawberry (*Fragaria ananassa*) production with biofilmed biofertilizer application. *Scientia Horticulturae*, 234, p.411-413. [SCI, IF : 1.961]

Rhizobium Project

1. **Kulasooriya, S.A.** (2019). The amazing world of microorganisms. (A review article). *Ceylon Journal of Science*, 48(4), p.303 – 310.

EARTH, ENVIRONMENT & BIODIVERSITY RESEARCH UNIT

Earth Resources and Renewable Energy

1. Bandara, H.M.D.A.H. Sooriyarachchi, N.B. Dissanayake, C.B. **Subasinghe, N.D.** (2019). Geothermal Energy - Potential Applications in Sri Lanka. *Peer Reviewed Journal on Vidulka National Energy Symposium*, 5(1), p.161-173.

Environmental Science Research Programme

1. Dai, X, Dharmage, S, **Bowatte, G,** Waidyatillake, N, Perret, J, Hui, J, Erbas, B, Abramson, M, Lowe, A, Burgess, J, Svanes, C, Lodge, C.J (2019). Interaction of Glutathione S-Transferase M1, T1, and P1 Genes With Early Life Tobacco Smoke Exposure on Lung Function in Adolescents. *CHEST*, 155(1), p.94-102. [SCI, IF : 9.657]

2. Makehelwala, M., Wei, Y., Weragoda, S.K., Zheng, L., and **Weerasooriya, R.** (2019). Characterization of Dissolved Organic Carbonin Shallow Groundwater of Chronic Kidney Disease Affected Regions in Sri Lanka. *Science of the Total Environment*, 600, p.865-875. [SCI, IF : 5.589]

3. Titus Cooray, Yuansong Wei, Hui Zhong, Libing Zheng, Sujithra K. Weragoda, and **Weerasooriya, R.** (2019). Assessment of Groundwater Quality in CKDu A ected Areas of Sri Lanka: Implications for drinking water Treatment. *International Journal of Environmental Research and Public Health*, 16(1698), p.1-16. [SCI/SCIE, IF : 2.468, SJR : 0.818]

4. Madhubhashini Makehelwala, Yuansong Wei, Sujithra K. Weragoda, and **Weerasooriya, R.** (2019). Ca2þ and SO4 2¡ interactions with dissolved organic matter: Implications of groundwater quality for CKDu incidence in Sri Lanka. *Journal of Environmental Science*, , p.1-12. [SCI/SCIE, IF : 3.556, SJR : 1.017]

5. Zhi-Wen Wang, Hong-Jin Liu, Chun-Yang Li, Xing Chen, **Weerasooriya, R.,** Juan Wei, Jun Lv, Pin Lv, and Yu-Cheng Wu (2019). Mesoporous g-C3N4/?-CD nanocomposites modified glassy carbon electrode for electrochemical determination of 2,4,6-trinitrotoluene. *Talanta*, , p.1-9. [SCI/SCIE, IF : 4.916, SJR : 1.152]
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7. Cheng-Cheng Bi, Xu-Xu Ke , **Weerasooriya, R.,** Zhan-Yong Hong, Lian-Chao Wang, and Yu-Cheng Wu (2019). Assembling Reduced Graphene Oxide with Sulfur/Nitrogen- "Hooks" for Electrochemical Determination of Hg(II). *Analytica Chimica Acta*, , p.1-40. [SCI/SCIE, IF : 5.256, SJR : 1.467]

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ABSTRACTS 2019

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4. **Marikkar, J.M.N.** (2019). Influence of Major Triglyceride Constituents of *Madhuca logifolia* seed fat and Engkabang fat on their Crystallization Behaviour: A Comparative Study. *Rajarata International Research Conference-2019, Mihintale*.

Natural Products

1. Baheej, M. A. A., Siddiqui, H., Haroon, M. H., Choudhary, M. I., and **Jayasinghe, L.** (2019). Synthesis of novel glucosidase and carbonic anhydrase based on 1,2,3-triazole derivatives of hydrochlorothiazide (HCT) through click chemistry approach. *7th International Symposium cum-training course on molecular medicine and drug research*.

2. Devanarayana, P. N., Sathya, S., **Jayasinghe, L.,** and Amarasinghe, N. R. (2019). Investigation of anti-inflammatory and acetylcholinesterase inhibitory activities of ceylon black tea. *Anual scientific sessions, Pharmaceutical society of Sri-Lanka*.

3. Dissanayake, D., **Kumar, N. S., Jayasinghe, L.,** Araya, H., and Fujimoto, Y. (2019). Role of endophytic fungi in combating metabolic disorders. *9th International ANRAP Seminar*.

4. Jayakodi, J. A. K. C., Sathya, S., and **Jayasinghe, L.** (2019). Comparative study of antioxidant and antidiabetic activities of fresh and processed pericap of *Myristica fragrans. Annual Scientific sessions, Pharmaceutical Society of Sri-Lanka*.

5. Liyanarachchi, C. E., Napagoda, M., Witharana, S., and **Jayasinghe, L.** (2019). Determination of photoprotective potential and photo-stability in the methanolic extract of leaves of *Hibiscus furcatus. Sri Lanka medical association 132nd anniversary international medical congress*.

6. Manawadu, L.N., **Adikaram, N.K.B.,** Yakandawala, D. , and **Jayasinghe, L.** (2019). Internal Pulp Browning, a new disorder of ripe mango (*Mangifera indica L.)* fruit. Plant Health 2019. *1st National Symposium of Sri Lanka Association of Mycology and Plant Pathology*.

7. Napagoda, M., De Soyza, S., Gerstmeier, J., Butschek, H., Lorenz, S., Qader, M., Nagahawatte, A., Wijayarathne, G. B., Schneider, B., Svatos, A., **Jayasinghe, L.,** Koeberle, A., and Werz, O. (2019). *Plenctranthus zeylanicus Benth*: A potent source of secondary metabolites with antimicrobial disinfectant and anti-inflammatory activities. *Trends in Natural Product Research- PSE Young scientists' meeting, Budapest, Hungary*.

8. Napagoda, M., Liyanarachchi, C. E., Malkanthi, S., Abayawardana, K., Witharana, S., and **Jayasinghe, L.** (2019). Development of herbal sunscreen formulations from flowers of *Caesalpinia pulcherrima* (L.) Sw. *Sri Lanka medical association 132 nd anniversary international medical congress*.

9. Napagoda, M., Liyanarachchi, C., Malkanthi, S., Abayawardana, K., Witharana, S., and **Jayasinghe, L.** (2019). Development of herbal sunscreen formulations from flowers of *Osbeckia octandra. Trends in Natural Product Research- PSE Young scientists' meeting, Budapest, Hungary*.

10. Niyangoda, D., **Kumar, N. S.,** and **Jayasinghe, L.** (2019). Edible fruits as a source of drug candidates. *7th international symposium-cum-training course on molecular medicine and drug research*.

11. Qader, M. M., Amarasinghe, N. R., and **Jayasinghe, L.** (2019). Amylase inhibitory and antioxidant activities of fruits of four Sri Lankan Artocarpus species. *9th International ANRAP seminar*.

12. Sathya, S., Amarasinghe, N. R., **Jayasinghe, L.,** Araya, H., and Fujimoto, Y. (2019). Glucosidase inhibitors from mace. *9th International ANRAP Seminar*.

13. Shamika, D. G. H., **Jayasinghe, L., Kumar, N. S.,** Perumpuli, B., and Dissanayake, D. (2019). Study on the effect of heat sterilization on bioactivity of *Flacourtia indica. Proceedings of the University of Peradeniya International Research Sessions*.

Nutritional Biochemistry

1. Amriya, M.N.F., Wickramarachchi, D., Rizliya, V., Bawazeer, M., Tissera, B., Qader, M., Rateb, M.E., Vasantharuba, S., and **Liyanage, R.** (2019). Phytochemical screening and *in vitro* anti diabetic properties of *hemidesmus indicus* methanolic root extract. *National Science and Technology Commision (NASTEC), Proceedings of the 2nd National Undergraduate Research Symposium - 2019*.

2. Deen, A., Visvanathan, R., Rathnayaka, I., Jayawardana, B.C., and **Liyanage, R.** (2019). Effect of boiling and simulated digestion on the total phenol, total flavonoid and antioxidant activity of commonly consumed legumes in Sri Lanka. *Faculty of Science, University of Kelaniya. 4th International Research Symposium on Pure and Applied Sciences (IRSPAS)*.

3. Deshapriya, R.M.C, Ranasinghe, I.G.L.C., and **Liyanage, R.** (2019). Determination of Concentration of Heavy Metals in Bovine Blood and Milk in identified Human CKDu-prevalent areas of Sri Lanka. *71st Annual Scientific Sessions of the Sri Lanka Veterinary Association*.

4. Hegodaarachchi, S. Y., Jayawardana, B.C., Warnasooriya, S. G. V. B., and **Liyanage, R.** (2019). The Use of Mee Oil (*Madhuca longifoilia*) as a Fat Replacer and Its Effect on Physicochemical and Sensory Characteristics of Pork Sausages. *University of Peradeniya, Faculty of Agriculture Undergraduate Research Symposium (FAuRS)*.

5. Liyanage, T. P., Jayawardana, B.C., **Liyanage, R.,** Deen, A., and Rathnayaka, I. (2019). *Invitro* Hydrolysis Rates and Physicochemical Properties of Fifteen Different Staches in Sri lanka. *University of Peradeniya, Faculty of Agriculture Undergraduate Research Symposium (FAuRS)*.

6. Premawansha, P. M., Jayawardana, B.C., Perera, N., and **Liyanage, R.** (2019). Antioxidant, Physiochemical, Microbiological, and Sensory Properties of Yoghurt Incorporated with Beetroot(*Beta vulgaris*) Powder. *University of Peradeniya, Faculty of Agriculture Undergraduate Research Symposium (FAuRS)*.

7. Ranasinghe, I. G. L. C., **Liyanage, R.,** Isobe, N, and Deshapriya, R. M. C. (2019). Investigation of Accumulation of Heavy Metals in Bovine Blood and Milk in Human CKDu prevalent areas of Sri Lanka. *Conference on Sri Lanka - Japan Collaborative Research 24 August 2019 at University of Peradeniya*.

8. Randika, W. A. T., Deshapriya, R. M. C., and **Liyanage, R.** (2019). Accumulation of Heavy metals in Bovine Milk and Blood in Human CKDu Identified Ares in Sri Lanka. *University of Peradeniya, Faculty of Agriculture Undergraduate Research Symposium (FAuRS)*.

9. Sewwandi, S.M.V.K., Jayawardana, B.C., **Liyanage, R.,** Visvanathan, R., and Deen, A. (2019). Prebiotic Activity of Commonly Available Starches in Sri Lanka. *University of Peradeniya, Faculty of Agriculture Undergraduate Research Symposium (FAuRS)*.

MICROBIOLOGY & CARBON SEQUESTRATION RESEARCH UNIT

Bioenergy & Soil Ecosystems

1. Bowange, T., Hossain, M.D.F., Kumara, W., and **Ratnayake, R.R.** (2019). Cyanobacteria as one of the most promising botanical sun protecting agents; A way towards healthy cosmetics. *The Early Career Microbiologists' Forum Summer Conference, Moyne Institute, Trinity College, Dublin, Ireland*.

2. Bowange, T.K., **Ratnayake, R.R.,** and Kumara, W. (2019). Cyanobacteria Biomass as an Alternative Source of Essential Macro and Micro Nutrients for Healthy life. *NIFS- Young Scientists' Symposium on Multidisciplinary Research 2019*.

3. Dissanayake, D.D.M.O., Perera, G.A.D., Kadupitiya, H.K., and **Ratnayake, R.R.** (2019). Evaluation of Mangrove Ecosystems in Regulating Atmospheric Carbon. *NIFS-Young Scientists' Symposium on Multidisciplinary Research 2019*.

4. Jayasekara, S., Abayasekara, C., and **Ratnayake, R.R.** (2019). Lignocellulose digestion by anaerobic rumen microbial consortia from sheep. *The Early Career Microbiologists' Forum Summer Conference, Moyne Institute, Trinity College, Dublin, Ireland*.

5. Jayasekara, S.D., **Ratnayake, R.R.,** and **Seneweera, S.** (2019). Nitrogen Uptake and Utilization of Rice under the Influence of Cyanobacteria. *NIFS-Young Scientists' Symposium on Multidisciplinary Research 2019*.

6. Jayasekara, S.K., Abayasekara, C.L., and **Ratnayake, R.R.** (2019). Potential application of vinasse as low-cost culture media for fungi. *Australian Society for Microbiology Conference, Adelaide Convention Centre, Adelaide, South Australia*.

7. Jayasekara, S.K., Abayasekara, C.L., and **Ratnayake, R.R.** (2019). Microbial cellulase: An enzyme with a huge potential. *NIFS-Young Scientists' Symposium on Multidisciplinary Research 2019*.

8. Jayasekara, S.K., Abayasekara, C.L., and **Ratnayake, R.R.** (2019). Efficient Microorganisms for Bioethanol Production from the Natural Environment of Sri lanka. *International Research Conference of Uva Wellassa University 2019*.

9. Jayasinghe, J.A.V.R., Jayasekara, S.K., and **Ratnayake, R.R.** (2019). The potential of genetic modification in enhancing cellulase production by fungal species. *NIFS-Young Scientists' Symposium on Multidisciplinary Research 2019*.

10. Madusanka, T.Y.G., Jayasekara, S.K., **Ratnayake, R.R., Seneweera, S.,** and Rupasinghe, C.P. (2019). The effect of heat treatment on enhancing cellulolytic microbial activity on sugarcane bagasse. *NIFS-Young Scientists' Symposium on Multidisciplinary Research 2019*.

11. Madusanka, T.Y.G., Jayasekara, S.K., **Ratnayake, R.R., Seneweera, S.,** and Rupasinghe, C.P. (2019). Biological pre-treatment of Sugarcane bagasse for cellulosic ethanol production. *International Symposium on Agriculture & Environment. Proceedings Young Graduates Forum of Faculty of Agriculture, University of Ruhuna, Sri Lanka*.

12. Mudalige, T., **Ratnayake, R.R.,** and Jayasekara, S.K. (2019). Bioethanol production: a co-culturing approach of yeast with cellulolytic fungi. *NIFS- Young Scientists' Symposium on Multidisciplinary Research 2019*.

13. Paranavithana, T.M., Karunaratne, S., Gunathilake, S., Gnanavelrajah, N., and **Ratnayake, R.R.** (2019). Microbial Biomass Carbon Status of Paddy Growing Soils in Dry Zone, Sri Lanka. *NIFS- Young Scientists' Symposium on Multidisciplinary Research 2019*.

<u>Microbial Biotechnology</u>

1. Gunarathne, S., and **Seneviratne, G.** (2019). Biofilm biofertilizer: A promising Eco-friendly alternative to futuristic martian agriculture. *Postgraduate Institute of Science Research Congress, University of Peradeniya*.

2. Lakmini, A.L.A., **Seneviratne, G.,** and Madushani, K.P.K. (2019). Effect of biofilm biofertilizer and chemical fertilizer application practices on growth and endophytic bacterial count of rice (Oryza sativa L.). *International Postgraduate Research Conference 2019, University of Kelaniya*.

3. Maheshika,W.A.H., Singhalage, I.D., Henagamage, A.P., and **Seneviratne, G.** (2019). Development of microbial biofertilizer for tomato *(Solanum Lycopersicum). International Research Conference, Uva Wellassa University, Badulla*.

4. Meepegamage, S.W., **Seneviratne, G.,** and Rajapakse, R.G.S.C. (2019). Efficiency of biofilm biofertilizer in increasing plant growth parameters of rice cultivation in Sri Lanka. *International Postgraduate Research Conference, University of Kelaniya*.

5. Meepegamage, S.W., **Seneviratne, G.,** and Rajapakse, R.G.S.C. (2019). Biofilm biofertilizer application can increase soil carbon content in tea cultivation. *National Agriculture Information Center, Kandy. International Symposium on Sustainable Soil Management*.

6. Meepegamage, S.W., **Seneviratne, G.,** and Rajapakse, R.G.S.C. (2019). Biofilm biofertilizer mediated restoration of nitrogen fixers in the soil-plant system in paddy cultivation. *Postgraduate Institute of Science Research Congress, University of Peradeniya*.

7. Perera, S.M.D., Chinthaka, S.D.M., Wijayarathna, C.D., Wijesundera, W.S.S., **Seneviratne, G.,** and Jayasena S.M.T. (2019). High efficiency degradation of crude oil by *Aspergillus* sp. MM1. *27th FAOBMB & 44th Annual MSBMB Conference 2019, Kuala Lumpur, Malaysia.*
8. Prematunga, C., Wijekoon, N., **Seneviratne, G.,** and Jayalal, U. (2019). Green mirror on bare lands: a reality? *Annual Session of the Institute of Biology*.

9. Prematunga, C., Wijekoon, N., **Seneviratne, G.,** and Jayalal, U. (2019). Towards eco-friendly agriculture on mars: a preliminary study with lettuce. *Postgraduate Institute of Science Research Congress, University of Peradeniya*.

10. Rathnathilaka, A.T.D., and **Seneviratne, G.** (2019). Does biofilm biofertilizer work in large scale rice cultivation under farmers' field condition? *Postgraduate Institute of Science Research Congress, University of Peradeniya*.

11. Rathnathilaka, A.T.D., **Seneviratne, G.,** and Madawala, H.M.S.P. (2019). Application of Biofilm biofertilizer to increase grain yield via enhanced rhizosphere nutrient availability in large scale rice cultivation of Sri Lanka. *National Agriculture Information Center, Kandy. International Symposium on Sustainable Soil Management.*

12. Rathnathilaka, A.T.D., **Seneviratne, G.,** Madawala, H.M.S.P., and Rizvi, E.M.J.M (2019). Effect of biofilm biofertilizer on availability of soil diazotrophs, plant endophytic diazotrophs and increasing of grain yield in rice (*Oryza sativa*) cultivation of Sri Lanka. *International Postgraduate Research Conference 2019, University of Kelaniya*.

13. Singhalage, l.D., **Seneviratne, G.,** and Madawala, H.M.S.P. (2019). Developing a non host-specific biofertilizer: a microbial biofilm approach. *Peradeniya University International Research Sessions*.

14. Rathnathilaka, A.T.D., and **Seneviratne, G.** (2019). Does biofilm biofertilizer work in large scale rice cultivation under farmers' field condition? *Postgraduate Institute of Science Research Congress, University of Peradeniya*.

EARTH, ENVIRONMENT & BIODIVERSITY RESEARCH UNIT

Earth Resources and Renewable Energy

1. Abesinghe, A.M.A.M, Dharmapriya, P.L, Malaviarachchi, S.P.K, Krishnan, S., Satish Kumar, M., **Subasinghe, N.D.,** (2019). Petrology and Geochemistry of Kadugannawa Complex, Sri Lanka. *Proceedings of the 35th Annual technical sessions of the Geological society of Sri Lanka*.

2. Bandara, H.M.D.A.H., Suriyaarachchi, N.B., **Subasinghe, N.D.,** (2019). Study of Shallow and Deep resistivity structures of the Nelumwewa Hot spring, Sri Lanka. *Proceedings of the 35th Annual technical sessions of the Geological society of Sri Lanka.*

3. Bandara. Wickramanayake. H.P.T.S. , Jayawardhane. Y. Pathmanathan. R, H.M.D.A.H. Dharmapriya. P.L., **Subasinghe, N.D.** Weerasooriya. R., (2019). Site Recommendation for The Installation of Water Treatment Plant at Villages in The Dry Zone of Sri Lanka. *Proceedings of the 35th Technical Session of Geological Society of Sri Lanka.*

4. Suriyaarachchi. N, **Subasinghe, N.D.** (2019). Study on shallow water circulation mechanisms using Time domain electro-magnetic(TDEM) data, case study from Nelumwewa thermal spring. *NIFS-Young Scientists' Symposium on Multidisciplinary Research 2019*.

Environmental Science Research Programme

1. Ariyarathna, R.W.U.N., Jayawardhana, Y., Rukshagini, P., Jayasundera, A.C.A., Wijekoon, P., and **Weerasooriya, R.** (2019). A Hierarchial Clustering Approach to Groundwater Classification. *Postgraduate Institute of Science (PGIS), University of Peradeniya, Sri Lanka, Proceedings of the International Symposium on Water and Air Pollution; Recent trends in Research.*

2. Ariyarathna, R.W.U.N., Wickramanayake, T., Rukshagini, P., Jayasundera, A.C.A., Wijekoon, P., and **Weerasooriya, R.** (2019). Applications of Integrated Water Quality Index (IWQI) for Rapid Demarcation of Palatability Problems in Groundwater. *Geological Society of Sri Lanka (GSSL), Proceedings of the 35th Annual Technical Sessions "Emerging Trends in Geoscience & Geology of Sri Lanka"*.

3. **Bandara, J.,** Halpegama, J.U., Priyantha, N., and **Weerasooriya, R.** (2019). Continuous Flow Studies for Nitrate Removal using Naturally Synthesized Zero Valent Nano Iron. *Postgraduate Institute of Science (PGIS), University of Peradeniya, Sri Lanka, Proceedings of the International Symposium on Water and Air Pollution; Recent trends in Research*.

4. Halpegama, J.U., Fernando, C.A.N., Herath, A.C., and **Weerasooriya, R.** (2019). Sri Lankan Vein Graphite as a Potential Substrate for Zero Valent Iron Stabilization for Pollulants Abatement. *Geological Society of Sri Lanka (GSSL), Proceedings of the 35th Annual Technical Sessions "Emerging Trends in Geoscience & Geology of Sri Lanka"*.

5. Halpegama, J.U., Herath, A.C., **Jayarathna, L.,** Yeh, C.Y., and **Weerasooriya, R.** (2019). Chemical Destruction of Excess Nitrate in Water by Graphene Nano Zero Valent Iron Composition. *Postgraduate Institute of Science (PGIS), University of Peradeniya, Sri Lanka, Proceedings of the International Symposium on Water and Air Pollution; Recent trends in Research*.

6. Heenkenda, K., Rukshagini, P., Jayawardhana, Y., **Jayarathna, L.,** and **Weerasooriya, R.** (2019). Determination of Chemical Fate of Fluoride Distribution of Mihintale Aquifer in Sri Lanka by Experimental and Modeling Methods. *Postgraduate Institute of Science (PGIS), University of Peradeniya, Sri Lanka, Proceedings of the International Symposium on Water and Air Pollution; Recent trends in Research*.

7. Perera, M.G.N., Ren, Y., **Weerasooriya, R.,** and **Jayarathna, L.** (2019). Improvement of Performance of Forward Osmosis Membrane by Incorporation of Carbon Nanotubes to Reduce Pollution in Marine Systems. *Postgraduate Institute of Science (PGIS), University of Peradeniya, Sri Lanka, Proceedings of the International Symposium on Water and Air Pollution; Recent trends in Research*.

8. Witharana, S., Rukshagini, P., Jayawardhana, Y., Chandrajith, R.L.R., and **Weerasooriya, R.** (2019). Groundwater Resources Development in Hard Rock Terrain in Dry Zone of Sri Lanka - An Approach using Geochemical and Isotope Signatures. *Geological Society of Sri Lanka (GSSL), Proceedings of the 35th Annual Technical Sessions "Emerging Trends in Geoscience & Geology of Sri Lanka"*.

<u>Evolution, Ecology & Environmental Biology</u>

1. Bopearachchi, D.P., Kanesharatnam, N., Athukorala, N., and **Benjamin, S.P.** (2019). A Preliminary phylogeny of Ballini jumping spiders in Sri Lanka (Araneae: Salticidae). *Postgraduate Institute of Science, University of Peradeniya and PGIS Research Congress 2019*.

<u>Plant & Environmental Sciences</u>

1. Dissanayake, D.M.R.E.A., Iqbal, S.S., Priyantha, N., and **Iqbal, M.C.M.** (2019). Green synthesis of MIL 53(Fe) and its use as an effective adsorbent of cationic dyes. *4th Green & Sustainable Chemistry Conference, Hilton Hotel Dresden, Germany*.

2. Karunarathna, H.G.M.K., Medagama, K., **Wijesundara, D.S.A.,** and **Iqbal, M.C.M.** (2019). Use of natural growth enhancer for in vitro micropropagation of Stevia rebaudiana. *39th Annual Session, Institute of Biology*.

3. Wijesinghe, K.E.H., Dissanayake, D.M.R.E.A., Priyantha, N., Iqbal, S.S., and **Iqbal, M.C.M.** (2019). Efficient adsorption of phosphate by kaoline-alginate composite. *4th Green & Sustainable Chemistry Conference, Hilton Hotel Dresden, Germany*.

Plant Taxonomy & Conservation

1. Ananda, N. D. J. L , Bandara, N. C, **Wijesundara, D.S.A.,** and Bandara, B. M. R (2019). Alien invasive plant Prosopls juliflora : Alkaloid –Montmorillonite nanocomposites and antioxidant and cytotoxic properties. *Post Graduate Institute of Science Research Congress, University of Peradeniya, Sri Lanka*.

2. De Alwis, s, Perera, S. J, Kudavidanage, E. P, and **Wijesundara, D.S.A.** (2019). Quantification of habitat regeneration after removing invasive plant Ulex europaeus in Horton Plains National Park. *Seventh International Conference of Sabaragamuwa University of Sri Lanka*.

3. Dilakshana, K, Bandara, N. C, Ekanayake, A, Liyanapathirana, L. V. C, **Wijesundara, D.S.A.,** and Bandara, B. M. R (2019). Antibacterial activity of Aristea ecklonii and Prosopis juliflora against multi drug resistant Acinetobacter Spp. and Methicillin-resistant Staphylococcos aureus. *Postgraduate Institute of Science Research Congress, University of Peradeniya, Sri Lanka*.

4. Gunasekara. R. S, Yakandawala. Y, Jayakody. S, and **Wijesundara, D.S.A.** (2019). A case study on Vanda tessellata (Roxb) Hook. Ex G. Don trade in Sri Lanka. *Association for Tropical Botany and conservation Asia Pacific Conference*.

5. Gunasekera, R.S, Yakandawala, K, Jayakody, S, and **Wijesundara, D.S.A** (2019). Orchid Trade in Sri Lanka with Special Reference to Vanda tessellata. *Global dialogue on wildlife trafficking - International Symposium University of Colombo. CITES CoP 18 Secretariat*.

6. Hewa Welage, N. S, Perera, S. J, Kudavidanage, E. P, and **Wijesundara, D.S.A.** (2019). Stakeholder knowledge and perception of Invasive Plant species in Horton Plains and Udawlawe national Parks, Sri Lanka. *Seventh International Conference of Sabaragamuwa University of Sri Lanka*.

7. Jayamaha, J. H. P. K, Marasinghe, M. P. C. K, Bandara, N. C, Nishantha, K. M. D. W. P, **Wijesundara, D.S.A.,** and Bandara, B. M. R (2019). Aphicidal, antioxidant and cytotoxic properties of four invasive alien plants. *Postgraduate Institute of Science Research Congress,University of Peradeniya, Sri Lanka*.

8. Lekamge, P. C. U. S. B, Iqbal, M. C. M, and **Wijesundara, D.S.A.** (2019). Can Short Term Assisted Natural Regeneration Initiate Restoration of Dry Forest. *Research Symposium on Dry Zone Forests*.

9. Lekamge. P. L. C. U. S. B, **Iqbal, M.C.M.,** and **Wijesundara, D.S.A.** (2019). Can Assisted Natural Regeneration increase forest cover in Sri Lanka. *Association for Tropical Botany and conservation Asia Pacific Conference*.

10. Madumika, W. L. M, Perera, S. J, Kudavidanage, E. P, and **Wijesundara, D.S.A.** (2019). Quantification of habitat regeneration after removing invasive plant Lantana camara in Udawalawe National Park. *Seventh International Conference of Sabaragamuwa University of Sri Lanka*.

11. Peiris. H. M. P, Wijesundara. C, and **Wijesundara, D.S.A.** (2019). Ecotouristically sound biological resources survey of the Maskeliya Basin. *Association for Tropical Botany and conservation Asia Pacific Conference*.

12. Samarasinghe, V. G. A. U, Nishantha, K. M. D.W.P, Bandara, N. C, Damunupola, J. W, **Wijesundara, D.S.A.,** and Bandara, B. M. R (2019). Insecticidal activity of seven invasive alien plants against aphids (Myzus persicae). *Postgraduate Institute of Science Research Congress, University of PeradeniyaSri Lanka*.

13. Thakshila. S. A. D, Sirisena. U. G. A. I, Geekiyanage. N, **Iqbal, M.C.M., Wijesundara, D.S.A.,** and Abeysekera, T.J.D. (2019). Comparative study of insect diversity in an abandoned chena and vegetable agro-ecosystem in Dambulla, Sri Lanka. *Association for Tropical Botany and conservation Asia Pacific Conference*.

14. Wickramasinghe, K.G.K.M, Nakandalage, N, Lekamge, P.L.C.U.S.B, and **Wijesundara, D.S.A** (2019). Study on Selected Species of Family Thymelaeaceae for Agarwood Type Resin and Their Propagation Methods. *International Symposium on Agriculture and Environment 2019. University of Ruhuna.*

15. Wijayaraja, I, Kumarathunge, D.P, **Wijesundara, D.S.A, Iqbal, M.C.M,** and Geekiyanage, N (2019). Thermal response of photosynthesis in intact leaves of ten evergreen tree species in a secondary tropical dry forest in central Sri Lanka. *11th Annual Research Symposium Faculty of Agriculture University of Rajarata*.

16. Wijesuriya. I, Kumarathunga. D. P, **Wijesundara, D.S.A., Iqbal, M.C.M.,** and Geekiyanage. N (2019). How does elevated temperature affect leaf photosynthesis in evergreen tree species in a tropical dry forest in Central Sri Lanka. *Association for Tropical Botany and conservation Asia Pacific Conference*.

17. Wijewickrama, M. P. T, Herath, H. M. S. B, **Wijesundara, D.S.A.,** and Madawala, H. M. S. P (2019). Tree and shrub diversity and abundance along an elevation gradient of Ambokka mountain range, Sri Lanka. *Postgraduate Institute of Science Research Congress, University of Peradeniya, Sri Lanka*.

18. Wijewickrama. M. P. T, Karunaratne. W. A. I. P, **Wijesundara, D.S.A.,** and Madawala. H. M. S. P (2019). Bambusa bambos (L.) Voss alters regeneration potential in tropical moist evergreen forests in Sri Lanka. *Association for Tropical Botany and conservation Asia Pacific Conference*.

<u>Primate Biology</u>

1. **Dittus W.P.J.** (2019). The phylogenetic diversification of Sri Lankan mammals in relation to those of subcontinental India. *Proceedings of the Association for Tropical Biology Conservation (MAS Athena, Thulhiriya, Sri Lanka).*

2. **Dittus, W.P.J.** (2019). The solution to reducing human-monkey conflict lies not in acting on its symptoms but in removing its causes; a 50-year study reveals in Sri Lanka. *Proceedings of the Association for Tropical Biology Conservation (MAS Athena, Thulhiriya, Sri Lanka).*

MOLECULAR BIOLOGY & BIOTECHNOLOGY RESEARCH UNIT

Molecular Microbiology & Human Diseases

1. Ekanayake, E.M.U.A., Madegedara, R.M.D., Chandrasekharan, N.V., and **Magana-Arachchi, D.N.** (2019). Bacteria load in respiratory specimens in lung cancer and bronchiectasis suspected patients; a molecular approach. *Rajarata University of Sri Lanka, Rajarata International Research Conference (RIRC) 2019*.

2. Ekanayake, E.M.U.A., Madegedara, R.M.D., Chandrasekharan, N.V., and **Magana-Arachchi, D.N.** (2019). Characterization of lung bacterial microbiota of lung cancer and bronchiectasis patients: a 16S metagenomic approach. *8th annual conference and scientific sessions of the Sri Lankan society for microbiology (SSM)*.

3. Ekanayake, E.M.U.A., Madegedara, R.M.D., Chandrasekharan, N.V., and **Magana-Arachchi, D.N.** (2019). Variations of bacterial load in respiratory specimens in lung cancer and bronchiectasis suspected patients. *NIFS-Young Scientists' Symposium on Multidisciplinary Research 2019*.

4. Hettiarachchi, H.H., Wanigatunge, R., and **Magana-Arachchi, D.N.** (2019). Culture-Dependent Characterization of Marine Bacteria from Ussangoda Coast, Sri Lanka. *20th International Postgraduate Research Conference (IPRC), Faculty of Graduate Studies, University of Kelaniya, Sri Lanka, 2019*.

5. Jayasinghe, J.A.S.M., Medhavi, P.I.H.R., **Magana-Arachchi, D.N.,** Wanigatunge, R., and Herath, H.M. (2019). Production of certain extracellular enzymes by some bacteria and amplification of cellulase gene from *Bacillus* species. *4th International Research Symposium on Pure and Applied Sciences 2019 (IRSPAS 2019), Faculty of Science, University of Kelaniya*.

6. Madamarandawala, J.M.P.S., Madegedara, R.M.D., and **Magana-Arachchi, D.N.** (2019). Nearly one third of drug resistant *Mycobacterium tuberculosis* strains reported in Sri Lanka belong to Beijing lineage; a preliminary investigation. *Rajarata University of Sri Lanka, Rajarata International Research Conference (RIRC) 2019*.

7. Madamarandawala, J.M.P.S., Madegedara, R.M.D., and **Magana-Arachchi, D.N.** (2019). Comparative drug susceptibility testing of *Mycobacterium tuberculosis* using conventional agar proportion method and MGIT. *NIFS-Young Scientists' Symposium on Multidisciplinary Research 2019*.

8. Nagendran, T., and **Magana-Arachchi, D.N.** (2019). Morphological diversity of cyanobacteria from Nothern Sri Lanka. *NIFS-Young Scientists' Symposium on Multidisciplinary Research 2019*.

9. Nagendran, T., Samarasinghe, D.G.S.N., Madamarandawala, J.M.P.S., Ekanayake, E.M.U.A., and **Magana-Arachchi, D.N.** (2019). Molecular identification of potential microcystin producing cyanobacteria in Northern Sri Lanka. *Faculty of Applied Sciences South Eastern University of Sri Lanka, 8th Annual Science Research Sessions (ASRS) - 2019*.

10. Samarasinghe, D.G.S.N., Wanigatunge, R., and **Magana-Arachchi, D.N.** (2019). Diversity of culturable thermophilic bacteria and cyanobacteria in Mahapellessa hot spring in Sri Lanka. *8th annual conference and scientific sessions of the Sri Lankan society for microbiology (SSM)*.

11. Samarasinghe, D.G.S.N., Wanigatunge, R., Herath, H.M., and **Magana-Arachchi, D.N.** (2019). PCR amplification of microcystin synthetase genes from cyanobacterial mats collected from Maha Oya hot springs. *NIFS-Young Scientists' Symposium on Multidisciplinary Research 2019*.

Plant Stress Biology & Molecular Genetics

1. Jayasekara, D., **Ratnayake, R.R.,** and **Seneweera, S.** (2019). Nitrogen uptake and utilization of rice under the influence of Cyanobacteria. *NIFS-Young Scientists' Symposium on Multidisciplinary Research 2019*.

2. Madusanka, T.Y.G., Jayasekara, S.K., **Ratnayake, R.R., Seneweera, S.,** and Rupasinghe, C.P. (2019). The effect of heat treatment on enhancing cellulolytic microbial activity on sugarcane bagasse. *NIFS-Young Scientists' Symposium on Multidisciplinary Research 2019*.

3. **Seneweera, S.** (2019). Altered primary and secondary metabolism of plants under future CO2 rich atmosphere could impact the development of pathosystems. *Plant Health 2019 - The First National Symposium of Sri Lanka Association for Mycology and Plant Pathology (SLAMPP): Ensuring safer plant produce for human consumption*.

BOOKS/MONOGRAPHS & BOOK CHAPTERS

Books/ Monographs

1. Senavirathne, M.M.K.R.N.D., Amaraweera, T.H.N.G., and **Wijayasinghe, H.W.M.A.C.**, (2019). *Sri Lankan Graphite Then, Now and Tomorrow* (1).Kandy:Muses Publishing House, 34/4, Katuwalamulla, 11020, Ganemulla.

Books Chapters

1. Deen, A., Visvanathan, R., and **Liyanage, R.** (2019). Extraction of Bioactive Compounds: Conventional and Green Extraction Techniques. *Bio active Compounds from Plant Origin Extraction, Applications, and Potential Health Benefits* (p. 45-68). New York, Taylor & Francis Group/Apple Academic Press.

2. **Iqbal, M.C.M.,** and Iqbal, S.S. (2019). Remediation of Potentially Toxic Elements Through Transgenic Plants: In Vitro Studies and the Way Forward. *Transgenic Plant Technology for Remediation of Toxic Metals and Metalloids* (p. 103-128)., Academic Press.

3. **Jayarathna, L.,** Karunathilake, N., Bandara, A., and **Weerasooriya, R.** (2019). Adsorption Configurations of 2-Chlorophenols on Colloidal Silica. *Colloid Science in Pharmaceutical Nanotechnology* (p. 1-11), IntechOpen.

4. Jayasekara, S.K., and **Ratnayake, R.R.** (2019). Microbial Cellulases: An Overview and Applications. *IntechOpen* (p. 1-22), IntechOpen.

5. Munasinghe, E., Aththapaththu, M., and **Jayarathna, L.** (2019). Magnetic and Quantum Dot Nanoparticles for Drug Delivery and Diagnostic Systems. *Colloid Science in Pharmaceutical Nanotechnology* (p. 1-15), IntechOpen.

NEWSPAPER/ MAGAZINE ARTICLES

1. Jayasinghe, J.A.V.R., Dissanayake, D.D.M.O., and **Ratnayake, R.R.** (2019-08-05), A Dying Unsung Hero: The Role of Salt Marshes in Climate Change Mitigation. *The Sri Lankan Scientist* p.13-15.

2. **Marikkar, J.M.N.** (2019-03-10), Addressing Food Fraud: A Social Responsibility. *The Trend Magazine* p.28-29.

International Film (TV) productions.

1. 2019. A Life Among Monkeys (in English). **Smithsonian Channel**, Mission Critical (USA). A one-hour documentary portraying the scientific life of Dr. Wolfgang Dittus 50 years of research in Sri Lanka. https://www.terramater.at/productions/a-life-among-monkeys/

2. 2019. Ein Leben unter den Affen (in German). A one-hour documentary portraying the scientific life of Dr. Wolfgang Dittus 50 years of research in Sri Lanka. **Terra Mater** Production. Broadcast in Europe, 2019.

3. 2019. Animal Babies: First Year in the Life of a Toque Macaque. **BBC Natural World**. Broadcast 2020. https://www.bbc.co.uk/programmes/articles/QgKp6ksLWP9y7nq6q0NxZd/meet-the-scientists and https://www.bbc.co.uk/programmes/p07j7329

4. 2019. "Mamas of toque macaques" Plimsoll Productions, UK (Alex Minton, producer). Broadcast 2020. **Animal Channel, Discovery**.

5. 2019. Born to Explore, Sri Lanka – Land of Wonder with Richard Wiese. USA. US Natural History **Public Broadcasting System**. https://nhpbs.org/schedule/summary.aspx?progId=BorntoExplorewithRichardWiese213

6. 2019. Monkey Island – A Mother's Tale. Natural History, Plimsoll Prod., UK (Claire Clements, producer). https://www.smithsonianchannel.com/shows/monkey-island/a-mothers-tale/1005772/3470246 . **Smithsonian Channel**.

7. 2019. Monkey Island – Leaving Home. Natural History, Plimsoll Productions, UK (Claire Clements, producer). On **Smithsonian Channel**. https://www.smithsonianchannel.com/shows/monkey-island/1005772

8. 2018-2019. Monkey Island – Trouble in Primate Paradise. Animal Planet (Plimsoll Prod; Claire Clements, producer). On **Smithsonian Channel**.

9. 2019. Monkey Island – The Secret Life of Monkeys. Plimsoll Prod., UK (Beth Brooks, producer). On **Smithsonian Channel**.

10. 2019. "One male and his harem of Sri Lankan toque macaques face survival challenges" **NHK, Japan** (Kenta Takahashi, producer). Broadcast 2020.

GRANTS

ENERGY & ADVANCED MATERIALS RESEARCH UNIT

Condensed Matter Physics & Solid State Chemistry

New:

- Senthuran, S. received a Research Grant from National Science Foundation on 2019-03-15 for Postgraduate Research (to cover the cost of chemicals). (Grant Value - 600,000 LKR)

- **Senadeera, G.K.R.** received a Research Grant from Open University of Sri Lanka on 2019-02-01 for to develop high efficiency low cost dye sensitized solar cells. (Grant Value - 500,000 LKR)

- **Senadeera, G.K.R.** received a Research Grant from Ministry of Higher Education, World Bank on 2019-09-01 for to develop nano-materials from photovoltaic and environmental remedial applications. (Grant Value - 30,000,000 LKR)

- **Seneviratne, G.** received a Research Grant from Ministry of Science, Technology & Research on 2019-01-01 for Introducing Biofilm Biofertilizer Practice for rice Cultivation. (Grant Value - 20,000,000 LKR)

Ongoing:

- **Dissanayake, M.A.K.L.** (Co-grantee) received a Research Grant from Ministry of Science, Technology and Research on 2017-01-01 for collaborative national. (Grant Value - 24,000,000 LKR)

- **Dissanayake, M.A.K.L.** received a Research Grant from National Science Foundation (NSF), Sri Lanka and Pakistan Science Foundation (PSF), Pakistan on 2018-01-01 for Joint research grant for collaborative research. (Grant Value - 3,100,000 LKR)

- Jaseetharan, T. received a Research Grant from National Science Foundation on 2018-02-15 for Postgraduate research. (Grant Value - 860,000 LKR)

Energy & Advanced Material

Ongoing:

- **Bandara, J.** received a Research Grant from National Science Foundation on 2018-04-20 for Research. (Grant Value - 8,900,000 LKR)

- **Bandara, J.** received a Instrument Grant from National Research Council on 2018-04-30 to purchased Research. (Grant Value - 5,000,000 LKR)

Material Processing & Device Fabrication

Ongoing:

- **Kumara, G.R.A.,** and Rajapakse, R.M.G. received a Research Grant from National Science Foundation on 2016-06-01 for Photon Upconversion as a Tool to Harvest Infrared Radiation for Direct Illumination in the Dark and to Fabricate Dye-sensitized Solar Cells to Generate Electricity Under Illumination as well as in the Dark. (Grant Value - 4,900,000 LKR)

- **Kumara, G.R.A.** received a Research Grant from National Science Foundation on 2018-06-14 for Development of highly efficient and environmentally stable perovskite solar cells and perovskite solar panels by industrially viable methods for power generation. (Grant Value - 5,257,000 LKR)

Nanotechnology & Advanced Materials

Ongoing:

- **Weerasooriya, R.,** and Weragoda, S.K. and **Wijayasinghe H.W.M.A.C.** (as a collaborative Scientist) received a Research Grant from National Research Council on 2017-01-01 for Development a model treatment facility for remediation of total dissolved solids and fluoride in groundwater. (Grant Value - 50,000,000 LKR)

- **Wijayasinghe, H.W.M.A.C.,** and NIFS received a Research Grant from Mega grant from General Treasury of Sri Lanka on 2018-01-01 for Development of Sri Lankan graphite for rechargeable batteries. (Grant Value - 49,800,000 LKR)

NATURAL PRODUCTS & FOOD CHEMISTRY RESEARCH UNIT

Natural Products

Ongoing:

- Napagoda, M.T. (PI), and **Jayasinghe, L.** received a Research Grant from National Science Foundation on 2017-12-01 for Development of effective sunscreen formulations from Sri Lankan medicinal plants. (Grant Value - 3,890,656 LKR

- Amarasinghe, N.R. (PI), and **Jayasinghe, L.** received a Research Grant from University of Peradeniya on 2017-01-01 for Investigation of chemistry and bio-activity of *Olax zeylanica*.. (Grant Value - 960,000 LKR)

- Amarasinghe, N.R. (PI), and **Jayasinghe, L.** (CI) received a Research Grant from National Science Foundation on 2016-08-01 for Investigation of acetylcholinesterase inhibitory activity of Sri Lankan grown spices as potential therapeutic agents for Alzheimer's disease. (Grant Value - 2,385,000 LKR)

- Adikaram, N (PI), **Jayasinghe, L (CI),** and Yakandawala, D. (CI) received a Research Grant from National Research Council on 2018-09-15 for Study of some postharvest diseases and disorders adversely affecting the export potential of mango var. TomEJC and their management. (Grant Value - 3,642,222 LKR)

- **Jayasinghe, L.** (CI), **Kumar, N.S (PI), Adikaram, N.,** (CI)and Amarasinghe, N.R. received a Research Grant from National Science Foundation on 2018-04-02 for Chemistry and bioactivity of endophytic fungi from four popular condiment plants *Curcuma longa*, *Myristica fragrans*, *Syzygium aromaticum* and *Zingiber officinale* used in indigenous system of medicine in Sri Lanka: Possible applications in health and agriculture. (Grant Value - 2,646,300 LKR)

- **Jayasinghe, L.** (PI), **Kumar, N.S,** and **Adikaram, N.** (CI) received a Research Grant from National Research Counsil on 2018-05-15 for Bioactive metabolites of endophytic fungi from the medicinal plants *Coccinia grandis, Costus speciosus* and *Gymnema sylevestre* used in indigenous medicine for treatment of diabetes mellitus and possible commercial applications. (Grant Value - 4,629,302 LKR)

- **Jayasinghe, L.** (PI), **Kumar, N.S.** (CI), **Adikaram, N.K.B.** (CI), and Amarasinghe, N.R. received a Research Grant from National Research Council on 2018-10-02 for For development of eco-friendly new weedicides from microbial metabolites. (Grant Value - 4,643,724 LKR)

MICROBIOLOGY & CARBON SEQUESTRATION RESEARCH UNIT

Bioenergy & Soil Ecosystems

Ongoing:

- **Ratnayake, R.R.** received a Research Grant from National Science Foundation on 2016-06-10 for For conducting the research project titled "Isolation of Denitrifying Bacteria and their Potential use in Nitrate Removal from Well Water of Jaffna District". (Grant Value - 2,854,142 LKR)

- **Ratnayake, R.R.** received a Research Grant from National Research Council on 2018-05-10 for Conducting the research titled "Development of baseline soil information system for soil C and other nutrients for paddy growing soils in Sri Lanka". (Grant Value - 4,695,723 LKR)

EARTH, ENVIRONMENT & BIODIVERSITY RESEARCH UNIT

Earth Resources and Renewable Energy

New:

- Dharamapriya., P.L, **Subasinghe, N.D.** received a Research Grant from NRC on 2019-09-01 for Research Project. (Grant Value - 2,500,000 LKR)

Ongoing:

- Malaviarachchi, S.P.K, **Subasinghe, N.D.** ,Dharamapriya., P.L. received a Research Grant from Ministry of science, Technology and Research on 2014-09-01 for Research project. (Grant Value - 4,000,000 LKR)

- **Subasinghe, N.D.** received an Instrument Grant from National Science Foundation on 2018-02-05 to purchase Walking Magnetometer with gradiometer. (Grant Value - 1,500,000 LKR)

- **Subasinghe, N.D.** received a Research Grant from National Research Council on 2016-01-01 for Thermoelectricity Research. (Grant Value - 3,283,750 LKR)

Environmental Science Research Programme

New:

- **Bowatte, G.,** Heyworth, J., and Dharmage, S. received a Research Grant from New Colombo Plan Scholarships - funded by the Australian Federal Government on 2019-07-30 for Addressing environmental health challenges in Sri Lanka. (Grant Value - 3,300,000 LKR)

- **Jayarathna, L., Weerasooriya, R.,** and Bandra.A received a Research Grant from National Research Council on 2019-06-12 for Synthesis of modified Zeolite for catalytic converting and removal of NOx, SOx and CO from the vehicle exhaust. (Grant Value - 4,247,000 LKR)

Ongoing:

- **Bowatte, G.,** Morawska, L., Knibbs, L., **Weerasooriya, R.,** and Dharmage, S. received a Research Grant from Centre for Air pollution, energy and health Research (CAR) on 2018-09-30 for Building a 3D air pollution model for the city of Kandy, Sri Lanka: a platform to evaluate health outcomes. (Grant Value - 2,600,000 LKR)

- **Jayarathna, L.,** and Hapugoda,M received a Research Grant from NRC on 2014-08-28 for Comprehensive research proposal on an operational model to control dengue in Sri Lanka using multiple intervention, new product development and community participation-2014, Development of monoclonal antibodies against NS1 region of Dengue virus and determination of the feasibility of a nano-material to detect the antigen for the development of a diagnostic kit. (Grant Value - 50,000,000 LKR)

- **Weerasooriya, R.** received a Research Grant from National Research Council on 2016-12-29 for Water Research. (Grant Value - 50,000,000 LKR)

- **Weerasooriya, R.,** and Weragoda, S.K. and **Wijayasinghe H.W.M.A.C.** (as a collaborative Scientist) received a Research Grant from National Research Council on 2017-01-01 for Development a model treatment facility for remediation of total dissolved solids and fluoride in groundwater. (Grant Value - 50,000,000 LKR)

Evolution, Ecology & Environmental Biology

New:

- **Benjamin, S.P.** received a Instrument Grant from Alexander von Humboldt Foundation, Germany on 2019-06-06 to purchased Equipment (Leica DM 3000 Research microscope). (Grant Value - 3,828,049 LKR)

Ongoing:

- **Benjamin, S.P.** received a Research Grant from National Research Council on 2017-08-31 for Project entitled 'Taxonomic revisions of jumping spider subfamilies *Ballinae* and *Spartaeinae* of Sri Lanka based on morphology and DNA barcodes. (Grant Value - 4,969,600 LKR)

Plant & Environmental Sciences

New:

- Iqbal, S.S., Iqbal**, M.C.M.,** and Schaefer, T. received a Research Grant from National Science Foundation Sri Lanka and the German Academic Exchange Service (DAAD) on 2019-05-01 for investigate the photo-catalytic conversion of CO_2. As catalysts we will use materials based on metal organic frameworks (MOFs), studying the reduction of CO_2 to formic acid. The performance of the catalysts will be studied in liquid phase and in gas phase. (Grant Value - 1,191,550 LKR)

Ongoing:

- **Iqbal, M.C.M.** (co-grantee) received a Research Grant from National Research Council on 2014-12-01 for Comprehensive research proposal on an operational model to control; dengue in Sri Lanka using multiple vector control intervention, new product development and community engagement. (Grant Value - 4,900,000 LKR)

Plant Taxonomy & Conservation

Ongoing:

- **Wijesundara, D.S.A.** received a Research Grant from Mass holdings Ltd. on 2017-07-13 for the assessment on the distribution of Invasive Alien plant, *Ageratina ripraia* in Horton Plains National Park. (Grant Value - 250,000 LKR)

- **Wijesundara, D.S.A.** received a Research Grant from Biodiversity secretariat ministry of Mahaweli development and environment on 2016-10-25 for Floristic Survey of NIFS-Popham Arboretum, Dambulla. (Grant Value - 334,925 LKR)

- **Wijesundara, D.S.A.** received a Research Grant from Biodiversity secretariat ministry of Mahaweli development and environment on 2016-06-02 for *Panicum trichocladum* Project. (Grant Value - 440,000 LKR)

- **Wijesundara, D.S.A.** received a Research Grant from Biodiversity secretariat ministry of Mahaweli development and environment on 2016-06-02 for *Clusia rosea* project. (Grant Value - 350,000 LKR)

MOLECULAR BIOLOGY & BIOTECHNOLOGY RESEARCH UNIT

Molecular Microbiology & Human Diseases

New:

- **Magana-Arachchi, D.N.** received a Research Grant from Ministry of Science, Technology & Research, NRC on 2019-01-01 for Epidemiological Study on asbestos related occupational health problems among Asbestos Industry workers in Sri Lanka. (Grant Value - 3,800,000 LKR)

- **Vithanage, M., Magana-Arachchi, D.N.,** Wanigatunge, R., and Rajapaksha, A.U. received a Research Grant from National Science Foundation on 2019-04-26 for Enrichment mechanisms of CKDu-risk factors in groundwaters, their uptake pathways and potential remedies. (Grant Value - 19,209,155 LKR)

Ongoing:

- **Magana-Arachchi, D.N.** received a Research Grant from National Science Foundation on 2018-04-20 for Genetic characterization of drug resistant MTB isolates from Sri Lankan and Pakistani patients and their associations with transcriptomic biomarkers of TB. (Grant Value - 2,750,650 LKR)

- **Magana-Arachchi, D.N., Vithanage, M.,** and Wickramasinghe, C. received a Research Grant from The Bjornson and Prodan Foundation on 2018-05-30 for Ballon flights over central Sri Lanka to detect possible ingress of cometary microorganisms and particulate matter with object of testing Hoyle-Wickramasinghe theory of cometary panspermia. (Grant Value - 1,957,956 LKR)

Plant Stress Biology & Molecular Genetics

New:

- **Seneweera, S.** received a Research Grant from National Research Council on 2019-07-12 for the project titled efficacy and welfare of Aversive Geofencing Devices for managing the movements of Asian elephants. (Grant Value - 4,902,000 LKR)

- **Seneweera, S**. received a Research Grant from Ministry of Higher Education, Technology and Innovation on 2019-10-30 for Creating global benchmark yields in paddy and minor crops. (Grant Value - 9,000,000 LKR)

- **Seneweera, S.,** and Kamral, C received a Research Grant from Australian Nuclear Science and Technology Organization (ANSTO Australia) on 2019-12-09 for Use of the X-ray fluorescence microscopy beamline at the Australian Synchrotron. (Grant Value - 12,000,000 LKR)

RESEARCH COLLABORATIONS

ENERGY & ADVANCED MATERIALS RESEARCH UNIT

Condensed Matter Physics & Solid State Chemistry

Ongoing collaborations:

- Condensed Matter Physics and Solid State Chemistry research programme of NIFS collaborates with University of Peradeniya, University of Kelaniya, University of Jaffna and University of Ruhuna from 2017-01-01 to 2021-12-31.
  Summary: Collaborative national "EduTraining" project towards R&D and training of personnel competent in thin film solar cell prototype manufacturing maintaining. NIFS is the principal coordinator. Work was just started in 2017 and continuing.

- Condensed Matter Physics and Solid State Chemistry research programme of NIFS collaborates with University of Agriculture, Pakistan from 2018-01-01 to 2020-12-31.
  Summary: A joint research grant under the NSF, Sri Lanka and Pakistan Science Foundation (PSF) for collaborative research on Graphite/Graphene based counter electrodes for dye sensitized solar cells.

- Condensed Matter Physics and Solid State Chemistry research programme of NIFS collaborates with Sabaragamuwa University of Sri Lanka from 2018-01-01 to 2021-12-31.
  Summary: Applications of TiO2.
  Collaborators: Dr. H.N.M. Sarangika .
- Condensed Matter Physics and Solid State Chemistry research programme of NIFS collaborates with Department of Physics, University of Peradeniya from 2017-01-01 to 2021-12-31.
  Summary: Dye sensitized solar cells and polymer electrolytes.
  Collaborators: Dr. B. Dassanayake

- Condensed Matter Physics and Solid State Chemistry research programme of NIFS collaborates with Department of Physics, University of Peradeniya from 2018-01-01 to 2021-12-31.
  Summary: Dye sensitized solar cells
  Collaborators: Dr. T.M.W.J. Bandara

Material Processing & Device Fabrication

Ongoing collaborations:

- Material Processing and Device Fabrication research project of NIFS collaborates with University of Uva Wellassa from 2018-09-01 to 2021-09-01.
  Summary: Fabrication of highly efficient and low-cost dye-sensitized solar cells.
  Collaborator: Prof. Sirimanne, P.M.

- University of Jaffna from 2017-01-02 to 2022-01-01.
  Summary: Development of perovskite and dye-sensitized solar cells.
  Collaborator: Prof. P.Ravirajan, P.

- Georgia State University, USA from 2017-01-02 to 2022-01-01.
  Summary: Development of Supercapacitors, dye-sensitized solar cells and perovskite solar cells.
  Collaborator: Prof. Tennakone, K.

- Shizuoka University, Japan from 2017-01-02 to 2022-01-02.
  Summary: Development of dye-sensitized solar cells and perovskite solar cells.
  Collaborator: Prof. A. Konno

- Western Norway University from 2017-01-02 to 2022-01-02.
  Summary: Development of Perovskite and dye-sensitized solar cells.
  Collaborator: Prof. Dhayalan Velauthapillai

- University of Peradeniya from 2017-01-02 to 2022-01-02.
  Summary: Exfoliation and purification of Sri Lankan graphite.
  Collaborator: Prof H.M.T.G.A. Pitawala

- University of Peradeniya from 2017-01-02 to 2022-01-01.
  Summary: Improvement of all types of dye-sensitized solar cells using low-cost materials and development of highly efficient and environmentally stable perovskite solar cells..
  Collaborator: Prof. R.M.G. Rajapakse

Nanotechnology & Advanced Materials

Ongoing collaborations:

- Nanotechnology and Advanced Materials research programme of NIFS collaborates with Prof. H.M.T.G.A. Pitawala and DR. N. Balasooriya of Department of Geology, University of Peradeniya from 2018-01-01 to 2021-12-31.
  Summary: Geological aspects of Sri Lankan graphite and their materials applications.
  Collaborators: **Dr. H.W.M.A.C. Wijayasinghe,** Dr. N.W.B. Balasooriya, and Prof. H.M.T.G.A. Pitawala.

- Nanotechnology and Advanced Materials research programme of NIFS collaborates with Department of Physics, Charlmers University, Sweden from 2016-06-01 to 2019-05-31.
  Summary: Advanced characterization of materials develop for rechargeable battery applications.
  Collaborators: **Dr. H.W.M.A.C. Wijayasinghe,** Dr. T.H.N.G. Amaraweera, and Prof. B.E. Mellander.

NATURAL PRODUCTS & FOOD CHEMISTRY RESEARCH UNIT

Food Chemistry

New Collaborations:

- Food Chemistry research programme of NIFS collaborates with Dalhousei University, Canada from 2019-07-31 to 2021-07-30.
  Summary: An alternative approach in anti-diabetic research is to discover foods with anti-hyperglycemic potentials that are safe and have less side effects. The current study aims at investigating the anti-diabetic potential of the brown testa of Sri Lankan coconut cultivars namely Ran thembili, Gon thembili, San Raman, Tall xTall and commercial hybrid. Plenty of brown testa is generated during manufacture of the desiccated coconut as a by-product, which is available in the coconut processing industry as base material for value addition. Owing to lack of research and technical studies, it is being either wasted or underutilized by the coconut sector. In this study, we propose to explore the phytochemical constituents, type of pigments, protein class types, and anti-nutritional factors of this raw material along with antioxidantive and antidiabetic properties. The knowledge generated through this research study could be utilized for the preparation of wholemeal bread beneficial to those who suffer from type 2 diabetes. Since the percentage of brown testa is roughly around 15% of the whole wet kernel weight, this initiative might help to improve the economic value of coconuts produced in Sri Lanka. Apart from this, recovering or finding alternative uses for waste material would help address concerns regarding the future food security of our nation.
  Collaborators: Prof. H.P.V. Rupasinghe

Ongoing collaborations:

- Food Chemistry research project collaborates with Dr. Chandi Yalegama, Coconut Research Institute, Lunuwila from 2018-06-08 to 2023-05-08.
  Summary: Food chemistry project of NIFS signed an MOU with Coconut Research Institute (CRI), Lunuwila in early August, 2018 to undertake a study on the anti-diabetic and anti-oxidative potentials of coconut testa; a by-product generated by desiccated coconut processing industries in Sri Lanka. Under this MOU, CRI agreed to work with the food chemistry research group of the National Institute of fundamental Studies by providing samples of coconut varieties, laboratory facilities for chemical analysis.

- Food Chemistry research project collaborates with Dr. Emma Chiavaro, University of Parma, Italy from 2018-01-02 to 2020-12-01.
  Summary: Food chemistry project of NIFS has been working with Dr. Emma Chiavaro of the department of food & drugs at University of Parma, Italy on a mutual understanding basis to prepare grant proposals for research studies and publish research results in international peer reviewed journals.

Natural Products

Ongoing collaborations:

- Natural Products research programme of NIFS collaborates with University of Peradeniya, Faculty of Medicine from 2012-01-01 to 2024-01-01.
  Collaborators: Dr. Irushika Fernando, and **Prof. L. Jayasinghe**

- Natural Products research programme of NIFS collaborates with University of Ruhuna, Faculty of Medicine from 2012-01-01 to 2024-01-01.
  Collaborators: Dr. M.T. Napagoda, and **Prof. L. Jayasinghe**

- Natural Products research programme of NIFS collaborates with University of Peradeniya, Faculty of Allied Health Science from 2015-01-01 to 2024-01-01.
  Collaborators: Dr. N.R. Amarasinghe, and **Prof. L. Jayasinghe**

Nutritional Biochemistry

Ongoing collaborations:

- Nutritional Biochemistry research programme of NIFS collaborates with Western Sydney University from 2017-01-05 to 2020-12-31.
  Summary: Sri Lanka is a tropical island with a large number of medicinal plant varieties. Most of the plants have been used in Sri Lankan traditional medicinal practices and Ayurveda from ancient times. These systematic medicinal practices have gained popularity and have been accepted by the Sri Lankan community for promoting health and preventing and curing diseases. Therefore, medicines made of herbal plant extracts are an important part of the culture and tradition of Sri Lankan people. Because of better cultural acceptability, better compatibility with the human body and lesser side effects, Ayurvedic medicine is still used by about 75–80% of the world population, mainly in the developing countries, for primary health care. Although most of these herbs have been used for treating many health problems, medicinal value of many plants still needs to be properly analysed. This study investigates the antidiabetic, antinflammatory and anticancer properties of some selected Ayurvedic plants in Sri Lanka.
  Collaborators: Dr.Srinivas Nammi

- Nutritional Biochemistry research programme of NIFS collaborates with Faculty of Agriculture, University of Peradeniya from 2018-06-06 to 2020-12-12.
  Summary: Health benefits of legumes have been investigated in experimental, epidemiological and clinical studies. Consumption of legumes significantly lowers the risk of heart diseases, high blood pressure, stroke, cancer and diabetes. These health benefits are

due to the presence of different bioactive compounds such as phenolic compounds, peptides and proteins. However, it has been shown that during gastrointestinal digestion and fermentation these bioactive properties are modulated. This study focuses on the bioavailability of pro-nutritive and anti-nutritive factors in legumes after in vitro digestion and fermentation. Findings of this study will be useful in determining potential uses of these legumes in food formulation.
Collaborators: Prof. Barana Jayawardana

- Nutritional Biochemistry research project of NIFS collaborates with University of Peradeniya from 2018-04-03 to 2019-03-31.
  Summary: Heavy metal accumulation in milk and blood can vary in grazing animals. Degree of bioaccumulation and bio transfer are different for different elements, concentration of heavy metals in milk and blood samples of milking animals can be considered as bio indicators of heavy metal pollution in an environment. In this study, milk and blood samples collected from bovines living in selected areas where Chronic Kidney Disease of Unknown aetiology (CKDu) is prevalent were analysed.
  Collaborator: Dr. R.M.C Deshapriya

- Nutritional Biochemistry research project of NIFS collaborates with University of the West of Scotland from 2018-05-01 to 2019-12-30.
  Summary: Diabetes mellitus is one of the major non-communicable diseases affecting around 2.8% of the world's population and is estimated to cross 5.4% by the year 2025. Diabetes mellitus is characterized by abnormality in glucose metabolism owing to resistance to the action of insulin in peripheral tissues. Currently available anti-diabetic drugs are reported to cause several side effects including body weight gain and enhancement of gastrointestinal problems. Hence, recently there is an increased interest in natural anti-diabetic agents derived from herbs due to their less toxicity. Sri Lanka being one of twenty-five biodiversity hot spots in world possesses great diversity of herbal plants. These plants have been found to be good sources of phytochemicals. Scientific information about commonly consumed plants with biological functions, such as alpha-amylase and alpha-glucosidase inhibition is still missing. The present study was designed to assess the in vitro anti-diabetic activity and chemical composition of ten medicinal plants; Belimal (*Aegle marmelos*), Iramusu (*Hamides musindicus*), Ranawara (*Cassia auriculata*), Walkottamalli (*Scoparia dulcis*), Nelli (*Phyllanthus emblica*), Rasakinda (*Tinospora cordifolia*), Polpala (*Aerva lanata*), Babila (*Sida rhombifolia*), Beligeta (*Aegle marmelos*) and Venivel (*Coscinium fenestratum*), which are extensively used in Ayurveda medicine in Sri Lanka.
  Collaborator: Dr. Mostafa Rateb, PhD, FHEA, MRSC.

MICROBIOLOGY & CARBON SEQUESTRATION RESEARCH UNIT

Bioenergy & Soil Ecosystems

Ongoing collaborations:

- Bioenergy and Soil Ecosystems research programme of NIFS collaborates with School of Environment Sciences, University of Guelph, Canada. from 2016-11-15 to 2024-11-15.
  Summary: Biochemistry
  Collaborator: Dr. A. Biswas

- Bioenergy and Soil Ecosystems research programme of NIFS collaborates with Dept. of Biochemistry & Molecular Biology, GonoBishwabidyalay (University), Savar, Dhaka, Bangladesh from 2017-05-05 to 2022-05-05.
  Summary: This collaboration is with regard to the bioenergy project. Main objectives are isolation, characterization and studying of possible applications of freshwater cyanobacteria in Sri Lanka.
  Collaborator: Dr.Md. Fuad Hossain

- Bioenergy and Soil Ecosystems research programme of NIFS collaborates with Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka from 2014-05-05 to 2021-05-05.
  Summary: This collaboration is relevant to the soil ecosystems research project and mainly focuses on soil carbon sequestration. The main objective is to determine soil carbon stocks in different ecosystems in Sri Lanka and develop a digital soil carbon map. This can be used as baseline information for future carbon trading.
  Collaborator: Dr.S.K. Gunathilake

- Bioenergy and Soil Ecosystems research programme of NIFS collaborates with School of Geoscience, University of Aberdeen, UK from 2013-05-10 to 2021-12-31.
  Summary: This is relevant to the soil ecosystems research project. Mainly focuses on soil carbon sequestration. The main objective is to determine soil carbon stocks in different ecosystems in Sri Lanka and developing a digital soil map. This can be used as baseline information for future carbon trading.
  Collaborator: Dr.J.S. Lessels

- Bioenergy and Soil Ecosystems research programme of NIFS collaborates with University of Western Sydney, Sydney, Australia from 2013-05-20 to 2020-05-25.
  Summary: The project is on soil carbon sequestration. The main objective is to determine soil carbon stocks in different ecosystems in Sri Lanka and developing a digital soil map. This can be used as baseline information for future carbon trading.
  Collaborator: Dr.S.B.Karunaratne

- Bioenergy and Soil Ecosystems research programme of NIFS collaborates with University of Peradeniya from 2012-07-10 to 2020-01-20.
  Summary: This project focuses on bioenergy. Development of microbial strains and co-cultures for efficient production of ethanol from cellulosic materials is a major area of research. Apart from this study of cellulolytic microorganisms and their potential applications are continuing.
  Collaborator: Prof. C.L. Abayasekara

- Bioenergy and Soil Ecosystems research programme of NIFS collaborates with University of Ruhuna from 2018-06-15 to 2021-12-31.
  Summary: This project is relevant to the Bioenergy field. The areas of research such as 4. Suppression of Causal Agents of Damping-off Disease in Tomato by using Microbial Cellulases and 5. Evaluation of cellulolytic fungi from Sri Lanka for bio stone washing of Denim in comparison with commercial cellulase has already completed. Currently, the project focuses on Morphological and Molecular biological identification and characterization of cyanobacteria from freshwater bodies. The project will also be further expanded to toxin analysis of cyanobacteria.
  Collaborator: Prof. K.L.W. Kumara

- Bioenergy and Soil Ecosystems research programme of NIFS collaborates with University of Jaffna from 2016-09-23 to 2019-12-31.
  Summary: The main objective of the project is to isolate denitrifying bacteria from the natural environment of Jaffna peninsula and study their potential use in nitrate removal from well water in the Jaffna District. Using cyanobacterial isolates for different purposes is also under investigation. Potential to use cyanobacterial strains as biofertilizer and formulation of a low-cost medium for cyanobacteria and assessment of their potential use as bio-fertilizer in paddy are some of the applications that have already completed.
  Collaborator: Dr. N. Gnanavelrajah

- Bioenergy and Soil Ecosystems research programme of NIFS collaborates with Uwa Wellassa University of Sri Lanka from 2014-05-05 to 2021-05-05.
  Summary: This collaboration is relevant to the soil ecosystems research project and mainly focuses on soil carbon sequestration. The main objective is to determine soil carbon stocks in different ecosystems in Sri Lanka and to develop a digital soil carbon map. This can be used as baseline information for future carbon trading.
  Collaborators: Dr. S.N. Premetilake

- Bioenergy and Soil Ecosystems research programme of NIFS collaborates with Faculty of Science, University of Peradeniya from 2014-06-12 to 2022-12-31.
  Summary: This collaboration is relevant to the soil ecosystems research project and mainly focuses on soil carbon sequestration. The main objective is to determine soil carbon stocks in different ecosystems in Sri Lanka and develop a digital soil carbon map. This can be used as baseline information for future carbon trading.
  Collaborators: Dr.H.M.S.P. Madawala

- Bioenergy and Soil Ecosystems research programme of NIFS collaborates with Faculty of Agriculture, Aquinas University College from 2013-02-10 to 2021-02-10.
  Summary: digital mapping of soil carbon stocks in different ecosystems in Sri Lanka.
  Collaborators: Dr. B.M.A.C.A. Perera

Microbial Biotechnology

New Collaboration:

- Microbial Biotechnology research programme of NIFS collaborates with Department of Agriculture from 2019-10-01 to 2020-10-01.
  Summary: We collaborate with the department of Agriculture for island wide testing of efficacy of Biofilm Biofertilizer in rice cultivation.
  Collaborator: Director General, Department of Agriculture, **Seneviratne, G.**

EARTH, ENVIRONMENT & BIODIVERSITY RESEARCH UNIT

Earth Resources and Renewable Energy

Ongoing collaborations:

- Earth Resources and Renewable Energy research project of NIFS collaborates with Department of Geology, University of Peradeniya from 2015-06-01 to 2020-12-31.
  Summary: Petrology and Mineralogy project.
  Collaborator: Dr. Sanjeewa Malaviarachchi.

- Earth Resources and Renewable Energy research project of NIFS collaborates with Atomic Energy Board, Sri Lanka from 2017-02-01 to 2019-08-31.
  Summary: Hybrid Solar Thermoelectric generation
  Collaborator: Prof M. Eswaramoorthy, India

Environmental Science Research Project

Ongoing collaboration:

- Environmental Science Research Program research project of NIFS collaborates with Queensland University of Technology from 2018-07-30 to 2021-07-30.
  Summary: To establish an air pollution monitoring network in Kandy.
  Collaborators: Prof. L. Morawska, and Dr. R. Jayaratne.

Evolution, Ecology and Biodiversity

Ongoing collaboration:

- Evolution, Ecology and Biodiversity research programme of NIFS collaborates with Zoological Research Museum Alexander Koenig (ZFMK) from 2018-11-01 to 2022-12-31.
  Summary: Biodiversity patterns of herbivore scarab chafers of Sri Lanka (Sericini: Coleoptera: Scarabaeidae). Beetles are by far the most species-rich animal radiation. They are an extremely important group. Our current understanding of general patterns of beetle evolution in the past decade is based on several phylogenies on morphology and DNA sequences. However, only few studies have been done specifically on Sri Lankan beetles. This project aims to understand the evolutionary processes underlying the exceptional beetle diversity of the Indian subcontinent using a combination of phylogenetic, macroecological and biogeographical data. The phylogenetic patterns retrieved from DNA sequences will be particularly useful to investigate the dynamic biogeography of the region.
  Collaborators: **Prof. S.P. Benjamin,** Dr. D. Ahrens, Dr. J. Eberle, and Ms. U.G.S.L. Ranasinghe

Plant & Environmental Sciences

Ongoing collaboration:

- Plant and Environmental Sciences research project of NIFS collaborates with Georg-August-Universität Göttingen, Department of Crop Science, Von Siebold Str. 8, 37075 Göttingen, Germany from 2016-08-01 to 2020-08-01.
  Summary: Androgenesis in Brassica. NLN-medium has been successfully used, since 1982, for microspore culture in Brassica napus and other Brassica species. Changes to the media composition were restricted to carbohydrate and nitrogen sources and growth regulators while micro-nutrients have not been optimized. The NLN-medium contains boron at a concentration of 162 µM. Boron is required for diverse physiological and metabolic processes in the cell. This study would investigate the effect of seven- and 13-fold increased boron concentration on the induction of embryos in microspore cultures of four genotypes of *B. napus.*
  Collaborator: Dr. C. Mollers

- Plant and Environmental Sciences research project of NIFS collaborates with Associate Professor in Plant Biology, Biological Sciences Department, California Polytechnic State University, San Luis Obispo from 2017-07-01 to 2020-06-01.
  Summary: Serpentine Ecology. Globally, ultramafic outcrops are renowned for hosting floras with high levels of endemism, including plants with specialised adaptations such as metal hyper-accumulation. Soils derived from ultramafic regoliths are nutrient-deficient, have major cation imbalances, and concomitant high concentrations of potentially phytotoxic trace elements. The South and Southeast Asian region has the largest surface expressions of ultramafic regoliths in the world, but the geo-ecology of these outcrops is still poorly-studied despite severe conservation threats. This collaboration investigates all the serpentine sites in Sri Lanka to study the soil-plant ecology of the serpentine sites.
  Collaborator: Prof. N. Rajakaruna

- Plant and Environmental Sciences research project of NIFS collaborates with Department of Chemistry, Faculty of Science, University of Peradeniya, from 2014-01-01 to 2019-12-01.
  Summary: Environmental Remediation of Pollutants: The contamination of the environment by hazardous materials such as heavy metals, textile dyes, fertilizers (nitrates, phosphates) and toxic organic and inorganic wastes is a concerning environmental issue in Sri Lanka. Improper discharge of effluents from industries such as batik, textile dyeing, metal plating and leather tanning contaminate the environment with these hazardous materials. Most of these industries are small and medium size and they are unable to invest in high tech expensive waste water treatment systems. A cost-effective simple decontamination method (i.e. end pipe treatment system) is therefore needed to use in these industries. Further, it is

necessary to decontaminate the contaminated water bodies to provide a safe environment for all living beings.
Collaborator: Prof. N. Priyantha

- Plant and Environmental Sciences research project of NIFS collaborates with Department of Plant Sciences, Faculty of Science, and University of Colombo from 2013-03-01 to 2019-12-01.
  Summary: Understanding the impacts of anthropogenic disturbances on forest tree communities and traditional knowledge associated with forest ecosystems will improve our understanding of dry forest service provision and effective conservation and restoration interventions. In the Hurulu Forest Reserve, a tropical dry forest in north-central Sri Lanka, forest disturbance can be classified into three levels and forest structure, tree species traits and tree species composition. Further, traditional knowledge on forest agrarian systems and classification, can be determined by interviewing local people.
  Collaborator: Dr. S. Ranwala, and Dr. Q. Francis

- Plant and Environmental Sciences research programme of NIFS collaborates with Department of Chemistry, Faculty of Natural Sciences, Open University of Sri Lanka, Nawala, Sri Lanka and Institute of Physical Chemistry, Faculty of Chemistry, University of Goettingen, Germany from 2019-05-01 to 2021-04-30.
  Summary: Global warming is one of the major adverse environmental effect associated with industrialization, which is considered as one of the biggest challenges in the future. The greenhouse gases emitting from industries and automobiles are the major causes of global warming. Global warming can result in climate change, biodiversity loss and severe health issues for humans. With industrialization, emission of CO_2 gas has gradually increased which contributes to the overall greenhouse effect. Catalytic conversion of greenhouse gases to chemically usable compounds is therefore a convenient way to kill two birds with one stone. In the proposed research project, we intend to investigate the photocatalytic conversion of CO_2. As catalysts we will use materials based on metal organic frameworks (MOFs), studying the reduction of CO_2 to formic acid. The performance of the catalysts will be studied in liquid phase and gas phase. For this, we plan to combine the expertise of Prof. Iqbal's research group in Sri Lanka with the expertise of Tim Schäfer's group at Göttingen University. MOF's will be prepared and characterized in Prof. Iqbal's lab at the Open University in Sri Lanka and National Institute of Fundamental Studies in Sri Lanka.
  Collaborators: Prof. S.S. Iqbal, Prof. T. Schaefer, Mr. D.M.R.E.A. Dissanayake, and Prof. M.C.M. Iqbal.

<u>Plant Taxonomy & Conservation</u>

Ongoing Collaborations:

- Plant Taxonomy and Conservation research project collaborates with University of New England, Australia (School of Environmental and Rural Science) from 2018-03-27 to 2020-03-27.
  Summary: Potential distribution of invasive plants in Sri Lanka and impacts on biodiversity under climate change.
  Collaborators: **Prof. D.S.A. Wijesundara,** Prof. Lalit Kumar, and Ms. Champika Kariyawasam (Ph.D. Sudent)

- Plant Taxonomy and Conservation research project collaborates with National Herbarium, Peradeniya from 2018-12-03 to 2020-12-03.
  Summary: Taxonomic treatment of genus Syzygium in Sri Lanka.
  Collaborators: **Prof. D.S.A. Wijesundara,** Dr. Subhhani Ranasnghe, and Mr. Himesh D. Jayasinghe (M.Phil. Student)

- Plant Taxonomy and Conservation research project collaborates with University of Vayamba (Department of Horticulture & Landscape Gardening), (Department of Aquaculture and Fisheries) from 2018-04-01 to 2020-04-01.
  Summary: Geographical distribution & genetic diversity of Vanda tessellata (Roxb) Hook.f. ex G.Don in Sri Lanka.
  Collaborators: **Prof. D.S.A. Wijesundara,** Prof. Kapila Yakandawala , Dr. Sewwandi Jayakjody, and Mr. Samantha Gunasekera (M.Phil. Student)

- Plant Taxonomy and Conservation research project collaborates with Department of Chemistry, Faculty of Science,University of Peradeniya from 2018-09-01 to 2020-09-01.
  Summary: Antifungal and anti-insecticidal plants from Invasive plants,.
  Collaborators: **Prof. D.S.A. Wijesundara,** Prof. B.M.R. Bandara, and Ms. Eishani Samarasinghe (Ph.D. Student)

- Plant Taxonomy and Conservation research project collaborates with Department of Botany, Faculty of Science,University of Peradeniya from 2018-09-17 to 2020-09-17.
  Summary: Impact of Bambusa bambos on native ecosystems in Moragahakande,.
  Collaborators: **Prof. D.S.A. Wijesundara,** Prof. Sumedha Madawala, and Mr. Tharanga Wijewickrama (Ph.D. Student)

- Plant Taxonomy and Conservation research project collaborates with Biotechnology Center, Faculty of Agriculture University of Peradeniya from 2018-01-15 to 2020-01-15.
  Summary: Genus Strobilanthes in Sri Lanka.
  Collaborators: **Prof. D.S.A. Wijesundara,** Dr. P.Bandaranayake, and Ms. N. Rajapakshe (M.Phil. Student)

- Plant Taxonomy and Conservation research project collaborates with Natural History Museum, London, UK from 2016-01-01 to 2019-12-01.
  Summary: Lichen studies in Sri Lanka, (Lichens & Slime Moulds).
  Collaborators: **Prof. D.S.A. Wijesundara,** and Dr. Gothamie Weerakoon

Primate Biology

Ongoing Collaborations:

- Primate Biology research programme of NIFS collaborates with Indian Institute of Science/ NIFS from 2018-10-03 to 2021-10-31.
  Summary: The phylogenetics of hybrids between the Sri Lankan primate species of langur (*Semnopithecus priam* and *S. vetulus*). Naturally occurring hybrids are of interest because of their role in the diversification of animals and the evolution of new species, the setting of limits to genetic compatibility between species, and in the extinction of species. The last 50 years of primate studies at Polonnaruwa by Prof. Wolfgang Dittus have uncovered 36 cases of hybrids between the Gray or Hanuman langur (*Semnopithecus priam thersites*) and the Purple-faced langur (*Semnopithecus vetulus philbricki*). The behavioral, demographic and ecological events surrounding these hybridizations are being summarized towards publication. The focus in this collaboration is to investigate the genetic consequences and underpinnings of the hybridization events among Sri Lankan langurs. The research involves collection of faecal DNA from the different populations of langurs, and their genetic characterization. Prof. Benjamin and Prof. Karanth undertake the genetics analyses. The research will contribute significantly to our understanding of the genetics in these populations in relation to the demographic, behavioral and ecological events at Polonnaruwa and by extrapolation to the phylogeny of species of langur (Colobinea) in South Asia..
  Collaborators : Prof. W. Dittus, Prof. S. Benjamin, Prof. Karanth.

MOLECULAR BIOLOGY & BIOTECHNOLOGY RESEARCH UNIT

Molecular Microbiology & Human Diseases

Ongoing Collaborations:

- Molecular Microbiology and Human Diseases research project collaborates with Molecular Biology/ Biochemistry Department, National University of Medical Sciences, Rawalpindi, Pakistan from 2018-04-20 to 2021-04-20.
  Summary: The study focuses on drug resistant tuberculosis (MDR-TB), the condition in which the TB bacterium becomes resistant to the two most powerful first line drugs: rifampin and isoniazid. Herein, we aim to determine the prevalence of MDR-TB in the country, detect the mutations responsible for resistance development and study the differential patterns of host immune responses.
  Collaborator: Prof. S. Younis

- Molecular Microbiology and Human Diseases research project collaborates with Buckingham Centre for Astrobiology, Buckingham, UK, and Centre for Astrobiology, from 2018-05-31 to 2020-05-31.
  Summary: The aim is to launch specially designed devices using balloons to collect samples of stratospheric air from heights between 30 and 50 km, recover the samples safely, and to analyse their bacterial content. The proposed work is of crucial importance in the validation of the Hoyle-Wickramasinghe theory of cometary panspermia, the evidence for which appears to be rapidly growing at the present time.
  Collaborator: Prof. Chandra Wickramasinghe

- Molecular Microbiology and Human Diseases research project collaborates with Respiratory disease treatment unit, Teaching Hospital, Kandy from 2018-04-20 to 2021-04-20.
  Summary: Information generated on local tuberculosis epidemiology, drug resistance patterns and differential host immune responses, will help in establishing better procedures in controlling drug resistant tuberculosis, improve patient status and reduce the overall health care cost spent on tuberculosis in Sri Lanka.
  Collaborator: Dr. R.M.D. Madegedara

- Molecular Microbiology and Human Diseases research project of NIFS collaborates with Respiratory disease treatment unit, Teaching hospital, Kandy from 2016-11-16 to 2019-05-16.
  Summary: 'Microbiota', denotes the population of microorganisms in a particular environment. The study of microorganisms in the environment is widely investigated, leading to investigation of the human microbiome which is assumed to play a role in mediating human diseases. The respiratory tract, being the major portal, through which a microorganism has the access to the human body, therefore, is assumed to play a significant role in inhabiting microbiota.
  Collaborator: Dr. R.M.D. Madegedara

Plant Stress Biology & Molecular Genetics

- Plant Stress Biology & Molecular Genetics research programme of NIFS collaborates with University of Southern Queensland from 2014-01-01 to 2021-01-01.
  Summary: rice and wheat biofortification.
  Collaborator: Professor Stephen Neate

Research Supervision

A.1 Post graduate degrees completed in year 2019

- **Mr. A. Manjceevan**
  Supervisor: **Prof. J. Bandara**
  Thesis title:
  Fabrication and Characterization of High Efficiency Quantum Dot -Based Solar Cells to Harvest Solar Energy in a Wide Spectrum
  Ph.D degree, awarded by *Postgraduate Institute of Science, University of Peradeniya*

- **Mr. K. Mohanan**
  Supervisors: **Dr. R.R. Ratnayake,** and **Prof. S.A. Kulasooriya**
  Thesis title:
  Development of Microbial Co-cultures for Lignocellulose degradation
  Ph.D degree, awarded by *Postgraduate Institute of Science, University of Peradeniya*

- **Mr. S. Sayanthooran**
  Supervisors: **Prof. D.N. Magana-Arachchi,** and Dr. S.S. Sooriyapathirana
  Thesis title:
  Gene Expression Analysis for The Identification of Candidate Biomarkers for Chronic Kidney Disease of Unknown Etiology (CKDu) In Sri Lanka
  Ph.D degree, awarded by *Postgraduate Institute of Science, University of Peradeniya*

- **M. M. Qader**
  Supervisor: **Prof. L. Jayasinghe,** Prof. N. S. Kumar
  Thesis title:
  Chemistry of Secondary Metabolites Produced by Plant and Marine Endophytic Fungi and Bioactivity Studies
  Ph.D degree, awarded by *Postgraduate Institute of Science, University of Peradeniya*

- **Ms. R.W.K. Amarasekera**
  Supervisor: **Prof. D.N. Magana-Arachchi,** and Prof. P. Samaraweera
  Thesis title:
  Identification of Bacteria and Fungi in The Atmospheric Particulate Matter at Selected Locations of Kandy, Sri Lanka
  M.Phil. degree, awarded by *Postgraduate Institute of Science, University of Peradeniya*

- **Ms. D. M. D. M. Dissanayake**
  Supervisor: **Prof. L. Jayasinghe,** and Prof. N. S. Kumar
  Thesis title:
  Chemistry and bioactivity of secondary metabolites produced by endophytic fungi in the fruits of *Phyllanthus acidus* and *Elaeocarpus serratus*
  M.Phil. degree, awarded by *Postgraduate Institute of Science, University of Peradeniya*

- **Mr. M.N. Jayakody**
  Supervisor: Prof. A. **Nanayakkara, and** Prof. (Mrs.) K.A.I.L. Gamalath
  Thesis title:
  Investigation of wave function collapse due to classical and quantum interactions
  M.Phil. degree, awarded by *University of Colombo*

- **Ms. N. Kanesharatnam**
  Supervisor: **Prof. S.P. Benjamin,** and Prof. M. Meegaskumbura
  Thesis title:
  Molecular phylogeny and taxonomic revision of tribe chrysillini including selected jumping spider genera (family: salticidae) from sri lanka
  M.Phil. degree, awarded by *Postgraduate Institute of Science, University of Peradeniya*

- **Ms. S. Sathya**
  Supervisor: **Prof. L. Jayasinghe,** and Dr. N. R. Amarasinghe
  Thesis title:
  Investigation of acetylcholonesterase inhibitory activity of Sri-Lankan grown spices as potential therapeutic agents for alzheimer,s disease
  M.Phil. degree, awarded by *Postgraduate Institute of Science, University of Peradeniya*

- **Ms. H. R. W. M. D. P. K. Niyangoda**
  Supervisor: **Prof. L. Jayasinghe,** and Prof. N. S. Kumar
  Thesis title:
  Chemistry and bioactivity of five popular edible fruits in Sri Lanka
  M.Phil. degree, awarded by *Postgraduate Institute of Science, University of Peradeniya*

- **Miss. A. Thurairajah**
  Supervisor: **Dr. R.R. Ratnayake**
  Thesis title:
  Isolation of Denitrifying Bacteria and their Potential use in Nitrate Removal from Well Water of Jaffna District
  M.Phil. degree, awarded by *University of* Jaffna

- **Ms. M.A.Y.U. Jayathilaka**
  Supervisor: **Prof. G.R.A. Kumara,** and Dr. A.C.A. Jayasundara
  Thesis title:
  Liquid Based Dye-Sensitized Solar Cells Using Activated Charcoal Counter Electrode with Morphol as Binder
  M.Sc. degree, awarded by *Postgraduate Institute of Science, University of Peradeniya*

A.2 Postdoctoral research work in progress

Name of the Supervisors	Name of the student	Title of the research area	Research student type
Prof. D.N. Magana-arachchi, Prof. C. Wickramasinghe, and Dr. M. Vithanage	Dr. C.A. Thotawatthage	Environmental Sciences	Research Assistant/ NIFS??

A.3 PhD research work in progress

Name of the Supervisors	Name of the student	Title of the research area	Research student type
Prof. M.A.K.L. Dissanayake, and **Prof. G.K.R. Senadeera**	Ms. J.M.K.W. Kumari	Dye/Q-dot sensitized solar cells	Research Assistant/ NIFS
Prof. M.A.K.L. Dissanayake, and **Prof. G.K.R. Senadeera**	Mr. T. Jaseetharan	Quantum dot solar cells and IR detectors	Research Assistant/ Grant
Prof. M.A.K.L. Dissanayake, and **Prof. G.K.R. Senadeera**	Ms. W.I. Sandamali	Engineering nano-materials for photovoltaics	Research Assistant/ Grant
Prof. M.C.M. Iqbal, Prof. S.S. Iqbal, and Prof. N. Priyantha	Mr. D.M.R.E.A. Dissanayake	Environmental Science	Research Assistant/ NIFS
Dr. L. Jayarathna	Mrs. M. M. E. Munasinhge	Nano Technology	Research Assistant/ NIFS
Prof. L. Jayasinghe, Prof. N. B. K. Adikaram and Dr. N.R. Amarasinghe	Ms. D. M. D. M. Dissanayake	Natural Product Chemistry	Research Assistant/ NIFS
Prof. L. Jayasinghe, and Dr. N.R. Amarasinghe	Ms. H.M.S.K.H. Bandara	Natural Product Chemistry	Research Assistant/MRI
Prof. G.R.A. Kumara, and Prof. R.M.G. Rajapakse	Ms. K.D.M.S.P.K. Kumarasinghe	Solar energy materials	Research Assistant/ NIFS
Prof. S. Seneweera, and Prof. Steven Neate	Ms. Chamika Wijerathna	Plant Biotechnology, Plant Physiology, and Nanotechnology	External
Prof. S. Seneweera, and Dr. L. Jayarathne	Mrs. U.M.P.K. Perera	Plant stress biology and Nanotechnology	Research Assistant/ NIFS
Prof. S. Seneweera, Dr. C. Perera, Dr. D. Gamage, and Prof. H. Naoki	Ms. N.D.U.S. Nakandala	Plant Molecular Biology and Physiology	Research Assistant/ NIFS
Prof. S. Seneweera, Dr. B. Allen, Prof. T. Maraseni, Prof. D. Weerakoon, and Prof. A. Dangolla	Ms. L. S. J. Cabral de Mel	Wildlife Biology	Research Assistant
Prof. S. Seneweera, Dr. K. Bandara, and Dr. L. Kouadio	Ms. M. Aryal	Agriculture, climate change and crop modeling	External
Prof. S. Seneweera	Mr. R. R. Abdulsada	Plant pathophysiology	External
Prof. S. Seneweera	Mr. P. Dehigaspitiya	Plant physiology	External
Prof. S. Seneweera	Mr. I. Herath		External

Name of the Supervisors	Name of the student	Title of the research area	Research student type
Prof. J. Bundschuh, **Prof. S. Seneweera,** Prof. A. Meharg, and Prof. Y. S. Ok	Mr. P. Kumarathilaka	Environmental Science	External
Prof. S. Senaweera, and Dr. W. Senadheera	Ms. H. Senevirathne	Rice fortification	External
Prof. N.D. Subasinghe	Mr. N.B. Suriyaarachchi	Geophysics	Research Assistant/ NIFS
Prof. R. Weerasooriya	Mr. Y. M. I. B. Samarakoon	Computational Chemistry	External
Prof. G. Seneviratne	Mr. S. A. T. A Perera	Microbial Biotechnology	Research Assistant

* *Thesis submitted*

A.4 M.Phil. Research work in progress

Name of the Supervisors	Name of the student	Title of the research area	Research student type
Prof. N.K.B. Adikaram, Prof. L. Jayasinghe, and Prof. D. Yakandawala	Ms. C. P. Amarasinghe	Plant Pathology	Research Assistant/ Grant
Prof. N.K.B. Adikaram, Prof. L. Jayasinghe, and Prof. D. Yakandawala	Mrs. L. N. Manawadu	Post-Harvest Pathology	Research Assistant/ Grant
Prof. J. Bandara	Mr. A.M.K.L. Abeykoon	Solar Cells	Research Assistant/ NIFS
Prof. J. Bandara	Ms. M.A. Farhana	Solar Cells	Research Assistant/ NIFS
Prof. S.P. Benjamin, and Prof. W.A.P. Karunaratne	Ms. D.P. Bopearachchi	Molecular Systematics	Research Assistant
Prof. S.P. Benjamin	Ms. A. Satkunanathan	Molecular Systematics	Research Assistant
Prof. S.P. Benjamin	Ms. M. Tharmarajan	Molecular Systematics	Research Assistant/ NIFS
Prof.M.A.K.L. Dissanayake, and **Prof. G.K.R. Senadeera**	Mr. S. Senthuran	Dye sensitized solar cells	Research Assistant/ Grant
Prof. M.A.K.L. Dissanayake, and **Prof. G.K.R. Senadeera**	Mr. K. Umair	Dye sensitized solar cells	Research Assistant/ NIFS

Name of the Supervisors	Name of the student	Title of the research area	Research student type
Prof. M.C.M. Iqbal	Ms. H.G.M.K. Karunarathna	Plant Biology	Research Assistant/ NIFS
Dr. L. Jayarathna	Ms. A. Rajapakshe	Environmental Science	Research Assistant/ NIFS
Prof. L. Jayasinghe, **Prof. N.K.B. Adikaram,** and Prof. N. S. Kumar	Ms. B.M.S. Nilmini	Natural Product Chemistry	Research Assistant/External
Prof. L. Jayasinghe, Prof. N. S. Kumar, and **Prof. N.K.B. Adikaram**	Ms. H. S. T. Kaushalya	Natural Product Chemistry	Research Assistant/ NIFS
Prof. L. Jayasinghe, Prof. N. S. Kumar, and **Prof. N. K. B. Adikaram**	Ms. E. A. I. A. Perera	Natural Product Chemistry	Research Assistant/ NIFS
Prof. G.R.A. Kumara, and Prof. P.M. Sirimanne	Mr. P.N. Dissanayake	Photochemistry	Research Assistant/ NIFS
Prof. G.R.A. Kumara, and Prof. R.M.G. Rajapakse	Mr. D.G.B.C. Karunarathne	Solar Energy	Research Assistant/ External
Prof. G.R.A. Kumara, and Prof. R.M.G. Rajapakse	Mr. A.U. Malikaramage	Nanoscience	Research Assistant/ External
Prof. G. Seneviratne	Ms. H. K. S. N. S. Gunarathne	Microbiology, Plant Biology	Research Assistant/ NIFS
Dr. R. Liyanage, and **Prof. L. Jayasinghe**	Ms. F. A. Deen	Food and Nutrition	Research Assistant/ NIFS
Dr. R. Liyanage, Prof. R. Sivakanesan, **Prof. D.S.A. Wijesundara,** and Prof. C. N. R. A. Alles	Ms. S.M.V.K. Sewwandi	Nutritional Biochemistry	Research Assistant/ NIFS
Prof. D.N. Magana-Arachchi, and Prof. N.V. Chandrasekharan	Ms. E.M.U.A. Ekanayake	Lung microbiome	Research Assistant/ NIFS
Prof. D.N. Magana-Arachchi, Prof. R.G.S.C. Rajapakse, and Dr. R.M.D. Madegedara	Ms. J.M.P.S. Madamarandawala	Drug-resistant tuberculosis	Research Assistant/ Grant - NSF
Prof. D.N. Magana-Arachchi, and Dr. R. Wanigatunge	Ms. D.G.S.N. Samarasinghe	Molecular Microbiology	Research Assistant/ Grant - NSF
Prof. D.N. Magana-Arachchi, and Dr. R. Wanigatunge	Ms. M.A.T.M. Senevirathna	Cyanotoxins	Research Assistant/ NIFS

Name of the Supervisors	Name of the student	Title of the research area	Research student type
Prof. D.N. Magana-Arachchi, Dr A. Wijayasinghe, and **Dr. M. Vithanage**	Ms. W.B.C.P. Weerarathne	Asbestos-Related Occupational Health	Research Assistant/ Grant-NRC
Prof. J.M.N. Marikkar	Ms.K.M.R.U.Gunarathne	Food Chemistry	Research Assistant/ NIFS
Prof. J.M.N. Marikkar	Ms. S.S.K. Marasinghe	Food Chemistry	Research Assistant/ NIFS
Dr. R.R. Ratnayake	Miss. S.K. Jayasekara *	Microbiology	Research Assistant/ NIFS
Dr. R.R. Ratnayake, and **Prof. S. Seneweera**	Miss. D.D.M.O. Dissanayake	Soil Carbon sequestration	Research Assistant/ NIFS
Dr. R.R. Ratnayake	Miss. R.W.T.M.R.T.K. Bowange	Microbiology	Research Assistant/ NIFS
Dr. R.R. Ratnayake	Miss. T.M. Paranavithana	Bioenergy & Soil Ecosystems	Research Assistant/ Grant-NRC
Prof. G. Seneviratne	Ms. S. W. Meepegamage	Molecular Microbiology	Research Assistant/ NIFS
Prof. G. Seneviratne	Mr. M. Premarathna	Microbiology	Research Assistant/ NIFS
Prof. G. Seneviratne	Ms. A.T.D. Rathnathilaka	Microbiology	Research Assistant/ NIFS
Prof. N.D. Subasinghe, Dr. S.P.K. Malaviarachchi Dr. L. Dharmapriya	Mr. H.M.D.A.H. Bandara Mr. D.W.M.S.S.K. Dissanayake G. Wijeratne	Geology and Geophysics	Research Assistant/ NIFS
Prof. N.D. Subasinghe	Mr. W.M.H.S. Wijekoon	Physics of Materials	Research Assistant/ Grant-NRC
Prof. N.D. Subasinghe	Mr. P. Mahakumara	Environmental Science	
Prof. R. Weerasooriya	Ms. J. U. Halpegama	Electro Material Chemistry	External
Prof. R. Weerasooriya	Ms. P. Rukshagini	Water chemistry	Research Assistant/ Grant-NRC
Dr. H.W.M.A.C. Wijayasinghe, and **Prof. M.A.K.L. Dissanayake**	Mr. R.I.C.N. Karunarathne	Development of materials for battery applications	Research Assistant/ Grant-Treasury

Name of the Supervisors	Name of the student	Title of the research area	Research student type
Dr. H.W.M.A.C. Wijayasinghe, Dr. N.W.B. Balasooriya, and Dr. T.H.N.G. Amaraweera	Ms. J.N. Kanagaratnam	Structural modification of local graphite for novel batteries	Research Assistant/ NIFS
Dr. H.W.M.A.C. Wijayasinghe, and Dr. N.W.B. Balasooriya	Ms. H.M.H.D.K. Naranpanawa	Development of local graphite for lithium-ion batteries	Research Assistant/ Grant-Treasury
Dr. H.W.M.A.C. Wijayasinghe, Dr. T.H.N.G. Amaraweera, and Dr. R.J.K.U. Ranathunga	Mr. Y.M.I.B. Samarakoon	Development of vein quartz for energy conversion applications	Research Assistant/ NIFS
Dr. H.W.M.A.C. Wijayasinghe, Dr. N.W.B. Balasooriya, and Prof. H.M.T.G.A. Pitawala	Ms. T.C. Senevirathna	Development of local graphite for lithium-ion batteries	Research Assistant/ Grant-NRC
Dr. H.W.M.A.C. Wijayasinghe, and **Prof. R. Weerasooriya**	Mr. G.D.K. Heshan	water purification	Research Assistant/ NIFS
Prof. D.S.A. Wijesundara, Dr. Ranasinghe, S., and Dr. Kathriarachchi, H.	Mr. H.D. Jayasinghe	DNA Barcoding, Morphological Taxonomy and Phylogeny	Research Assistant/ NIFS
Prof. D.S.A. Wijesundara, Prof. M.C.M. Iqbal, and Prof. H.M.S.P. Madawala	Mr. P.L.C.U.S.B. Lekamge	Forest restoration and Conservation	Research Assistant/ NIFS

* *Thesis submitted*

A.5 MSc research projects in progress

Name of the Supervisors	Name of the student	Title of the research area	Research student type
Prof. N.K.B. Adikaram	Ms. W.M.S. Kurera	Molecular biology and biotechnology"	Research Assistant/ Grant
Prof. J. Bandara	Ms. M.C.M. Rajapaksha	Photocatalyst	Research Assistant/ NIFS
Prof. J. Bandara	Mr. S.A.D.A.V. Sumithraarachchi	Water Purification	Research Assistant/ Grant-NSF

Name of the Supervisors	Name of the student	Title of the research area	Research student type
Prof. M.A.K.L. Dissanayake	Ms. Imali Madigasekara	HgS heterojunction solar cells	External
Prof. M.C.M. Iqbal, and Dr. C.S. Kalpage	Ms. R.G.C.P. Rajapaksha	Environmental Science	External
Prof. G.R.A. Kumara, and Prof. R.M.G. Rajapakse	Mr. D.A.N.C. Abeysekara	Nanoscience and nanotechnology	Research Assistant/ Grant
Prof. G.R.A. Kumara, and Prof. R.M.G. Rajapakse	Mr. N.M. Keppetipola	Dye-sensitized Solar Cells	External
Dr. R. Liyanage, and Prof. Terrence Madhujith	Ms. W.A.P.M.M. Ariyarathna	In vitro screening of Sri Lankan Ayurvedic plants for their antioxidant activity	External
Prof. D.N. Magana-Arachchi, and Dr. B. Jayasooriya	Ms. E.G.J. Jayantha	Pharmacognacy	External
Prof. D.N. Magana-Arachchi	Ms. H.A.H. Hiroshini	Molecular microbiology	External

B.1. Undergraduate research projects completed

Supervisors	Research Area	Name of the student & affiliated University
Prof. B.C. Jayawardana, **Dr. R. Liyanage,** P. Weththasinghe, and N. Perera	Antioxidant, physiochemical, microbiological and sensory properties of yogurt incorporated with beetroot powder	Ms. P.M. Premawansha University of Peradeniya
Prof. B.C. Jayawardana, and **Dr. R. Liyanage**	In vitro hydrolysis rates and physio-chemical properties of fifteen different starches available in Sri Lanka	R.T.P. Liyanage University of Peradeniya
Prof. B.C. Jayawardana, and **Dr. R. Liyanage**	Prebiotic Activity of Commonly Available Starch Sources in Sri Lanka"	Ms. S.M.V.K. Sewwandi University of Peradeniya
Dr. R. Liyanage and Dr. S. Vasantharuba	Screening for anti-diabetic properties and phytochemicals of hemidesmus indicus	Ms. M.N.F. Amriya University of Jaffna
Prof. B.C. Jayawardana, **Dr. R. Liyanage,** and Ms. S.G.V.B.	The Use of Mee Oil as Fat Re-placer and Its Effect on Physicochemical and Sensory Characteristics of Pork Sausages	Ms. S. Y. Hegodaarachchi University of Peradeniya

Supervisors	Research Area	Name of the student & affiliated University
Prof. J.M.N. Marikkar	Development of cookies partially substituted with coconut (Cocos nucifera) testa flour	Ms. N. Rubini Sabaragamuwa University
Prof. J.M.N. Marikkar	Glycemic response and quality evaluation of coconut (Cocos nucifera) flour incorporated crackers	E.M.P.H. Ekanayake Wayamba University of Sri Lanka
Dr. R.R. Ratnayake, and Prof. G.A.D. Perera	Carbon Sequestration and arbuscular mycorrhizal fungi in dry zone home gardens at Thalawa,Sri Lanka	Miss. H.M.N.D Premalal University of Peradeniya
Dr. R.R. Ratnayake, and Prof. N. Gnanavelrajah	Formulation of a low-cost medium for cyanobacteria and assessment of their potential use as bio fertilizer in paddy	Miss. P. Balasubramaniam University of Jaffna
Dr. R.R. Ratnayake, and Prof.N.Gnanavelrajah	Potential to use Cyanobacterial strains as bio fertilizer	Miss. N. Sivaprakasam University of Jaffna
Dr. R.R. Ratnayake, and Prof. G.A.D. Perera	Soil Carbon stocks and its relation to nitrogen and phosphorus levels in salt marsh ecosystems in Kalpitiya	Miss. B.K. Morahenpita University of Peradeniya
Prof. G.R.A. Kumara, and Prof. A.R. Kumarasinghe	Efficient Synthesis of Graphene from Sri Lankan Vein Graphite	Ms. U.D.P.R. Dahanayake University of Sri Jayawardenapura
Dr. R. Liyanage, and Dr. N. S. Weerakkody	Evaluation of antioxidant activity of rice grown with biofilm biofertilizer"	Ms. B.H.S.M.Bopagoda Open University of Sri Lanka

B.2. Undergraduate research projects in progress

Supervisors	Research Area	Name of the student & affiliated University
Dr. G. Bowatte	Air pollution monitoring and modelling	Mr. M. Senarthna University of Peradeniya
Dr. G. Bowatte	Air pollution monitoring and modelling	Mr. S. Priyankara University of Peradeniya
Prof. M.A.K.L. Dissanayake	Solar cells	Ms. Ivani Jayalath University of Sri Jayawardenepura

Supervisors	Research Area	Name of the student & affiliated University
Prof. M.A.K.L. Dissanayake	Solar cells	Ms. I.W. Ridmi Nisansi University of Sri Jayawardenepura
Prof. M.A.K.L. Dissanayake, and **Prof. G.K.R. Senadeera**	solar cells	Ms. M.M. Raazidha Farhath South Eastern University of Sri Lanka
Prof. M.C.M. Iqbal	Environmental Science	Ms. W.A.H. Abayawardhana University of Peradeniya
Prof. M.C.M. Iqbal	Environmental Science	Ms. K.T.S. Nirmanee Faculty of Agriculture, Rajarata University
Prof. M.C.M. Iqbal	Environmental Science	Ms. G.H. Nilooma, University of Peradeniya
Dr. L. Jayarathna	Environmental Science	Ms. L. Thilakarathne University of Peradeniya
Dr. L. Jayarathna	Environmental Science	Ms. M. K. N. Ranasinghe University of Peradeniya
Dr. L. Jayarathna	Environmental Science	Ms. P. S. Dias
Dr. L. Jayarathna	Chemical synthesis	Mr. N. Rajeevan Uva Wellasa University of Sri Lanka
Dr. L. Jayarathna, Prof. R. Weerasooriya, and Prof. Athula Bandara	Iron oxide Zeolite	Ms. H.D.S. Wijenayake University of Peradeniya
Dr. L. Jayarathna, Prof. R. Weerasooriya, and Prof. Athula Bandara	Fluoride removal using iron oxide coated zeolite	Mr. E.M.A.P.B. Ekanayake University of Peradeniya
Dr. Somarathne, T., and **Dr. R. Liyanage**	Nutritional Biochemistry	Ms. D.A.D.M. Jayasekara
Dr. R. Liyanage, Prof. C. S. De Silva, and Ms. S. A. D. S. S. Maheepala	Food and Nutrition	Ms. I. Rathnayaka
Dr. R.R. Ratnayake	Soil Carbon Sequestration	Miss. H.K.M. Lakmali University of Peradeniya
Dr. R.R. Ratnayake	Soil Carbon Sequestration	Miss. J. Galappaththige BMS/Higher National Diploma in Biomedical Science

Supervisors	Research Area	Name of the student & affiliated University
Dr. R.R. Ratnayake	Soil Carbon Sequestration	Miss. M.D.R. Perera South Eastern University
Dr. R.R. Ratnayake	Soil Carbon Sequestration	Mr. R.H.S.P. Wishvajith South Eastern University
Dr. R.R. Ratnayake	Soil Carbon Sequestration	Miss. E.M.D. Perera The Open University of Sri Lanka
Dr. R.R. Ratnayake	Soil Carbon Sequestration	Mr. D.M.B.A. Chathuranga University of Jaffna
Prof. G. Seneviratne	Microbiology	Mr. Ekanayake, S. Uva wellassa University
Prof. S. Seneweera, and Prof. C. Boehmer	Application of nanotechnology to manage Fall armyworm in Maiz	Ms. P. S. Jayalath Hochschule Rhein-Waal, Germany
Prof. S. Seneweera, and Dr. C. P. Rupasingha	Plant Biology	Mr. B. H. I. A. Jayathissa University of Ruhuna
Prof. R. Weerasooriya	Geochemistry	Mr.W.P.S.A. Witharana
Prof. R. Weerasooriya	Graphene oxide coated Super sand for fluoride removal	Mr.B.G.N.R.M. Premasinghe University of Kelaniya
Prof. R. Weerasooriya	Water Chemistry	Ms. H. Kushanie
Prof. R. Weerasooriya	Environmental Science	Ms. S. Dayarathna University of Peradeniya
Dr. H.W.M.A.C. Wijayasinghe, and Dr. T.H.N.G. Amaraweera	Developing Ag-graphite composites for battery applications	Ms.Kumari, T.D.D. Uva Wellassa University
Dr. H.W.M.A.C. Wijayasinghe, and Dr. T.H.N.G. Amaraweera	Development of graphite intercalated compounds for rechargeable batteries	Mr. Ranasinghe, U.G.K.L.S. Uva Wellassa University
Dr. H.W.M.A.C. Wijayasinghe, and Mr. H.P.T.S. Hewathilake	Development Sri Lankan vein graphite for Li-ion Rechargeable batterries	Ms. Tamali Bandara Uva Wellassa University
Prof. D.S.A. Wijesundara	Plant taxonomy and Invasive Plant Species	Ms. D.D.L.S. De Alwis Sabaragamuwa University

Supervisors	Research Area	Name of the student & affiliated University
Prof. D.S.A. Wijesundara	Plant taxonomy and Invasive Plant Species	Ms. W.L.M.Madumika Sabaragamuwa University
Prof. D.S.A. Wijesundara	Plant taxonomy and Invasive Plants Species	Ms. H.W.N Sewwandi Sabaragamuwa University

* *Thesis submitted*

B.3. Undergraduate Industrial Training projects:

Supervisors	Research Area	Name of the student & affiliated University
Prof. S.P. Benjamin	Evolution, ecology and biodiversity	Mr. S.N. Rathnasiri
Dr. L. Jayarathna	Environmental Science	Ms. S. M. S. U. L. Siriwardhana Institute of Chemistry Ceylon
Prof. G.R.A. Kumara	Advanced Material Chemistry	Ms. G.W.E.G.K. Somarathne University of Rajarata
Prof. D.N. Magana-Arachchi	Molecular microbiology	Ms. H.M.H.P. Herath Wayamba University of Sri Lanka
Dr. R.R. Ratnayake	Applied Microbiology	Ms. N. Sivaprakasam University of Jaffna
Dr. R.R. Ratnayake	Bioenergy & Soil Ecosystems	Mr. I.M.D.B. Idisooriya Open University of Sri Lanka
Prof. S. Seneweera	Wildlife Biology	Ms. M. Noyalin Vavuniya campus of the University of Jaffna
Dr. R.R. Ratnayake	Soil Carbon Sequestration	Miss. K. Jeyakumar University of Jaffna
Dr. R.R. Ratnayake	Soil Carbon Sequestration	Mr. D.M.B.A. Chathuranga University of Jaffna
Dr. R.R. Ratnayake	Soil Carbon Sequestration	Miss. D.M.B.M Deegala Rajarata University of Sri Lanka
Dr. R.R. Ratnayake	Soil Carbon Sequestration	Miss D.N. Rathnayake University of Ruhuna
Dr. R. Liyanage	Food and Nutrition	Ms. A.S. Polwattage

Supervisors	Research Area	Name of the student & affiliated University
Prof. S. Seneweera	Electronic Engineering	Mr. S. M. M. H. Senanayake Open University
Prof. M.A.K.L. Dissanayake, and **Prof. G.K.R. Senadeera**		Ms. M.M. Raazidha Farhath South Eastern University of Sri Lanka
Prof. M.C.M. Iqbal	Environmental Science	Ms. G.H. Nilooma University of Peradeniya
Prof. M.C.M. Iqbal	Environmental Science	Ms. K.T.S. Nirmanee Rajarata University of Sri Lanka
Prof. M.C.M. Iqbal	Tissue Culture	Ms. K. Medagama
Prof. M.A.K.L. Dissanayake	Solar cells	Mr. T.S.M. Liyanage
Prof. R. Weerasooriya	Material Chemistry	Mr. R.T. Perera University of Kelaniya
Prof. G. Seneviratne	Microbiology	Mr. W. M. K. D. S. Warnakulasooriya
Dr. R.R. Ratnayake	Microbiology	Miss. M.M.P.H. Jayasinghe
Dr. R.R. Ratnayake	Soil Carbon Sequestration	Ms. U.L.R.W. Premathilaka
Dr. R. Liyanage, and Dr.B. L. W. K. Balasooriya		Ms. S. D. H. Kaushalya Wayamba University of Sri Lanka

B.4. Other research supervision:

Supervisors	Name of the student	Research Area	Research Student Type
Prof. D.N. Magana-Arachchi	Ms. S.M.N.K. Thilakarathne	Environmental resistomes	Research Assistant/NIFS
Prof. D.N. Magana-Arachchi	Ms. M.A.Y.N. Weerasinghe	Bird gut microbiome	Research Assistant/NIFS
Prof. D.N. Magana-Arachchi, and **Dr. M. Vithanage**	Ms. H.M.H.P. Herath	Molecular microbiology	Research Assistant/ Grant
D.N. Magana-Arachchi, and **Dr. M. Vithanage**	Ms. K.G.M.M. Rajapaksha	Molecular microbiology	Research Assistant/ Grant
Prof. D.N. Magana-Arachchi	Mr. G.P.R.D. Pathirana	Molecular microbiology	Pre-university Research Assistant

Awards & Recognitions 2019

Awards:

- NRC Merit Award for scientific Publicatiom-2017, received on 2019
  Ms. R.W.K. Amarasekera,
  Prof. D.N. Magana-Arachchi,
  Dr. M. Vithanage
  Dr. R.R. Ratnayake

- E.M.H.G.S. Ekanayake; R.K.G.K. Kumara; H.M.A.C. Gunarathne received an NRC Merit Award for Soil carbon sequestration and nutrient of tropical rice based cropping systems: Rice-Rice, Rice-Soya, Rice-Onion and rice-Tobacco in Sri Lanka on 2019-09-28.

- Prof. G.K.R. Senadeera received the Open University of Sri Lanka (OUSL) Research Award on 2019-10-30.

- NRC award for Scientific achievements 2019
  Prof. N.D. Subasinghe

- The Best Presenter awards:
  - Prof. J.M.N. Marikkar received a National Award for Best poster presenter at the Rajarata International Research Conference-2019 on 2019-11-06.
  - Ms. H.M.H.D.K. Naranpanawa and Ms. J.M.K.W. Kumari received the Best Presenter - Poster Presentation of NIFS - Young Scientists' Symposium on Multidisciplinary Research 2019 at NIFS from National Institute of Fundamental Studies, Kandy on 2019-12-06
  - Ms. P. Ariyarathna received an International Competitive Award for Best presenter award in Medicine and Health Sciences track at the Rajarata International Research Conference (RIRC 2019) on 2019-11-06.
  - Ms. S.M.V.K. Sewwandi received the Best Oral Presentation in the session on Food Quality & Natural Resources management from University of Peradeniya, Faculty of Agriculture Undergraduate Research Symposium on 2019-02-21.
  - S. Sathya received an International Award for Best poster presentation on 2019-01-28 at ANRAP 2019 held in University of Karachi, Pakistan.

- Most Outstanding researcher 2018
  Senior Level: Prof. R. Weerasooriya
  Middle Level: Prof. G. R. A. Kumara
  Junior level: Dr. H. W. M. A. C. Wijayasinghe

- S. Sathya received a National Competitive Award for Winner of 3MT competition on 2019-10-16. organized by SLAYS

Recognitions:

- Reviewer for Reviewing a Manuscript for Journal Publication in 2019:

  Prof. S.P. Benjamin
  ZooKeys

  Prof. M.A.K.L. Dissanayake
  Editor-in-Chief, Ceylon Journal of Science at University of Peradeniya

  Prof. J.M.N. Marikkar
  Grasas Y Aceitas
  Journal of the National Science Foundation
  LWT Food Science and Technology
  Nutricon
  RESCON
  Ceylon Journal of Science

  Prof. G.R.A. Kumara
  Chemistry Letters
  International Journal of Energy Research
  Journal of Alloys and Compounds
  Journal of Photochemistry and Photobiology
  Materials Today: Proceedings
  SN Applied Science
  35th Technical session's extended abstract publication of the Institute of Physics Sri Lanka-IPSL in 2019

  Prof. D.N. Magana-Arachchi
  Journal Current Microbiology
  Journal Microbial Drug Resistance
  Journal of Environmental Science and Health, Part C

  Dr. R. Liyanage
  Journal of Potato Research

  Dr. R. R. Ratnayake
  Land Degradation and Development
  Applied Microbiology and Biotechnology
  Archives of Agronomy and Soil Science

- Reviewer in International Conference in 2018/2019:

  Dr. Liyanage, R.
  International Conference on Dryzone Agriculture (ICDA)
  International Research Symposium on Pure and Applied Sciences (IRSPAS)
  PGIS ResCon
  Archives of Endocrinology and Metabolism in 2019
  International journal of Food Properties in 2019
  Ceylon Journal of Science in 2019
  International Journal of Food Science and Technology in 2019

- Editor, Journal of Food and Nutritional Sciences
  Dr. R. Liyanage

- Prof. S. Seneweera received the Panellists of 32nd Annual Conference 2019: Role of professional in sustainable national development from Organisation of Professional Associations of Sri Lanka on 2019-09-17.

- Serving in committees:

Prof. M.A.K.L. Dissanayake	Principal National Coordinator, Shilpasena National Exposition at BMICH at Ministry of Science, Technology and Research on 2019-01-06.
Dr. R. Liyanage	Scientific Committee Member at The 3rd International Conference on Food and Nutrition, Health and Lifestyle, The International Institute of Knowledge Management (TIIKM)
Prof. J.M.N. Marikkar	Member of the Scientific Committee at The International Institute of Knowledge Management, Colombo, Sri Lanka
Prof. M.C.M. Iqbal	Member of the Board of Study for Crop Science from Post Graduate Institute of Agriculture, University of Peradeniya
Prof. M.C.M. Iqbal	Member of the General Research Committee from National Institute of Fundamental Studies
Dr. R.R. Ratnayake	Member of the Board of Study in Biochemistry and Molecular Biology at Postgraduate Institute of Science
Prof. N.D. Subasinghe	Board Member of the Board of Earth Science, PGIS at Postgraduate Institute of Science - University of Peradeniya .
Prof. N.D. Subasinghe	Member of the CEA Group for Ecosystem Services and Guidelines for Environmental Assessment in Sri Lanka at Central Environmental Authority Sri Lanka
Prof. N.D. Subasinghe	President of the Geological Society of Sri Lanka at Geological Society of Sri Lanka
Prof. D.S.A. Wijesundara	Chairman at National Species Conservation Advisory Group of Ministry of Mahaweli Development and Research
Prof. D.S.A. Wijesundara	Chairman at UNESCO National Man and Biosphere Committee of NSF
Prof. D.S.A. Wijesundara	Coordinator (Flora) at Preparation of the National Red List project
Prof. D.S.A. Wijesundara	Member at Council of National Academy of Sciences, Sri Lanka

Prof. D.S.A. Wijesundara	Member at National Expert Committee on Biodiversity of Ministry of Mahaweli Development and Research
Prof. D.S.A. Wijesundara	Member at National Expert Committee on Climate Change Control and Adaptation of Ministry of Mahaweli Development
Prof. D.S.A. Wijesundara	Member at National Expert Committee on Conservation and Sustainable Utilization of Mangroves of Ministry of Mahaweli Development and Research
Prof. D.S.A. Wijesundara	Member at NSF Working Group on Biodiversity and Environment

- Evaluator/ Examiner

Prof. M.A.K.L. Dissanayake	Evaluator for NSF Research Grants Final Reports in 2019 Evaluator for Progress report of NRC Grant in 2019 Evaluator for NRC Research Grant proposals in 2019 Evaluator for STEM Research Proposals of AHEAD Grand scheme (World Bank) in 2019
Prof. D.N Magana-Arachchi:	Evaluator for Progress Report of NRC grant 16-038 Evaluator for the international inventions of "Sahasak Nimavum - 2019", International Inventions Exhibition & Competition organized by Sri Lanka Inventors Commission
Dr. R. Liyanage	Stakeholder in curriculum revision of B.Sc. food Science Technology degree, Faculty of Agriculture from University of Peradeniya on 2019-05-17
Prof. N.D. Subasinghe	Evaluator for NSF committee on marine Science & Oceanography, 2019

- Other recognitions:

Dr. R. Liyanage	received the Top 20 most read paper from Journal of Food Biochemistry, Wiley on 2019-06-06.
Prof. Dittus WPJ,	received Editor's Choice Award for the publication; from the journal Folia Primatologica

Training / Participation related to research work

Training

- Mr. S. Senthuran Trained at an International Workshop on Introductory Training Course in Nano fabrication Technologies from 2019-01-14 to 2019-02-01 at Centre for Nano Science and Engineering (CeNSE), Indian Institute of Science, Bangalore, INDIA.

- Ms. J.M.P.S. Madamarandawala Trained at an International Workshop on TDR operational research workshop from 2019-02-04 to 2019-02-16 at Colombo.

- Ms. W.B.C.P. Weerarathne Trained at an International Workshop on Internship in minerological study of asbestos-bearing materials by optic microscopy and X-ray powder diffraction analysis. from 2019-05-26 to 2019-05-31 at Moscow, Russia.

- Miss. S.K. Jayasekara Trained at a National Workshop on Identification of non-lichenized fungi and Mushrooms from 2019-09-14 to 2019-09-16 at Royal Botanical Garden, Peradeniya.

- Ms. J.M.P.S. Madamarandawala Trained at an International Workshop on Asia SORT IT operational research course-Module 2 from 2019-10-10 to 2019-10-18 at Colombo.

- Miss. S.K. Jayasekara, and Miss. T.K. Bowange Trained at an International Programme on Training Programme on Biogas Production, Power generation and Vehicular Application from 2019-10-14 to 2019-10-25 at Delhi.

- Ms. D.P. Bopearachchi Trained at an International Conference on Student Conference on Conservation Science (SCCS) - Bengaluru from 2019-10-14 to 2019-10-19 at Indian Institute of Science (IISc), Bengaluru- India.

- Ms. S.M.N.K. Thilakarathne Trained at an International Workshop on *Hands on training in Computational Biology for (Meta) Genomics Analysis* on 2020-02-12 at Pokhara, Nepal.

- Miss. T.M. Paranavithana, and Miss. D.D.M.O. Dissanayake Trained at a National Programme on *117th 6 day Residential Short Course on* from 2020-02-10 to 2020-02-15 at Postgraduate Institute of Science (PGIS), University of Peradeniya.

Participation

- Mr. A.M.K.L. Abeykoon Participated at an International Conference on Advanced Materials for Clean Energy and Health Applications from 2019-02-05 to 2019-02-06 at University of Jaffna.

- Mr. G.D.K. Heshan Participated at an International Conference on 2019 E2S2-CREATE and AIChE® Waste Management Conference from 2019-03-11 to 2019-03-13 at Singapore.

- Prof. D.S.A. Wijesundara Participated at an International Symposiums on wildlife trafficking on 2019-03-15 at University of Colombo.

- Prof. J.M.N. Marikkar Participated at a National Workshop on Stakeholder Workshop on Curriculum Review of the B.Sc. Food Science & Technology Program on 2019-05-17 at Board room of the Faculty of Agriculture, University of Peradeniya.

- Prof. D.S.A. Wijesundara Participated at a National Symposiums on indigenous medicine on 2019-06-25 at PGIS Peradeniya.

- Prof. D.S.A. Wijesundara Participated at an International Symposiums on Wildlanka on 2019-09-02 at Water's Edge Hotel, Colombo.

- Prof. D.S.A. Wijesundara Participated at an International Conference on Association of Tropical Biology and Conservation - Asia Pacific Chapter 2019 from 2019-09-10 to 2019-09-15 at MAS Athena, Thulhiriya.

- Prof. D.S.A. Wijesundara Participated at a Workshop on Sri Lanka Australia Blue Carbon Technical on 2019-10-03 at Cinnamon Grand Hotel, Colombo.

- Prof. S.P. Benjamin Participated at an International Conference on 9th Bonn Humboldt Award Winners' Forum ''Frontiers in Biogeography, Ecology, Anthropology and Evolution. Humboldt and the 'Cosmos' revisited in the 21st century'' from 2019-10-16 to 2019-10-20 at Bonn, Germany.

- Prof. J.M.N. Marikkar Participated at a National Symposiums on Sixth Undergraduate Research Symposium, Wayamba University of Sri Lanka on 2019-12-10 at Auditorium of the Faculty of Livestock, Fisheries & Nutrition.

- Prof. N.D. Subasinghe Participated at a National Programme on Development of Biodiversity Ecosystem Services Indicators and Guidelines from 2018-10-14 to 2019-12-31 at Colombo.

- Miss. T.K. Bowange, and Ms. R. Premathilaka Participated at an International Workshop on *Agilent chromatography, mass spec and spectroscopy seminar* on 2020-01-07 at Hotel Hilton, Colombo..

Dissemination of Science

Conferences & Workshops:

- National Workshop: *"Lichens in the Asia Pacific Region- their components, diversity and conservation"* was organized by the Prof.Siril.Wijesundara, Dr. Gothamie Weerakoon , and SEDU for the Scientific Community at the Botanical Gardens Kandy from 2019-09-16 to 2019-09-20 with 20 participants.
  Resource Persons: Prof. D.S.A. Wijesundara**,** and Dr. Gothamie Weerakoon .

- *"Annual Research Review 2018"* was organized by the Science Education and Dissemination Unit for the Scientific Community at the NIFS Premises from 2019-03-28 to 2019-03-29 with 300 participants

- *"NIFS Young Scientists' Symposium on Multidisciplinary Research – 2019"* was organized by the NIFS Young Scientists for the Scientific Community at the Large Auditorium, NIFS on 2019-06-12 with 80 participants.

- *"Meeting on Kandy Lake Protection Research Experts Committee"* was organized by the SEDU, Prof.R.Weerasooriya for the Officials at the Small Auditorium,NIFS on 2019-09-05 with 25 participants.
  Resource Persons : Dr. S.K. Weragoda, Prof.E.I. L Silva, Prof.Sudhrama K. Yatigammana, Dr. Shameen Jinadasa, and Mr.Nuwan Gamage .

Speeches:

- Bopearachchi, D.P., and Benjamin, S.P. (2019). *Phylogeny and Conservation of Ballini Jumping spiders (Family -Salticidae) in Sri Lanka*. Poster, Indian Institute of Science (IISc), Bengaluru, India.
- Dissanayake, M.A.K.L. (2019). *Fascination of Physics*. Invited Speech, National Institute of Fundamental Studies.
- Dissanayake, M.A.K.L. (2019). *Mixed cation effect and iodide ion conductivity in electrolytes for dye sensitized solar cells*. Invited Speech, Jakarta, Indonesia.
- Dissanayake, M.A.K.L. (2019). *Mixed cation polymer electrolytes for efficiency enhancement in dye sensitized solar cell*. Invited Speech, University Kebangsaan, Malaysia.
- Dissanayake, M.A.K.L. (2019). *The role of "mixed cations" in electrolytes in dye sensitized solar cells*. Invited Speech, University of Jaffna, Sri Lanka.
- Dittus W.P.J. (2019). Love and hate in monkey society. The Explorer's Club. New York, NU, USA.
- Dittus W.P.J. (2019). Primate sociobiology and conservation. Conservation Research Center, Smithsonian Conservation Biology Institute, Front Royal, VA, USA.
- Ekanayake, S., and Kumara, R.K.G.K. (2019). *Bio - Products for Agricultural Productivity Improvement*. Special Lecture, Huruluwawa.
- Ekanayake, S., and Kumara, R.K.G.K. (2019). *Bio - Products for Agricultural Productivity Improvement*. Special Lecture, Hasalaka.
- Ekanayake, S., and Kumara, R.K.G.K. (2019). *Bio - Products for Agricultural Productivity Improvement*. Special Lecture, Galewella.

- Ekanayake, S., and Kumara, R.K.G.K. (2019). *Minimizing of Urea application by using Rhizobial Inoculants*. Special Lecture, Marassana.
- Ekanayake, S., and Kumara, R.K.G.K. (2019). *Minimizing of Urea application by using Rhizobial Inoculants*. Special Lecture, Dalpitia, Attabage.
- Ekanayake, S., and Kumara, R.K.G.K. (2019). *Rhizobial Inoculants for Grain Legumes*. Special Lecture, Huruluwawa.
- Kulasooriya, S.A. (2019). *Water quality and Human Health: Challenges Ahead*. Invited Speech, University of Peradeniya, Sri Lanka.
- Kumara, G.R.A. (2019). *Carbon electrodes for solar cells from graphite produced in Sri Lanka*. Invited Speech, SPD Laboratory, Japan.
- Kumara, G.R.A. (2019). *Renewable Energy*. Keynote, St. Anthony's Girls' College, Kandy.
- Kumara, G.R.A. (2019). *Research for Energy*. Keynote, Kingswood Collage, Kandy.
- Liyanage, R. (2019). *Scientific Research*. Invited Speech, Gothami Vidyalaya, Kandy.
- Liyanage, R. Demonstrators Rathnayaka, I., and Sewwandi, S.M.V.K. (2019). *Starch Production Technology - 6 hours lecture and practicals*. Special Lecture, National Institute of Fundamental Studies, Kandy.
- Magana-Arachchi, D.N. (2019). *Scientific Research*. Special Lecture, NIFS.
- Marikkar, J.M.N. (2019). *Proposed New Course for Diploma in Food Technology*. Special Lecture, Seminar room, INSIGHT Institute of Management & Technology, Naramala.
- Marikkar, J.M.N. (2019). *Research Proposal Writing and Writing a Paper for Journal Publication*. Special Lecture, Large Auditorium, NIFS.
- Senadeera, G.K.R. (2019). *Efficiency enhancement in dye sensitized solar cells by light scattering in photoanode with TiO2 nanotubes*. Invited Speech, Jakarta, Indonesia.
- Seneviratne, G (2019). *Use of Biofilm Biofertilizer as a solution for Agricultural issues*. Special Lecture, Polonnaruwa.
- Seneviratne, G. (2019). *Microbial biofilm engineering: a next-generation biotechnological application*. Keynote, Guangzhou, China.
- Seneviratne, G. (2019). *Reinstate Microbial Networks for Sustainability of Degraded Agroecosystems: a Microbial Biofilm Approach*. Invited Speech, Guangzhou, China.
- Seneweera, S. (2019). *Adapting to climate change to address the global nutrient security: What nanotechnology can offer*. Keynote, Australia.
- Subasinghe., N.D (2019). *Geothermal energy potential in Sri Lanka*. Plenary, Kothalawala Defence University, Colombo.
- Subasinghe, N.D. (2019). *Renewable Energy*. Invited Speech, Australian College of Business & Technology.
- Subasinghe, N.D. (2019). *Geothermal Energy - potential in Sri Lanka*. Invited Speech, BMICH - Colombo, Sri Lanka.
- Subasinghe, N.D. (2019). *What would happen if a meteoroid hits the Earth*. Invited Speech, Mahamaya College, Kandy.
- Wijesundara, D.S.A. (2019). *Biodiversity of Sri Lanka*. Special Lecture, NIFS-Popham Arboretum, Dambulla.
- Wijesundara, D.S.A**.** (2019). *Endemic and Threatened Plants of Sri Lanka*. Invited Speech, National Zoological gardens Auditorium.
- Wijesundara, D.S.A. (2019). *Floristic Composition of Mangroves in Sri Lanka*. Invited Speech, Cinnamon Grand hotel, Colombo.
- Wijesundara, D.S.A. (2019). *National Biodiversity Strategic Action Plan and success stories in Kandy District*. Invited Speech, at District Secretariat Auditorium, Kandy.
- Wijesundara, D.S.A. (2019). *Plant Distribution in Sri Lanka*. Invited Speech, Meteorology Department Auditorium, Colombo.
- Wijesundara, D.S.A. (2019). *Plant Taxonomy*. Special Lecture, Forest College Nuwara Eliya.

- Wijesundara, D.S.A**.** (2019). *Role of a Curator of Botanic Gardens*. Special Lecture, Royal Botanic Gardens, Peradeniya.
- Wijesundara, D.S.A. (2019). *Role of Botanic Gardens in Ex-situ Conservation*. Special Lecture, Royal Botanic Gardens, Peradeniya.
- Wijesundara, D.S.A. (2019). *The floral wealth of Sri Lanka*. Invited Speech, Oak Ray Hotel, Kandy.
- Wijesundara, D.S.A. (2019). *Wild Flowers of Sri Lanka*. Special Lecture, Dilly and Carlo Auditorium, Colombo.

Special lectures:

- *"Opportunities for graduate studentship and research collaboration with The University of Melbourne"* was organized by the Science Education and Dissemination Unit for the Scientific Community at the Large Auditorium,NIFS on 2019-12-20 with 29 participants. Resource Persons : Professor Frank Dunshea, Redmond Barry Distinguished Prof. & Chair of Ag. University of Melbourne.

- *"Playing Squash with Molecules -Investigating Heterogeneous Catalysis with Molecular Beams"* was organized by the Science Education Dissemination Unit, Prof. M.C.M. Iqbal for the Scientific Community at the Small Auditorium,NIFS on 2019-11-27 with 31 participants. Resource Persons : Dr.Tim Schäfer Göttingen University, Germany.

- *"Myths on Rainwater Harvesting and health issues: Global experiences"* was organized by the Science Education and Dissemination Unit for the Scientific Community at the Large Auditorium,NIFS on 2019-10-04 with 25 participants.
  Resource Persons: Prof.Jane Heyworth.

- *"Solar Energy Applications, Solar Village Project, and Key Advances in thin Film Solar Cell Development"* was organized by the SEDU under the guidance of Prof. M.A.K.L. Dissanayake for the Scientific Community at the NIFS Premises on 2019-08-30 with 25 participants. Resource Persons: Prof. I M Dharmadasa Senior Staff Grade Professor of Electronic Materials & Devices Sheffield Hallam University in the UK Head of the Electronic Materials & Sensors Research Group within the Materials and Engineering Research Institute.

- *"Fundamental Research: Challenges and Opportunities in a Developing Country"* was organized by the SEDU for the Scientific Community at the NIFS Premises on 2019-06-17 with 35 participants.
  Resource Persons: Dr. Keerthi Devendra, Director, KD Engineering Consultancy,UK.

- *"Do Genes Hijack and Play-hide-and-seek? Dissecting "Designer" Genes for Crop Improvement"* was organized by the Science Education and Dissemination Unit for the Scientific Community at the Large Auditorium,NIFS on 2019-04-26 with 39 participants. Resource Persons : Prof. Dilantha Fernando Dean Faculty of Science at the University of Manitoba.

- *"Importance of International Collaborative Work in Plant Science Research"* was organized by the SEDU for the Scientific Community at the Large Auditorium,NIFS on 2019-04-22 with 45 participants.
  Resource Persons : Prof.Naoki Hirotsu,Professor. Faculty of Life Sciences, Toyo University, Japan.

- *"Research Quality+; A Tool for Assessing Quality of Research"* was organized by the The National Academy of Sciences of Sri Lanka/NIFS, SEDU for the Scientific Community at the Small Auditorium,NIFS on 2019-04-18 with 12 participants.
  Resource Persons: Dr. Robert McLean, [International Development Research Centre (IDRC), Canada].

- *"Material Characterization"* was organized by the SEDU for the Scientific Community at the Small Auditorium,NIFS on 2019-04-04 with 10 participants.
  Resource Persons: Dr. Joshi Abhaya.

- *"Quantum Control of Electrons in Semiconductor Nanostructures for Advanced Electronics : A Historical Perspective"* was organized by the Science Education and Dissemination Unit, Prof. G.R.A. Kumara for the Scientific Community at the NIFS Premises on 2019-03-18 with 60 participants.
  Resource Persons : Prof. Hiroyuki Sakaki, President, Toyota Technological Institute.

- *"Publishing your research work in high impact journals"* was organized by the Science Education and Dissemination Unit for the Scientific Community at the NIFS Premises on 2019-02-26 with 60 participants.
  Resource Persons: Prof. Hetherington, A. Editor-in-chief of the Journal New Phytologist.

- *"Bio Accumulators"* was organized by the Science Education and Dissemination Unit for the Scientific Community at the NIFS Premises on 2019-02-13 with 17 participants.
  Resource Persons : Ms. Jeleo Oaha Coriha, Babes Bolyzi University Romania.

- *"Problem of Mass:The Most Baffling Issue in Physics"* was organized by the Science Education and Dissemination Unit for the Scientific Community at the NIFS Premises on 2019-01-30 with 72 participants.
  Resource Persons: Prof. K. Tennakone, Department of Physics, Georgia State University, USA.

Other Presentations:

- Thurairajah, A (2018). Isolation of fresh water cyanobacteria and screening their potential in nitrate reduction. Presentation, Wayamba University, Kuliyapitiya, Sri Lanka.

- *"Panel Discussion on Dr. Gamini Piyadasa's Anti-gravity paper "* was organized by the SEDU for the Scientific Community at the NIFS Premises on 2019-04-17 with 15 participants.
  Resource Persons : Dr. Gamini Piyadasa, and Prof. M.A.K.L. Dissanayake .

For school community:

- *46th School Science Programme 2019"* was organized by the Science Education and Dissemination Unit at the NIFS Premises from 2019-08-27 to 2019-08-29 for the School students (125 participants).

  Resource Persons : J.Edirisinghe, Dr. G. Bowatte, Prof. S. Seneweera, Prof. M.C.M. Iqbal, Prof. J. Bandara, and Prof. M.A.K.L. Dissanayake

  Research groups: Earth Resources and Renewable Energy lab,Bio Energy and Soil Ecosystems, Nanotechnology & Physics of Materials lab,Molecular Microbiology & Human Diseases lab,Natural Products Lab,Plant Taxonomy & Conservation Lab,Plant & Environmental science Lab,Condensed Matter Physics & Solid-State Chemistry Lab,Material Processing & Device

Fabrication Lab,Nutritional Biochemistry Lab, Evolution, Ecology and Biodiversity Lab,Environmental Science Programme Lab,Energy & Advance Material Chemistry lab,Microbial Biotechnology Lab.

Laboratory Visits:

- Undergraduate Students of Molecular biology and Plant Biotechnology University of Kelaniya visited to the NIFS to visit the Molecular Microbiology and Human Diseases laboratories on 2019-07-09.
  Resource Persons: Prof. D.N. Magana-Arachchi

- Technology Stream AL Students of Pushpadana Girls' College Kandy visited to the NIFS to visit the Plant and Environmental Science laboratories on 2019-11-27.
  Resource Persons: Prof. M.C.M. Iqbal

- Undergraduate students of Bachelor of Pharmacy University of Peradeniya visited to the NIFS to visit the Natural Products lab, Environmental Science Research Program lab laboratories on 2019-08-22.
  Resource Persons: Prof. R. Weerasooriya, and Prof. L. Jayasinghe

- Undergraduate students of Sri Jayawardane University visited to the NIFS to visit the Condensed Matter Physics & Solid State Chemistry Lab,Energy & Advance Material Chemistry Lab,Earth Resources and Renewable Energy lab laboratories on 2019-08-22.
  Resource Persons : Prof. M.A.K.L. Dissanayake, Prof. J. Bandara, and Prof. N.D. Subasinghe

- Royal International A/L School students visited to the NIFS to visit the Nutritional Biochemistry Project, Bioenergy and Soil Ecosystems, Material Processing & Device Fabrication, Earth Resources and renewable energy laboratories on 2019-07-30.
  Resource Persons: Dr. R. Liyanage, Dr. R.R. Ratnayake, Prof. G.R.A. Kumara, and Prof. N.D. Subasinghe

- Faculty of Agriculture (agriculture biology), University of Ruhuna visited to the NIFS to visit the Natural Products , Bioenergy and soil ecosystems, Microbial Biotechnology Project laboratories on 2019-07-09.
  Resource Persons : Prof. L. Jayasinghe, Prof. G. Seneviratne, and Dr. R.R. Ratnayake

- Undergraduate Students visited to the NIFS to visit the Nutritional Biochemistry, Molecular Microbiology and Human Diseases, Microbial Biotechnology laboratories on 2019-06-19.
  Resource Persons: Prof. M.A.K.L. Dissanayake, and Prof. D.N. Magana-Arachchi

- Department of Plant Sciences University of Colombo (Agro Biotechnology & Biotechnology Industry courses Students) visited to the NIFS to visit the Natural Products, Food Chemistry, Nutritional Bio chemistry laboratories on 2019-04-08.
  Resource Persons : Prof. L. Jayasinghe, Dr. R. Liyanage, and Prof. J.M.N. Marikkar

- 36 Undergraduate students of Science Faculty University of Peradeniya visited to the NIFS to visit the Rhizobium Project, Microbial Biotechnology laboratories on 2019-02-21.
  Resource Persons: Prof. G. Seneviratne, and Prof. S.A. Kulasooriya .

Exhibition stall:

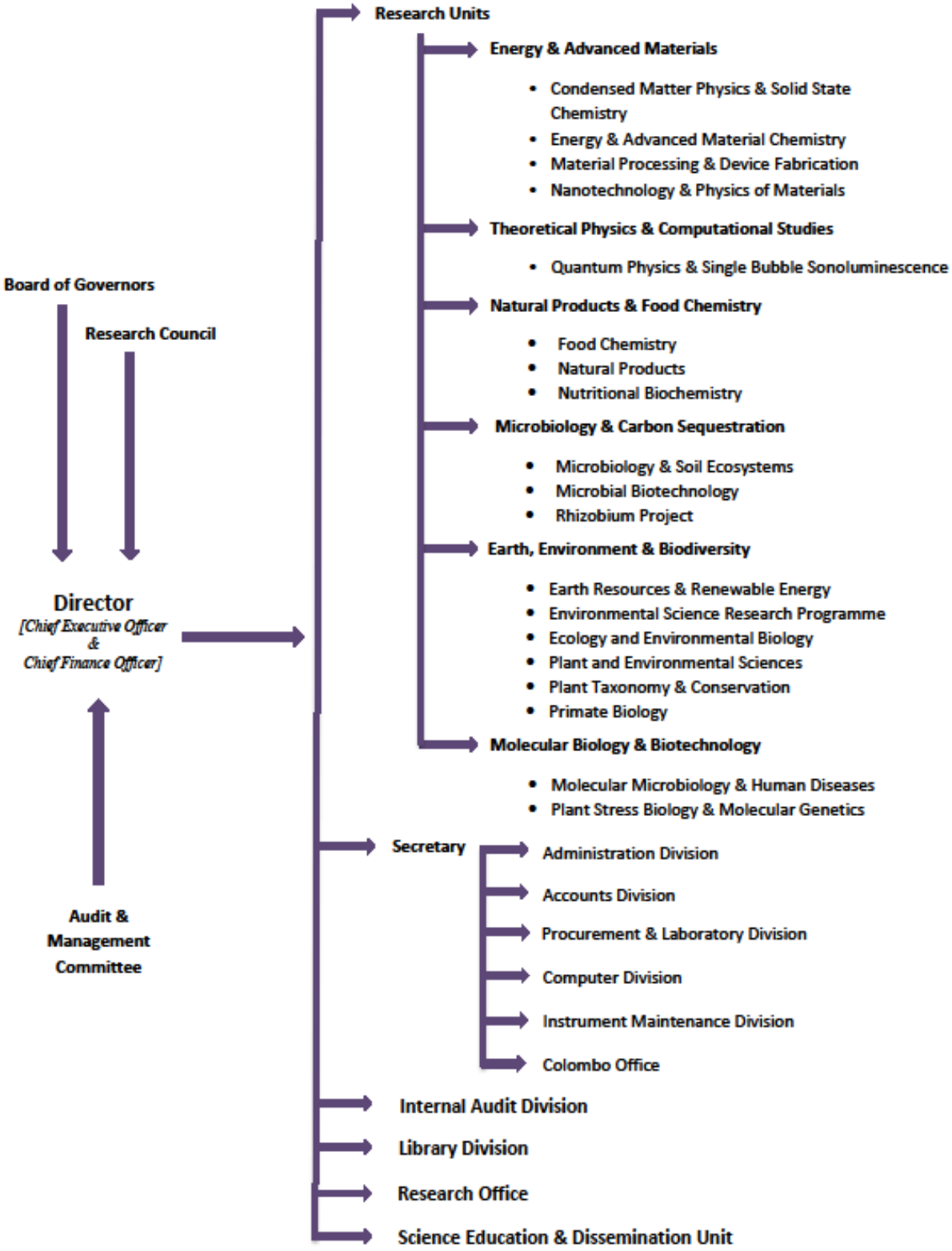
- NIFS had two stalls in National Exhibition *"Shilpasena -01" which* was organized by the Ministry of Science Technology and Research for the General Public at BMICH from 2019-07-18 to 2019-07-21 and *"Shilpasena -02" at* the Kaduruwela Sports Complex, Polonnaruwa from 2019-09-25 to 2019-09-29


NEW ENERGY

- *"OPEN DAY"* was organized by the National Institute of Fundamental Studies for the General Public at the NIFS Premises on 2019-03-29 with 485 participants.

SECTION 3- ORGANIZATION

ORGANIZATIONAL CHART



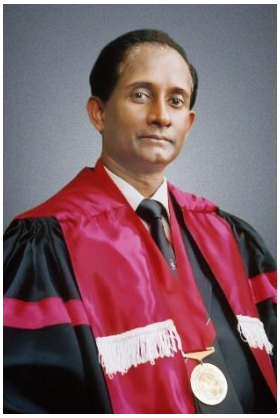
BOARD OF GOVERNORS 2019

Chairman

Prof. Janaka Bandara Ekanayake
Department of Electronic and Electrical Engineering
Faculty of Engineering
University of Peradeniya

(*Appointed by H.E the President)*

Members



Prof. Mohan De Silva,
Chairman/ University Grants Commission

(Ex-Officio member)

Prof. Saman Seneweera,
Director/ NIFS
(appointed on 4th June 2018)

(Ex-Officio member)

Vacant — The Advisor to the President on Scientific Affairs

Prof. Sarath G. Ilangantileke
(Member appointed by H.E the President)

Prof. Missaka P.B. Wijayagunawardane

(Member appointed by H.E the President)

Dr. Ravi Weerakoon

(Member appointed by H.E the President)

Prof. Upul B. Dissanayake

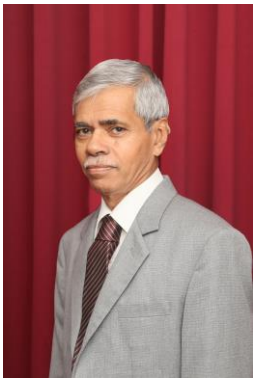
(Member appointed by the Minister)

Dr. A.D. Dharmapala

(Member appointed by the Minister)

Prof. Namal Priyantha,
Senior Professor
Department of Chemistry
University of Peradeniya

(Member elected by the Research Council)



Prof. M.C.M. Iqbal,
Associate Research Professor/NIFS

(Member elected by the Research Council)

Mr. J.M.U.P. Jayamaha,
Additional Director General
Dept. of Public Enterprises, Ministry of Finance

(Member appointed by the Treasury)

Dr. P.S.B. Wanduragala
Secretary to the Board of Governors/ NIFS

RESEARCH COUNCIL

Chairman

- Prof. Saman Seneweera, Director/ NIFS

Members

Appointed by H.E the President

- Prof. D.M.D. Yakandawala, Department of Botany, Faculty of Science, University of Peradeniya
- Prof. Ruwan Duminda Jayasinghe, Faculty of Dental Studies, University of Peradeniya

Nominated by the University Grant Commission

- Prof. H.M.D. Namal Priyantha, Department of Chemistry, Faculty of Science, University of Peradeniya
- Prof. R.L. Chandrajith, Department of Geology, Faculty of Science, University of Peradeniya
- Prof. G.K.R. Senadeera, Department of Physics, The Open University of Sri Lanka
- Prof. L.R. Jayasekara, Department of Botany, Faculty of Science, University of Kelaniya

Ex-Officio:

Senior Research Professors, Research Professors, Associate Research Professors & Senior Research Fellows of National Institute of Fundamental Studies

- Prof. A. Nanayakkara, Senior Research Professor
- Prof. J. Bandara, Senior Research Professor
- Prof. U.L.B. Jayasinghe, Senior Research Professor
- Prof. G. Seneviratne, Senior Research Professor
- Prof. M.A.K.L. Dissanayake, Research Professor
- Prof. D. S. A. Wijesundara, Research Professor
- Prof. G.R.A. Kumara, Research Professor
- Prof. R. Weerasooriya, Research Professor
- Prof. S.P. Benjamin, Associate Research Professor
- Prof. M.C.M. Iqbal, Associate Research Professor
- Prof. N.D. Subasinghe, Associate Research Professor
- Prof. D.N. Magana-Arachchi, Associate Research Professor
- Prof. N. Marikkar, Associate Research Professor
- Dr. R.R. Ratnayake, Senior Research Fellow

Elected by the Research Fellows of National Institute of Fundamental Studies

- Dr. H.W.M.A.C. Wijayasinghe
- Dr. R. Liyanage
- Dr. I.P.L. Jayaratne

Secretary to the Research Council

- Dr. P.S.B. Wanduragala

OFFICE OF THE DIRECTOR

Professor Saman Senaweera
Director, National Institute of Fundamental Studies (NIFS)

Dr. P.S.B. Wanduragala
Secretary to the Board of Governors (NIFS)

From left:
Standing: Ms. D.A.S.T. Ranawaka, Ms. K.B.J.B.K. Bandara, Ms. M.D.J. Kasthuri. Ms. O.W.K. Seneviratne, Ms. D.M.A.D.E. Liyanage, Mr. A.G.J.S. Bandara

Accounts Division

From left:

Seated Mrs. P.S.S. Samarakkody

Standing Mr. M.K.D. Keshan, Ms. P.H. Wijesuriya, Ms. R.M.V.P. Ratnayaka, Mr. B.J. Weerasooriya Mr. G. Ariyarathne, Ms. M.P.P. Guruge Ms. K.G.T. Pamukshi, Ms. M.K. Nissanka

Administration Division

From left:

1st raw: Mr. T.R. Peiris, Mr. H.A.D.N. Jayasinghe, Mr. M.A.G. Somananda, Mr. M.G.D.K. Malwewa, Mr. D.W.G.A.C. Dodamwela, Mr. P.G.N.S. Wijewardena, Mr. U.B.R.S. Udapitiya, Mr. K.G.T.B. Gunasekara, Mr. D.M.D.B. Dissanayake,

2nd raw: Mr. D.G.K. Dorakumbura, Mr. A.V.A.P. Kumara, Mr. A.G.S.T. Gunathilake, Mr. D.G. Gunathilake, Mr. K.A.S.D. Kuruppuarachchi, Ms. R.P.M. Weerasooriya, Ms. C.L.S. Illangakoon, Ms. C. Ranasinghe

Computer Division

From left: Mr. W.M.R.B. Weerakoon, Ms. S.S.K. Sakalasooriya

Instruments & Maintenance Division

From left: Mr. S.M.M. Hasun, Mr. M.N.B. Kulathunga, Mr. H.M.A.B. Herath

Internal Audit Division

Mr. W.M.I.U.B. Wijesinghe

Library

From left: Ms. T.C.P.K. Tilakaratne, Ms. R.M. Witharana

Procurement & Laboratory Stores Division

From left:

Standing: Ms. G.W.R.P. Chandrakanthi, Ms. H.M.T.L. Sumanarathne, Ms. P.R.I.M. Paliyawadana,

Seated : Ms. W.D.S.P. Perera

Research Office

From left:

Ms. T.P. Wijewickrama, Dr. S. Rajakaruna

Science Education & Dissemination Unit

From left:
Standing: Mr. G.C.K.S. Bandara, Mr. V.M. Ekanayake, Mr. S.M.C.V.B. Senevirathne, Ms. D. Seneviratne, H.M.G.N.N. Herath, Ms. K.I.K. Samarakoon,
Seated: Dr. C.T.K. Tilakaratne

NIFS STAFF LIST 2019

Director : Prof. S. Seneweera
Secretary : Dr. P.S.B. Waduragala

Research Staff

Senior Research Professors

Prof. J. M. S. Bandara
Prof. U. L. B. Jayasinghe
Prof. A. Nanayakkara
Prof. P. R. G. Seneviratne

Research Professors

Prof. M. A. K. L. Dissanayake
Prof. G. R. A. Kumara
Prof. R. Weerasooriya
Prof. D. S. A. Wijesundara

Associate Research Professors

Prof. S. P. Benjamin
Prof. M.C.M. Iqbal
Prof. D. N. Magana Arachchi
Prof. N. Marikkar
Prof. N. D. Subasinghe

Senior Research Fellows

Dr. R. R. Rathnayake

Research Fellows

Dr. N. L. B. R. Liyanage
Dr. I. P. L. Jayarathne
Dr. H. W. M. A. C. Wijayasinghe
Dr. Gayan Bowatte *(up to 12.03.2019)*

Visiting Research Professor

Prof. S.A. Kulasooriya
Prof. G.K.R. Senadeera
Prof. N.K.B. Adikaram
Prof. W.P.J. Dittus
Dr. Nalin Wijayawardhana
Dr. G. Bowatte

Visiting Associate Research Professor

Dr. M.S. Vithanage

Research Assistants

Bioenergy & Soil Ecosystems Research project

Ms. D.D.M.O. Dissanayake	Research Assistant Gr. II
Ms. S.D. Jayasekara	Research Assistant Gr. II (up to 23.08.2019)
Ms. S.K. Jayasekara	Research Assistant Gr. II (up to 01.11.2019)

Condensed Matter Physics & Solid State Chemistry Research project

Ms. J.M.K.W. Kumari	Research Assistant Gr. I
Mr. K. Umair	Research Assistant Gr. II

Earth Resources & Renewable Energy Research project

Mr. H.M.D.A.H. Bandara	Research Assistant Gr. II
Mr. N.B. Suriyaarachchi	Research Assistant Gr. II (up to 08.09.2019)

Energy & Advanced Material Chemistry Research project

Mr. A. M. K. L. Abeykoon	Research Assistant Gr. II (up to 21.04.2019)
Ms. M. A. Farhana	Research Assistant Gr. II

Environmental Science Research programme

Mr. B.A.Y.B. Jayawardena	Research Assistant Gr. II (up to 15.09.2019)
Ms. M.G.N. Perera	Research Assistant Gr. II (up to 03.08.2019)
Mrs. W.M.L.S. Weerasundara	Research Assistant Gr. II

Evolution, Ecology & Biodiversity Research project

Ms. Abira Sathkunanathan	Research Assistant Gr. II
Ms. Mathura Tharmarajan	Research Assistant Gr. II

Food Chemistry Research project

Ms. S.S.K. Marasinghe	Research Assistant Gr. II

Material Processing & Device Fabrication Research project

Ms. K. D. M. S. P. K. Kumarasinghe	Research Assistant Gr. I
Mr. P.N. Dissanayake	Research Assistant Gr. II

Microbial Biotechnology Research project

Ms. H.K.S.N.S. Gunarathne	Research Assistant Gr. II (up to 04.02.2019)
Ms. S.W. Meepegamage	Research Assistant Gr. II
Ms. A.T.D. Rathnathilake	Research Assistant Gr. II
Ms. S.M.N.K. Thilakaratne	Research Assistant Gr. II

Molecular Microbiology & Human Diseases Research project

Ms. E.M.U.A. Ekanayake	Research Assistant Gr. II (up to 15.11.2019)
Ms. D.G.S.N. Samarasinghe	Research Assistant Gr. II
Ms. M.A.Y.N. Weerasinghe	Research Assistant Gr. II (up to 31.01.2019)

Nanotechnology & Advanced Materials Research project

Mr. G.D.K. Heshan	Research Assistant Gr. II (up to 02.08.2019)

Natural Products Research project

Ms. H.S.T. Kaushalya	Research Assistant Gr. II

Nutritional Biochemistry Research project

Ms. F.A. Deen	Research Assistant Gr. II

Plant & Environmental Sciences Research project

Mr. D.M.R.E.A. Dissanayake	Research Assistant Gr. I
Ms. H.G.M.K. Karunaratne	Research Assistant Gr. II

Plant Taxonomy & Conservation Research project

Mr. P.L.C.U.S.B. Lekamge	Research Assistant Gr. II
Mr. H.D. Jayasinghe	Research Assistant Gr. II

Quantum Physics & Applied Electronics Research project

Mr. J. A.D.M.N. Jayakody	Research Assistant Gr. II (up to 14.02.2019)

Technical staff attached to Research Projects

Ms. D.M. Aluthpatabendi	Chief Technical Officer
Mr. N.P. Athukorale	Chief Technical Officer
Mr. D.S. Jayaweera	Chief Technical Officer
Mr. W.G. Jayasekara Banda	Chief Technical Officer
Mr. S. Opatha	Chief Technical Officer
Ms. R.K.C. Karunaratne	Chief Technical Officer
Mr. G.P.A.K. Pathirana	Chief Technical Officer
Ms. R.S.M. Perera	Chief Technical Officer
Ms. R.H.W.M.I.C. Ratnayake	Technical Officer Grade III

Office of the Director

Ms. M.D. Jeewa Kasthuri	Senior Personal Secretary to the Director
Ms. O.W.K. Seneviratne	Stenographer Gr. I
Ms. D.M.A.D.E. Liyanage	Management Assistant Gr. III
Mr. A.G.J.S. Bandara	Office Aid

Accounts Division

Ms. P.S.S. Samarakkody	Accountant
Ms. P.H. Wijesuriya	Accounts Officer
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Ms. M.P. Palliya Guruge	Senior Staff Assistant – Clerical
Ms. R.M.V.P. Rathnayake	Senior Staff Assistant – Clerical
Mr. G. Ariyaratne	Senior Staff Assistant – Store Keeping
Ms. T.P. Gamalath	Management Assistant Gr. III
Mr. M.K.D. Keshan	Management Assistant Gr. III
Mr. B.J. Weerasooriya	Management Assistant Gr. III
Mr. M.A.P. Perera	Office Machine Operator (up to 01.06.2019)

Administration Division

Mr. K.A.S.D. Kuruppuarachchi	Administrative Officer
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Ms. T.P. Wijewickrama	Senior Staff Assistant- Stenographer
Ms. C.L.S. Illangakoon	Senior Staff Assistant- Stenographer

Ms. C. Ranasinghe	Senior Staff Assistant- Receptionist
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Mr. A.G.S.T. Gunathilake	Management Assistant Gr. III
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Mr. H.A.D.N. Jayasinghe	Driver Gr. III
Mr. D.M.D.B. Dissanayake	Driver Gr. III
Mr. A.V.A.P. Kumara	Machinist – Special Grade
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Mr. M.A. Lal	Laboratory Attendant- Special Grade
Mr. R.B. Hapukotowa	Laboratory Attendant- Special Grade
Ms. D.R.T.L. Harischandra	Lapidarist Gr. III
Mr. T.R. Peiris	Electrician Gr. III
Mr. D.G.K. Dorakumbura	Mason - Special Grade
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Mr. D.W.G.A.C. Dodamwela	Primary level-unskilled
Mr. S.M.S. Hasun	Primary level-unskilled
Mr. P.G.N.S. Wijewardena	Primary level-unskilled

Computer Division

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Ms. S.S.K. Sakalasooriya	Chief Technical Officer

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Mr. H.M.A.B. Herath	Chief Technical Officer

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Ms. K.B.J.B.K. Bandara	Management Assistant

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Ms. R.M. Witharana	Library Assistant

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Ms. D.M.K.L. Kumari	Chief Technical Officer (up to 30.11.2019)
Ms. G.W.R.P. Chandrakanthi	Senior Staff Assistant- Stenographer
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Research Office

Dr. S. Rajakaruna	Scientific officer

Science Education & Dissemination Unit

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Ms. K.I.K. Samarakoon	Stenographer Gr. I
Mr. V.M. Ekanayake	Technical Officer Gr. III

Mr. G.C.K.S. Bandara	Technical Officer Gr. III
Ms. H.M.G.N.N. Herath	Management Asst. Gr. III
Mr. S.M.C.V.B. Senevirathne	Audio Visual Assistant

Rhizobium project Staff

Mr. E.M.H.G.S. Ekanayake	*Research & Development Officer*
Mr. R.K.G.K. Kumara	*Field Manager*
Mrs. A.H.M.C.D. Aberathne	*Technical Assistant*
Mr. A.H.M.A.K. Tennakoon	*Technical Assistant*

Grant Staff

Mr. C. Thotawatthage	*Junior Research Fellow*
Ms. S. Balasooriya	*Research Assistant*
Ms. S. Cabral de Mel	*Research Assistant*
Ms. D. Dissanayake	*Research Assistant*
Ms. H. Herath	*Research Assistant*
Mr. M. Kurera	*Research Assistant*
Mr. L. Manawadu	*Research Assistant*
Ms. P. Madamarandawala	*Research Assistant*
Ms. T. Paranavithana	*Research Assistant*
Ms. M. Rajapaksha	*Research Assistant*
Mr. S. Senuthuran	*Research Assistant*
Ms. T. Senevirathna	*Research Assistant*
Mr. S.A.D.A.V. Sumithraarachchi	*Research Assistant*
Ms. C. Weerarathne	*Research Assistant*
Ms. N. Kanagaratnam	*Temporary Research Assistant*
Mr. N. Karunarathna	*Temporary Research Assistant*
Ms. H. Narampanawa	*Temporary Research Assistant*
MS. D. Bopearachchi	*Research student*
Ms. A. Perera	*Research Student*
Ms. H.M.S.K.H. Bandara	*Ph.D. Student (MRI)*
Mr. J. Thillainathan	*Ph.D. Student*

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National Institute of Fundamental Studies
Hantana Road
Kandy 20000
Sri Lanka

Tel. : +94 812 232 002
Fax : +94 812 232 131
E-mail : info@nifs.ac.lk

Colombo Office:
380/71,72
Bauddhaloka Mawatha
Colombo 7

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