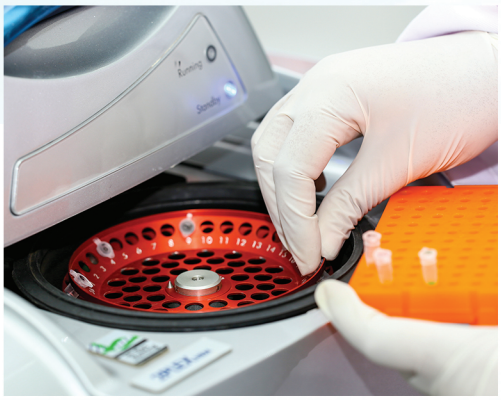
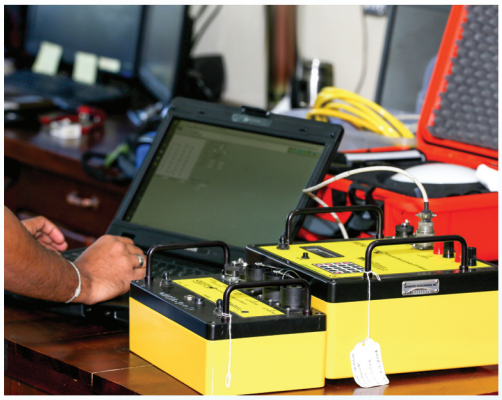
ANNUAL RESEARCH REVIEW 2018



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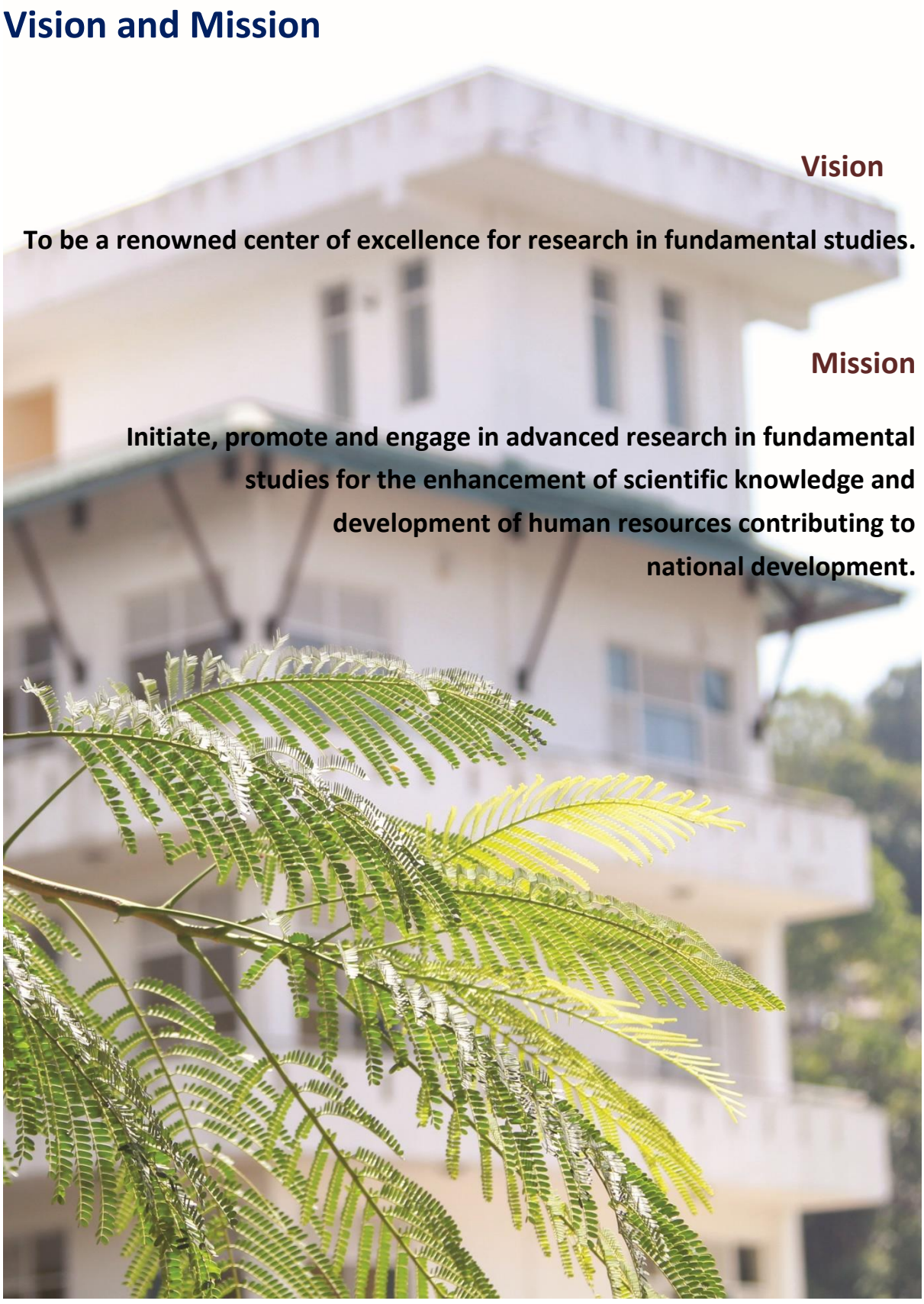
Vision and Mission



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.

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இலங்கை சனாதிபதி

President of Sri Lanka

Message

I am pleased to send this message on the occasion of the 2018 Annual Review of the National Institute of Fundamental Studies, Sri Lanka. I regard NIFS is an important national institute mandated to conduct scientific research on fundamental and advanced studies with emphasis on national development as well as for the advancement of science.

NIFS scientists are expected to engage in cutting edge research which will not only have an impact on Sri Lankan society but also on the advancement of scientific knowledge globally. I am glad to note that the institute has been mandated, from this year, to be the leading institute in the country to conduct research leading to the Blue-Green revolution - a concept close to my heart -by engaging in research on improving agricultural productivity, water quality, developing renewable energy resources, and new strategies to protect food quality and safety.

This institute was established and administered under the Presidential Secretariat from its inception in 1981 until 2010 with the objective of obtaining the services of the best scientists to solve problems of national importance while contributing to the advancement of scientific knowledge that supports and maintains our academic system.

There are many acute problems faced by the Sri Lankan people to date: chronic kidney disease, dengue, lack of clean water resources in rural communities, limited access to renewable energy resources, lack of food production at a national level, waste management, human animal conflict etc. All these issues can be addressed, only through the basic understanding of individual issues through fundamental research. NIFS has a major role to play in addressing such persistent national problems plaguing the country. It is my sincere hope that the scientists at NIFS are able to take on these massive challenges and come up with innovative solutions to alleviate the problems of our countrymen.

I wish all the scientists and staff of the NIFS every success during this annual review.

Maithripala Sirisena

March 21, 2019

Message from Hon. Sujeewa Senasinghe, Minister of Science, Technology and Research

I am indeed happy to contribute this message to the Annual Research Review 2018 of the National Institute of Fundamental Studies (NIFS). The NIFS is the only Research Institute in Sri Lanka engaged in basic and fundamental research, where curiosity driven research is possible. Scientists at NIFS have successfully engaged in undertaking such research.

Today, the economies of developed countries are mainly based on scientific innovations. Economic targets of a country can largely achieved through a dynamic and progressive education system that gears towards creating scientists from a very young age by instilling curiosity in their minds. A good example is wondering about the stars in the sky, to finding out the structure of matter. NIFS had initiated the school science program in the late eighties, and still continues to implement this programme and make a significant contribution for science education in the country. However, this has to be expanded to embrace the concept of Science, Technology and Mathamatics (STEM) education. Considering this, we at the Ministry have initiated programmes at a national and regional level to encourage our younger generations to shape their scientific talents by embarking on promotion of STEM education in collaboration with the Ministry of Education.

On the other hand, it is important that we encourage our young scientists to engage in research and contributes towards addressing societal issues. In this respect, the annual research review undertaken by scientists is an important initiative so as to guide them towards national priorities while providing support for them to engage in curiosity driven research. In fact, these bright minds should ideally be focusing on the natural sciences and thereby, perhaps be able to contribute to technology and entrepreneurship development in our country.

Similarly, being the beneficiaries of free education, the knowledge gained through the free education should be shared among the general public and the society at large. By providing adequate facilities for researches will definitely help Sri Lanka to reduce the rate of brain drain. The NIFS has the capacity to reverse this process by providing them with research opportunities on par with developed countries to work in Sri Lanka by providing international exposure and joint researches with internationally ranked universities and research institutes.

During my brief period as the Minister of Science, Technology and Research, we have been able to initiate many programmes to bring science to the people. The NIFS is immensely contributing to our efforts and I hope it will continue to do so in the future. I take this opportunity to convey my best wishes to the Director and the staff of the NIFS in conducting their Annual Review, which looks at their achievements critically and provides them with new scope for future research and innovation.

Message from the Chairman, Board of Governors

I am pleased to provide a message on the occasion of the 2018 Annual Review of the National Institute of Fundamental Studies (NIFS).

The NIFS is mandated to conduct research into fundamental studies in general, taken in the broadest sense, in the natural sciences, social sciences and philosophy.

The scientists of NIFS are renowned in their fields have a great deal of freedom in choosing their areas of work and research projects. They are expected to carry out research at the cutting edge of science or on projects which will have an impact on problems faced by the people of Sri Lanka.

The Annual Research Review should provide scientists with an opportunity to demonstrate the high quality of the work they have carried out and to highlight the impact their work has had on the citizens of Sri Lanka. Scientists agree that scientific research should be subjected to critical peer review and I hope the reviewers and scientists invited to the review will critically analyse the work, identify any deficiencies or shortcomings and make suggestions on improving it while being lavish with praise where it is due. It is only through critical thinking and encouragement that science can flourish.

Although I have been Chairman only for a few months beginning this year, I am well aware of the impact the work of our scientists is having, the contribution that NIFS makes on popularizing science, particularly among school children and the support provided by the technical and administrative staff in ensuring the smooth operation of the Institute.

I wish the Annual Review all success with the hope it will lead to a sharpened focus on good science and the achievement of results that can potentially have a high impact. It should hopefully result in identifying new areas of work which would project the image of the Institute as the leading institution in the country engaged in basic research and the calibre of its scientists.

Vijaya Kumar, *D.Phil. (Oxon.)*

Chairman, Board of Governors, NIFS.
Immediate Past President, National Academy of Sciences, Sri Lanka.
Professor Emeritus, University of Peradeniya, Sri Lanka

Message from the Director

It is with immense pleasure I write this message on the occasion of the 2018 Annual Review of the National Institute of Fundamental Studies (NIFS), Kandy.

During the past year, NIFS has seen many changes including the appointment of a new Director and new staff. Currently, we have 19 scientists, 29 research assistants and 64 non- academic and supporting staff at our institute. Our scientists are engaged in cutting edge research and have published 73 papers in international and local journals, attended 30 international and 35 national conferences. They have also attracted funding to the tune of Rs. 32.12 million. Our scientists have formed strong collaborations and networks both nationally and internationally. We currently have collaborations with the Ruhuna University, Peradeniya University, and Colombo University nationally with agendas to set up collaborations with national institutes in the following years through the provision of adjunct professorships to raise our research calibre. We collaborate with many international universities and institutions around the world to share and strengthen our research activities.

Over the last four decades, NIFS has trained many MSc and PhD students, with a focus on fostering research and leadership in our young graduate scientists through its six research areas under 16 thematic units and has received recognition nationally and internationally. Currently, we have 100 postgraduate students working on various research areas including theoretical physics, particle chemistry, biotechnology and molecular biology. Through our efforts, we have been able to obtain 3 scholarships from the University of Southern Queensland, Australia to engage in national research based at NIFS.

I am excited to take on the challenge of finding new ways to make this great Institute even better. In particular, I would like to focus on enhancing research collaboration and promoting graduate education. To this effect, we conducted our first ever 3 Minute Thesis presentation for our undergraduate and post graduate students to present their research in layman terms. This was an astounding success and provided a much-needed platform for our young scientists to improve their presentation skills. We also conducted various seminars and workshops to provide a dynamic working and learning environment for our students. The Young Researchers Forum, welfare, entertainment and spiritual programs run by the Welfare Association and the student run magazine have been other ways through which we foster a sense of belonging for our undergraduate and postgraduate students.
The purpose of research is not only to explore for new knowledge, but is a process for knowledge dissemination. To foster this way of thinking amongst school students, NIFS conducted its 45th School Science Program in August 2018 under the leadership of the Science and Dissemination Unit (SEDU). Students who obtained 10 distinctions in their 'O' Level examinations from all around the island participated in the program and had the opportunity to listen to presentations by scientists, use state of the art equipment and view the work conducted in our labs.

Our scientists have also regularly written articles in national newspapers and presented interviews in all leading television channels further disseminating their research findings to the wider public. Further, scientists at NIFS also focus on addressing burning national issues like, human animal conflicts, chronic kidney disease, food and nutrient security, water quality etc.
NIFS is on a fascinating path of growth and development in the coming years and I wish all the staff the very best during the annual review and in the future.

Prof Saman Seneweera/Director, NIFS

Contents

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Research Units

ENERGY & ADVANCED MATERIALS RESEARCH UNIT

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

THEORETICAL PHYSICS & COMPUTATIONAL STUDIES RESEARCH UNIT

Quantum Physics & Applied Electronics

NATURAL PRODUCT & FOOD CHEMISTRY RESEARCH UNIT

Food Chemistry
Natural Products
Nutritional Biochemistry

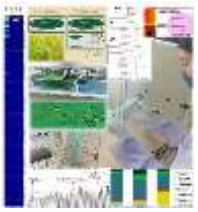
MICROBIOLOGY & CARBON SEQUESTRATION RESEARCH UNIT

Bioenergy & Soil Ecosystems
Rhizobium Project
Microbial Biotechnology

EARTH, ENVIRONMENT & BIODIVERSITY RESEARCH UNIT

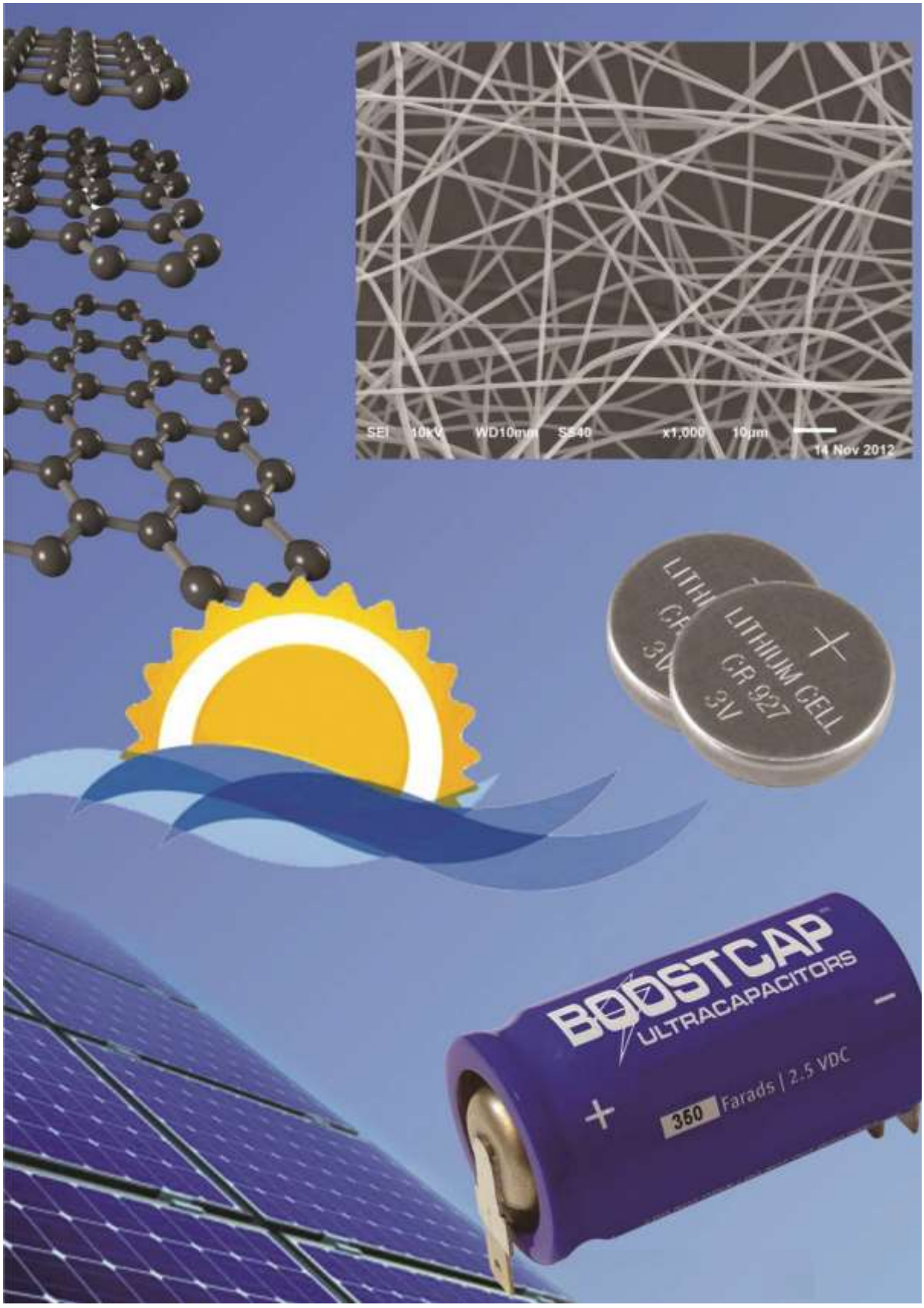
Earth Resources and Renewable Energy
Environmental Science research Programme
Evolution, Ecology & Environmental Biology
Plant & Environmental Sciences
Plant Taxonomy & Conservation
Primate Biology

MOLECULAR BIOLOGY & BIOTECHNOLOGY RESEARCH UNIT



Molecular Microbiology & Human Diseases
Medical Entomology
Plant Stress Biology & Molecular Genetics

Project Leaders are responsible for authenticity of reports they have submitted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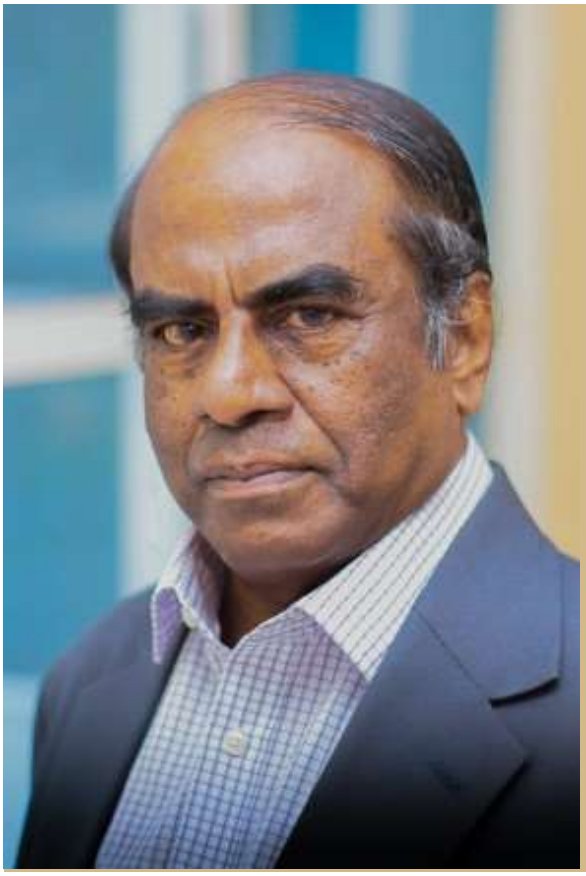
Energy & Advanced Materials

Energy and Advanced Materials project 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: Condensed Matter Physics and Solid State Chemistry project mainly deals with synthesis and characterization of novel polymeric electrolytes for dye sensitized solar cells, rechargeable batteries and electrochromic display devices. Nanotechnology and Advanced Materials project covers target oriented fundamental and advanced investigations leading to the development of Sri Lankan minerals and related materials for nano-technological and advanced materials based applications.

Energy and Advanced Materials Chemistry project focuses on chemistry and physics of novel materials for the conversion of solar energy into chemical and electrical energies. Material Processing and Device Fabrication project involves experimentation and basic studies in Materials Processing and Device Fabrication with 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. Lakshman 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), Committee of Vice Chancellors' & Directors' (CVCD) Award (2010) for research excellence and "Vidya Nidhi" National Award (2005). Former Director of the Postgraduate Institute of Science and Senior Professor of Physics at University of Peradeniya. Visiting Professor, University of Illinois at Chicago (2009), University of Oklahoma, USA (1994), University of Aberdeen, UK (1993), Visiting Postdoctoral Fellow, Chalmers University of Technology, Sweden (1985-2018).

Title: Research Professor

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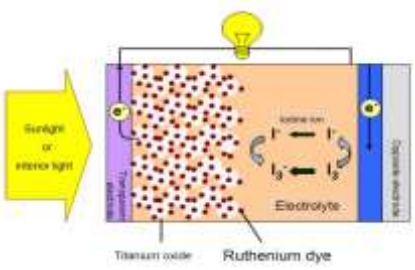
Condensed Matter Physics & Solid State Chemistry

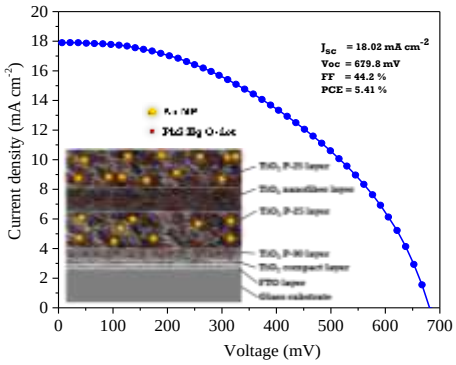
Condensed Matter Physics & Solid State Chemistry project at NIFS focuses on the synthesis and characterization of technologically important novel solid state and quasi-solid state (gel) materials and in particular on developing novel materials and devices for energy generation and utilization. During 2018, the group has carried out several sub-projects on enhancing the efficiency of dye sensitized and quantum dot sensitized, nanostructured titanium dioxide (TiO_2) based solar cells by developing novel, Nano structurally modified TiO_2 photoanodes, enhancing the photocurrent by plasmonic effect, using semiconductor quantum dots in place of the sensitizing dye and developing quasi-solid redox electrolytes incorporating polymer nanofibers. (a) Plasmon enhanced, PbS:Hg quantum dot sensitized solar cells with triple layer TiO_2 photoanode, (b) High efficiency plasmonic dye-sensitized solar cells with silver nanowires and TiO_2 nanofibers incorporated multi-layered photoanode, (c) Characterization of poly (vinylidene fluoride-co-hexafluoropropylene)(PVdF-HFP) nanofiber membrane based quasi solid electrolytes and their application in dye sensitized solar cells and (d) Efficiency enhancement in dye sensitized solar cells fabricated with $AlCl_3$ treated, SnO_2 based nanoparticle/nanofiber/nanoparticle triple layered photoanode.



Schematic diagram of a dye-sensitized solar cell

Plasmon enhanced, PbS:Hg quantum dot sensitized solar cells with triple layer TiO_2 photoanode

Quantum dot-sensitized solar cells (QDSCs) have attracted extensive attention recently and become promising candidates for the cost – efficient energy conversion applications due to the unique optical and electrical properties of semiconductor quantum dots. Plasmonic gold nanoparticle incorporated Hg – doped PbS quantum dot-sensitized solar cells (QDSSCs) were fabricated using successive ionic layer adsorption and reaction (SILAR) method with TiO_2 triple layer photoanode nanostructures and characterized by optical and electrical characterization techniques. This nanostructure was fabricated by using a TiO_2 nanofiber (NF) layer sandwiched between two TiO_2 nanoparticle (NP) layers in order to enhance light harvesting through effective light scattering process. Plasmonic enhanced QDSSC showed a better efficiency of 5.41 % with an open-circuit voltage of 679.8 mV and a short-circuit current density of 18.02 mA cm^{-2}.

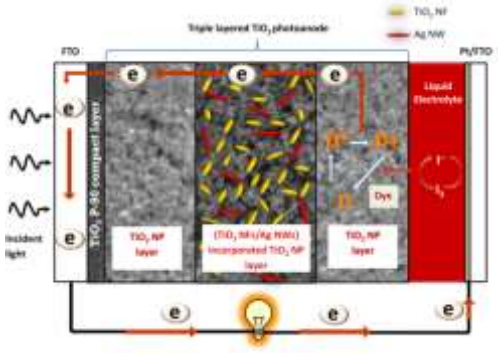


Short circuit Current density vs Open Circuit Voltage

Photocurrent density and overall efficiency of the QDSSC were enhanced by 38.8 % and 15.8 %. The enhanced efficiency of the Quantum dot – sensitized solar cells appears to be due to enhanced light harvesting due to the triple layer photoanode and improved photoelectron generation due to the localized surface plasmon resonance (LSPR) effect of the plasmonic gold nanoparticles.

High efficiency plasmonic dye-sensitized solar cells with silver nanowires and TiO_2 nanofibers incorporated multi-layered photoanode

The effect of incorporating silver nanowires (Ag NWs) and TiO_2 nanofibers (NFs) into a tri-layer photoanode of dye sensitized solar cells (DSSCs) has been investigated. Ag NWs with diameter 60-90 nm and length of 1-2 µm were synthesized via polyol reduction method. TiO_2 nanofibers (NFs) with diameter 80-120 nm were prepared by electrospinning. The DSSC with tri-layer photoanode made with a composite of TiO_2 P25, Ag NWs and TiO_2 NFs sandwiched between two TiO_2 P25 layers exhibited a power conversion efficiency of 9.74% and open circuit voltage (V_{oc}), short circuit current density (J_{sc}) and fill factor (*FF*) of 727.4 mV, 19.8 mA cm^{-2} and 67.6% respectively under irradiance of 100 mW cm^{-2}. The efficiency of the reference DSSC with TiO_2 P25/P25/P25 tri-layer photoanode of the same thickness was found to be 6.69%.



TiO_2 nanofibers and silver nanowires incorporated multi-layered photoanode

The efficiency enhancement of the DSSC with Ag NWs and TiO_2 NF incorporated composite, tri-layer photoanode compared to the reference DSSC is 45.6%. This is evidently due to the enhancement in short-circuit photocurrent density (J_{sc}) by (a) localized surface plasmon resonance effect by Ag NWs and (b) increased light harvesting by multiple scattering events by the presence of TiO_2 NFs.

PVdF-HFP nanofiber membrane based quasi solid electrolytes for dye sensitized solar cells

A quasi-solid state (gel) electrolyte has been formed by incorporating a liquid electrolyte made with KI dissolved in ethylene carbonate (EC) and propylene carbonate (PC) in poly (vinylidene fluoride-hexafluoropropylene) (PVdF-HFP) co-polymer nanofiber membrane prepared by electrospinning. SEM images of the electrolyte membrane showed the formation of a three-dimensional network of polymer nanofibers with diameters between 100-300 nm and average membrane thickness of 14 µm. DSC thermograms revealed that the crystallinity of the PVdF-HFP nanofiber is 14% lower than that of the pure PVdF-HFP polymer. The DSSCs fabricated with nanofiber based gel electrolyte showed an energy conversion efficiency of 5.36% under 1.5 AM solar irradiation, whereas the efficiency of the DSSC made with the liquid electrolyte based cell was 6.01 %. This shows the possibility of replacing the liquid electrolyte in DSSCs by electro-spun polymer nanofiber based gel electrolyte and thereby minimizing some major drawbacks associated with liquid electrolyte based solar cells while maintaining reasonably high conversion efficiency.

M.Phil. & PhD. Students

Mr. C.A. Thotawatthage (NIFS RA) completed the Ph.D. in June, 2018
Mr. A.M.J.S. Weerasinghe (NIFS RA) completed the M.Phil. in December, 2017
Mr. T. Jaseetharan: Ph.D. student
Mr. S. Senthuran: Ph.D. Student
Ms. J.M.K. W. Kumari: Ph.D. student (NIFS RA)
Mr. K. Umair: M.Phil. student (NIFS RA)

Key publications

A novel, PbS: Hg quantum dot-sensitized, highly efficient solar cell structure with triple layered TiO_2 photoanode, MAKL Dissanayake, T Jaseetharan, GKR Senadeera, CA Thotawatthage Electrochimica Acta (2018) 269, 172-179

Characterization of poly (vinylidene fluoride-co-hexafluoropropylene) (PVdF-HFP) nanofiber membrane based quasi solid electrolytes and their application in a dye sensitized solar cells. T MWJ Bandara, AJMS Weerasinghe, MAKL Dissanayake, GKR Senadeera, M Furlani, Electrochimica Acta (2018)266, 276-283

A five-fold efficiency enhancement in dye sensitized solar cells fabricated with $AlCl_3$ treated, SnO_2 nanoparticle / nanofiber/ nanoparticle triple layered photoanode;
G.K.R. Senadeera, M.A.K.L. Dissanayake, A.J.M.S. Weerasinghe,
Journal of Applied Electrochemistry (2018) 48:1255–1264

From left:(standing) Ms. R. Farhath, Ms. K.W. Kumari, Mr. T. Jaseetharan
(seating) Mr. K. Umair, Prof. M.A.K.L. Dissanayake, Mr. C.A. Thotawatthage, Prof. G.K.R. Senadeera

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 2017, SUSRED award by NSF 2018.

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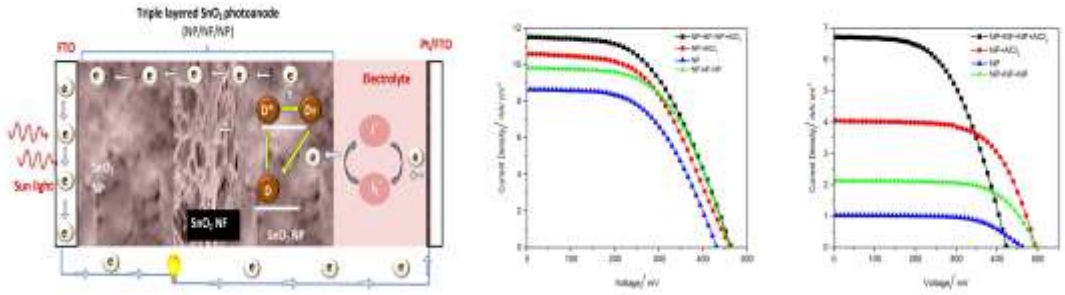
Efficiency enhancement in dye sensitized solar cells fabricated with $AlCl_3$ treated, SnO_2 triple layered photoanode

The use of electrospun nanofibers of SnO_2 in triple layered photoanode with $AlCl_3$ treatment towards the efficiency enhancement in dye sensitized solar cells(DSSC) is revealed. More than fivefold enhancement in overall conversion efficiency can be achieved by incooperation of this novel photoanode in SnO_2 based DSSCs with the optimized thickness of the nanofiber layer. Interconnected network type structure of SnO_2 nanofibers is observed using scanning electron microscopy (SEM). Enhanced light scattering due to the incorporation of nanofiber layer in the photoanode might be the major reason for this efficiency enhancement as reflected from the increase in the photo current density. EIS measurements on both the conventional and novel photoanode reveal that, the series resistance of the DSSC can be reduced by employing this novel triple layered photoanode in these DSSCs. The observed higher electron lifetime from Blode plots revealed that electron recombination is lower in the DSSCs with this photoanode. DSSCs fabricated with the conventional nanoparticle single layered photoanode sensitized by Indoline and Eosin-Y dyes showed 0.3% and 2.02% efficiencies respectively under the irradiance of 100 mW cm^{-2} (AM 1.5), while devices with triple layered photoanodes showed 1.55% and 2.73% efficiencies respectively under the same conditions.



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Chathuranga Asela Thotawatthage

Chathuranga Thotawatthage is currently a Junior Research Fellow attached to the Molecular Microbiology & Human Diseases Project at National Institute of Fundamental Studies (NIFS). He received his B.Sc degree from the University of Peradeniya in 2007 and joined NIFS the same year. He completed his M.Sc. (2014) and Ph.D. (2018) from PGIS. His research focuses on ''Microbiology and chemistry of particulate matter in the stratosphere at different elevations above Central Sri Lanka" investigating stratosphere up to 50km above Sri Lanka. Additionally, his research interest also include renewable energy and solar cells.

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Kalpani Wasana Kumari

Kalpani Wasana Kumari is currently a Research Assistant (Ph.D.) 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 joined NIFS in 2013. Her research focuses on dye/quantum dot sensitized solar cells. Her research interests includes polymers, conducting polymer-based electrolytes, graphite-based nanomaterials and counter electrodes for solar cells.

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Sivasubramaniam Senthuran

Sivasubramaniam Senthuran is currently an M.Phil student with the Condensed Matter Physics and Solid State Chemistry group at National Institute of Fundamental Studies (NIFS). 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. He joined NIFS in 2018. His research mainly focuses on photoanode modification for Dye-Sensitized Solar Cells. His research interests includes numerical simulation of nanophotonics for solar cell applications, and energy storage devices.

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Umair Khaleelullah

Umair Khaleelullah is currently a M.Phil Research Assistant with the Condensed Matter Physics and Solid State Chemistry project in 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 Cell by developing novel electrolytes and novel photo anodes. His research interests include Polymer electrolytes, Conducting polymers and Nano-fillers.

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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 Postgraduate Institute of Science, University of Peradeniya in 2015 and joined NIFS in 2016. His research focuses on Semiconductor quantum dots for solar cells and Infrared detectors. His research interests include colloidal quantum dots, polymer-based gel & solid electrolytes for photovoltaic application and IR detectors.

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Jayasundera Bandara

Jayasundera Bandara, is a Senior Research Professor in NIFS, since 2015 to date. He was a Research Professor (2009-2015), Senior Research Fellow (2005-2008), Research Fellow (1999-2004) at NIFS. His research is focused in novel materials and nanostructures for application in dye/q-dot sensitized solar cells and solar fuels production. He has 83 research publications in SCI journals (5049 citations, h-index 36). He was honored by an 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-October, 2014), Turkey; Humboldt Fellowship (July-September 2016), Max-Plank institute, Awards: Young Scientist Award, NASTEC (2005), Presidential Awards (2000-2016);.CAS resident's international fellowship initiative (pifi) award (2017-2018), Chinese Academy of science, China.

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Energy & Advanced Material Chemsitry

The main objective of the Energy & Advanced Material Chemistry project is to carry out research on renewable energy and specifically our research is focused on the chemistry and physics of new materials for the conversion of solar energy into chemical and electrical energies. Under the broad theme of solar energy conversion into useful energy, the project has several sub-projects such as photocatalysis/catalysis, solar cell and environment remediation. In the photocatalysis project, we construct artificial chemical devices mimicking photosynthesis to collect, direct, and apply solar radiation, for example to split water, convert atmospheric carbon dioxide and thus produce various forms of environmentally clean fuels. Our research is mainly focused on the production of hydrogen by water splitting reaction where hydrogen is considered to be the future energy source. Also, water splitting reaction is still one of the unresolved problems in physical chemistry and we are trying to understand how an electromagnetic energy be efficiently converted to chemical energy i.e. can water be efficiently split in to hydrogen and oxygen using solar energy? Can we convert CO_2 into useful chemicals? 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.

In the research topics of conversion of solar energy into electrical energy, our research is mainly focused on the understanding and improvement 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 is being 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.

Hydrogen production by water splitting reaction

Harvesting of waste energy is one of the most promising technologies to address the contemporary energy shortage. The basic concept in waste energy harvesting technology is the conversion of waste energy such as heat, vibrational energy and mechanical energy into a useable form of energy such as electrical energy or chemical energy. Recently, there is a keen interest on the use of piezoelectric materials in harvesting waste energy and the use of the piezoelectric properties of piezoelectric materials is a very promising alternative energy harvesting method. Though the piezoelectric effects have been applied in piezoelectric nanogenerators optoelectronics, sensors, piezoelectric transducers, transparent conductor and nanogenerators successfully, it has not been exploited fully in catalysis/photocatalysis to produce chemical energy such as hydrogen due to the lack of suitable piezoelectric materials.

As the generation as well as the separation of charges in piezoelectric materials are highly controlled by the dielectric capacity, crystal structure as well as the electronic states of the material and also depends on the reaction medium, finding an appropriate piezoelectric material for piezocatalytic applications is an uphill task. Potassium niobate ($KNbO_3$) and sodium niobate ($NaNbO_3$) gained much interest in piezoelectric materials in harvesting waste energy especially in piezotronic devices. Pervoskite potassium niobate ($KNbO_3$) that exhibits unique physicochemical properties in acoustic-optics, electro-optic, nonlinear optic, and piezoelectrics and is a good lead-free piezoelectric material for piezoelectric application owing to its excellent piezoelectric properties.

Despite their excellent piezoelectric properties, the piezocatalytic activity of $KNbO_3$ is found to be poor. In Piezocatalysis, the presence of free charges in these materials is essential to induce the piezocatalytic activity and it has been demonstrated that the intrinsic charge carrier density but not the piezoelectric charges in piezoelectric crystallites is the key factor in charge transfer in the piezocatalysis process. Hence piezocatalytic process can be enhanced by regulating the concentration of charge carriers by using narrow band gap semiconductors or defect doping. If free charge carriers are present due to defects in these materials, they can be effectively separated under the influence of piezoelectric potential generated under stress and could involve redox reactions. In this investigation, we synthesized the piezoelectric $KNbO_3$ by modified solid-state reaction and enhanced the free charge carrier in piezoelectric $KNbO_3$ by introducing a large number of oxygen vacancies and demonstrated the excellent piezocatalytic activity of $KNbO_3$ by harnessing waste energy to produce H_2.

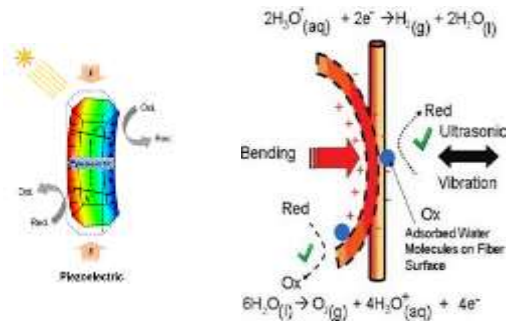

Figure 1. Schematic understanding of free carrier reorganization and photo-excited carrier separation in piezoelectric materials under the influence of piezoelectric [mechanical force, F).

CZTS THIN FILM solar cell

Thin-film solar cells technology is one of the low cost solutions for expensive silicon solar cells. The kesterite-structured Cu_2ZnSnS_4 (CZTS) semiconductor has been considered as a promising light-harvesting material and a great progress on CZTS based solar cells has been achieved during the past few years. For the fabrication of CZTS solar cells, vacuum and non-vacuum deposition techniques have been reported. Among these methods, non-vacuum techniques such as spray pyrolysis, spin coating, and electrodeposition are widely being used owing to their simplicity and the low cost.

Figure 2: CZTS Solar Cell Device Structure and Process Direction

In this study, CZTS thin films were prepared on Florine doped tin oxide (FTO) by spray pyrolysis, spin coating, and electrodeposition methods and their properties were compared.

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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*

Superior solar-to-hydrogen energy conversion efficiency by visible light-driven hydrogen production via highly reduced Ti $^{2+}$/Ti $^{3+}$ states in a blue titanium dioxide photocatalyst, NL De Silva, ACA Jayasundera, A Folger, O Kasian, S Zhang, CF Yan, C. Scheu, J. Bandara, *Catalysis Science & Technology 8 (18), 4657-4664, 2018.*

Systematic stacking of PbS/CdS/CdSe multi-layered quantum dots for the enhancement of solar cell efficiency by harvesting wide solar spectrum, A Manjceevan, J Bandara Electrochimica Acta 271, 567-575, 2018.

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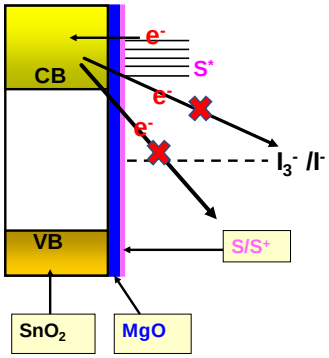
Material Processing & Device Fabrication

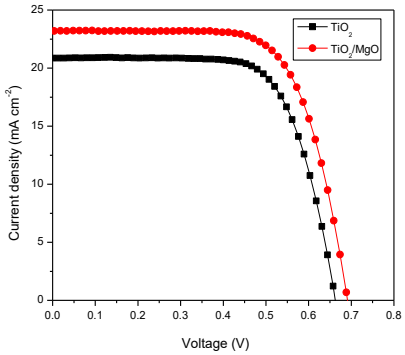
This project conducts experiments and basic studies in the areas of material processing and device fabrication, emphasizing on energy conversion and storage, attempting to utilize locally available raw materials, whenever possible. Coconut charcoal and graphite will be innovatively developed as electrodes for solar cells and supercapacitors. Exfoliation and purification of Sri Lankan graphite will be continued with view 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 objective would be to adopt an unconventional approach to compete with the international effort. Project will promote local and international collaboration and support student research achievement.

Highly Efficient Dye-Sensitized Solar Cells Made from Nanocrystalline TiO_2 Films Surface Modified with MgO

In this study, nanoporous TiO_2 photoanode was prepared by spray pyrolysis deposition on fluorine doped tin oxide (FTO) substrate which empowers the efficient absorption of dye molecules using its large surface area. However, recombination of dye cations and the injected electrons limits the conversion efficiency of DSCs. The extent of recombination mainly depends on the nature of TiO_2 surface, the structure and the mode of anchoring of the dye molecule to the TiO_2 surface. With the intention of suppressing electron recombination and improve the power conversion efficiency of DSCs, TiO_2 photoanode surface was covered with a thin layer of MgO by immersing TiO_2/FTO substrate in a magnesium acetate solution.

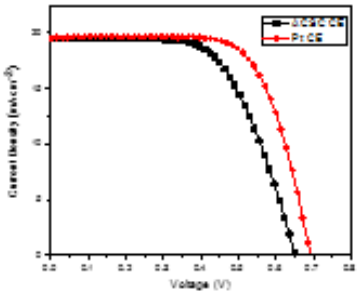


This ultra-thin MgO layer on TiO_2 surface, suppresses the recombination of injected electrons with the dye cation and electrolyte species. Power conversion efficiency was increased from 9.8% to 11.0% as a result of the blocking effect of MgO surface modification on TiO_2 photoanode



Coconut shell charcoal based counter electrode for a dye-sensitized solar cells

Cost of dye-sensitized solar cells depends mainly on the counter electrode material where the best catalyst for triiodide reduction at the counter electrode (CE) is platinum, which is highly expensive. Among various non-platinum counter electrode catalysts, carbon-based materials stand out to be the best alternative as far as low-cost and ready abundance are concerned. A simple procedure was used for producing high electrical conductive activated coconut shell charcoal (ACSC) and depositing it on FTO glass as a thin film, to be used as the counter electrode for dye-sensitized solar cells.



Performances of DSCs made from FTO-ACSC CE and usual FTO-Pt CE.

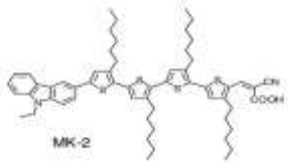
The efficiency of 7.85% obtained exceeds values obtained from other forms of activated carbon derived from bio-materials.

Evaluation of the solar cell parameters

Donor-π conjugated spacer-acceptor dye-sensitized solid-state solar cell using CuI as the hole-collector

Dye-sensitized Solid-state Solar cells (DSSCs) replace the liquid type electrolyte with p-type semiconductor to solve the practical problems associated with wet type solar cells. We have fabricated solid-state solar cells using copper iodide (CuI) as the hole conductor sensitized with alkyl-functionalized carbazole dye MK-2.

These TiO_2 based DSSC sensitized with MK-2 showed solar-to-electrical power conversion efficiency of 3.33 % under AM 1.5 simulated sunlight.



Molecular structure of MK-2 dye comprises of donor- π conjugated spacer –acceptor

The long alkyl chains act as a barrier for charge recombination and strong acceptance and donating ability of cyanoacrylic and carbozole group respectively absorb light in longer wavelength, increase the short circuit current density which contributes to enhancement of the power conversion efficiency of the cell.

Coconut shell Charcoal supercapacitors with sugar binder:

An issue with supercapacitor electrodes is the necessity of using binders to fix the carbon granules. The binder reduces the electrical conductivity of the material, resulting in energy loss. The project found a way of fabricating hard, binder free electrodes constituted entirely of carbon. The first step of the procedure is to incinerate coconut shells, under special conditions to produce activated charcoal, which is washed, dried, pulverized and sieved. Powders of mesh sizes are blended with a sugar solution and heated to a viscous consistency in a die to pyrolyse sugar.

Electrodes produced in this manner are hard and highly conducting and yielded a capacity of 110 F/g.

Performance evaluation of Supercapacitors

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Key publications:

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Ranasinghe, C.S.K., Jayaweera, E.N., Kumara, G.R.A., Rajapakse, R.M.G., Bandara, H.M.N., Yoshimura, M., (2015), Low-cost Dye-sensitized Solar Cells Based on Interconnected FTO-Activated Carbon Nanoparticulate Counter Electrode Showing High Efficiency, Journal of Materials Science and Engineering A. 5, 361-368.

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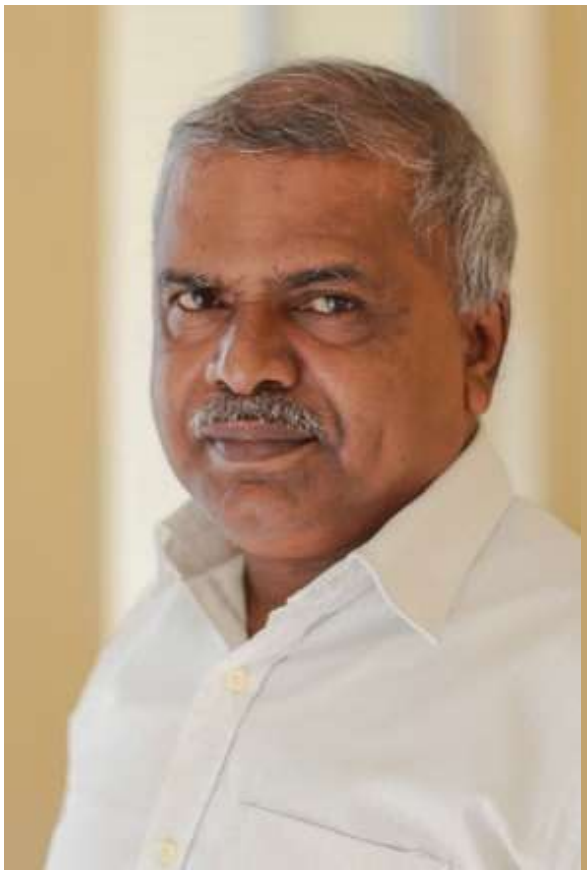

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Nanotechnology and Advanced Materials

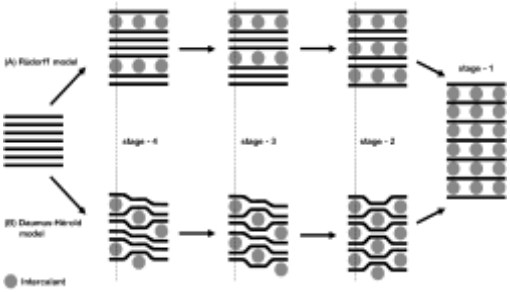
The emerging fields of Nanotechnology and Advanced Materials could easily be attributed to the most of the recent technological advancement and innovative applications. These technological applications are mostly dependent on material resources, specially acquired by upgrading minerals resources. Sri Lanka possess a variety of economically useful minerals and related materials, however, they are mostly exported as cheap raw materials without being subjected to proper value addition. A main reason for this unfortunate situation could be the dearth of advanced scientific research conducted in the country targeting higher value addition to our mineral resources.

Our research project at NIFS will seriously mind these factors inherent to our country, when adapting or contributing to these emerging fields of Nanotechnology and Advanced Materials. It is addressed here by emphasizing on performing target oriented fundamental and advanced scientific investigations leading to the development of Sri Lankan minerals and related materials for nano-technological and advanced industrial applications, such as energy storage, water purification, synthesis of nano-materials and highly upgraded raw materials for high-tech industrial applications. This project explores low-cost but performance enhanced advanced semiconducting materials by introducing novel nano-materials synthesis techniques for energy storage applications.

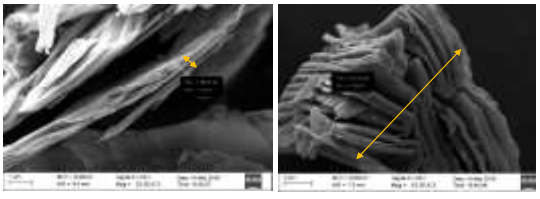
This project commenced its work in 2013 and its successful outcome has already resulted in three Sri Lankan Patents in 2018 and also attracted a number of research grants. Among them, the most prominent Research and Development grant (Rs. 49.8 Millions) was received from the General Treasury through the Cabinet Memorandum (No. 17/1907/ 16/038 on 2017-08-09) of the Government of Sri Lanka in 2018. ''National Battery material testing laboratory'' is now being established under our project at NIFS.

A. Study of ion intercalation in advanced materials derived from local minerals

Investigations on deriving advanced materials out of abundant Sri Lankan minerals having layered or other suitable crystalline structures for ion intercalation was carried out under this sub-project. The upgraded minerals are subjected to fundamental investigations on structural/surface modification in atomic/ nano scale in order to facilitate ion intercalation.



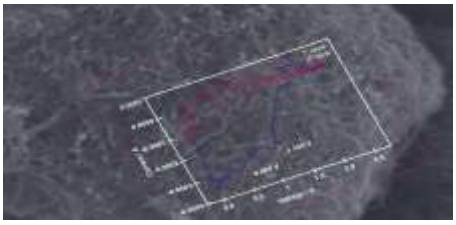
Some of the fundamental scientific aspects investigated/explored under this project are atomic/nano scale techniques and related mechanisms for structural/surface modification, ion intercalation/de intercalation and electrochemical behavior of these modified materials. The ultimate objective is to introduce efficient surface/structural modification techniques to develop performance enhanced Sri Lankan minerals for advanced energy conversion applications including rechargeable batteries.



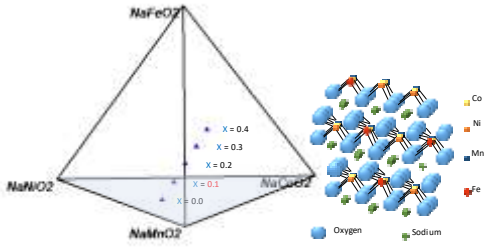
Already, investigation on intercalation/ de-intercalation of Li and Na ions to the Extended Graphite (EG) derived from Sri Lankan natural vein graphite and surface graphite has been started aiming for the anode application in Li-ion and Na-ion rechargeable batteries. The preliminary study showed promising results and further research is currently being conducted.

B. Study of mechanism and effect of dopents in advanced transition metal semiconductors

Primarily, the effect of the precursor on crystal growth in nano particle formation is investigated under this sub-project in order to understand the mechanisms controlling the morphology and size of the particles from micron to nano scales. The gained knowledge will be extended to prepare advanced transition metal semiconducting materials with appropriate particle size and morphology.



Further, more advanced and fundamental scientific investigations will be carried out to study the mechanism and the effect of dopents on electrical and electrochemical behavior of these transition metal semiconductors with the long term objective of developing performance enhanced transition metal semiconductors as the electrode material of electrochemical energy conversion applications, especially in rechargeable batteries.



$NaNi_{(0.4-x)}Mn_{0.4}Co_{0.2}Fe_xO_2 (0 \leq x \geq 0.4)$

Our recent investigation carried out on Na-Ni-Mn-Co oxides doped with cheaper dopents such as Fe has revealed the possibility of using these novel materials for the cathode application of Na-ion rechargeable batteries.

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

Sri Lankan vein graphite can be categorized into four structurally distinct morphological varieties and our preliminary investigations revealed that each of these varieties has inherited its own unique morphological behavior. Hence these distinctive morphological features could result in different characteristics and performance in the materials derived from these structurally different varieties of cheaper vein graphite.

Therefor this sub-project involves advanced scientific investigations to derive nano-materials having diverse characteristics and performance out of Sri Lankan vein graphite structural varieties. It has been further extended to fabricate vein graphite based nano-structured composites aiming for a diverse range of advanced industrial and nano-technological applications.

Ag/graphene nano-composite derived from Needle Platy vein graphite varitiy revealed its possibility to be developed into a potential antimicrobial agent. Further investigations are currently ongoing in deriving nano-graphene powder from all these four structural vein graphite varieties and fabricating them into carbon nano-composites.

D. Development of local minerals and related materials for efficient water purification.

This sub-project involves the development of already identified potential minerals as filter materials, through property enhancement and formation into effective structures. It has been carried out through purification of natural materials followed by morphological and structural modifications. The composites fabricated with upgraded local clays and sands together with bio-char, have shown promising results.

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R.M.N.M. Rathnayake, S.K. Jayasekara, H. H. Huang, M. Yoshimura, H.W.M.A.C. Wijayasinghe, R.R. Ratnayake and H.M.T.G.A. Pitawala, Mater. Res. Express 5 (2018) 015404.

H.P.T. S. Hewathilake, N.W.B. Balassoriya, Y. Nakamura, H.M.T.G.A. Pitawala, H.W.M. A.C. Wijayasinghe* and M. Sathish–Kumar, *Mineralogical and Pathological Sciences, Volume 113, 2018, 96-105.*

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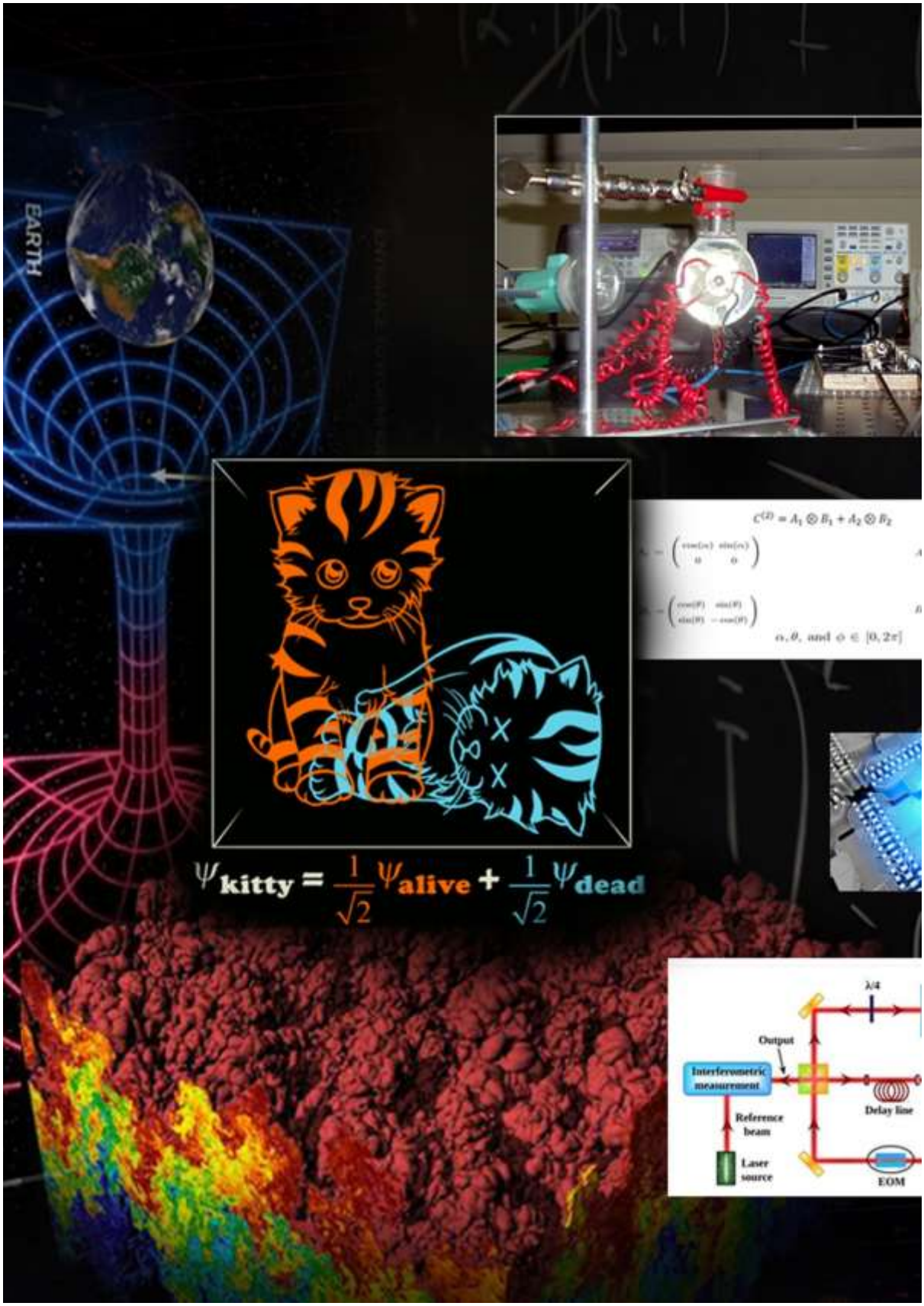
EARTH
$\Psi_{kitty} = \frac{1}{\sqrt{2}}\Psi_{alive} + \frac{1}{\sqrt{2}}\Psi_{dead}$
$C^{(2)} = A_1 \otimes B_1 + A_2 \otimes B_2$
$\alpha, \theta, \text{and } \phi \in [0, 2\pi]$
λ/4
Output
Interferometric measurement
Delay line
Reference beam
Laser source
EOM

Theoretical Physics & Computational Studies

In 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 fundamental aspects of Quantum to Classical Transition, Quantum chaos, Quantum Computing and Quantum non-locality.

- Quantum Physics & Applied Electronics

Asiri Nanayakkara

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Theoretical Physics

In 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 fundamental aspects of Quantum to Classical Transition, Quantum chaos, Quantum Computing and Quantum non-locality.

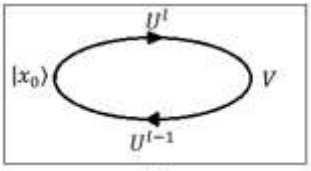
Quantum mechanics, quantum field theory and relativity together form the theoretical foundations of modern Physics. Even 100 years after its inception, fundamental aspect of quantum mechanics is one of the most dynamic areas of current physics research. In particular, fundamental research on Quantum 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. Quantum physics research Group at NIFS which was initiated in January 2016 is currently engaged in investigating fundamental aspects of Quantum to Classical Transition, Quantum chaos, Quantum Computing and Quantum non-locality.

Quantum Physics:

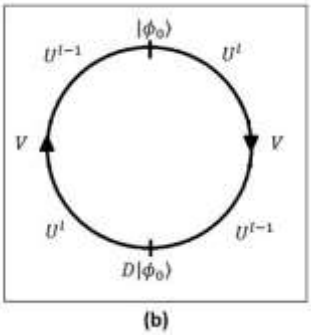
Introduction

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.

Although single particle one dimensional quantum walk cannot exhibit entanglement within the coin degree of freedom or the position degree of freedom separately, the conditional shift in the evolution operator of a quantum walk generates entanglement between coin and position degrees of freedom. Many investigations have been carried out for generation and utilization of entanglement in multidimensional quantum random walks as well as multiparticle random walks. Even though multidimensional coin operators constructed by taking direct tensor products of one dimensional unitary operators usually preserves entanglement if the initial coin state is entangled, they do not generate entanglement if the initial coin state is a product state.



(a)



(b)

Research activities

During 2018 we continued carrying out several investigations with regards to quantum and classical correlations and periodic nature of quantum random walks.

In the paper (2010 Phys. Scr. T140 014035), Stefanek et al has proved that for any four-state quantum walk, there cannot be cycled longer than two steps. Our investigations revealed that they have not used the most general form of characteristic polynomials in their proof. Consequently, the result is not generally valid and hence there can be quantum walks having cycles longer than two steps.

Recurrence in classical random walks is well known and the idea has been investigated in quantum walks in many aspects. The 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. So far, full revival 2D quantum walks with a period larger than two steps have not been found and it has been argued that four state quantum walks cannot have periods longer than two steps. In this research, with the aid of simple 2-D non-local coins we showed that some four-state quantum walks can have full revivals with any even period and the periodicity can be controlled with a slight change of a single parameter within the coin operator.

Full state revivals in a quantum walk can be viewed as returning of the walker to the initial quantum state in a periodic fashion during the propagation of the walk. In this study 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.

We also introduced a quantum scheme which can generate recurrence in n-dimensional quantum walks. 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. Only a single intervention is required to back pedal a walker on a line and the number of interventions increases with the dimensionality of the walk. We used an analytical treatment to prove these results. Moreover, this scheme can be used to generate periodic bounded quantum walks and to control the locations where walker can be found with highest probability. From the point of view of quantum computation and simulations, this scheme could be useful in resetting quantum operations and implementing certain quantum gates.

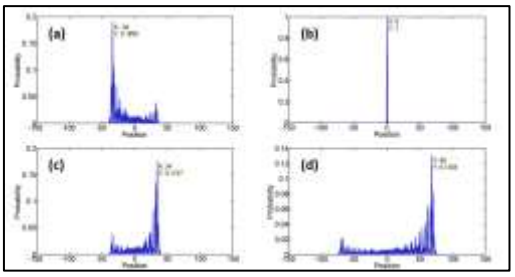


FIG 2 Probability distributions for Hardamard walk with and without interventions. Initial state is $|\psi_{in}\rangle = |1\rangle_c \otimes |0\rangle_x$ and $t = 100$ time steps
(a) intervention at $t = 26$ (b) intervention at $t = 51$
(c) intervention at $t = 76$ (d) No intervention.

Time	State	
	Unbiased	Biased
t=0	$\frac{1}{\sqrt{3}}(\|1_c,3_x\rangle + \|2_c,2_x\rangle + \|3_c,1_x\rangle)$	$\frac{4}{5}\|1_c,-1_x\rangle + \frac{1}{\sqrt{5}}\|2_c,0_x\rangle + \frac{2}{5}\|3_c,2_x\rangle$
t=1	$\frac{1}{\sqrt{3}}\|1_c,-4_x\rangle + \frac{1}{\sqrt{3}}e^{\frac{2\pi i}{3}}\|2_c,6_x\rangle + \frac{1}{\sqrt{3}}e^{\frac{-2\pi i}{3}}\|3_c,4_x\rangle$	$\frac{2}{5}\|1_c,-3_x\rangle + \frac{4}{5}e^{\frac{2\pi i}{3}}\|2_c,2_x\rangle + \frac{1}{\sqrt{5}}e^{\frac{-2\pi i}{3}}\|3_c,2_x\rangle$
t=2	$\frac{1}{\sqrt{3}}e^{\frac{-2\pi i}{3}}\|1_c,-1_x\rangle + \frac{1}{\sqrt{3}}e^{\frac{2\pi i}{3}}\|2_c,-1_x\rangle + \frac{1}{\sqrt{3}}\|3_c,8_x\rangle$	$\frac{1}{\sqrt{5}}e^{\frac{-2\pi i}{3}}\|1_c,-3_x\rangle + \frac{2}{5}e^{\frac{2\pi i}{3}}\|2_c,0_x\rangle + \frac{1}{\sqrt{3}}\|3_c,4_x\rangle$
t=3	$\frac{1}{\sqrt{3}}(\|1_c,3_x\rangle + \|2_c,2_x\rangle + \|3_c,1_x\rangle)$	$\frac{4}{5}\|1_c,-1_x\rangle + \frac{1}{\sqrt{5}}\|2_c,0_x\rangle + \frac{2}{5}\|3_c,2_x\rangle$

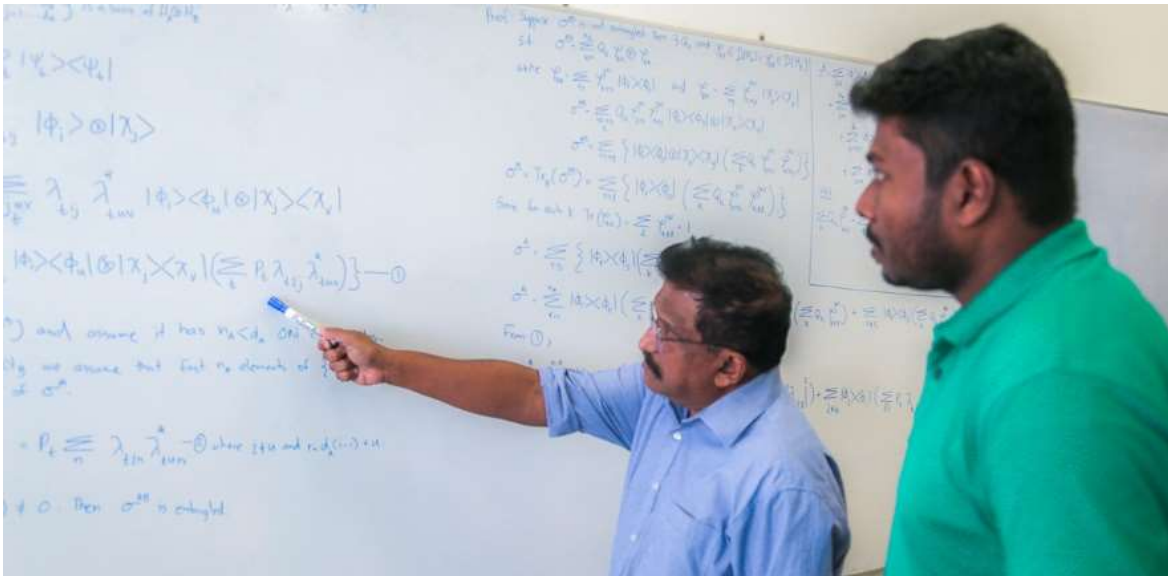
Table1: Full revivals of quantum states with a period of 3 steps $U^{(3)} = S^{(3)}(I \otimes C^{(3)})$

M.Phil Students:

Mahesh N. Jayakody (Quantum Physics),
RandikaDodangodage (Quantum Physics)

Key Publications

(1) Randika Dodangodage and Asiri Nanayakkara (2018) "Comment on 'Full revivals in 2D quantum walks'" Phys. Scr. 93, 117001
(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 single-bubble sonoluminescence threshold in sulfuric acid: An experimental study" Physical Review E 91, 063015



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Mahesh N. Jayakody

Mahesh N. Jayakody is currently a M.Phil. Research Assistant in the Quantum Physics research project at National Institute of Fundamental Studies (NIFS). His research project is focused on exploring fundamental aspects of Quantum to Classical Transition. He holds a B.Sc. in Physics and a M.Sc. degree in Nuclear Science from University of Colombo, Sri Lanka. His research interests include Classical and Quantum correlations, Quantum to Classical transition & Decoherence, Quantum walks & algorithms and Nuclear Power Plants.
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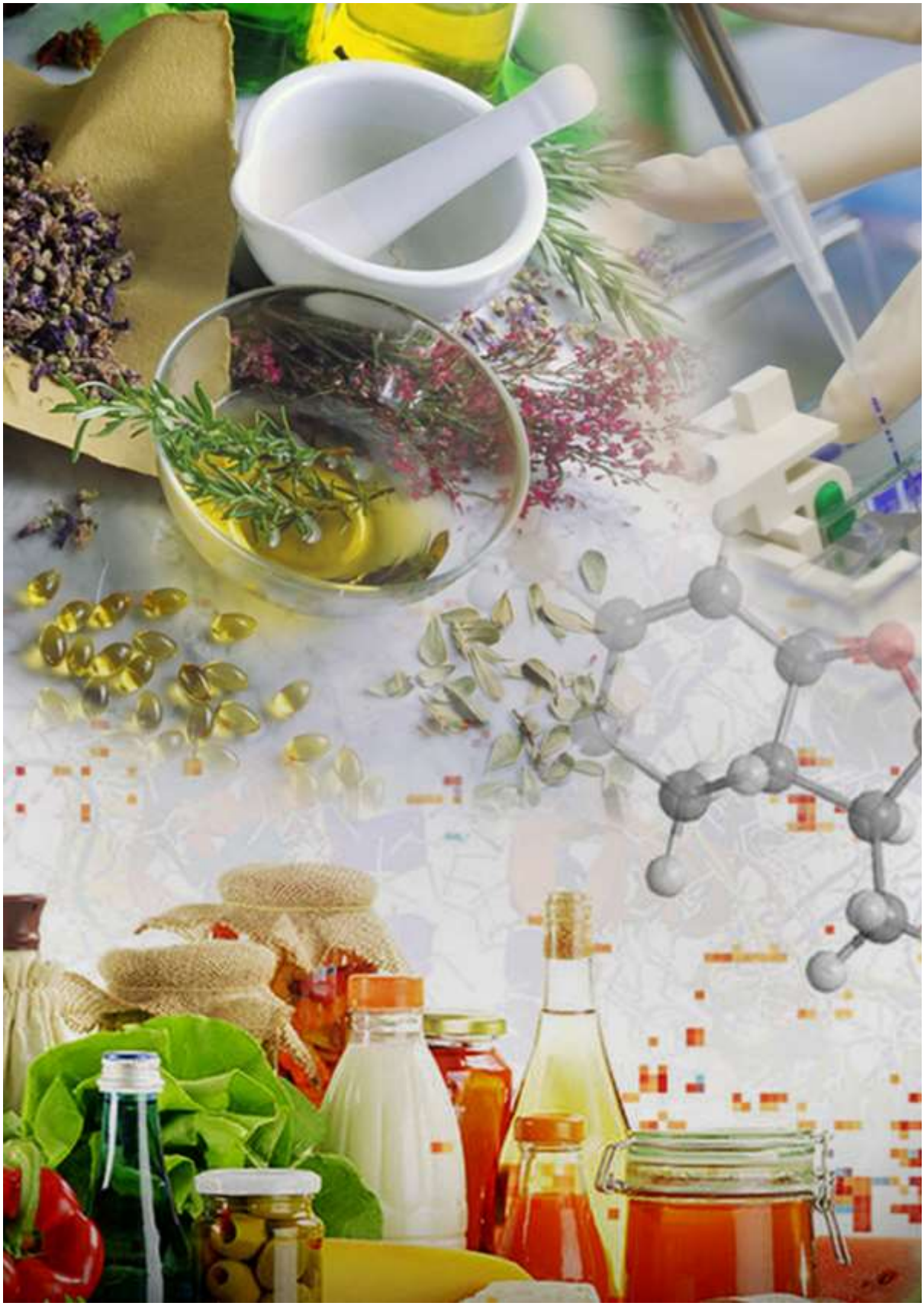

Natural Products & Food Chemistry

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 the Natural Products and Food Chemistry unit of the NIFS is to study medicinal plants, natural products and functional food science. Under 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 covers 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 the 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 health foods with enhanced nutritional and functional properties.

- Food Chemistry
- Nutritional Biochemistry
- Natural Products

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Food Chemistry

Food chemistry project at the NIFS focuses on exploring the application of food chemistry to add value to under-utilized plant resources to address the national food security. Food security is a problem of national importance for Sri Lanka in the context of challenges arising from climate change. In this backdrop, adding value to underutilized resources could be a good strategy. Sri Lanka as a tropical country with a rich biodiversity has got several underutilized plant resources; some of them are edible plants, fruits, seeds etc. in the wild. In the agricultural sector of the country, there are several byproducts, which are wasted or underutilized due to lack of research on commercial exploitation.

However, through systematic studies, these byproducts can be value added to formulate novel food products or ingredients. These novel products, formulated through value addition not only serve the purpose of addressing the food and nutritional needs of the society but also serve as functional foods to mitigate the risk of developing chronic diseases such as diabetes. We investigate nutritional composition, bioactivities, keeping quality 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 might undergo changes by the application of different food processing methods such freezing, thawing, drying, frying, etc. Research on these changes are of considerable importance for human nutrition, food safety and wellness. As a part of the project, we also focus our attention to the application of food chemistry to ensure the quality and authenticity of food products to safeguard consumers from fraudulent practices.

Utilization of coconut testa generated as waste product by food processing industries

Coconut testa is the brown coloured thin outer covering of the coconut endosperm. Approximately, 18 % (w/w, wet basis) of the coconut kernel is composed of testa. Plenty of brown testa is generated by coconut processing industries throughout the year. Owing to lack of research and technical studies, it is being either wasted or underutilized by the coconut sector. The current study aims at investigating the potential of the brown testa of Sri Lankan coconut cultivars for value addition. Through value addition, the waste can be converted into wealth by giving additional income to the coconut sector. This may also help reduce the waste disposal problem in the coconut processing industry. In this study, we attempted to dry the wet coconut testa. After grinding the dried testa, we managed to obtain a brown flour. Analysis of nutritional composition showed that the flour is suitable for diabetic patients who are required to eat foods with low-glyceamic index. Biochemical studies are in progress to explore the anti-oxidative and anti-diabetic properties of the flour. In addition, we will explore the phyto-chemical constituents present in the coconut testa.

Figure 1: coconut testa and brown flour

Quality and authenticity of oils and fats

Virgin coconut oil (VCO) is a premium product that commands higher prices in the edible oil market. Owing to its high demand and short supply, VCO is vulnerable to adulteration with cheaper oils such palm olein, which is the liquid fraction of palm oil. This type of economic fraud will definitely alter the chemical composition of VCO affecting its nutritional and therapeutic values. In this study, an attempt was made to authenticate VCO from VCO adulterated with palm olein (PO) using principal component analysis (PCA) of fatty acid (FA) compositional data. Authentication of VCO is important to safeguard customers from adulteration. Fatty acid compositions of oil samples were obtained using capillary columns fitted with gas liquid chromatography. Out of the thirteen FA variables investigated, ten were found to display high correlation with increasing adulteration. Application of PCA to fatty acid data showed that lauric, palmitic and oleic acids were the most influencing parameters to discriminate VCO from adulterated VCO.

Figure 2: Virgin coconut oil

M.Phil Student:

Ms. S.S.K. Marasinghe

Key publications:

Marikkar, J.M.N., N.A.M. Yanty, M. Peciulli, M.S. Miskandar, and E. Chiavaro. Composition and thermal properties of quaternary mixtures of palm oil:palm stearin:soybean oil:cocoa butter. *Ital J. Food Sc.* 30: 740–751 (2018)

Marikkar, J.M.N. and Noorziyanna Yanty. Fats, Oils and Emulsifiers. In: *Preparation and Processing of Religious and Cultural Foods*, Eakub Ali and Nina Naquiyah (Editors). Elsevier Publishers, pp. 241–251 (2018)

Marikkar, J.M.N. and N.A.M. Yanty**.** Principal component analysis of fatty acid data to detect virgin coconut oil adulteration by palm olein**.** *Int. J. Coco Res. Dev.* 34: 30-38.

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Sanjila Marasinghe is currently an M.Phil Research Assistant with Food Chemistry project at National Institute of Fundamental Studies (NIFS). She received her MSc (Clinical Biochemistry) from University of Peradeniya and BSc (Food Science & Technology) from Sabaragamuwa University of Sri Lanka in 2017 and 2012 respectively. She 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. Her 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.

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Natural Products

Natural Products are compounds produced by plants, fungi, marine organism 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. The fungal flora native to Sri Lanka is around 25,000 and a vast majority of these remain to be studied for the presence of bioactive metabolites. The use of natural products in the management and treatment of disorders and diseases in humans and plants is more acceptable and offers lesser risk than the use of synthetic compounds. The overall objective of the Natural Products Project at the NIFS is the identification of bioactive extracts and compounds from natural sources, as potential resources 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 found 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 at the NIFS focus mainly on the following three areas.

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

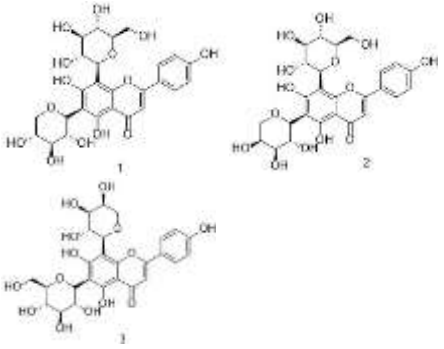
Chemistry and bioactivity of fungi associated with medicinal plants, edible fruits

Fungi can be mainly categorized as endophytic and epiphytic fungi. Endophytes are found in the inner tissues or even in the cells of their host while epiphytic fungi grow on the surface of the host. Endophytes are considered to be a rich source of secondary metabolites with novel structures and interesting bioactivities. These metabolites have found extensive applications as agrochemicals, antibiotics, antiparasitic immunosuppressants, and anticancer agents. Some endophytic fungal strains produce natural products that are either identical or closely related to those produced by the host plant. A well-known example is the production of Taxol, an anti-cancer drug obtained from the Pacific Yew tree *Taxus brevifolia*, which was also produced by the endophytic fungus *Taxomyces andreanae* isolated from the bark of *T. brevifolia.* Currently we are studying the chemistry and bioactivity of secondary metabolites produced by the endophytic fungi isolated from some medicinal plants. Several secondary metabolites with interesting structural features and some useful bioactivities have been isolated.

Enzyme inhibitors from plants

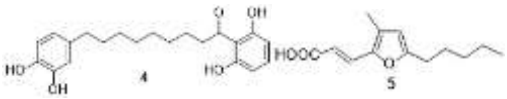
Clinically important enzymes are attractive targets for drug discovery. Studies on enzyme inhibitors remain an important area in pharmaceutical research as these studies have led to the discovery of drugs against a variety of diseases. Enzyme inhibitors represent almost half the drugs in clinical use today. Specific inhibitors can interact with the enzyme and inhibit its activity either in a reversible or irreversible manner. The role of natural products in the treatment of diseases has inspired pharmaceutical scientists in their search for new avenues in drug discovery. There has been renewed interest in the therapeutic potential of plants and plant based products in the current health care systems. Pharmacological evaluation of plant extracts is an essential aspect of the drug discovery process. In this context, activity guided (bioassay guided) fractionation is crucial for the successful isolation of active compounds. Our recent research work on spices led to the discovery of several secondary metabolites with enzyme inhibitory activity against three clinically important enzymes.

Obesity has become a major health challenge and is strongly associated with chronic diseases such as dyslipidemia, fatty liver diseases, osteoarthritis, hypertension and diabetes mellitus. Pancreatic lipase is an important lipolytic enzyme which plays a significant role in the hydrolysis and absorption of dietary triglycerides. Investigations of potent lipase inhibitors serve as one of the strategies to discover anti-obesity drugs. Activity-guided fractionation of methanol extract of *Trigonella foenum-graecum* seeds furnished three flavone C-glycosides having pancreatic lipase inhibitory activity. Structures of these compounds were established as vicenin-1 (**1**), isoschaftoside (**2**) and schaftoside (**3**) with pancreatic lipase inhibitory activity of 60.3% 33.8% and 95.5% respectively at the concentration of 250 µg/ml. This is the first report of the isolation of lipase inhibitors from *T. foenum-graecum* seeds.



α-Glucosidase and α-amylase are the key enzymes involved in the digestion of complex dietary carbohydrates. α-Amylase acts on dietary starch, hydrolyzing random α(1→4

bonds to oligo and disaccharides which are ultimately converted into monosaccharides by α-glucosidase. The inhibition of above enzymes significantly decreases the postprandial increase in blood glucose after a carbohydrate containing diet by delaying the process of carbohydrate hydrolysis and absorption.



Anticholinesterases inhibit the enzyme acetylcholinesterase (AChE) which is found in neuronal junctions of the cholinergic neurons. Anticholinesterases are used as one of the treatment strategy to improve cognitive function in patients with age related neurodegenerative disorders such as Alzheimer's disease. Anticholinesterase activity of spices used in Sri Lankan cuisine was investigated. Among them *Myristica fragrans* (mace), seeds of *Tamarindus indica* (tamarind) and Garcinia *cambogia* (goraka) were found to have the highest AChE inhibitory activity. Activity guided fractionation of combined methanol and ethyl acetate extracts of mace furnished 6 compounds; malabaricone C (**4**), 3'-methyl-5'-pentyl-furylarylic acid (**5**), fatty acid (**6**), licarin A (**7**), elemicin (**8**) and 5'-methoxylicarin B (**9**). These compounds were screened for antioxidant, anticholinesterase and α-glucosidase inhibitory activities.

Compound **4** showed highest AChE inhibitory and antioxidant activity with IC_{50} 2.06±0.04 ppm respectively. Compound **5** and **6** showed α-glucosidase inhibitory activity with IC_{50} 51.02±0.01 ppm and 46.74±0.01 ppm respectively; indicating fruit aril of *M. fragrans* is a good source of anticholinesterases and α-glucosidase inhibitors.

Key References

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Nimal Adikaram

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Postharvest pathology of horticultural fresh produce

Postharvest diseases constitute a major cause of postharvest losses of freshly harvested horticultural produce. Postharvest losses of fruits and vegetables amount 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) programme, investigates disorders and fungal diseases, including the stem-end browning (SEB) in ripe mango variety TomEJC. These disorders and diseases adversely affect the export quality of harvested fruits. The aim of the research is to understand the cause/s, factors affecting and the mechanism of development of each condition and finally, using all information, to formulate appropriate management practices. Two postgraduate research students are working on the project.

Fruit pitting and lenticel darkening are two disorders reported in certain fruit species including mangoes. These have not been recorded or studied with respect to Sri Lankan mango varieties. Pitting appears as small (1 – 1.5 cm diameter), mostly circular or sometimes irregular, concave, depressed and isolated areas on the fruit surface after harvest. Tissue anatomy of pitting development revealed that the cell layers with weaker cell walls underneath the epidermis collapse forming depressed areas on the fruit peel. Tissue analysis indicated the involvement of macro- and micro-nutrients in the development of pitting. Addition of a nutrient mixture containing a macronutrient and a micronutrient to soil as a fertilizer, soon after flowering, reduced the incidence of pitting significantly down to less than 0.01% in the two previous seasons, September 2018 – January 2019 and May – August 2018. Pitting was first detected in 2016 and continued to occur in the fruit seasons to follow. The percentage of harvested fruits affected in both seasons in 2017/2018 was 13%.

Lenticel Darkening (LD) is a condition 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.

Internal Pulp Browning (IPB) is a new disorder, first encountered in 2012 in ripe mango var. TomEJC. The condition has not been reported from any other mango variety. The cause of the disorder was not known. The symptoms appear in the pulp just outside the seed as dark brown areas on either side of the seed. Externally the affected fruits show no symptoms and the condition can be detected only when the internal pulp is exposed by cutting through the fruit pulp. Development of IPB was found to be associated with some physiological and environmental factors. A bacterium could also be isolated from affected tissue. Tissue analyses indicated that the IPB affected pulp tissue contained two additional compounds that were not found in the respective healthy tissues. IPB was not observed in any of the fruit seasons in the year 2016 and 2017. Several fruits with IPB symptoms were encountered in December 2018 and January 2019. Where the monthly rainfall was higher. Only a small percentage of harvested fruits (<1%) were found affected with IPB in the relatively drier 2018/19 season. Among the fungal diseases, stem-end browning (SEB) was found to be a new and important disease that could adversely affect the marketing of fruits, especially in the export market. The fruits after harvest do not show any symptoms of stem-end browning. However, 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 darker, lighter or pale brown color. In affected fruits, the superficial pulp tissue also becomes affected. SEB was found to be a complex disease, caused by a number of pathogenic fungi. The fungi were isolated, identified and the pathogenicity of some of them was tested.

Field hygiene by removal and destruction of diseased leaves, twigs and peduncles from the previous season helps reducing fungal inoculum and lowers disease incidence. Concurrent field application of a fungicide, especially immediately after flowering, and also postharvest dips with a safer fungicide reduced the occurrence of SEB. Several other fungal diseases were also observed and are being studied. These include the mango scab, *Glomerella cingulata* spots and the *Pestalotiopsis* spot.

Mango var. TomEJC is presently cultivated in the dry and arid zones of Sri Lanka and with the current expansion of cultivation, the future fruit production, hence exportation also, 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 exportation.

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

Molecular identification of *Colletotrichum* species associated with anthracnose disease in fruits, cut-flowers and ornamental foliage plants was carried out in collaboration with Prof. Deepthi Yakandawala, Department of Botany, University of Peradeniya. The plants studied during the period included papaya (*Carica papaya L.)* and *Begonia species.* Anthracnose is a most common and destructive postharvest disease in fruits, vegetables and cut-flowers. The disease affects the foliage plants and cut-flowers lowering their marketability. Accurate identification of pathogens is important for formulation of proper management practices and biosecurity purposes.

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The tea shot hole borer (TSHB) beetle *Euwallacea fornicatus* is a major insect pest of tea in Sri Lanka. It forms an ectosymbiotic relationship with the filamentous fungus *Monacrosporium ambrosium* (ambrosia fungus) syn *Fusarium ambrosium*. We conducted extensive studies to understand the relationship between the TSHB and ambrosia fungus.

Caffeine, the major alkaloid present in tea, was reported to have an antifungal effect on *M. ambrosium*. We investigated if ambrosia fungus is capable of bio transforming caffeine into a non-toxic form such as theophylline or theobromine. The effect of 24 h, 48 h, 62 h, 96 h and 120 h old cultures of *M. ambrosium*, in glucose-yeast extract-peptone medium on caffeine, studied using TLC and HPLC, showed that caffeine was unchanged in all five culture media. The effect of *M. ambrosium*, grown in minimal media composed of KH_2PO_4, Na_2HPO_4, NH_4Cl and dextrose, in both nitrogen containing and nitrogen free minimal media, on caffeine, also showed that biotransformtaion of caffeine does not take place in cultures of *M. ambrosium* in both types of minimal media.

We isolated and investigated the biochemical nature of secondary metabolites produced by *M. ambrosium* in laboratory culture media in order to further probe the importance of ambrosia fungus in the symbiotic association with TSHB. The metabolites produced by *M. ambrosium*, were isolated, separated using chromatographic techniques and identified. Six naphthoquinones produced during spore germination in a laboratory culture broth of *M. ambrosium* were isolated and identified as dihydroanhydrojavanicin, anhydrojavanicin, javanicin, 5,8-dihydroxy-2-methyl-3-(2- oxopropyl)naphthalene-1,4-dione, anhydrofusarubin and solaniol. Chloroform extracts of tea stems with red-colored galleries occupied by TSHB, were found to contain UV active compounds similar to the above naphthoquinones. Laboratory assays demonstrated that the combined EtOAc extracts of the fungal culture broth and mycelium inhibited the growth of endophytic fungi *Pestalotiopsis camelliae* and *Phoma multirostrata*, isolated from tea stems. It is likely that the pigmented naphthoquinones secreted by *M. ambrosium* during spore germination, prevents other fungi from invading TSHB galleries in tea stems.

The antifungal nature of the naphthoquinone extract suggests that it protects the habitat of TSHB. *M. ambrosium* therefore provides not only the food and sterol skeleton necessary for the development of the beetle during its larval stages, but also serves as a producer of fungal inhibitors that help to preserve the purity of the fungal garden of TSHB.

Mycelial interactions between *M. ambrosium* and the three endophytic fungi were evaluated using a dual culture technique. The mean percentage inhibition of radial mycelial growth (PIRG) of each of the three fungi in the presence of *M. ambrosium*, was evaluated and the highest PIRG value (35.3 ± 0.9) was observed with *P. camelliae* while PIRG values of *G. mangiferae* (9.5 ± 2.4) and *P. multirostrata* (10.8 ± 1.8) were not significantly different ($P<0.05$) from each other. The PIRG values indicate *M. ambrosium* is not inhibitory to the growth of *G. mangiferae*, *P. camelliae* and *P. multirostrata*.

These studies have helped us understand the symbiotic relationship between the beetle and the fungus. They provided information regarding the biochemical nature and importance of the secondary metabolites produced by ambrosia fungus in the symbiotic association with the TSHB.

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Nutritional Biochemistry

Nutritional Biochemistry project is focused on several areas, including functional and nutritional properties of food, food safety, and bioavailability of food to improve health and well-being of people. Chemical properties of nutrients and other dietary constituents and their biochemical functions are studied to understand the interactive relationship between diet and health.

Functional and nutritional properties of food: Under this research theme, studies are done 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 there are two ongoing studies such as assessing physicochemical properties of some starches and commonly consumed ayurvedic plants in 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 are studied. Further, the effect of simulated digestion on prebiotic activity of processed legumes was studied.

Interaction of glucose oxidase with other sugars and its implications in blood glucose monitoring: Novel method was developed to assess α amylase inhibitory activity using Glucose oxidase kit. Due to some concerns and doubts we confirmed the reaction of maltose with α amylase by quantifying the maltose level by HPLC method.

In vitro digestion on the bioavailability and antioxidant activities of polyphenols in legumes

Gastrointestinal digestion modulates bioavailability and antioxidant activities of polyphenols. This study investigates the effect of simulated gastro intestinal digestion on the bioavailability and antioxidant activities of polyphenols in processed mung bean (MI6) and cowpea (Waruni). Raw, boiled and germinated legumes were digested using synthetic digestive enzymes and digesta was analysed for total phenol, total flavonoid content and antioxidant activity using previously described methods. The results demonstrated that simulated digestion significantly ($P< 0.05$) improved the total phenol and total flavonoid content in both boiled, germinated mung bean and cowpea. Digested germinated mung bean showed the highest ($P< 0.05$) total phenol content while digested germinated cowpea showed the highest($P< 0.05$) total flavanoid content. Regardless of the processing methods, *in-vitro* digestion significantly ($P< 0.05$) increased the antioxidant activity in both cowpea and mung bean. This study reveals that *in–vitro* digestion increases ($P< 0.05$) the bioavailability and antioxidant activity in polyphenols in cowpea and mung beans. The study will be continued for three more legumes (chickpea, Dawala Cowpea and Horse gram) and a LC/MS study will be carried out for further confirmation of results and quantification of selected phenolics before and after digestion.

Interaction of Glucose Oxidase (GOx) with non-Glucose Sugars and its associated clinical Implications

The glucose assay kit available in the market is comprised of the enzymes glucose oxidase (GOx) and peroxidase. According to reported literature, GOx is highly specific for glucose and there is no significant reaction with other mono or disaccharides. However, from our preliminary studies the enzyme was found to interact with non-glucose sugars including maltose, mannose, galactose and xylose. Based on the interaction of GOx with maltose, a sound, simple, and high-throughput analytical technique was developed to determine α-amylase activity using the glucose assay kit.

According to the results, the newly developed GOD method demonstrated good accuracy, precision and reproducibility in determining α-amylase activity. Furthermore, HPLC studies confirmed the interaction of GOx with maltose and the products of α-amylase action. At normal physiological conditions, the only sugar present in the blood stream of a healthy person is glucose. However, in some disease conditions, some other sugars are found in high concentration in the circulation, which can be misinterpreted as glucose. Thus, the primary aim of the present work was to determine the clinical implications associated with the interaction of GOx with other sugars. According to the results, other than glucose, maltose, mannose, galactose, xylose, fructose and sorbitol acted as substrates for GOx and among these, the interaction with mannose, galactose, maltose, and xylose can be considered clinically critical. The magnitude of interference caused by galactose, maltose, and xylose on blood glucose reading was below 3.75, 2.2 and 1.7%, respectively. Since, maltose level in blood following infusion of maltose-containing agents and galactose level in galactosaemic patients are not elevated to a degree to alter the meter readings, the specificity of GOx based glucose monitoring systems can be considered sufficient in most clinical situations except for extraordinary cases. In addition, though, the positive interference from mannose was above 10%, so far no reports are reported regarding mannose interference in blood glucose reading. Overall, since blood glucose monitoring is a basic principal test carried out in clinical set-ups for almost all disease conditions, it is important that the practicing clinicians are made aware of the pitfalls and technical deficiencies associated with these systems to avoid any unexpected bad consequences.

Antidiabetic and antimicrobial properties of three Sri Lankan medicinal plants: *Phyllanthus emblica, Cassia auriculata* and *Hemidesmus indicus*

Sri Lanka is a tropical country rich in high floral diversity. Throughout decades, herbal plants have played a vital role in the field of traditional Ayurveda medicine. Scientific information on the ethnomedicinal significance of commonly consumed medicinal plants in Sri Lanka is insufficient. Thus, the present study focused on determining the antidiabetic activity of ten selected Sri Lankan medicinal plants in terms of their inhibitory activity on the starch hydrolysing enzymes, α-amylase and α-glucosidase. Among the studied plants, methanol extracts of *P. emblica* (*Pe*), *C. auriculata (Ca)* and *H. indicus (Hi)* demonstrated the highest α-amylase and α-glucosidase enzyme inhibitory activity. The active samples were further fractionated into hexane, dichloromethane, and ethyl acetate and according to the results, both hexane and ethyl acetate fractions of Pe displayed potential α-amylase and α-glucosidase enzyme inhibitory activity whereas, only the ethyl acetate fractions of Ca and Hi showed good inhibitory activity for both enzymes. To identify the phytochemicals present in the extracts of these three plants, qualitative analysis and chemical profiling using GCMS were carried out. Results of qualitative phytochemical analysis for methanolic crude extracts revealed the presence of alkaloids, flavonoids, tannins and terpenoids in all three plants whereas saponins and steroids were found only in *Ca* and *Hi*. Hexane extract of *Pe* showed a good inhibitory activity against pathogenic Gram positive and Gram negative bacteria. GC-MS profiling identified the presence of α-amyrin, β-amyrin, sitosterol and stigmasterol metabolites in hexane fraction of *Pe* which may be responsible for the observed high antimicrobial and antidiabetic activity. This provides the scientific basis for the antidiabetic and antimicrobial activity of these three Sri Lankan medicinal plants. Further, LC-HRESIMS profiling of other fractions are underway.

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Key Publications

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

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

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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 complex network interactions among the variables, and then applying the knowledge gained to sustain and improve 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 work is also directed towards microbial generation of bioenergy to circumvent the use of environmentally damaging fossil fuels.

- Bioenergy & Soil Ecosystems
- Microbial Biotechnology
- Rhizobium Project

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Bio Energy & Soil Ecosystems

Main research areas under investigation are Bio energy and Soil C sequestration with sub projects in each category. A fair amount of studies have been reported and some data are available on the above ground C-sequestrations in the major vegetation types of Sri Lanka. However, very little or no information is available on the below ground or soil C sequestration. In consideration of this importance, the project on soil C sequestration and management was initiated in 2010 at the National Institute of Fundamental Studies. This project aims 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 and small holder cultivations etc. The potentiality of coastal ecosystems such as mangroves and intertidal saltmarshes 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 will be studied.

The aim of the Bioenergy research project is to explore the microbial flora of Sri Lanka for cellulase production and their applications. 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.

A significant increase in nitrate contamination in well water was detected recently in the Jaffna District. Studies are continuing to find out the possibility of utilizing denitrifying bacteria for nitrate removal from well water from the Jaffna District.

Taxonomic evaluation via molecular and morphological characterization of cyanobacteria available in inland water bodies of Sri Lanka and the possibility of using them for value added products and processes are also under investigation. 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 in Sri Lanka not only for academic and industrial research but also for future reference.

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, SOC and its fractions of paddy soils and their links to nutrient availability will be determined. A GIS based map will be prepared to show the availability of soil C stocks in paddy soils.

Estimation and Mapping of Soil Carbon and other nutrients in some selected Blue Carbon Ecosystems of Sri Lanka

The soil carbon sequestration by coastal blue C ecosystems and effects on the carbon budget has not yet been determined. The continuum of construction and management activities going on and proposed on, and once these areas had been under warzone significant amount of the coastal wetlands; mangroves and saltmarsh ecosystems have deprived. Therefore, through the study it is intended to uniquely estimate the below ground carbon stock of the ecosystems and map them to utilize it in climate change mitigation and for the conservation and restoration of this maximally threatened wetlands.

Salt marsh & mangrove Association

Nitrogen uptake and utilization in rice under the influence of Cyanobacteria

Modern agriculture is largely dependent on the steady supply of synthetic nitrogen (N) fertilizers. However, uptake and utilization of N by plants is relatively low under a range of conditions. On the other hand, excess N supply has major impacts on the environment; in particular, increases in greenhouse gas emissions from the soil. It has been previously demonstrated that cyanobacteria promote plant N utilization and Uptake, However, a fundamental understanding of how cyanobacteria facilitate plant N uptake and Utilization is / are not clearly understood. Uptake and utilization of N by some traditional and modern rice varieties under the influence of cyanobacteria will be studied to understand the problem.

Microbial cellulases: The application in Biofuel production and other value added products and processes.

This project aims to study the possible applications of cellulase enzyme extracts obtained from locally isolated cellulolytic microorganisms. The application in bioethanol production and biological pretreatment of sugarcane bagasse was studied. The reported highest ethanol yield was 10% using a yeast fungal coculture. *Earliella scabrosa* and *Aspergillus niger* was found to be an efficient basidiomycetes-filamentous fungal combination to carry out complete pre-treatment along with hydrolysis of sugarcane bagasse to consequent production of fermentable sugars.

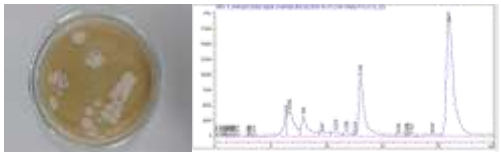

Figure 01: Efficient ethanologenic yeast and their ethanol production detected by High Performance Liquid Chromatography. The Peak is observed at 21 minutes retention time.

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

Experiments have been initiated for broad taxonomical evaluation of cyanobacteria in inland water bodies, representing different ecosystems and agro ecological zones. Microbial genetic diversity of selected waterbodies with extreme environmental conditions will be further evaluated using metagenomics sequencing technique. The value addition and toxin producing capability will be analyzed to recommend their applicability in different industries.

The establishment of culture collection will facilitate the preservation and conservation of pure cyanobacteria strains and their genetic material present in different types of water bodies in Sri Lanka.

Isolation of Denitrifying Bacteria and their Potential use in Nitrate Removal of Well water of Jaffna District

Nitrate removal in groundwater is of great interest due to excessive amounts of nitrate in groundwater. In agricultural areas of Jaffna well water contains about 20 – 50 mg/l of nitrate nitrogen. Methods available for remediation of nitrate contaminated water; are expensive and less applicable to the Sri Lankan economy. Therefore, the goal of the present study is to develop a biological method using denitrifying bacteria isolated from the environment and evaluate their potential use in nitrate removal of well water from Jaffna district. The study has identified two bacterial strains namely *Paracoccus pantotrophus* and *Paenebacillus polymyxa* having potential to remove nitrate nitrogen from water by up to 57.37 mgl^{-1} to below 11 mgl^{-1} in the tested water. With further improvement of culture conditions for efficient nitrate removal followed by post treatment techniques, a commercially feasible process for bacterial denitrification using starch as carbon source may possibly be developed.

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Key publications:

1. Ratnayake, R.R., Perera, B.M.A.C.A., Rajapaksha, R.P.S.K., Ekanayake, E.M.H.G.S., Gunaratne, H.M.A.C. (2017). Soil carbon sequestration and nutrient status of tropical rice based cropping systems in Sri Lanka, Catena, 150: 17–23.
2. Ratnayake, R.R., Karunaratne, S.B., Lessels, J.S., Yogenthiran, N., Rajapaksha, R.P.S.K., Gnanavelrajah, N. (2016). Digital soil mapping of organic carbon concentration in paddy growing soils of Northern Sri Lanka. Geoderma Regional, 7: 167–176.
3. M.F Hossain, R.R. Ratnayake, K. Meerajini, K.L.W kumara "Antioxidant properties of some selected cyanobacteria isolated from fresh water bodies of Sri Lanka." *Food Science & Nutrition* (2016).

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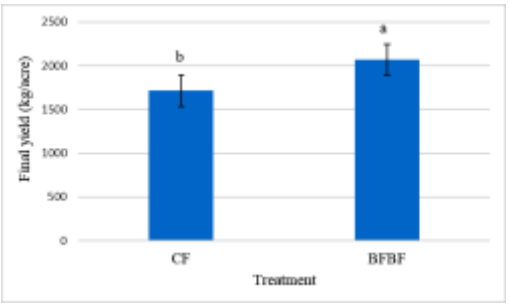
Microbial Biotechnology

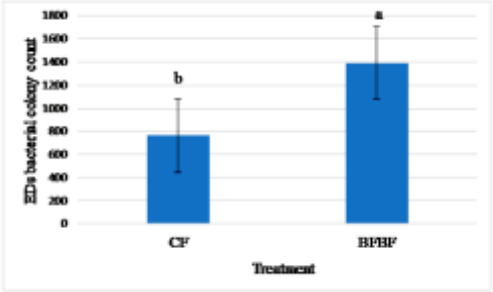
The research program focuses on investigations of the role of developed microbial biofilms in agriculture, plantations and the environment. With the invention of development of microbial biofilms [fungal-bacterial biofilms (FBBs) in particular] in vitro in 2002, several basic research studies were conducted 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 on 30,000 acres 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 India, Indonesia, Brazil and Iraq.

Current studies are centered on agriculture, health and environmental benefits of the use of BFBFs, and industrial applications of FBBs.

Rice (*Oryza sativa* L.) is the staple food of Sri Lanka. Chemical fertilizer usage for rice cultivation is comparatively higher than that of other agricultural crops in Sri Lanka. Extensive and excessive use of these synthetic fertilizers lowers soil quality, fertility, microbial diversity, and also leads to health hazards. It has been shown in small scale studies that Biofilm biofertilizer (BFBF) can cut down chemical fertilizers (CF) used in rice cultivation by up to 50% or more without affecting grain yield. There are no sufficient studies carried out to evaluate BFBF in medium scale for rice with special reference to endophytic diazotrophs (EDs) that are important in biological nitrogen fixation (BNF) and crop production. Therefore, this study was designed to evaluate the effect of BFBF practice on EDs and grain yield by analyzing soil, plant and microbial parameters. Rice crop for this study during Yala season (2018) was established in 12 farmer fields in Polonnaruwa district. In each location, two consecutive, uniform paddy fields with BFBF practice and farmers' CF practice were established. Results indicated significant increases ($P < 0.05$) in soil moisture, total N, total C, shoot and root dry weights, thousand grain weight and grain yield in the BFBF practice. Furthermore, the BFBF practice showed significant increases ($P < 0.05$) of EDs colony count and endophytic non-diazotrophs colony count over farmers' CF alone practice. Thus, it can be concluded that BFBF helps in cutting down CF while improving grain yield, soil C and nutrients, and also microbial abundance and/or diversity.



Rice grain yield of the BFBF practice and farmers' CF practice (n = 12).

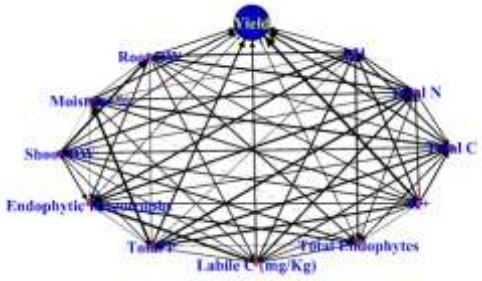


Endophytic diazotrophs (EDs) colony count of the BFBF practice and farmers' CF practice (n = 12).

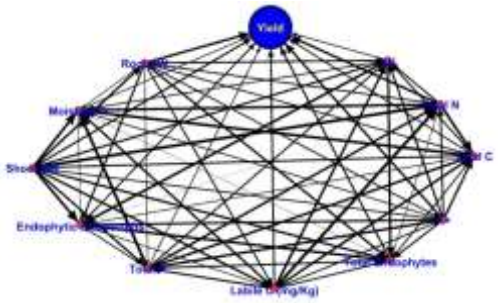
Agro-ecosystems consisting of soil, plant and microbial communities are affected by farmers' practices (e.g. excessive use of chemical fertilizers, CF), disrupting its natural cycles by depleting beneficial microorganisms. BFBF application to a crop soil increases N_2 fixing bacteria, P-solubilizing fungi and many other useful microorganisms which help reinstate the degraded networks in the agro-ecosystem by replacing lost organisms and also producing various biochemicals such as phytohormones, signaling molecules, etc. Thus, the present study was designed for analyzing soil, plant and microbial parameters with the application of farmers' CF practice and BFBF practice in 25 different locations using rice (*Oryza sativa* L.) as the test crop, and to reveal the effect of BFBF in re-establishing networks in the agro-ecosystem.

Results indicated that although the parameters were variable among different locations, there was an increasing trend of rice grain yield in the BFBF practice. Further, it helped in cutting down chemical fertilizers use up to 50% of the farmers' practice without hampering yields. This has been attributed to the positive effects of the biofilms in the BFBF practice towards soil and microbial properties.

Therefore, it is concluded from this study that the BFBF practice can be considered as an eco-friendly and economically viable method to replace farmers' current practice of CF alone application.



Network interaction of soil, plant and microbial parameters of the BFBF practice.



Network interaction of soil, plant and microbial parameters of the farmers' CF practice.

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Key publications:

Kulasooriya, S.A., Seneviratne, G., Ekanayake, E.M.H.G.S. (2017) Soil microbial diversity and its utilization in agriculture in Sri Lanka. In: J.K. Patra et al. (eds.), Microbial Biotechnology, Springer Nature, Singapore, pp. 203-244.

Seneviratne, G., Wijepala, P.C., Chandrasiri, K.P.N.K. (2017) Developed biofilm-based microbial ameliorators for remediating degraded agroecosystems and the environment. In: I. Ahmad, F. M. Husain (eds.), Biofilms in Plant and Soil Health, John Wiley & Sons Ltd., Chichester, United Kingdom, pp. 327-335.

Perera, T.A., Tirimanne, T.L.S., **Seneviratne, G., Kulasooriya, S.A.** (2017) *Azorhizobium caulinodans ORS 571–Aspergillus spp*. biofilm in the presence of flavonoid naringenin: An extremely effective association for rice root colonization with a definite future as a nitrogen biofertilizer. Indian Journal of Biochemistry and Biophysics 54, 214-222.

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Rhizobium Project

The research program focuses on investigations of 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 on over 30,000 acres in the country with a 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 India, Indonesia, Brazil and Iraq.

Current studies are centred on agriculture, health and environmental benefits of the use of BFBFs, and industrial applications of FBBs.

While the application of chemical fertilizers has now become an integral part of agriculture it has also been realized the world over that the indiscriminate use of such fertilizers in the long term had not given the expected increases in crop yields, but had aggravated environmental pollution. There is therefore, international agreement to minimize the use of chemicals in agriculture without compromising crop yields. The rhizobium project conducts studies to improve nitrogen fixation in legume crops by increasing root nodulation and activity by applying rhizobial inoculants prepared from selected and field tested rhizobia. It has been possible to replace the use of chemical N-fertilizers entirely by the application of rhizobial inoculants without any reduction in crop yields.

Work continued successfully with the supply of rhizobial inoculants to soybean, mung bean and vegetable bean (Table 1) that could completely replace the application of urea fertilizer to these crops without any reduction in yields.

Table 1: Inoculants supplied in 2018

Crop	Inoculant packets	Collaborator
Soybean	4422	Plenty Foods (Pvt) Ltd., Mahawelli Authority, Provincial Agriculture Anuradhapura, Kurunegala, Matale, Govt Department of Agriculture and Mahaweli Authority.
Vegetable Bean	200	Provincial Agriculture Kandy
Green gram	23	Plenty Foods (Pvt) Ltd

Field testing, extension work and demonstrations were conducted in several locations (Table 2 a & b).

Table 2a: Extension work

Extension programs	No of participants	Collaborators
10	380	Department of Agrarian service, Department of Provincial Agriculture Plenty Foods(PLC) ZOA(NGO)

Table 2b: Field Demonstrations

Crop	No of field demonstrations	Collaborators
Vegetable Bean	33	Department of Agrarian service, Department of Provincial Agriculture Plenty Foods(Pvt) Ltd, ZOA(NGO)
Ground Nut	13	Department of Provincial Agriculture ZOA(NGO)

These activities were extended to the Eastern Province and other areas with the receipt of a Grant from the Ministry of Science, Technology and Research in February 2018. Besides renovating the Green House at the NIFS, development and field testing of inoculants for groundnut also commenced. Field trials conducted at Karadiyanaru and Mavilaru areas gave promising results (Figs: 1, 2, 3 & 4) and such inoculants are ready for release to farmers after a few more field trials in other areas.

Fig 1: Karadiyanaru: Discussion with farmers

Fig 2: Inoculated groundnut seeds

Fig 3: Groundnut harvests, inoculated and uninoculated

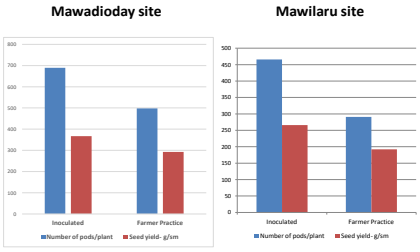

Fig 4: Pod and seed yields of groundnut

Phosphate solubilizing biofertilizer

Next to nitrogen, phosphorus is the essential major nutrient needed for crop growth and yield. Currently soluble phosphate fertilizers required for short-term crops are all imported and provided to farmers under heavy subsidies. This project aims at isolating and selecting efficient P-solubilizing microorganisms and preparing biofertilizers that could enhance P release from natural sources like Eppawala Rock Phosphate (ERP). Potential P-solubilizing microbes were isolated from soil samples collected from dry zone fields where field trials are being conducted.

Fig 1: P-solubilizing bacteria and fungi

Preliminary studies have shown that among the organisms isolated, the fungus *Aspergillus niger* was the most efficient (Fig:1). A low cost sensitive bioassay for the rapid evaluation of P-solubilizing abilities was developed using *Azolla* plants. A research paper on this work is in preparation.

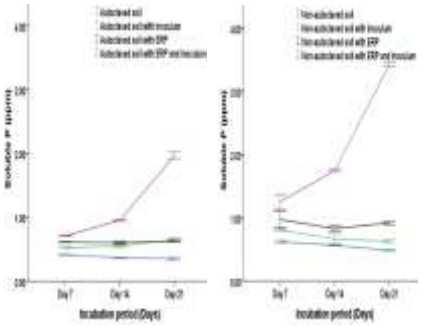

Fig 2: P-solubilization from ERP containing soil inoculated with the fungal isolate.

Key publications

Kulasooriya, S. A., Gamini Seneviratne and E. M. H. G. S. Ekanayake (2017) Soil Microbial Diversity and Its Utilization in Agriculture in Sri Lanka. Chapter 9: 203- 224. In: J. K. Patra et al (eds.) Microbial Biotechnology, Springer Nature, Singapore Pte Ltd.

Kulasooriya, S. A., E. M. H. G. S. Ekanayake, R. K. G. K. Kumara and A. M. Sarath Bandara (2017) Rhizobial inoculation of Trifolium repens L. in Sri Lanka. J. Natn. Sci Foundation, Sri Lanka 45 (4): 361 – 366.

Kulasooriya, S. A. and D. N. Magana-Arachchi (2016) Nitrogen fixing cyanobacteria: their diversity, ecology and utilization with special reference to rice cultivation. Jour Natnal Sci Foundation Sri Lanka, **44**(2): 3- 21.

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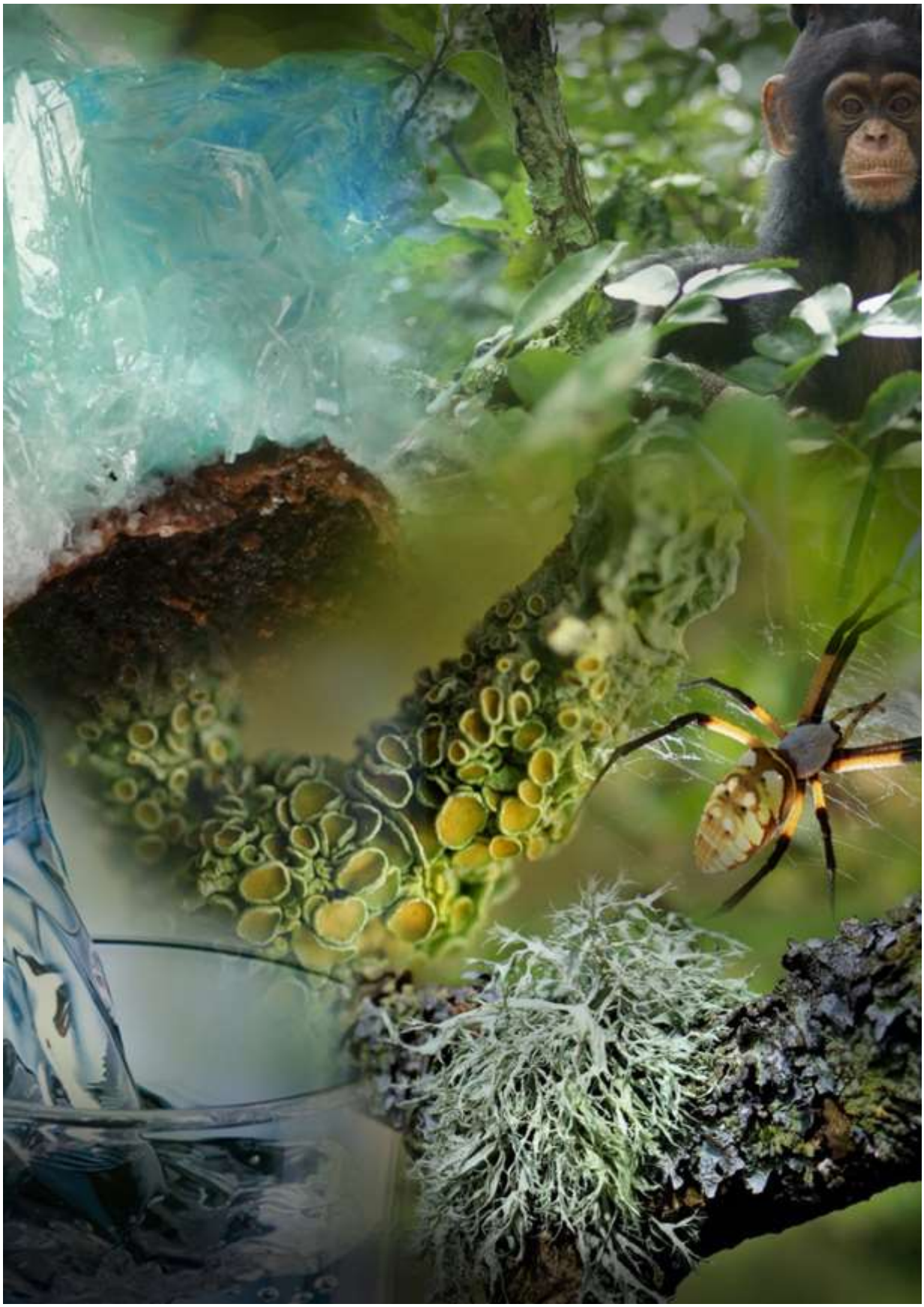

Earth, Environment & Biodiversity

The main focus of research in this cluster is discovering, evaluating, and developing the island's bountiful biotic and abiotic natural resources. Research activities are also focussed 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 toxic metal release from soil and water, remediation of soil and water contaminated with heavy metals, textile dyes and nutrients (phosphates, nitrates) using composite material and phytoremediation using plants. Eventually, researchers will provide a sustainable solution for the prevailing water quality issues in the dry zone of Sri Lanka by designing novel membranes using Sri Lankan vein graphite.

Some scientists in this cluster are focussing on evaluating earth resources such as mineral and geothermal resources, finding new ones, as well as on developing efficient ways to use energy through co-generation, using thermoelectricity.

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 the flora of Sri Lanka are also studied by the scientists attached to this cluster.

Another group of scientists in this cluster are focussed 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 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 Chemo-dynamics
- Evolution, Ecology & Environmental Biology
- Plant & Environmental Sciences
- Plant Taxonomy & Conservation
- Primate Biology

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Earth Resources & Renewable Energy

Energy is one of the single most important entities for mankind today. With the ever increasing demand, efficient use of existing energy sources is as important as finding new sources of energy. ER & RE project focuses on both these aspects. This concept has also been extended to other earth resources such as mineral resources.

Sub project on geothermal resources of Sri Lanka has both fundamental and applied aims. While there is no question about the usefulness of finding geothermal energy as a renewable energy source, there is also a strong academic interest to understand the origin of geothermal resources in Sri Lanka and its relationship to the Highland-Vijayan lithological boundary.

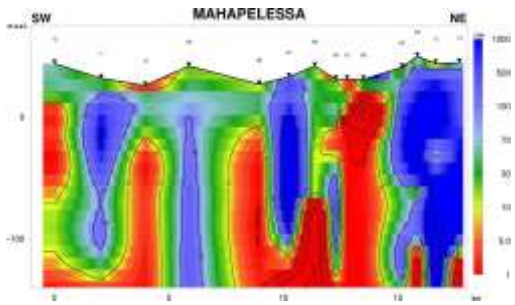
Sri Lanka is rich in minerals with economic value. Sustainable utilization of already known deposits as well as finding hitherto unknown mineral deposits will contribute to the economic development of the country. Deep understanding of the origin of minerals and rocks in Sri Lanka will not only help to identify new resources, but also help to understand the origins of lithological complexes in Sri Lanka and contribute to the advancement of knowledge.

A project on radon mapping is jointly conducted with the Atomic Energy Board, Sri Lanka to establish the baseline of the background radiation levels and to find mineral resources.

The project on thermoelectricity is a pioneering research area introduced to Sri Lanka. Thermoelectricity is the generation of electricity directly from heat energy using "*Seebeck Effect*". While thermoelectricity can generate electricity using renewable sources, one of the major advantages is the unique ability to increase the overall efficiency of existing systems by 'scavenging' and converting waste heat to electricity through co-generation.

Geothermal Resource Mapping Project:
As evidenced by a number of thermal springs, Sri Lanka has some geothermal resources, although not located in a volcanic region. 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 our dependence on imported fossil fuel, but will also help to reduce polution.

The NIFS initiated a project in collaboration with few other institutes, to conduct the first ever comprehensive study of Sri Lankan geothermal resources. Passive and active geophysical techniques were employed to investigate the near-surface as well as deep structures of the earth. 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 two 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, the focus was on the geochemical, petrological and mineralogical aspects of the areas around the geothermal belt.

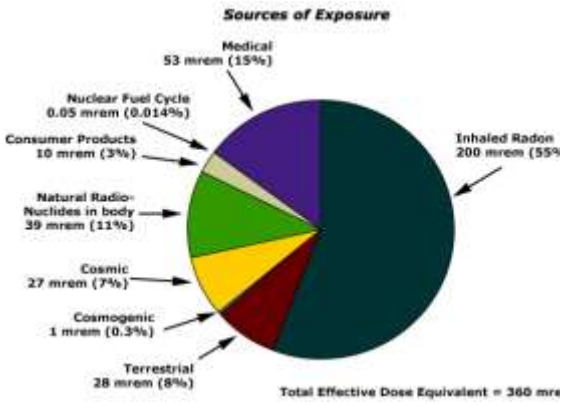


Resistivity profile of the area around Mahapelassa thermal spring, modelled using

Mineralogy & Economic geology Project: Evaluating, estimating and exploring mineral deposits using modern geophysical, geochemical and mineralogical techniques help not only to find new economic mineral resources, but also to understand the fundamental processes of nature. Sri Lankan rocks are studied using modern petrological and mineralogical tools as well as using geochemical and geophysical techniques.

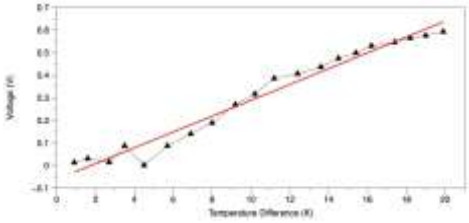
Radon Mapping Project: In collaboration with the Atomic Energy Board of Sri Lanka, NIFS is conducting a radon monitoring programme with a view to producing a radon map of the country. Passive and active methods are used in this exercise. Indoor and outdoor radon levels are mapped around the country.

Radon, the heaviest inert gas, is responsible for the largest dose of natural radiation on earth. Atmospheric radon levels vary with time and place, due to many factors. In health perspectives, it is important to monitor the indoor radon levels. Outdoor radon maps may help identifying U and Th bearing mineral deposits.



Thermoelectricity (TE) Research: Reasearch on TE is a fast growing field globally, although no serious research was going 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.

NIFS conducts research to enhance the thermoelectric properties of low-cost material, Graphene Thin Films produced at NIFS using Sri thermoelectric properties. These thin films may be used in niche applications such as extracting body heat to power-up wearable electronic devices and bionic devices or use of waste heat from automobile engines to generate electricity for creature comfort applications.



Variation of generated voltage for various thermal gradients across a graphene Thin Film

This project is partially funded by the NRC Grant 15-119.

Postgraduate Degrees Completed in 2018:
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Research Assistants in 2018:
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Three key publications in the last three years:

Dharmapriya, P. L., Malaviarachchi, S. P. K., Galli, A., Su, B-X., **Subasinghe, N. D.**, and Dissanayake, C.B. (2015), Rare evidence for formation of garnet + corundum during isobaric cooling of UHT meta-pelites: New insights for retrograde P-T trajectory of the Highland Complex, Sri Lanka, ***Lithos*****,** 220-223, 300-317**.**

Nimalsiri, T.B., Suriyaarachchi, N.B., Hobbs, B., Fonseka, M., Manzella, A., Dharmagunawardena, H.A. and **Subasinghe, N.D.** (2015) Structure of a low-enthalpy geothermal system inferred from magnetotellurics — A case study from Sri Lanka. ***Journal of Applied Geophysics***, 117, 104–110.

Jayathilaka, P.B., Pathiraja, G.C., Bandara, A., **Subasinghe, N.D.** and Nanayakkara, N. (2015). Electrochemical oxidation of phenol on Steel/IrO2-Sb2O3 electrodes: a mechanisms study, ***Canadian Journal of chemistry.*** 93, 536-541.

From left: Mr. H.S. Wijekoon, Mr. N.B. Sooriyaarachchi, Prof. N.D. Subhasinghe, Mr. H.M.D.A. Bandara, Mr. O.K.S. Opatha, Ms. D.R.T.L. Harischandra

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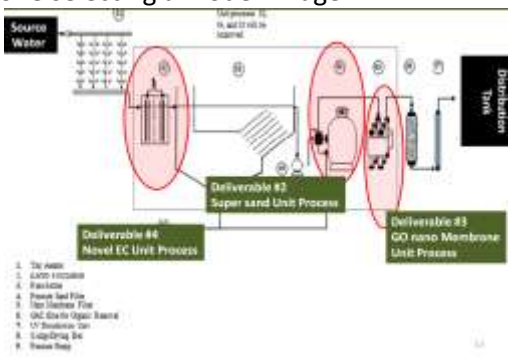
Environmental Science Research Program: Water Quality

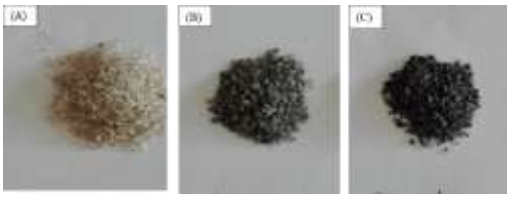
Environmental Science research has to date been considered an area of applied science. However, at NIFS it takes a different perspective in setting up environmental research programs. In essence, the **NIFS Environmental Science Research Program** is focused on addressing the fundamental scientific aspects of pressing environmental problems in Sri Lanka with global interest. The **NIFS Environmental Science Research Program** is in consonance with the National Environmental Action Plan of Sri Lanka that seeks insight into the environmental processes at a molecular level. The NIFS Environmental Science Research Program is focused on water, soil and atmospheric environmental systems.

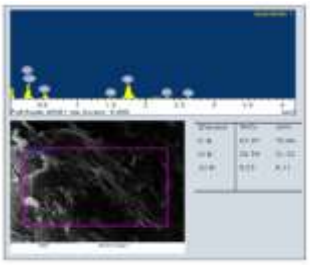
Water Quality Research in compliance with UN Sustainable Development Goals, the provision of clean water to the entire nation without any discrimination is set at the highest priority by the Government of Sri Lanka. Presently 14% of the Sri Lankan population (~3 million) does not have access to safe water. The overall aim of this project is to design a model water treatment facility based on sound scientific foundation utilizing electro-chemical and nanotechnology. The potential energy surfaces of the important chemical species will be examined by *ab inito* methods, and the existence of these species will be assessed experimentally. The researchers from University of Peradeniya, University of Jayawardhanapura, Rajarata University, Uva Wellassa University, University of Moratuwa, Wayamba University, National Water Supply and Drainage Board, Karlsruhe Institute of Technology, Lublin University, and Chinese Academy of Sciences, collaborate in the program. Support is received from the National Research Council of Sri Lanka, Natural National Research Foundation of China and other state and industrial sectors.

Model water treatment facility will provide a total solution for acute water problem in dry zone selecting a model village.



The model water treatment plant is now operational at Rajarata University, Sri Lanka. The aim of this project is to provide a robust water treatment facility to a village. After optimizing conditions, a model treatment facility to provide water to a village within 2018. However, our researchers will not conduct any research in the villages. They will be done at the university or national laboratories. At the same time, the villagers are not involved in plant operation. It will be carried out by professionals. However, villagers are responsible for safe guarding the water source against contamination. Modern appropriate technologies are used. Within a five years period, the technology will be transferred to Sri Lanka, and most of the consumables will be fabricated from indigenous materials.

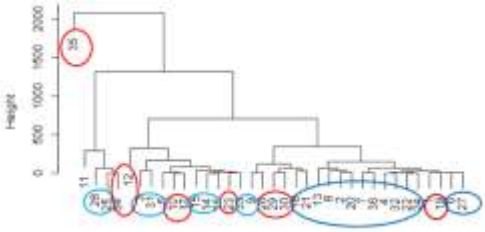




Sri Lankan sand and vein graphite is already being used to remove turbidity as well as excess fluoride from water. The novel material will soon be introduced in rapid sand filters.

Integrated Water Quality Index

Dominant water quality issues in Sri Lanka's dry zone groundwater are high TDS, hardness and fluoride that often exceed regulatory safety limits. Since fluoride is a primary contaminant, control of levels before consumption is mandatory. Even though, both TDS and hardness regulation is not mandatory, they are seriously impair water palatability. Therefore, water palatability requires improvement before treating with fluoride or other minor constituents. Water treatment based on reverse osmosis technology is a widely used treatment method in the dry zone.



We proposed an integrated water quality index (IWQI) utilizing chemical species for rapid demarcation of source water selection in a village in the dry zone. The IWQI values ranged from 9 - 406, and they were categorized into five classes (very good 0 – 25, good 26 – 50, poor 51 – 75, very poor 76 – 100, and unsuitable > 100). IWQI values were classified by cluster analysis.

Electrochemical water treatments use electric fields as a driving force for migration of ions through the membrane. Development of vein graphite based ion tunable membranes for the exchange of ions is in progress

We have developed a novel electro-coagulation cell to mitigate excess fluoride and TDS in water.

Environmental Soil Chemistry

Surface titration method is a mainstay technique in Environmental and Materials Characterization Laboratories to probe sites' reactivity of solids. The information is vital in designing pollutants remediation and water treatment methods, and semi-conductor and heterogeneous fabrication. However obtaining reproducible surface titration data is a challenge that requires a homogeneous suspension of particulates at critical solid / solution ratios.

To circumvent this difficulty, we invented a new flow cell suited for rapid surface titrations of heterogeneous particulates that are porous.

Desired solution is passed continuously through the materials and the steady state conditions can easily be achieved leading to surface hydroxylation. Suspension of particulates in aqueous/ non-aqueous phase is not mandatory.

Once the equilibrium is reached, protons/ other ions at the interfacial region can be estimated from the measurements of desired ion in bulk solution using Boltzmann equation:

$$\frac{m_i}{m_{i,bulk}} = exp\left(\frac{z_i F \Psi}{RT}\right)$$

This method works well for heterogeneous porous materials.

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Niluka Sewandi, Gimhani Perera

Key publications:

Y. Galagedara, GimhaniPerera, Y. Ren, M. Jayaweera, Y. Zhao, **R. Weerasooriya,** 2018. Development of sulfonated graphene oxidepolyamide thin film composite membranes for forward osmosis, Desalination and WaterTreatment[In press]

A.A.G.D. Amarasooriya, S.K. Weragoda, M. Makehelwala, **R. Weerasooriya** 2018 Occurrence of trihalomethane in relation to treatment technologies and water quality under tropical conditions. H_2Open Journal, IWA Publishing [In press]

Sanduni Ratnayake, Anoma Ratnayake, Dieter Schild, Edward Maczka, Elzbieta Jartych, Johannes Luetzenkirchen, Marek Kosmulski, **Rohan Weerasooriya,** 2017. Chemical reduction of nitrate by zero valent iron nanoparticles adsorbed radiation-

Ms. R.W.U.N. Ariyarathna, Ms. P.M.I.C.J. Bandara, Dr. I.PL. Jayarathne, Prof. R. Weerasooriya, Mr. B.A.Y.B. Jayawardhana, Ms. J.U. Halpegama, Ms. P. Rukshagini

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Environmental Science Research Program: Materials development & Pollution remediation

Environmental Science research has to date been considered an area of applied science. However, at NIFS it takes a different perspective in setting up environmental research programs. In essence, the **NIFS Environmental Science Research Program** is 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 air is the most focused. Monitoring and understanding of the basic and fundamental mechanisms of the pollutant materials in nature is important. Advanced materials such as nanomaterials and composite materials play a vital role in various applications. Synthesis of advanced materials using locally available materials such as zeolite from kaolin, contribute to national development. Nano and composite materials show higher efficiency in remediation of pollutants in the environment. Air pollution is a dynamic problem. Air pollution networks and statistical modelling is important in understanding levels of air pollution in different micro environments. We use newly emerging smart sensor technology, unmanned aerial vehicles (drones) and satellite data to produce high resolution air pollution models. Then we link these models to understand the effects of pollutants on human health.

Major Research Fields

Water Quality Research: The overall aim of this project is to design a model water treatment facility based on sound scientific foundation utilizing electro-chemical and nano technology.
Novel Substrates for Pollution Abatement: Novel nano and composite materials for pollutant remediation
Environmental Organic Chemistry: Disinfectants by-products are ubiquitous in Sri Lankan treated water In collaboration with National Water Authorities in Sri Lanka we will elucidate THM formation mechanisms and persistence in distribution networks
Air pollution Research: Air pollution modelling; health risk assessment

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

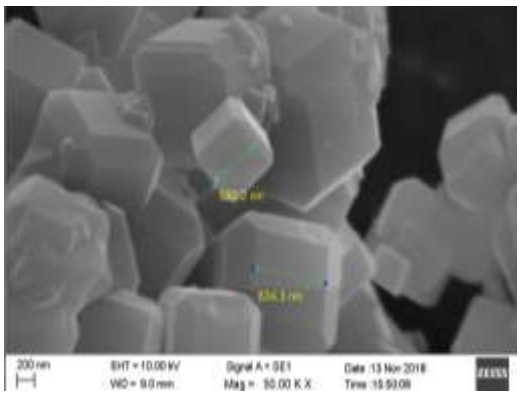
The conventional synthetic zeolites historically known as molecular sieves are crystalline aluminosilicates with well-defined pores structures. Nano-crystalline zeolite synthesis has received considerable attention in the past decade and has today turned into an essential commercial material. Zeolite-A (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 have been synthesized via low-temperature hydrothermal crystallization in the presence of 'organic templates'. Generally, Tetramethylammonium-hydroxide (TMAOH) will be used as a template. However, these templates are expensive and non-recyclable. Therefore, under 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 with the absence of mineralizers and organic templates. As a size controlling agent, an anionic surfactant called Sodium dodecyl sulfate (SDS) was used. The effect of different crystallization conditions including ageing time, synthesis time, synthesis temperature were studied under both methods.

In addition, the influence of surfactant amounts for particle size-control 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 requires much less time and no considerable change was found in crystal size and crystallinity.



Synthesis of L-Cysteine capped CdTe quantum dots in zeolite medium under atmospheric conditions

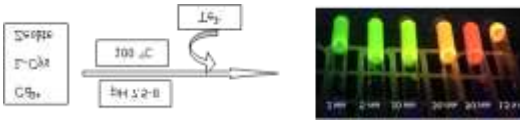
Recently, researchers have paid more attention to the construct distinctive varieties of nanomaterials such as quantum dots as a result of its extensive usage in numerous fields. Quantum dots are nano crystals, derived from bulk compound of semiconducting materials. These have unique semiconductor energy levels that can be tailored by simply altering size, shape and charge potential. Different-sized Quantum dots result in distinct colors due to the variation in their energy levels. In this study, zeolite, a micro porous alluminosilicate which is traditionally used as an adsorbent, was used as an air trapping agent during CdTe synthesis with the aim to maintain inert conditions under ambient environment. L-Cysteine (L-Cys) capped CdTe quantum dots were synthesized in the presence of zeolite. Results indicated successful synthesis of florescent CdTe quantum dot nano crystals.

These can be further modified and used in many applications especially in diagnostic assays for infectious diseases

L-Cysteine capped CdTe quantum dots coated iron oxide nanoparticles as diagnostics

Quantum dot nano-crystals are semiconductor nano-materials with intrinsic chemical and physical properties. These have unique semiconductor energy levels that can be tailored by simply altering size, shape and charge potential. Different-sized quantum dots (QDs) result in distinct colors due to the variation in their energy levels. Along with proper modification, particularly with iron oxide nanoparticles (IONP), these QDs can be of great importance in the fields of biotechnology and biomedical sciences. The current study focuses on synthesis and modification of CdTe QDs and magnetite (Fe3O4) nanoparticles, to be used as a diagnostic tool. Hydrothermal synthesis of L-Cysteine (L-Cys) capped CdTe quantum dots was applied. Poly Acrylic acid (PAA) coated magnetite nanoparticles were prepared by co-precipitation of Fe^{2+} and Fe^{3+} ions. All the above preparations were carried out under inert atmosphere. Trials for conjugation of PAA coated magnetite and QDs were conducted using deionized water, phosphate buffered saline (PBS) and acetate buffer as the medium using different temperature and pH combinations.

Acetate buffer at 25 °C temperature and pH 6.0 was demonstrated as the optimum combination for IONP-QD conjugation. IONP-QD complex was used to anchor rabbit polyclonal antibodies using EDC system, a carbodiimide cross-linker, followed magnetic extraction to purify IONP-QD-antibody complex. Enzyme Linked Immuno-sorbent Assay (ELISA) was carried out to confirm the conjugation of antibodies on the nano-complex. Results indicated successful synthesis of florescent CdTe QDs coated with IONP. Further, these antibody conjugated nanoparticles can be used in many biomedical applications especially in diagnostic assays for infectious diseases.



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Key Publications:

L. Jayarathna, M. Makehelwala, A. Bandara, R. Weerasooriya. Vibration spectroscopic evidence for different interactive modes of iodide on gibbsite in humic acid mediation, Colloid and Polymer Science, 2018,296(7),1259–1265

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Environmental Science Research Programme: Air Pollution & Risk assessment

Air pollution is a global public health issue. Annually, about 7 million people die from air pollution exposure. It is 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 and whole populations in a given areas are exposed. Therefore, even small increases 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 Sri Lankan economy by air pollution has significant consequences affecting economic growth as well as welfare.

Air pollution modelling is used to estimate population/individual level exposures which are important in health risk assessments. 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. This group’s research will provide evidence targeted at controlling air pollution by implementing policies.

Building an air pollution monitoring network using smart sensors:

Ambient air pollution in Sri Lanka is relatively high according to World Health Organization (WHO). However, air pollution monitoring in the country has been limited to a few specific locations. This sparse monitoring do not represent actual levels that Sri Lankans are exposed to. Hence, it is impossible to evaluate health risks associated with air pollution in Sri Lanka using existing ground monitoring stations. Air pollution monitoring using 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.

The solar powered sensor unit (Figure 1) established at the NIFS premises measures important pollutants – Particulate Matter (PM) less than 1=µm in diameter (PM1), PM less thsn 2.5µm in diameter (PM2.5) and PM less than 10=µm in diameter (PM10) continuously. These data are uploaded to a cloud-based server and the pollution levels can be observed real time.

The average PM1, PM2.5 and PM10 were 18 µg/m3, 31 µg/m3, 35 µg/m3 over the period of December and January 2019. The levels were significantly high compared to WHO standards (e.g. PM2.5-10Mg/m^3). The Figure 2 shows weekly variation of PM1, PM2.5 and PM10 in Kandy.

There is a notable pattern in weekly variation. Weekdays show high air pollution compared to weekends. These data together with other 10 monitoring sensor units planned to be established in Kandy City will be used to build a high-resolution air pollution map to identify spatial and temporal patterns of air pollution.

Figure 1. Smart sensor PM monitor

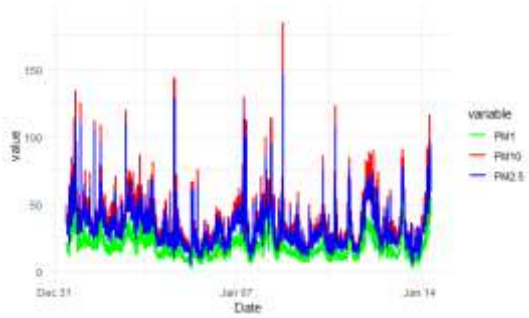

Figure 2. Time series of PM1, PM2.5 and PM10 in Kandy over December and January 2019

Mobile air pollution monitoring:

Fixed site air pollution monitoring stations do not provide accurate representation of spatial variations of air pollution. Mobile air pollution monitoring can identify broad spatial trends of the urban air quality. We use modern technology and mapping tools to measure and visualize air pollution over a large area.

Ground mobile air pollution monitoring.

In areas, such as cities the patterns of air quality will vary at a range of spatial and temporal scale with heavy traffic volumes, varied weather and sporadic emissions, and a fixed air pollution network may miss this complexity. Using mobile air pollution monitors we measure air pollution along the roads to identify air pollution hot spots in Kandy city. Figure 3 shows air pollution in some of the major roads of the Kandy City.

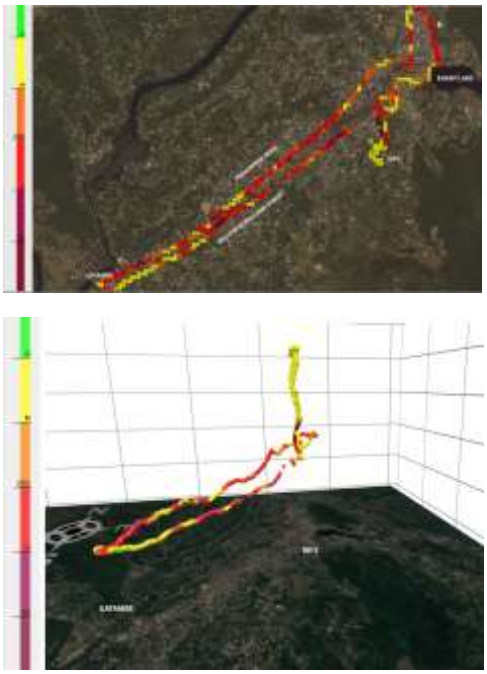

Figure 3: PM2.5 concentrations along Kandy streets.

Aerial air pollution monitoring:

Unmanned aerial vehicles (UAV) or drones are a recently developed technique that have been used in wide areas of research. Smart air pollution sensors can be harboured into these UAVs to easily measure air pollution over a wide area. This technology not only provides measurements horizontally, but also vertically. We use drone mounted air pollution sensors to characterize vertical distribution of air pollution.

Research Students:
Mahesh Senaratna, Sajith Priyankara

Key publications:

Bowatte G, Lodge C, Knibbs L, Erbas B, Perret J, Jalaludin B, Morgan G, Bui D, Giles G, Hamilton G, Wood Baker R, Thomas P, Thompson B, Matheson M, Abramson M, Walters EH, Dharmage S. Traffic related air pollution and development and persistence of asthma and low lung function. **Environment international. 2018;113:170-6.**

Yang M, Chu C, Bloom MS, Li S, Chen G, Heinrich J, Markevych I, Knibbs LD, **Bowatte G,** Dharmage SC, Komppula M, Leskinen A, Hirvonen MR, Roponen M, Jalava P, Wang SQ, Lin S, Zeng XW, Hu LW, Liu KK, Yang BY, Chen W, Guo Y, Dong GH. Is smaller worse? New insights about associations of PM1 and respiratory health in children and adolescents. **Environmentinternational. 2018;120:516-24.**

Bowatte G, Erbas B, Lodge CJ, Knibbs LD, Gurrin LC, Marks GB, Thomas PS, Johns DP, Giles GG, Hui J, Dennekamp M, Perret JL, Abramson MJ, Walters EH, Matheson MC, Dharmage SC. Traffic-related air pollution exposure over a 5-year period is associated with increased risk of asthma and poor lung function in middle age. **European Respiratory Journal. 2017;50(4).**

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Evolution, Ecology and Environmental Biology

Basic research in biodiversity covers every aspect of ecosystem function. Research in my 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 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.

Studies in my lab 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. The invertebrate fauna of our country remains largely unexplored, with most studies originating during the colonial period.

Arthropod diversity estimates are used as indirect assays of ecosystem function or productivity or as direct estimators of ecosystem responses to human induced change. Our findings are shared through papers published in international peer reviewed journals.

Molecular Phylogeny of Goblin Spiders with a Revision of Selected Genera (Araneae: Oonopidae) of Sri Lanka

The Oonopidae or goblin spiders is a midsize family (1807 species) of minute spiders that mostly inhabit leaf litter or the canopy of forests worldwide. The aims of the project "Sri Lankan Oonopidae" were to undertake a taxonomic revision of selected Oonopidae genera in Sri Lanka and to include Sri Lankan representatives of the family in a worldwide molecular analysis.

During this study, 30 new species were described. Identification keys and distribution maps were provided for all Sri Lankan species. New members were found in the genera *Grymeus* and *Cavisternum*, which were previously believed to be Australian endemics, as well as seven new species of *Silhouettella*, *Pelicinus*, *Ischnothyreus* and *Opopaea*. The study revealed the presence of 46 Oonopidae species (41 endemics) belonging to 13 genera in Sri Lanka.

Phylogenetic evidence from two nuclear ribosomal loci showing the relationships of Sri Lankan taxa to the remaining global goblin spider fauna was analyzed. The study inferred the phylogenetic relationship of the family Oonopidae including 154 taxa representing 140 oonopids belonging to 40 genera. All generated sequences were submitted to the Genbank.

The species of *Brignolia* are narrow endemics with very restricted distributions. Therefore, we supposed that most of this diversity is derived from island speciation. Hence to confirm this hypothesis, a biogeographic study using *16S*, *28S* and *CO1* sequence data for these short range endemics is ongoing.

Molecular Phylogeny and Systematics of Jumping spiders (Family: Salticidae) from Sri Lanka

The jumping spider (family Salticidae) is the most speciose spider family in the Araneae with 6109 described species categorized under 636 genera (World Spider Catalog, 2018) representing about 13% of global spider diversity. Sri Lanka possesses a relatively large jumping spider fauna of 86 species, placed in 50 genera, with a large endemic component. However, this might be only a small fraction of its true diversity. The aim of the project is to identify and document the jumping spider diversity of the island as well as the inclusion of them in the global molecular phylogeny of Salticidae.

Spiders were collected by leaf litter sifting, general hand collecting, sweeping and beating off bushes and trees. All materials were preserved in either 70% or 100% ethanol for morphological and molecular analysis respectively.

To date, nearly 1055 specimens have been identified up to genus and/or species level. Three new genera and several new species to science and new records of the genera *Habrocestum*, *Synagelides*, *Phintella*, *Carrhotus*, *Cosmophasis*, *Evarcha*, *Curubis*, *Telamonia*, *Onomastus*, *Menemerus*, *Ballus*, *Marengo*, *Rhene*, *Colaxes*, *Hyllus*, *Flacillula*, *Ptocasius*, *Plexippus*, *Epidelaxia*, *Bianor*, *Harmochirus*, *Cyrba*, *Siler*, *Simaetha*, *Stenaelurillus*, *Hispo*, *Thyene*, *Tamigalesus*, *Thiania*, *Hasarius*, *Phausina*, *Irura*, *Epocilla*, *Phaeacius* have been diagnosed. During 2018, four new species were added to the island's biodiversity.

In addition, molecular phylogeny of Tribe Chrysillini was undertaken to elucidate the interrelationships within their global molecular phylogeny. Genus *Evarcha* was revised with the description of seven new species and taxonomic keys.

MOLECULAR PHYLOGENETIC RELATIONSHIPS OF SELECTED CRAB SPIDER GENERA (ARANEAE: THOMISIDAE) WITH NOTES ON NEW SPECIES 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. Thomisidae is the sixth largest family of spiders and currently includes 2164 species placed in 170 genera distributed worldwide. 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 provide taxonomic description of the currently monotypic crab spider genus *Peritraeus*, re-circumscribe it in phylogenetic terms and placement of the genus in the thomisid tree of life, description of new species of *Tmarus* and assessment of its relationship to *Peritraeus* and phylogenetic placement and taxonomic revision of the crab spider genera *Diaea*, *Massuria* and *Tarrocanus* with provisional descriptions of new species and notes on their distribution. Molecular phylogeny of the selected crab spider genera was based on combined molecular data. Among the ten new species described, nine were endemic to Sri Lanka. *Tmarus hystrix*, *Diaea subdola* and *Tarrocanus capra* were re-described. Three species of *Tmarus*, one species of *Diaea*, one species of *Massuria* and one species of *Tarrocanus* will be described as species new to science in the near future. DNA barcodes for 47 Sri Lankan taxa were generated and these sequences were submitted to Genbank. The presence of the endemic species and their restricted distribution highlights their diversity and the necessity of conserving their habitats.

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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.

Ranasinghe, U.G.S.L. and **Benjamin, S.P.** 2018. 2018. Taxonomic descriptions of nine new species of the goblin spider genera *Cavisternum*, *Grymeus*, *Ischnothyreus*, *Opopaea, Pelicinus* and *Silhouettella* (Araneae, Oonopidae) from Sri Lanka. Evolutionary systematic. 2: 65-80.

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Plant and Environmental Science

The major focus of this group is on environmental remediation of hazardous materials polluting our waterways, particularly by heavy metals, textile dyes, fertilizers (nitrates, phosphates) and toxic organic and inorganic wastes. A cost-effective simple decontamination method is needed for small and medium scale enterprises who are unable to invest in high tech expensive waste water treatment systems. Bio-adsorbents were developed from polymers extracted from seaweeds (alginate) and crustacean shells (chitosan) and combined with kaolin clay to form Polymer Layer Silicate composites (PLS). The PLS adsorbed with 90% efficiency, heavy metals and textile dyes and colour from effluents of textile factories. PLS from alginate and the mineral materials feldspar and kaolin showed a removal efficiency of over 80% for phosphates; however, the efficiency of nitrate removal was moderate (~50%). Hence, aquatic weeds were used for phytoremediation of nitrate.

The plant tissue culture project is investigating the micro-propagation of selected species from the dry forests for restoration of degraded forests. Natural propagation through seeds is seasonal, and seedlings are usually unavailable when required. Thus, for large scale propagation traditional methods are inefficient and plant tissue culture can mass propagate species once the protocol is developed.

In Sri Lanka, climate change is manifested by extreme weather as floods and droughts. Since this has immediate implications in our agriculture and health sectors, understanding the historical trends in our rainfall and temperature patterns, particularly extreme weather events, is important to assess future trends. We also looked at socio-economic parameters and climate to combat the spread of the dengue virus, particularly knowledge, attitude and practices (KAP) in high risk areas in the Kandy district. A cross-sectional survey was conducted in five selected dengue free communities living in high risk areas.

Environmental Remediation

Contamination of the environment by hazardous materials such as heavy metals, textile dyes, and fertilizers (nitrates, phosphates) is a concerning environmental issue in Sri Lanka. A cost-effective simple decontamination method (i.e. end pipe treatment system) is needed for small and medium scale industries. The project developed Polymer Layer Silicate composites (PLS) and Metal Organic Frameworks (MOFs) to remediate the above pollutants from water. Polymers extracted from seaweeds (alginate) and crustacean shells (chitosan) were combined with kaolin clay to form polymer layer silicates. PLS showed over 90% removal efficiency for heavy metals and textile dye pollutants. PLS also successfully removed colour from effluents of textile factories.

MOFs are crystalline structures used in the separation and storage of toxic gases, catalytic reactions and electrochemistry. Few studies have reported using MOFs as a sorbent for heavy metals and textile dyes. We used a green synthesis method to synthesise the MOFs. The MOF prepared from Fe(III) and Terephthalic acid was able to remove methylene blue up to 80% and Cr(VI) up to 60%.

PO_4 and NO_3 remediation

Nitrate and phosphate removal was conducted using polymer-silicate composites. The polymers were from agar and alginate and the mineral materials were feldspar and kaolin. In some composites, fly ash was also used. The removal efficiency of these composites were over 80% for phosphates; however, the efficiency of nitrate removal was moderate (~50%). Hence, aquatic weeds were used for phytoremediation of nitrate. Experimental conditions were optimized for phosphate removal over a wide pH range (pH4-10). Phytoremediation by *Salvinia molesta* and *Pistia stratiotes* showed an absorption efficiency of 90% and 60% for phosphates and nitrates, respectively. Plants were able to tolerate and effectively remove these nutrients over a wide pH range (pH 3-9). The results from these studies showed that a phytoremediation system followed by an adsorption column system was more effective in treating the nutrients (>90% after 50 h). The adsorption mechanism of phosphate by the composites materials was investigated with theoretical studies using thermodynamics, kinetics and isotherm data. It was found that the phosphate is adsorbed by surface precipitation, ion exchange electrostatic forces and Lewis acid-base interactions. Phytoremediation studies are important to recover phosphates. The distribution of phosphate within the plant and its use as a phosphate-rich compost fertilizer is under investigation. The composites were used to treat wastewater from the university animal farm and the phosphate content was successfully reduced. The use of adsorbents and plants as nitrate and phosphate fertilizer is currently under investigation.

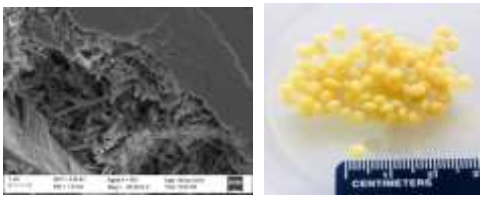

Figure 1. composite prepared from alginate, agar and feldspar.

Plant tissue culture methods for reforestation in the dry forests

The dry forests in Sri Lanka are being degraded due to extensive deforestation from *chena* cultivation, harvesting for fuelwood and fragmentation. Selection and successful propagation of tree species is important for ecological restoration in these forests. Species such as Mee (*Madhuka longifolia*), Palu (*Manilkara hexandra*), and Kaluwara (*Diospyros ebenum*) have high economic value as timber. Natural propagation through seeds is seasonal, slow, and seedlings are not available in the numbers required. In the present study, specific parts of plants, such as, shoot tip, root tip, seed, embryo and leaves were cultured either to achieve direct organogenesis or indirect embryogenesis.

Figure 2. Growth of the tissue cultured plants *Madhuka longifolia* and *Manilkara hexandra.*

Different basal media such as Murashige and Skoog (MS) and Woody Plant Medium (WPM) have the ability for initiation and proliferation of the selected woody plant species with the

combination of phyto-hormones such as cytokines, and auxins. From our preliminary studies we obtained callus induction through leaves and shoot tissue. Direct induction of shoots was observed from *Manilkara hexandra* and embryos were successfully cultured from *Diospyros ebenum*.

Climate change implications

In the recent past, Sri Lanka was affected by extreme weather: floods and droughts. Understanding the historical trends in our rainfall and temperature patterns, particularly extreme weather events, is important to assess future trends. Our analysis show that there is a significant increase in wet days and an increase in the annual average minimum and maximum temperatures. The spread of the daily temperature ranges also increased in the south western coastal regions. To combat the spread of the dengue virus, we looked at socio-economic parameters and knowledge, attitude and practices (KAP) in high risk areas in the Kandy district. A cross-sectional survey was conducted in five selected dengue free communities living in high risk areas. Their dengue free status was associated with their knowledge and awareness of the mosquito behavior (breeding, biting behavior, symptoms, waste management) and attitudes of the community. Vector controlling authorities should focus on these factors to encourage the communities to participate in control and transmission of dengue.

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Udayanga, L., Gunathilaka, N., **Iqbal, M. C. M.,** Najim, M. M. M., Pahalagedara, K. and Abeyewickreme, W. (2018) Empirical optimization of risk thresholds for dengue *Parasites and Vectors*. doi:10.1186/s13071-018-2961-y.

Naveendrakumar, G., Vithanage, M., Kwon, H. H., **Iqbal, M. C. M.,** Pathmarajah, S., & Obeysekera, J. (2018). Five Decadal Trends in Averages and Extremes of Rainfall and Temperature in Sri Lanka. *Advances in Meteorology*, *2018*. https://doi.org/10.1155/2018/4217917

Dissanayake, D.M.R.E.A., Iqbal, S.S, Priyantha, N. and **Iqbal, M. C.M.** 2018. The adsorption of Cr(III) onto Kaolin: Alginate composite adsorbent. Symposium Abstract. *Open University International Research Sessions*. Open University of Sri Lanka, Nawala.

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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.

Of the 3,160 indigenous flowering plants species, about 30% are endemic to Sri Lanka. According to 2012 National Red list, about 44% of the indigenous flowering plants are threatened. Due to the high level of endemism in plants and the threats to biodiversity, Sri Lanka, with Western Ghats in India, is included in the global list of biodiversity hotspots.

Conserving the natural forest ecosystems is vital for the wellbeing of both flora and fauna and the conservation of our 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 as 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 has been 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

A ten-acre (4.4 ha) land within the NIFS-Popham Arboretum, Dambulla was selected for this study in 2017. Another 1 ha land was added to the study area in 2018. Total area was divided into 10 x 10 m grids (plots) and the girth and species names of woody individuals above 10 cm within each grid were recorded. The data were entered into a GIS (Arc View) database.

Herbarium specimens were collected from different species to authenticate all the species encountered within the study area. These specimens were preserved and mounted on herbarium sheets. A total of 72 forest species belonging to 65 genera and 29 families were recorded within the area sampled. A total of 267 species (225 Genera in 75 Families) were observed and identified within the study area.

In 2018, pioneer species in a 2-ha woodland area were studied. Importance Value Index (IVI) for each species was calculated. Six forest species have shown high IVI, Diplodiscus verrucosus (78.29), Grewia damine (71.08), Syzygium cumini (46.64), Chloroxylon swietenia (39.26), Mitragyna parvifolia (26.31), Pterospermum suberifolium (23.2).

Seed rain and soil seed bank studies have been initiated to study natural regeneration within the site. Another area of 1000 sq.m. has been selected from the woodland area to imitate ANR process and as a permanent plot. Dendrochronology studies have been initiated for age determination of forest species.

DNA Barcoding, Morphological Taxonomy and Phylogeny of *Syzygium* spp. of Family Myrtaceae in Sri Lanka: Implications for Conservation and Sustainable Exploitation.

Syzygium Gaertn., in the family Myrtaceae Juss. is the largest woody plant genus in the world, which contains 1,152 species of Asian, Australian and African distribution. Sri Lanka is represented by more than 30 species and the majority of them are endemic to the country. Since the genus is very large, no attempt was taken to properly investigate it creating many taxonomic problems. Now a global working group undertake this tedious task, while dividing the whole global distribution in to 22 regional sub sections.

Sri Lanka is solely a single region of this division due to its high endemicity,

A taxonomic study basically comprising of field work, herbarium work, and molecular lab work was started to study this genus. Field collections outside the protected areas has been started and eight species with flowering materials has been collected up to now. Existing herbarium sheets at the National Herbarium, Peradeniya were sorted and some of them are annotated.

Study on selected species of family Thymelaeaceae for agarwood type resin and their propagation methods

Agarwood is obtained from a resin formed in the heartwood of family Thymelaeaceae. *Gyrinops walla,* locally known as walla patta was extensively used to obtain this resin during the recent past. In this work, analysis of chemical compounds of resin extracts of three other local species of the family Thymelaeaceae, namely *Gnidia glauca*, *Wikstroemia indica* and *Phaleria capitata* were studied. In the TLC, spots observed at $R_f = 0.785$ were common in all four samples.

In GCMS chromatographs Isolongefolene and Copeane were common in *Gyrinops walla* and *Wikstroemia indica*. Common occurrence of 4, 7 Methanoazulene was identified in *Gyinops walla, Gnidia glauca* and *Wikstroemia indica* extracts. Studies showed that vegetative propagation is a better method for propagation of those three species.

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Key publications:

Wijayabandara, S.M.K.H., J.W. Damunupola, S.A. Krishnarajah, W.A.M. Daundasekera, and **D.S.A. Wijesundara.** 2018. Effect of different vase solutions on postharvest longevity of cut foliage *Ophiopogon japonicus*. Ceylon Journal of Science. Vol. 47 No 2. 195-199

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Ratnayake R. M. N. D., B. M. R. Bandara, N. K. B. Adikaram, **D. S. A. Wijesundara**, V. Karunaratne. 2018. Potential of the antifungal activity of *Ageratina riparia* (Regel) R. M. King and H. Rob. against banana anthracnose disease caused by the fungus, *Colletotrichum musae*. 2018. Ceylon Journal of Science. 47 (3):287-291

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http://www.primates.lk

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 within the local and international communities. To date more than 30 such documentaries have been produced, more are planned for the future. The films also advertise a positive image promoting tourism in Sri Lanka.

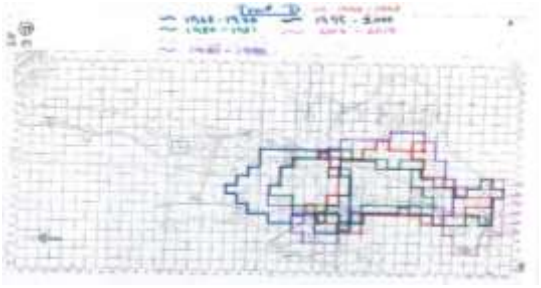
We test scientific hypotheses of social evolution and behavioral ecology through an interdisciplinary approach that examines the Darwinian outcomes (in terms of survival and reproductive success) of the various inter-relationships among parameters involving population genetics, genealogy, anatomy, epidemiology, 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 (2013-2018)

1. Dittus (2017). The biogeography and ecology of Sri Lankan mammals point to conservation priorities. Cey J Sci *46 (Special Issue): 33-64.*
2. Dittus, W. (2013). Arboreal adaptations of body fat in wild toque macaques (*Macaca sinica*) and the evolution of adiposity in primates. Am J Phys Anthrop 152:333–44.

Demography and range use of toque macaque *Macaca sinica sinica.*

Routine monthly census of groups of toque macaques has been reduced to a more manageable number of 10 groups in order to monitor rates of birth, death, immigration and emigration. We continue to search for and census "lost groups" of toque macaques that have left the limits of 3 km^2 designated study area and transferred into surrounding human inhabited areas. We also monitor group fission and analyse accumulated data.



Map of fission groups & home range changes macaque Group D 1968-2017.

Demography, range use and behavior of hanuman langurs *Semnopithecus priam thersites*. Routine monthly census of 11 groups of hanuman langurs to monitor rates of birth, reproductive seasonality, sex ratios at birth, and change in age-sex composition of groups with time, mortality and transfer between social groups. *Ad libitum* behavioural recording. Range use changes according to month and year. Project requires new staff training.

Unusual extreme sibling competition for maternal milk in a hanuman langur

The phylogenetics of langur species; *Semnopithecus vetulus, S. priam* and their hybrids.

A newly established (2017) collaboration between W. Dittus (WD), Suresh Benajamin (SB) of the NIFS and Praveen Karanth (PK) of the Indian Institute of Science, Bangalore, India. We aim to define the genetic differences among these populations as it pertains to the evolution of primate species. Hybrids have been identified, DNA samples have been collected in the field (WD), primers have been established and initial genetic analyses have been completed (SB & PK).

Hybrid female and infant

Demography, range use and behavior of the purple-faced langur, *Semnopithecus vetulus philbrickii*.

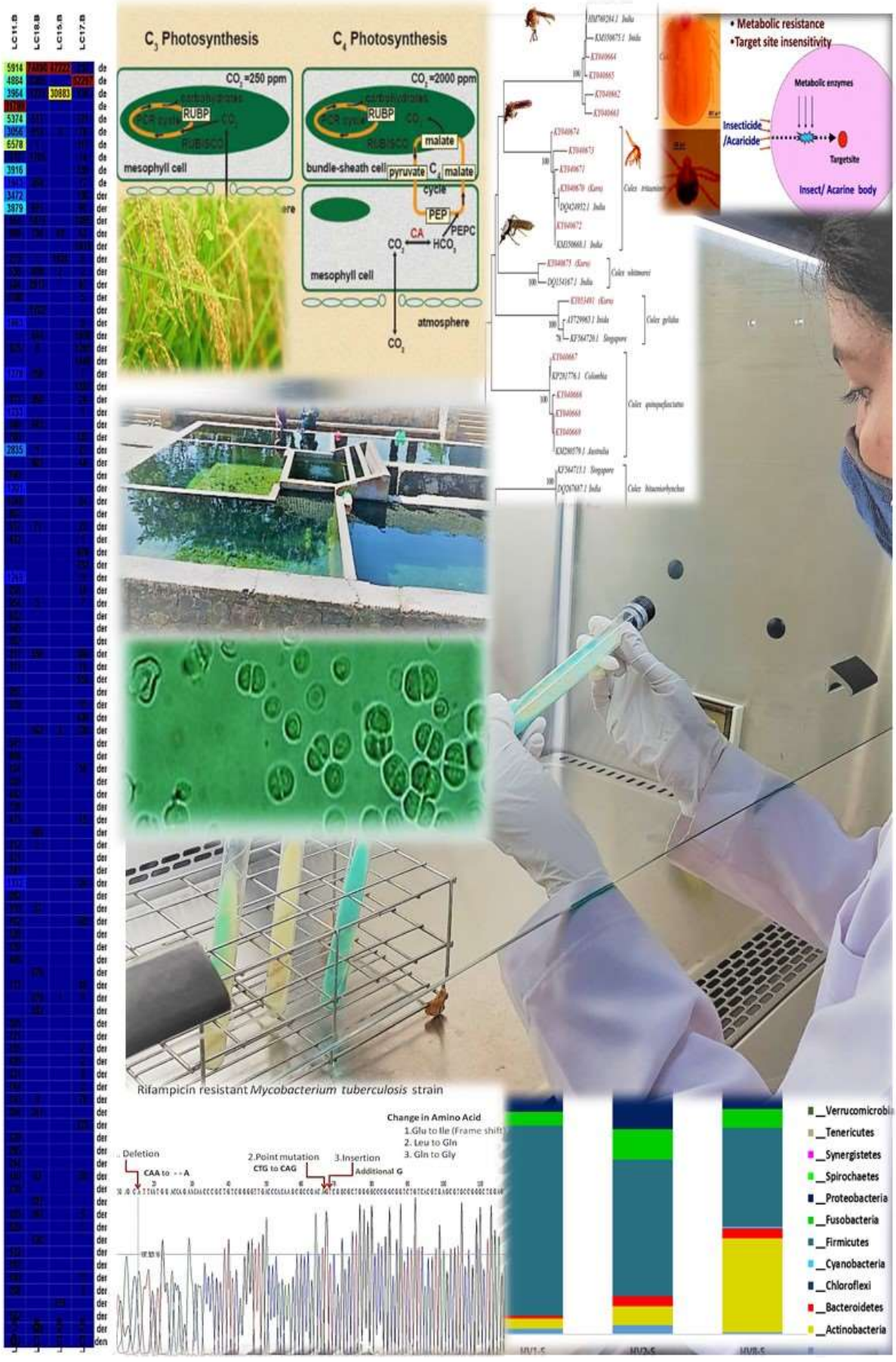
Routine monthly census of 14 groups PFL langurs to monitor rates of birth, reproductive seasonality, sex ratios at birth, change in age-sex composition of groups with time, mortality and transfer between social groups. Range use changes according to month and year. Comparative summaries of long-term demographic changes.

Sunil Rathnayake rescues an infant PFL victim of infanticide.

Primate field researchers at the Polonnaruwa nature Sanctuary (Archeological Reserve) recording behaviors among the toque macaques.

From left: Mr. C. Pathirathna, Prof. W. Dittus, Mr. Sunil Rathnayaka


SAM POPHAM
ARBORETUM
1964


C3 Photosynthesis
C4 Photosynthesis
CO2 =250 ppm
CO2 =2000 ppm
RUBP
malate
mesophyll cell
bundle-sheath cell
pyruvate
C4 malate cycle
PEP
PEPC
CA
HCO3
atmosphere
• Metabolic resistance
•Target site insensitivity
Metabolic enzymes
Insecticide /Acaricide
Targetsite
Insect/ Acarine body
Rifampicin resistant Mycobacterium tuberculosis strain
Change in Amino Acid
1.Glu to Ile (Frame shift)
2. Leu to Gln
3. Gln to Gly
Deletion
CAA to - - A
2.Point mutation
CTG to CAG
3.Insertion
Additional G
__Verrucomicrobia
__Tenericutes
__Synergistetes
__Spirochaetes
__Proteobacteria
__Fusobacteria
__Firmicutes
__Cyanobacteria
__Chloroflexi
__Bacteroidetes
__Actinobacteria

Molecular Biology & Biotechnology

Molecular Biology is the study of 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 2018, the project concentrated on four major sub projects which included studying the lung microbiota in lung cancer and bronchiectasis patients, to genetically characterize drug resistant *Mycobacterium tuberculosis,* how airborne microorganisms cause respiratory infections among pre-school children and potential microbial pathogens in bird droppings.

DNA barcoding of morphologically characterized Culicinae mosquitoes, pyrethroid resistance in dengue mosquitoes; *Aedes aegypti* and *Aedes albopictus,* frog- biting mosquitoes in Sri Lanka, predatory larvae of *Armigeres subalbatus* (Diptera: Culicidae) and their potential as biological control agent, Acaricide resistance of the brown dog tick *Rhipicephalus sanguineus* were the major research focuses of the Medical Entomology project.

The aim of 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 the stress tolerance levels of crops. Current focus 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**
- **Medical Entomology**
- **Plant Stress Biology & 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**; Molecular Microbiology & Human Diseases [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, Sri Lanka (2001 to 2002). **Assessor** for Laboratory Accreditation ISO 17025 & for Good Laboratory Practice (GLP)- Sri Lanka Accreditation Board for Conformity Assessment (SLAB). **Awards;** Paul Ehrlich Foundation Fellowship; Presidential Awards; WPSC Young Investigators Award; Prof. K. Rajasuriya Award for Tropical Medicine.

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Molecular Microbiology & Human Diseases

The research interests of our project revolve around microbial ecology and human diseases. Understanding the distribution of microbial communities in environment; air, water and soil as well as within the human lung. The study of human diseases include both communicable and non-communicable diseases namely pulmonary diseases and chronic kidney disease of unknown aetiology (CKDu) which has been gripping the country for the last two decades. A special focus is also directed on drug-resistant tuberculosis burden in the country.

The current research on pulmonary diseases focuses on the human lung microbiome. The study aims to identify how the bacterial colonization differs according to the human respiratory diseases. Furthermore, it is aimed to figure out how human-bacterial cellular interactions affect disease progression in lung cancer and bronchiectasis patients. Indoor and outdoor airborne microorganism studies investigate how the microbial community is spread throughout the environment, their composition, enumeration and identification of potential pathogenic microorganisms in the surroundings which we breathe. Thermophilic microorganisms in hot springs of Sri Lanka is an understudied area and we recommenced our studies on these extremophiles. Birds have the potential to act as carriers of pathogens for different infectious zoonotic diseases and we have commenced studies on wild birds surrounding the Kandy Lake, Sri Lanka.

In addition, 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 and to investigate stratosphere up to 50km above Sri Lanka for microorganisms and dust particles. We use comparative genomics, phylogenetics, cell biological and microbiological methods to study these exceptional microorganisms and the diseases they cause.

Study of lung microbiota in lung cancer and bronchiectasis patients

The microorganisms within and on the humans are considered as human microbiome. This study aims to identify the microbiota in the lungs of the patients with lung cancer and bronchiectasis, against a healthy population. The bacterium *Enterococcus faecalis* was isolated only in lung cancer suspects while *Delftia tsuruhatensis* and *Enterococcus hirae* were limited to bronchiectasis suspects. 16S metagenomics studies revealed that phyla Proteo bacteria, Firmicutes and Actinobacteria dominated the lung cancer and bronchiectasis lungs respectively, while Firmicutes live in abundance in a healthy lung, followed by Actinobacteria and Proteobacteria (Figure 1.).

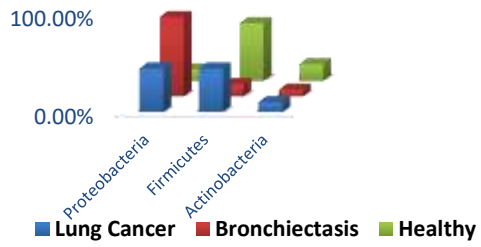

Figure 1. Distribution of the three most abundant phyla among the three study groups

Prevalence of Beijing strains among tuberculosis patients

Many countries keep an eye on the Beijing strain of *Mycobacterium tuberculosis*, due to its high prevalence, the ability to cause outbreaks and acquiring drug resistance. The study aims to assess the prevalence of Beijing strain among tuberculosis patients attending chest clinic, Kandy. DNA from culture positive isolates are amplified using Beijing lineage specific primers. As per the results, out of the samples collected, 41% belong to the Beijing lineage.

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

Multi-drug resistant tuberculosis is where the TB bacterium becomes resistant to two first line drugs: rifampin and isoniazid. We determine the prevalence of MDR-TB in the country, detect the mutations responsible for resistance and study the differential patterns of host immune responses. In this study, newly diagnosed TB patients from Kandy and Welisara chest hospitals are being assessed. To date, 54.5% of culture positivity is observed.

Study of airborne microorganisms and respiratory infections among pre-school children

Children of 3-5 years of age are more prone to respiratory infections. To determine the impact of airborne microorganisms, we enumerated and isolated microbes from indoor and outdoor atmosphere from two preschools in Kandy; one from a highly urbanized and other from a rural area. Simultaneously, we assessed the respiratory health status of each child. Following molecular identification, majority were opportunistic respiratory pathogens, *Pseudomonas* being the most dominant species.

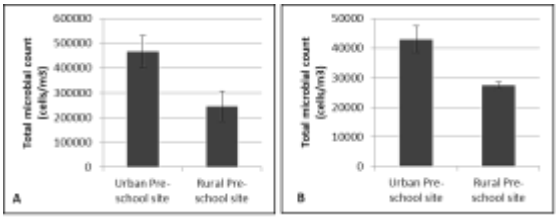

Figure 2. Total microbial count. A) Indoor B) Outdoor

Respiratory diseases were more prevalent among (27.9%) urban pre-school children while that of rural pre-school children was less (17.1%). Higher disease prevalence rates were correlated with high air microbial concentrations in the urban preschool (Figure 2).

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

The research aims to study the thermophilic microbial diversity (bacteria, cyanobacteria and archaea) in hot springs of Sri Lanka which could be utilize for biotechnological and industrial applications. A pilot study was conducted to identify thermophilic cyanobacteria in Maha Oya hot springs and to identify the presence of potential microcystin producers by microcystin synthetase (*mcy*) gene amplification. Eight cyanobacterial genera, were characterized; of that majority belonged to genus *Oscillatoria*. DNA Amplified from mat samples confirmed the presence of potential microcystin producing cyanobacteria in hot springs of Maha Oya.

Potential pathogenic bacteria from wild bird droppings around the Kandy Lake, Central Sri Lanka

Birds act as potential carriers of microbial pathogens for zoonotic diseases. The study focused on the bacterial composition and pathogenesis in wild bird droppings around Kandy Lake (trees in selected study locations along the southern edge of the Lake) (Figure 3).

Sampling was carried out for six months. The bacterial isolates were subjected to Sanger sequencing. Twenty different sequences were deposited in the NCBI GenBank (accession numbers from MK000881 to MK000895). Presence of human pathogenic bacterial species including *Enterobacter cloacae, Escherichia coli, Enterobacter hormaechei* and *Klebsiella quasipneumoniae* were confirmed. This study confirmed that birds can act as reservoirs for pathogenic bacteria and have the potential to transmit infectious agents to humans through their droppings.

Figure 3. Study sites; Trees around the Kandy Lake

Balloon flights to detect possible ingress of cometary microorganisms & particulate matter

Prof. Chandra Wickramasinghe and Late Sir Fred Hoyle proposed the Panspermia hypothesis - a theory suggesting that life began on Earth when the 'seeds' of life, already present in the Universe arrived here from space. The extraordinary survival of microorganisms high above the surface of the Earth is of increasing interest. In this study, we will be investigating the stratosphere up to 50km above Sri Lanka for microorganisms and dust particles. Assembly of GPS and SMS tracking system, sampler triggering system and all the programming was finalized and tested.

Balloons and parachutes were purchased for test run and preparation of sampler is at the final stage.

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EGJ Jayanatha,
T. Nagendran

Key publications:

1. Liyanage, H., **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

From left: Ms. E.M.U.A. Ekanayake, Mr. C. A. Thotawattage, Ms. D.G.S.N. Samarasinghe, Prof. D.N. Magana-arachchi, Ms. M.A.Y.N. Weerasinghe, Ms. P. Madamaradawala

Meththika Vithanage

Dr. Meththika Vithanage was a Senior Research Fellow at the National Institute of Fundamental Studies, Kandy and an Adjunct Associate Research Professor at the University of Southern Queensland, Australia. She obtained her PhD from University of Copenhagen, Denmark in February 2009. Dr. Vithanage has contributed more than 100 SCI journal articles and 25 book chapters.

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Molecular Microbiology & Human Diseases

Dr. Vithanage's research approach builds on enabling measurements of concentrations and reaction rates in environmental samples for key/emerging pollutants in the environment in order to assess their fate and transport to discover solutions to remediate those using different geo/bio/nano materials. She combines field observations with laboratory studies of kinetics and thermodynamics that provide detailed chemical information, in order to test, parameterize and evaluate models.

Dr. Vithanage is particularly interested in elucidating the mechanistic understanding of release/remediation of pollutants with contrasting physical and chemical properties that can be used to obtain insights into environmental partitioning, chemical persistence and risk assessment to biota. To this end, her current research interests are focused on monitoring atmospheric deposition, landfill leachate, water and soil for pollutants, develop and enhance the properties of biochar, nano/geo substances and composites as material for environmental remediation of emerging contaminants.

Potentially toxic elements in atmospheric deposition and associated health risks

Numerous epidemiological and field investigations suggest that pollutants emitted by traffic and non-traffic sources to the atmosphere have adverse consequences on human and ecosystem health. Human health impacts due to atmospheric pollutants are primarily dependent on the physical, chemical and microbial characteristics of respirable particles, PM10 or PM2.5, while the ecosystem health impacts are mainly due to particles deposited on ground surfaces via dry or wet deposition processes.

In the Sri Lankan context, studies focused on PM10 concentration in Kandy and found that it had a strong correlation with the respiratory illness of school students. A recent study characterized polycyclic aromatic hydrocarbons (PAHs) present in the respirable particles for the first time in Sri Lanka. Scientific literature relation to particulate materials and relation to the health are available in scientific literature, however, no results on microbial load is available. Hence, this was planned as a collaborative project at the Molecular Microbiology and Human Diseases group with Prof. Dhammika Magana-Arachchi.

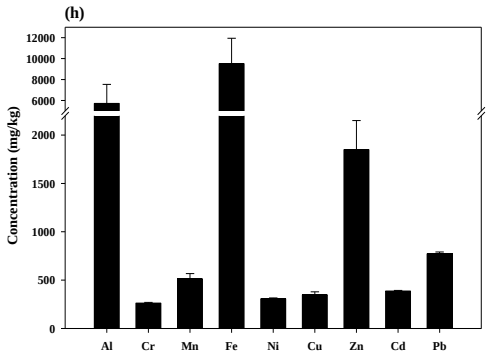

Figure 1. Heavy metal concentrations at the sampling location close to Trinity College, Kandy

Trace metals at high altitudes of the atmosphere

This project is planned to trap trace metals at high altitudes using a semi controlled sampling device developed and produced by the National Institute of Fundamental Studies. The project was again conducted with the collaboration of Prof. Dhammika Magana-Arachchi and Prof. Chandra Wickremasinghe, UK.

Sampling of particulate matter will be done at different heights from 0-40 km of the atmosphere. Once the sampling is done and the balloon is busted after reaching the height needed, sampling device will fall to the ground through a parachute, and the samples will be acid digested for trace metal analysis by ICP-OES (Figure 2).

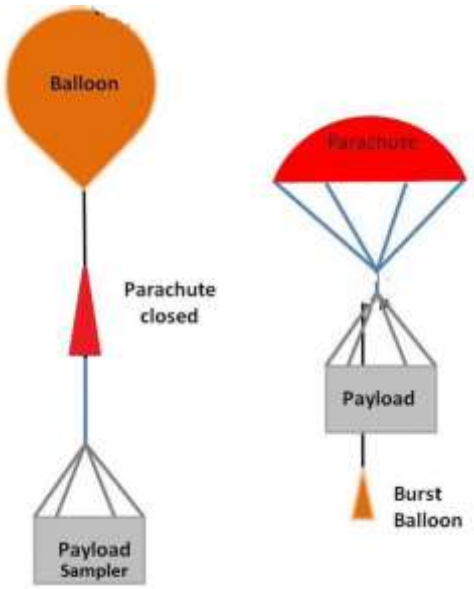

Figure 2. Schematic diagram of the sampling procedure

Biochar from municipal solid waste for remediation of volatile organic compounds in landfill leachate

Our recent attempts with biochar were focused on producing biochar from the organic portion of municipal solid waste and seek the potential for the removal of carcinogenic volatile organic compounds from municipal solid waste dumpsite in the landfill leachate. Further pot, incubation, batch, column experiments, modelling and spectroscopic techniques were conducted. This project was funded by National Research Council.

M.Phil Students:

Mr. Yohan Jayawardhana

Key publication:

Ahmad, M., Ahmad, M., El-naggar, A. H., Usman, A. R. A., Abduljabbar, A., **Vithanage,** M., Elfaki, J., Al-faraj, A. & Al-wabel, M. I. 2018. Aging Effects of Organic and Inorganic Fertilizers on Phosphorus Fractionation in a Calcareous Sandy Loam Soil. Pedosphere, 28, 873-883.

Kumarathilaka, P., Ahmad, M., Herath, I., Mahatantila, K., Athapattu, B. C. L., Rinklebe, J., Ok, Y. S., Usman, A., Al-wabel, M. I., Abduljabbar, A. & **Vithanage, M.** 2018. Influence of bioenergy waste biochar on proton- and ligand-promoted release of Pb and Cu in a shooting range soil. Science of the Total Environment, 625, 547-554.

Vithanage, M., Bandara, T., AL-wabel, M. I., Abduljabbar, A., Usman, A. R. A., Ahmad, M. & OK, Y. S. 2018. Soil Enzyme Activities in Waste Biochar Amended Multi-Metal Contaminated Soil; Effect of Different Pyrolysis Temperatures and Application Rates. Communications in Soil Science and Plant Analysis, 49, 635-643.

Weerasundara, L., **Magana-Arachchi, D. N.,** Ziyath, A. M., Goonetilleke, A. & **Vithanage, M.** 2018. Health risk assessment of heavy metals in atmospheric deposition in a congested city environment in a developing country: Kandy City, Sri Lanka. Journal of Environmental Management, 220, 198-206

Anuradha Ekanayake

Anuradha Ekanayake is currently a Research Assistant reading for M.Phil. in the Molecular Microbiology & Human Diseases research group at the National Institute of Fundamental Studies (NIFS). She received her B.Sc. (Hons) from the Northumbria University at United Kingdom in 2014 and joined NIFS in 2015. Her research focuses on human lung microbiome in chronic respiratory diseases. Her research interests include Molecular Microbiology, Metagenomics, Host-Microbe Biology and Cancer Biology.

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Nagasaijanani Pathmanathan

Nagasaijanani Pathmanathan was a Research Assistant at MMHD division at the National Institute of Fundamental Studies (NIFS). She received her B.Sc (special) degree in Microbiology from the University of Sri Jayawardenapura (Sri Lanka) in 2017 and joined NIFS in 2017. Her research focused on Cyanobacteria and Cyanotoxins in Kandy Lake. Her research interests are in correlation of programmed cell death and toxin release in Cyanobacteria.

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S.H.P. Parakrama Karunaratne

He received his B. Sc. (1984), M.Sc. (1990), University of Peradeniya, Sri Lanka; Ph.D. (1994) London School of Hygiene and Tropical Medicine, University of London, UK; Senior Professor & Chair of Zoology (2001 to date), Dean- Faculty of Science (2007-2013) & Deputy Vice Chancellor (Jan 2018 to date)/ University of Peradeniya; Director & Senior Research Professor/ National Institute of Fundamental Studies, Sri Lanka (2015 - 2017); Wellcome Trust Research Fellow (2002 – 2004) & Visiting Research Professor (2004 – 2010)/ Liverpool School of Tropical Medicine, UK; Member of the DDT expert group, UNEP/WHO, Geneva, Switzerland (2015 – 2019); 81 full paper (54 SCI) Research Publications, Google Scholar h-index of 25 & 2314 citations (January 2019); Elected Fellow of the National Academy of Sciences Sri Lanka (2006 to date) & Elected Fellow of the Royal Entomological Society, London, UK (1997 to date). Awards: GRC Award, SLAAS, Sri Lanka (2018); CVCD Excellence Award for the most outstanding senior researcher; University Grant Commission, Sri Lanka (2016); Vestergaard Frandsen Award for outstanding research contribution, NAVBD, Indian Council of Medical Research (2011); Bernard Soysa Memorial Award (Gold Medal) for Outstanding Scientific Research, SLAAS, Sri Lanka (2005);); Presidential Research Awards & NRC Merit Awards for Scientific Publications.

Medical Entomology

DNA barcoding of morphologically characterized Culicinae mosquitoes

Vectors of mosquito-borne diseases in Sri Lanka, except for malaria, belong to the subfamily Culicinae, which includes nearly 84% of the mosquito fauna of the country. Hence, accurate and precise species identification of culicine mosquitoes is a crucial factor in implementing effective vector control strategies. During the present project, a combined effort using morphology and DNA barcoding was made to characterize mosquitoes of the subfamily Culicinae for the first time from nine districts of Sri Lanka. Cytochrome *c* oxidase subunit 1 (*cox*1) gene from the mitochondrial genome and the internal transcribed spacer 2 (ITS2) region from the nuclear ribosomal DNA were used for molecular characterization.

Analysis of all the *cox*1 sequences (14 clades supported by strong bootstrap value in the Neighbor-Joining tree and inter-specific distances of > 3%) showed the presence of 14 different species. This is the first available DNA sequence in the GenBank records for morphologically identified *Ae. pallidostriatus*. The current study reflects the significance of integrated systematic approach and use of *cox*1 and ITS genetic markers in mosquito taxonomy. Results of DNA barcoding were comparable with morphological identifications and, more importantly, DNA barcoding could accurately identify the species in the instances where the traditional morphological identification failed due to indistinguishable characters of damaged specimens and the presence of subspecies.

Pyrethroid resistance in dengue mosquitoes *Aedes aegypti* and *Aedes albopictus*

Aedes aegypti and *Ae. albopictus* are the vectors of dengue, chikungunya and yellow fever in Sri Lanka. They are mainly controlled by pyrethroid insecticides and the development of resistance to pyrethroids has become a threat to control programmes. Our project aims to detect the resistance status and underline resistance mechanisms (metabolic resistance and target site insensitivity) of these mosquitoes to pyrethroids. Since both the pyrethroids and the organochlorine DDT share the same target site 'voltage gated sodium channel (VGSC)', resistance status of DDT was also tested. Adult mosquitoes obtained from the eggs/larvae collected from Central, Eastern, Northern, Northwestern, Uva and Western provinces were exposed to discriminating dosages of five pyrethroids and DDT. According to biochemical assays elevated mosquito enzymes carboxylesterases and GST are heavily involved in providing resistance to insecticides. DNA sequences were aligned and compared with *Musca domestica* VGSC gene. Two knock down resistant mutations, V1016I and S989P at domain II were reported respectively from Central and Western Provinces. Western province populations also reported kdr mutation F1534C at domain III. However, none of the *Ae. albopictus* mosquitoes reported any *kdr* mutations. The study highlights the emerging pyrethroid resistance in dengue vectors of Sri Lanka.

Frog- biting mosquitoes in Sri Lanka

Anurans and birds act as bridge vectors of diverse pathogens of emerging infectious diseases of humans and other wildlife. In Sri Lanka, any description on these mosquitoes and their role in transmitting diseases to anurans, wild birds and other organisms have never been reported. Resource partitioning is considered a critical component for species co-existence among closely related species. The majority of blood-feeding mosquitoes, however, are not species-specific in their biting behavior. We investigate frog-biting mosquitoes and the degree of specificity of their associations with anurans. We found high species-specificity between *Uranotaenia* frog-biting mosquitoes and their anuran hosts. Similarly, they were active at heights above ground that coincide with the calling sites of their host. We have reported previously unknown species occurrence and associations revealing a community of highly specialized frog-mosquitos. These findings highlight the complex and still largely unexplored nature of mosquito communities.

Predatory larvae of *Armigeres subalbatus* (Diptera: Culicidae) and their potential as biological control agent

This project mainly aims to investigate the predatory feeding pattern and the cannibalistic behaviours of *larvae of Armigerous subalbatus mosquitoes*. Second instars of *Aedes albopictus* and *Culex uniformis* larvae were used as prey larvae. The effect of meal type on growth rate and the pupation rate of *Ar. subalbatus* were also monitored and reported. The results showed the presence of voracious predatory behaviour of 3rd and 4th instars larvae of *Ar. subalbatus* in addition to the permanent cannibalistic nature of this species. Our findings provide crucial information about the population dynamics of co-existing predator and prey mosquito larvae in the natural breeding habits while giving insight to use *Ar. subalbatus* in natural control of vector mosquitoes.

Acaricide resistance of the brown dog tick *Rhipicephalus sanguineus*

Rhipicephalus sanguineus is the most prevalent dog tick in Sri Lanka and also the major vector for ehrlichiosis (caused by *Ehrlichia canis*) and canine babesiosis (caused mainly by *Babesia gibsoni*). *R. sanguineus* is able to withstand co-infections with many pathogens. Acaricides are extensively being used to control dog ticks and acaricide resistance has become a major problem in police kennels in Sri Lanka for the past few years. The present project assesses the resistance status of *R. sanguineus* collected from the two major police kennels of the country. Acaricide resistance status and the respected resistance mechanisms of the brown dog tick *Rhipicephalus sanguineus* (Acari: Ixodidae) was investigated using ticks collected from Kandy and Kurunegala Police kennels, Sri Lanka.

According to discriminating dosages specified in literature and FAO guidelines, both populations of ticks were 'susceptible' to permethrin and 'possibly resistant' to fipronil, DDT, coumaphos, flumethrin and RIDD®. Moderate insensitivity of AChEs were found with organophosphate and carbamate resistance. Enhanced activities were observed for both populations for all three enzymes *i.e.* carboxylesterases, glutathione S-transferases (GSTs) and monooxygenases. Applying efficient acaricide resistance monitoring methods for ticks and a better understanding of the resistance mechanisms prevalent is very important for future tick control programs and prevention of developing resistance.

Research Group

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Plant Stress Biology and Molecular Genetics

Climate change together with biotic and abiotic factors threaten food production globally.The primary reason for such negative responses is the inability of plants to adapt to these stresses. However, these response are largely varied between species, and even within the same specie depending on the magnitude of the enviromental stresses. Plant stress tolerance is a complex phenomenon involving multiple gene products which interact in complex ways to facilitate stress tolerance from subcellular to the whole plant level. A fundemantal understanding of these responses is essential to develop high yielding crops having climate insensitivity.

Most of the world's population depend on C_3 grains and legumes as their primary dietary source of micronutrients and proteins, and are more vulnerable to climate change. Recently, it has been recognised that dietary deficiencies of protein, zinc and iron are a substantial global public health problem which is exacerbated by climate change. Across the globe, an estimated two billion people suffer from these deficiencies, causing a loss of 63 million life-years annually. Further, a large degree of micro nutrients malnutrition has been recognised in Sri Lanka and is also associated with a number of metabolic diseases. This human catastrophy can only be avoided by improving the nutrient status of cereals and pulses.

The aim of our research 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 the stress tolerance levels of crops. Thus, molecular characterization of key changes associated with stress is followed using an "omics" approach in which high-throughput technologies are used for identification of transcripts, proteins and metabolites associated with stress tolerance. Biochemical, biophysical and physiological studies are used, as appropriate, to ascertain functional significance of putative traits. Such resources allow for an increasingly integrated understanding of the phenomenon of stress tolerance.

Improvement of rice yield gap by manipulating photosynthesis

Improvement in yield is currently required to meet future food demand. Massive starvation is inevitable in the coming years if this important issue is not addressed effectively. To be fully confident of avoiding this alarming problem, a 50% increase in rice yields is required by 2050. For the last 30 years, 10 t ha -1 has remained the maximum achievable yield of inbred cultivars of irrigated rice in the tropics, a value long regarded as a yield barrier. However, Sri Lankan national rice yield is 4.2 ton per hectare, which is much lower than international yield targets. Therefore, Sri Lanka has a great potential to increase rice yield, possibly by fine tuning the plant's biology to fit into the environment.

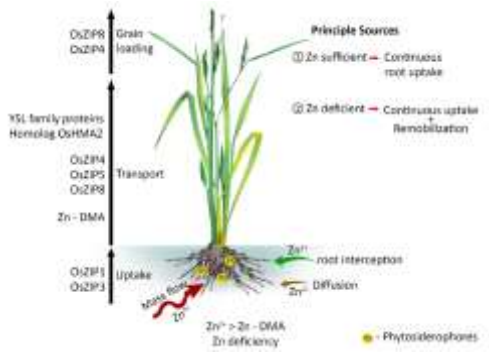
Among the key traits, lower photosynthesis rates are being recognized as a major bottle neck for yield improvement. It is suggested that genetic manipulation of photosynthesis is the most plausible method to increase yield potential. Most of the important grain crops including rice utilize C_3 photosynthesis, capturing CO_2 directly from the sub-stomatal air spaces of the leaf via Rubisco. The efficiency of CO_2 assimilation in C_3 plants is severely compromised by photorespiratory activity. In C_3 plants under current atmospheric CO_2 conditions, one-third of Rubisco, a key enzyme in CO_2 fixation, is involved in the incorporation of oxygen rather than CO_2 and the subsequent processing and recycling of the product of this reaction, phosphoglycolate, requires both energy and the loss of CO_2. This is a totally inefficient system. On the other hand, C_4 plants have evolved a complex biochemical mechanism to concentrate CO_2 at the site of Rubisco. In C_4 photosynthesis, photorespiration is eliminated and Rubisco operates at close to its theoretical maximum velocity. The efficiency of conversion of total solar energy of C_4 plants is approximately 2.2% while this figure is only 1.4% for the C_3 counterparts. Therefore, if C_4 traits can be fully transferred into the C_3 rice, a 60% increase in photosynthetic efficiency can be expected, yield potential could be improved by up to 50%, and this is the best pathway to address national food security and sustainability of the rice industry.

In our research group, a number of strategies have been employed to improve photosynthesis and yield gap. Four of the strategies aim to increase the CO_2 concentration around Rubisco, (1) improving CO_2 diffusion into the chloroplast and its site of fixation; (2) introducing C_4 like characteristics into C_3 plants (3) introduction of cyanobacteria rubisco (4) transfer of C_4 genes from the panicle to the shoot through CRISPACAS9.

Zinc and Iron biofortification of rice

Rice is the most widely consumed staple food for more than half of the world's population, especially in Asia.

Historically, a major focus of rice (*Oryza sativa* L.) breeding programmes has been on yield improvement and disease resistance. However, emerging global dietary deficiencies of zinc (Zn) and iron (Fe) among vulnerable populations has shifted research emphasis to the improvement of Zn and Fe density in the grain. Simultaneously, there is increasing recognition that accumulation of biologically toxic elements such as arsenic (As), cadmium (Cd) and lead (Pb) need to be minimized. In other studies, genetic bio fortification and selection has focused on these issues, but not concurrently. In our large germplasm screening studies, using inherent heterogeneity among 295 accessions of Sri Lankan rice, we identified five lines with high concentrations of [Zn] and [Fe], contemporaneous with low concentrations of [As], [Cd] and [Pb]. For the lines identified, yield relationships with grain [Zn] and/or [Fe]; and/or low concentrations of [As], [Cd] and [Pb], were not significant, indicating that Zn and Fe bio fortification targets could be achieved without compromising yield. These results indicate that sufficient genetic diversification exists to select rice lines among regional landraces that can both increase essential micronutrients while limiting exposure to known heavy metals.



The major bottle neck of Zn-uptake and transport to the rice grain (key transporter genes involve in Zinc homeostasis of plant).

RESEARCH PERFORMANCE IN YEAR 2018

Publications in journals 2018

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. Amaraweera, T.H.N.G., Balasooriya, N.W.B., **Wijayasinghe, H.W.M.A.C.,** Attanayake, A.N.B., Mellander, B.E., and **Dissanayake, M.A.K.L.** (2018). Surface modification of natural vein graphite for the anode application in Li-ion rechargeable batteries. *Ionics*, 24(11), p.3423-3429. [SCI Exp, IF : 2.347]*

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3. Senevirathne, R.D., Abeykoon, A.M.K.L., De Silva, N.L., Yan, C.F., and **Bandara, J.** (2018). Sono-photocatalytic production of hydrogen by interface modified metal oxide insulators. *Ultrasonics - Sonochemistry*, 45, p.279-285. [SCI Exp, IF : 6.012]

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4. Karunarathne, R.I.C.N., Pathirana, T., **Wijayasinghe, H.W.M.A.C.,** and **Dissanayake, M.A.K.L.** (2018). $Na_2Ti_3O_7$ nanofibers as an anode material for rechargeable Na-ion batteries. *Ceylon Journal of Science*, 47(2), p.125-128.*

5. Rathnayake, R.M.N.M., Jayasekara, S.K., Huang, H.H., Yoshimura M., **Wijayasinghe, H.W.M.A.C., Ratnayake, R.R.,** and Pitawala, H.M.T.G.A. (2018). Convenient process to synthesize reduced needle platy graphite silver nanocomposite: A prospective antibiotic against common pathogenic microorganisms in the environment. *Materials Research Express*, 5, p.0-0. [SCI Exp, IF : 1.151]*

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THEORETICAL PHYSICS & COMPUTATIONAL STUDIES RESEARCH UNIT

Quantum Physics & Applied Electronics

1. Dodangodage, R, and **Nanayakkara, A.** (2018). Comment on 'Full revivals in 2D quantum walks'. *Physica Scripta*, 93(11), p.117001. [SCI, IF : 1.902]

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3. Rath, B., **Nanayakkara, A.,** Mallick, P., and Samal, P.K. (2018). SUSY Quantum Mechanics for PT Symmetric Systems. *Proceedings of the National Academy of Sciences, India Section A: Physical Sciences*, 88(4), p.633-638. [SCI Exp, IF : 4.000]

4. Jayakody, M.N., and **Nanayakkara, A.,** Full state revivals in higher dimensional quantum walks, (2018-inpress) *Physica Scripta*

NATURAL PRODUCT & FOOD CHEMISTRY RESEARCH UNIT

Food Chemistry

1. **Marikkar, J.M.N.,** Yanty, N.A.M., Paciulli, M., Miskandar, M.S., and Chiavaro, E. (2018). Composition and thermal properties of quaternary mixtures of palm oil:palm stearin:soybean oil:cocoa butter. *Italian Journal of Food Science*, 29(4), p.740-751. [SCI Exp, IF : 0.615]

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1. Kehelpannala, C., **Kumar, N. S., Jayasinghe, L,** Araya, H., and **Fujimoto, Y.** (2018). Naphthoquinone Metabolites Produced by *Monacrosporium ambrosium,* the *Ectosymbiotic Fungus* of Tea Shot-Hole Borer, *Euwallacea fornicatus,* in Stems of Tea, *Camellia sinensis. Journal of Chemical Ecology*, 44(1), p.95-101. [SCI, IF : 2.419]

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3. Napagoda, M., Gerstmeier, J., Butschek, H., Lorenz, S., Kanatiwela, D., Quadar, M., Nagahawatte, A., De Soyza, S., Wijayaratne, G., Svatoš, A., **Jayasinghe, L.,** Koeberle, A., and Werz, O. (2018). Liphophilic extracts of *Leucas zeylanica,* a multi-purpose medicinal plant in tropics, inhibit key enzymes involved in inflammation and gout. *Journal of Ethnopharmacology*, 224, p.474-481. [SCI, IF : 3.115]

4. Quader, M. M., **Kumar, N.S., Jayasinghe, L.,** and *Fujimoto, Y*. (2018). Shikimic Acid Production by *Fusarium decemcellulare*, An Endophytic Fungus Isolated from *Flacourtia inermis* Fruits. *Journal of Biologically Active Products from Nature*, 8(1), p.43-50.

5. Rathnayake, G. R. N., **Kumar, N. S., Jayasinghe, L.,** Araya, H., and **Fujimoto, Y.** (2018). Chemical investigation of metabolites produced by an endophytic fungi *Phialemonium curvatum* from the leaves of *Passiflora edulis. Natural product research, 32(20), p.2483-2486.* [SCI Exp, IF : 1.928]

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1. Jayathilaka, B.R, Nayananjalie, W.A.D., Adikari, A.M.J.B., Jayawardana, B.C, and **Liyanage, R.** (2018). Dietary Supplementation of Dried Curry, Drumstick and Pepper Leaves on the Performance and Serum Characteristics of Broiler Chicken. *International Journal of Livestock Research*, 8(10), p.80-89.

2. Jayathilake, C., Visvanathan, R., Deen, A., Bangamuwage, R., Jayawardana, B.C., Nammi, S., and **Liyanage, R.** (2018). Cowpea: an overview on its nutritional facts and health benefits. *Journal of the Science of Food and Agriculture*, 98(13), p.4793-4806. [SCI, IF : 2.379]

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MICROBIOLOGY & CARBON SEQUESTRATION RESEARCH UNIT

Bioenergy & Soil Ecosystems

1. Hossain, F., **Ratnayake, R.R.,** Malika, M.S., Wijayaratne, W.M.D.G.B., and Kumara, K.L.W. (2018). Antimicrobial Activities of Some Selected Cyanobacteria from Fresh Water Bodies of Sri Lanka. *Scholars Journal of Applied Medical Sciences*, 6(9), p.3545-3549.

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1. Singhalage, I.D., **Seneviratne, G.,** Madawala, H.M.S.P., and Manawasinghe, I.S (2018). Characterization of structural properties of fungal-bacterial biofilms by Fourier Transform Infrared spectroscopy. *Ceylon Journal of Science*, 47, p.77-83.

2. Tirimanne, T.L.S., Perera, T.A., Anuradha, E.A.S., **Kulasooriya, S.A**., and **Seneviratne, G.** (2018). The Effect of flavonoid naringenin coupled with the developed biofilm *Azorhizobium caulinodans-Aspergillus S*pp*.* on increase in rice yields in conventionally and organically grown rice. *International Journal of Plant studies*, 1(1), p.1-6.*

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EARTH, ENVIRONMENT & BIODIVERSITY RESEARCH UNIT

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ABSTRACTS

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EARTH, ENVIRONMENT & BIODIVERSITY RESEARCH UNIT

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12. **Weerasooriya, R.,** and Pathmanadan, R. (2018). Potable Water Quality Stress in Sri Lanka. *Water-Planning for the Future* (p.19), *NIFS*.

Plant & Environmental Sciences

1. Dayarathne, M.A.L.A., **Iqbal, M.C.M.,** and Egodawatta, W.C.P. (2018). Phytoremediation of phosphates as a remedy for eutrophication. *10th Annual research symposium, Faculty of Agriculture, Rajarata University of Sri Lanka 2018*.

2. Dissanayake, D.M.R.E.A., Iqbal, S.S., Priyantha, N., and **Iqbal, M.C.M.** (2018). The adsorption of Cr(III) on to a kaolin alginate composite adsorbent. *Open University International Research Sessions 2018*.

3. Lekamge, C., Amarasinghe, J., Madawala, H.M.S.P., Iqba, M.C.M., and **Wijesundara, D.S.A.** (2018). Assisted Natural Regeneration of degraded land can improve Ecotourism in the Dry Zone. *Wildlanka Symposium*.

4. Wijesinghe, K.E.H., Wickramage, N.M., Dissanayake, D.M.R.E.A., Iqbal, S.S., and **Iqbal, M.C.M.** (2018). Phytoremediation of Nitrate and Phosphate by *Salvinia molesta* Mitchel. *Open University International Research Session 2018*.

Plant Taxonomy & Conservation

1. Dissanayake, P.K., Bandara, P. K. G. S. S., Dissanayake, M. L. M.C., **Wijesundara, D.S.A.,** Katipearachchi, K. W., and Wijeratne, A. W. (2018). Diversity of Leaf Morphology among *Syzigum cumini* (Madan) Trees from Different Regions of Sri Lanka. *8th Annual Research session of the Sabaragamuwa University of Sri Lanka*.

2. Gunasekara, R.S., Jayakody, K. S., **Wijesundara, D.S.A.,** and Yakandawala, K. (2018). Ultra violet vision of insects on *Vanda tessellata (Roxb.)* Hook. F. ex D. Don and the possible ecological role of pollination in maintaining the floral polymorphism of the species. *Wildlanka Symposium*.

3. Gunasekara, R.S., Yakandawala, K., Jayakody, S., and **Wijesundara, D.S.A** (2018). Pollinators of *Vanda tessellata (Roxb.)* Hook. f. ex D. Don in Sri Lanka. *Wayamba University International Conference*.

4. Lekamge, C., Amarasinghe, J., Madawala, H.M.S.P., Iqba, M.C.M., and **Wijesundara, D.S.A.** (2018). Assisted Natural Regeneration of degraded land can improve Ecotourism in the Dry Zone. *Wildlanka Symposium*.

5. Madumali K.A.A.D., Senaratne, R., Senevirathna, G., Lekamge, C., and **Wijesundara, D.S.A.** (2018). Effect of Some Selected Plant Species in Ameliorating Indoor CO2 Concentration. . *2nd International Research Symposium of Uva Wellassa University of Sri Lanka*.

6. Rajapakse,N., **D.S.A. Wijesundara** and P. Bandaranayake (2018). Taxonomic account of Strobilanthes sp. in Sri Lanka. *Proceedings of the 23rd International Forestry and Environment Symposium 2018 of the University of Sri Jayawardenepura, Sri Lanka*.

7. Ranathunga, R.A.D.C., and **Wijesundara, D.S.A.** (2018). Alien Invasive plants in Horton Plains National Park, Sri Lanka: current status and their management. *Wildlanka Symposium*.

8. Ranil, R.H.G., Wijewickrama, T., Gunawardhana, N.P.T., Kularatne, M.A.T.R., Pushpakumara, D.K.N.G., and **Wijesundara, D.S.A** (2018). Diversity and distributional ecology of lycophytes and ferns of Piduruthalagala Mountain in Sri Lanka. *Seventh Asian Symposium of Ferns and Lycophytes. National Taipei University, Taipei, Taiwan*.

9. Ratnayake, D., **Wijesundara, D.S.A.,** Bandara, B. M. R., Adikaram, N.K.B., and Karunaratne, V. (2018). Potential of the antifungal activity of the weed, *Ageratina riparia (Regel)* R.M. King and H. Rob., in the control of anthracnose disease in banana fruits. *Asian Symposium on Medicinal Plants, Spices and other Natural Products XVI*.

10. Samarasinghe, V.G.A.U., Nishantha, K.M.D.W. P, Damunupola, J.W N., Bandara, C., **Wijesundara, D.S.A.,** and Bandara, B.M. R. (2018). Pesticidal properties of some invasive plants. *Asian Symposium on Medicinal Plants, Spices and other Natural Products XVI*.

11. Weerakoon, G., and **Wijesundara, D.S.A** (2018). Lichens in tropical forests of Sri Lanka: Discovering Species New to Science. *Asian Symposium on Medicinal Plants, Spices and other Natural Products XVI*.

12. Weerakoon, G., and **Wijesundara, D.S.A** (2018). Lichens in tropical forests of Sri Lanka: Discovering Species New to Science. *Wet Zone Forests*, (p.17), Colombo: Forest department.

13. Weerakoon, G., and **Wijesundara, D.S.A** (2018). Sri Lanka the land of lichens: understanding the lichen richness in a mega diverse hotspot. *Asian Symposium on Medicinal Plants, Spices and other Natural Products XVI*.

14. Weerakoon, G., and **Wijesundara, D.S.A** (2018). Sri Lanka the land of lichens: understanding the lichen richness in a mega diverse hotspot. *Wet Zone Forests*, (p.18), Colombo: Forest department.

15. Wijewickrama, M. P. T., Karunaratne, W. I. J. P., **Wijesundara, D.S.A.,** and Madawala, H. M. S. P. (2018). Over dominance of *Bambusa bambos* alters structure and composition of Native forests: A study from tropical moist evergreen forests in Sri Lanka. *PGIS Research Congress*.

MOLECULAR BIOLOGY & BIOTECHNOLOGY RESEARCH UNIT

Molecular Microbiology & Human Diseases

1. Amarasekera, R.W.K., Samaraweera, P., **Vithanage, M.,** and **Magana-Arachchi, D.N.** (2018). Identification of specific bacteria in atmosphere in Kandy city using real-time PCR technique. *Proceedings of Seventh National Symposium on Air Quality Management in Sri Lanka*.

2. Ekanayake, E.M.U.A., Madegedara, R.M.D., Chandrasekharan, N.V., and **Magana-Arachchi, D.N.** (2018). Comparison of Bacterial Microbiome of Suspected Lung Cancer and Bronchiectasis Patients with Healthy Traffic Policemen. *ASM Microbe 2018*.

3. Ekanayake, E.M.U.A., Madagedara, R.M.D., Chandrasekharan, N.V., and **Magana-Arachchi, D.N.** (2018). Rapid molecular technique for the detection of bacteria in lung cancer and bronchiectasis patients. *South Asian Biotechnology Conference 2018*.

4. Madamarandawala, J.M.P.S., Ekanayake, E.M.U.A., Weerasinghe, A.M.J.S., Thotawatthage, C.A., **Senadeera, G.K.R.,** and **Magana-Arachchi, D.N.** (2018). A novel low cost approach for tuberculosis diagnosis using coconut water and silicon solar cell cum biosensor. *South Asian Biotechnology Conference 2018*.*

5. Madamarandawala, J.M.P.S., Keshura, R., Madegedara, R.M.D., and **Magana-Arachchi, D.N.** (2018). A multiplex PCR assay for Mycobacterium tuberculosis Beijing/W lineage identification. *7th Annual Conference and Scientific Sessions of the Sri Lankan Society for Microbiology (SSM)*.

6. Madamarandawala, J.M.P.S., Weerasinghe, M.A.Y.N., Rajapaksha, A.A.S.M., Ekanayake, E.M.U.A., Watagodakumbura, S.V., Madegedara, R.M.D., and **Magana-Arachchi, D.N.** (2018). Impact of airborne microbes on pulmonary health of preschool children in rural and urban sites of Kandy, Sri Lanka. *Proceedings of Seventh National Symposium on Air Quality Management in Sri Lanka*.

7. **Magana-Arachchi, D.N.,** Wanigatunge, R., Maheswaran, S., and Ekanayake, E.M.U.A. (2018). A process and a potential diagnostic kit for Drug-resistant Mycobacterium tuberculosis complex bacteria. *South Asian Biotechnology Conference 2018*.

8. Medhavi, P.I.H.R., Samarasinghe, D.G.S.N., Wanigatunge, R., Herath, H.M., and **Magana-Arachchi, D.N.** (2018). Isolation and identification of thermophilic bacteria and cyanobacteria in Maha Oya hot springs. *International research symposium on pure and applied sciences, University of Kelaniya, Sri Lanka*.

9. Samarasinghe, D.G.S.N., Herath, H.M., **Magana-Arachchi, D.N.,** and Wanigatunge, R. (2018). Morphological and molecular characterization of cyanobacteria in Maha Oya hot springs in Sri Lanka. *Annual sessions of the IOB, Sri Lanka*.

10. Thajudeen, T., Rizvi, E.M.J.M., **Magana-Arachchi, D.N.,** and Ekanayake, E.M.U.A. (2018). Molecular Identification of Bacteria isolated from lung cancer and bronchiectasis patients` samples through 16S PCR. *Seventh annual science research sessions 2018 Faculty of applied sciences, South Eastern University of Sri Lanka*.

11. Weerasinghe, M.A.Y.N., Watagodakumbura, S.V., and **Magana-Arachchi, D.N.** (2018). A preliminary study on isolation and characterization of pathogenic bacteria from wild bird droppings around the Kandy Lake, Central Sri Lanka. *38th Annual sessions of SLAAS*.

12. Weerasundara, L., **Magana-Arachchi, D.N.,** and **Vithanage, M.** (2018). Contamination assessment on heavy metals and polycyclic aromatic hydrocarbons in atmospheric deposition of Kandy, Sri Lanka. *Proceedings of Seventh National Symposium on Air Quality Management in Sri Lanka*.

Books/Monographs & Book Chapters

1. Gunarathne, V., Ginige, M.P., Alwis, A.D., Athapattu, B., Rajapaksha, A.U., and **Vithanage, M.** (2018). Municipal Waste Biochar for Energy and Pollution Remediation. *Environmental Chemistry for a Sustainable World 19* (p. 227-252). , Springer Nature Switzerland.

2. **Marikkar, J.M.N.,** and Yanty, N.A.M. (2018). Fats, Oils and Emulsifiers. *Preparation and Processing of Religious and Cultural Foods* (p. 241–251). Cambridge, Woodhead Publishing.

3. **Wijesundara, D.S.A.** (2018). Invasive alien species and their impacts on natural resources. *Wijeratne, M.J.S., Jayasuriya, A.H.M., Wijayananda, N.P., and Kumaraswamy, U., (eds) Natural Resources of Sri Lanka, Conditions, Trends and Prospects* (p. 345-363). Colombo, NSF.

PATENTS

ENERGY & ADVANCED MATERIALS RESEARCH UNIT

Nanotechnology & Advanced Materials

- National Institute of Fundamental Studies. (2018). *Method of manufacturing Lithium carbonate coated vein graphite anode for Lithium Ion Battery*, Sri Lanka. [Patent No: 18730].

- National Institute of Fundamental Studies. (2018). *Method of purification vein graphite by acid leaching to ultra-high purity*, Sri Lanka. [Patent No: 18729].

- National Institute of Fundamental Studies. (2018). *Method for preparing surface modified vein graphite through chemical oxidation*, Sri Lanka. [Patent No: 18728].

Energy & Advanced Material Chemistry

- National Institute of Fundamental Studies. (Filing Date: 2018-06-11). *A method of manufacturing electrically conducting and highly porous high grade activated carbon from coconut shells using a simple procedure*, Sri Lanka.

- National Institute of Fundamental Studies. (Filing Date: 2018-06-11). *A Method of Recovering Waste Graphite Attached to Wall Rocks in Graphite Mines*, Sri Lanka.

GRANTS

ENERGY & ADVANCED MATERIALS RESEARCH UNIT

Condensed Matter Physics & Solid State Chemistry

New:

- **Dissanayake, M.A.K.L.** received a 3-year Research Grant from National Science Foundation (NSF), Sri Lanka and Pakistan Science Foundation (PSF), Pakistan on 2018-01- 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 expenses. (Grant Value - 860,000 LKR)

Ongoing:

- **Dissanayake, M.A.K.L.** received a four year Research Grant from Swedish Research Council (SRC) on 2015-01-01 for Collaborative research between NIFS, Chalmers University (Sweden), Department of Physics Peradeniya and Rajarata University of Sri Lanka. (Grant Value - 5,200,000 LKR)

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

Energy & Advanced Material Chemistry

New

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

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

Material Processing & Device Fabrication

New:

- **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)

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)

Nanotechnology & Advanced Materials

New

- **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)

Ongoing:

- **Subasinghe, N.D.,** and **Wijayasinghe, H.W.M.A.C.** received a Research Grant from National Research Council on 2015-11-01 for Development of thermoelectric devices for energy harvesting and co-generation. (Grant Value - 3,283,750 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)

- **Wijayasinghe, H.W.M.A.C.** received a Research Grant from National Research Council on 2015-11-01 for Development of Sri Lankan natural vein graphite for the anode application in rechargeable batteries. (Grant Value - 2,490,000 LKR)

NATURAL PRODUCTS & FOOD CHEMISTRY RESEARCH UNIT

Natural Products

New:

- **Adikaram, N.K.B.** (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.K.B.**, 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.** (CI), **Kumar, N.S.** (PI), and **Adikaram, N.K.B** (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.** (CI), **Kumar, N.S.** (PI), and **Adikaram, N.K.B** (CI), and Amarasinghe, N.R. received a Research Grant from National Research Council on 2018-10-02 for development of eco-friendly new weedicides from microbial metabolites. (Grant Value - 4,643,724 LKR)

Ongoing:

- Amarasinghe, N.R. (Pl), and **Jayasinghe, L.** (Cl) 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)

- Amarasinghe, N.R. (Pl), 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)

- Eeswara, J.P. (Pl), **Jayasinghe, L.** (Cl), and Selvaskanthan, S. (Cl) received a Research Grant from National Research Council on 2015-11-02 for Rapid multiplication and production of Agarwood fragrant constituents by plant cell and tissue culture of *Gyrinopsis walla*. (Grant Value - 4,129,916 LKR)

- Napagoda, M.T. (Pl), and **Jayasinghe, L.** received a Research Grant from National Science Foundation on 2015-05-01 for A comprehensive study on the anti-inflammatory and antimicrobial secondary metabolites in selected medicinal plants. (Grant Value - 2,096,468 LKR)

- Napagoda, M.T. (Pl), 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)

MICROBIOLOGY & CARBON SEQUESTRATION RESEARCH UNIT

Bioenergy & Soil Ecosystems

New:

- **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)

Ongoing:

- **Ratnayake, R.R.** received a Research Grant from National Science Foundation on 2016-06-10 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)

EARTH, ENVIRONMENT & BIODIVERSITY RESEARCH UNIT

Earth Resources and Renewable Energy

New:

- **Prof. N.D. Subasinghe** received an Instrument Grant from National Science Foundation on 2018-02-05 to purchased Walking Magnetometer with gradiometer. (Grant Value - 1,500,000 LKR)

Ongoing:

- **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.,** 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)

Ongoing:

- **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 - 500 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

Ongoing:

- **Benjamin, S.P.** received a Research Grant from National Science Foundation on 2015-10-15 for Diversity of crab spiders of Sri Lanka based on morphology and DNA barcodes. (Grant Value - 3,988,600 LKR)

- **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

Ongoing:

- **Iqbal, M.C.M.** (co-grantee) received a Research Grant from National Research Council on 2015-08-01 for Historical trends in averages and extremes of rainfall, temperature and runoff in Sri Lanka. (Grant Value - 642,000 LKR)

- **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)

- Iqbal, S.S., and **Iqbal, M.C.M.** received a Research Grant from National Research Council on 2015-12-30 for Removal of Nitrates and Phosphates from drinking water using chemically and physically modified silicate materials. (Grant Value - 4 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 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.,** Wickramasinghe, C. received a Research Grant from The Bjornson and Prodan Foundation on 2018-05-30 for Balloon 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)

RESEARCH COLLABORATIONS

ENERGY & ADVANCED MATERIALS RESEARCH UNIT

Condensed Matter Physics & Solid State Chemistry

New collaboration:

- Condensed Matter Physics and Solid State Chemistry research project 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.

Ongoing collaborations:

Condensed Matter Physics and Solid State Chemistry research project 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.

- Chalmers University (Sweden), University of Peradeniya, Rajarata University of Sri Lanka from 2015-01-01 to 2018-12-31.
  Summary: Swedish Research Council (SRC) Grant 2015-2018 for collaborative research between NIFS, Chalmers University (Sweden), Department of Physics (Peradeniya, and Rajarata University (Mihinthale) on Dye sensitized solar cells..
  Collaborators: Prof. B.-E. Mellander et al,
- collaborates with
  Dr. T.M.W.J. Bandara, Department of Physics, University of Peradeniya
  Dr. V.A. Seneviratne, Department of Physics, University of Peradeniya on dye sensitized solar cells and polymer electrolytes
  Dr. Athula Wijayasinghe's Research group at NIFS (Nanotechnology and Advanced Materials).
  Dr. Buddhika Dassanayake, Department of Physics, University of Peradeniya on dye sensitized solar cells.
  Prof. K. P. Vidanapathirana & Prof. K.S. Perera et al Wayamba University

Material Processing & Device Fabrication

New Collaboration:

- 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.

Ongoing collaborations:

Material Processing and Device Fabrication research project of NIFS collaborates with:

- 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

New Collaboration:

- Nanotechnology and Advanced Materials research programme of NIFS collaborates with Prof. H.MTGA 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.

Ongoing collaborations:

- Nanotechnology and Advanced Materials research programme of NIFS collaborates with Prof. M. Yoshimura, Toyota Institute of Technology, Japan from 2015-07-01 to 2018-06-30.
  Summary: Advanced characterization of nano materials derived from Sri Lankan graphite.
  Collaborators: **Dr. H.W.M.A.C. Wijayasinghe,** Ms. R.M.N.M. Rathnayake, and Prof. M. Yoshimura.

- Nanotechnology and Advanced Materials research programme of NIFS collaborates with Department of Physics, Chalmers 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.

- Nanotechnology and Advanced Materials research programme of NIFS collaborates with Department of Science and Technology, Uva Wellassa University from 2015-11-01 to 2018-10-31.
  Summary: Development of Sri Lankan minerals for next generation technological applications.
  Collaborators: **Dr. H.W.M.A.C. Wijayasinghe**

NATURAL PRODUCTS & FOOD CHEMISTRY RESEARCH UNIT

Food Chemistry

New 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.

Nutritional Biochemistry

New Collaborations:

- 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 be 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 are 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 which has affected 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 on 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 the 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

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

  Summary: Experiments have been initiated for broad taxonomical evaluation of cyanobacteria in inland water bodies, representing different ecosystems and agro ecological zones. The value addition and toxin producing capability will be analysed to recommend their applicability in different industries.

  Collaborators: Prof. K.L.W. Kumara, Dept. of Agricultural Biology, Faculty of Agriculture, University of Ruhuna, Sri Lanka, Prof. D.M. Deepthi Yakandawala Department of Botany, University of Peradeniya.

- Isolation of Denitrifying Bacteria and their Potential use in Nitrate Removal of Well water of Jaffna District

  Summary: The nitrate removal in groundwater is a great interest due to excessive nitrate in groundwater. In agricultural areas of Jaffna well water contains about 20 – 50 mg/l of nitrate nitrogen. Methods available for remediation of nitrate contaminated water; are expensive and less applicable to Sri Lankan economy.

  Collaborator: Prof. N. Gnanavelrajah, Faculty of Agriculture, University of Jaffna

  Therefore, the goal of present study is to develop a biological method using denitrifying bacteria isolated from environment and evaluate their potential use in nitrate removal of well water of Jaffna district.

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

  Summary: Organic carbon accumulation in paddy ecosystems was faster and more pronounced than in other arable ecosystems. In this study SOC and its fractions of paddy soils and their links to nutrient availability will be determined. A GIS based map will be prepared to show the availability of soil C stocks in paddy soils.

  Collaborator: Dr. S.B., Karunaratne, University of Sydney, Australia

- Estimation and Mapping of Carbon Storage Capacity of Coastal Blue C Ecosystems of Sri Lanka

  Summary: The soil carbon sequestration by coastal blue C ecosystems and effects on the carbon budget has not yet been determined. Therefore, through the study it is intended to uniquely estimate the below ground carbon stock of the ecosystems and map them to utilize it in climate change mitigation and for the conservation and restoration of this maximally threatened wetlands.

  Collaborators: Prof. Anoma Perera, Faculty of Science, University of Peradeniya

  Collaborator: Dr. H.K. Kadupitiya, NRMC, Department of Agriculture, Peradeniya

Microbial Biotechnology

New Collaboration:

- Microbial Biotechnology research project collaborates with Department of Agriculture from 2018-01-01 to 2018-12-31.
  Summary: In the Biofilm Bio fertilizer application program to rice cultivation in Sri Lanka, we are collaborating with RRDI, Batalagoda, for designed field experiments.

Ongoing collaborations:

- Microbial Biotechnology research project collaborates with
  Sabaragamuwa University of Sri Lanka
  Rajarata University of Sri Lanaka
  South Eastern University of Sri Lanka
  Mahaweli Authority of Sri Lanka
  Irrigation management division, Irrigation Department
  Summary: In the Biofilm Bio fertilizer application program to rice cultivation in Sri Lanka, we educated farmers and distributed this bio fertilizer to about 2000 acres in Polonnaruwa, Ampara, Nikawaratiya and Mahiyanganaya during current Yala season. This could replace about 55% of chemical fertilizers and also some agrochemicals used by farmers.

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: Preparing a Radon Monitoring Map of Sri Lanka.
  Collaborator: Mr Prasad Mahakumara.

Environmental Science Research Project

New 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.

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. The 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 Natural Sciences, Open University of Sri Lanka, Nawala from 2015-06-01 to 2018-12-01.
  Summary: Environmental Remediation of Phosphates and Nitrates: Contaminations due to anionic pollutants such as nitrates and phosphates contribute to environmental pollution and enters the food chain leading to health problems. Wastewater from agricultural land, food production and industrial activities are the major sources of contamination of water bodies by these anionic pollutants. This research will seek to develop a low-cost, non-conventional method to remove such anionic pollutants from water bodies using surface modified silicate materials and polymer-silicate composites derived from silicate materials such as feldspar and quartz.
  Collaborator: Prof. S.S. Iqbal

- 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 ecosystem 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, disturbance forest disturbance would be classified into three levels and forest structure, tree species traits and tree species composition. Further, traditional knowledge on forest agrarian systems and classification, would be determined by interviewing local people.
  Collaborator: Dr. S. Ranwala, Dr. Q. Francis

Plant Taxonomy & Conservation

New 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 Wayamba (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)

Ongoing Collaborations:

- 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

- Plant Taxonomy and Conservation research project collaborates with Department of Chemistry, University of Sri Jayawardenapura from 2013-07-01 to 2018-07-01.
  Summary: Essential oils from Sri Lankan Plants.
  Collaborators: **Prof. D.S.A. Wijesundara,** Prof. Ajit Abeysekera, and Mr. T.M. S. G. Tennakoon (Ph.D. Student)

MOLECULAR BIOLOGY & BIOTECHNOLOGY RESEARCH UNIT

Molecular Microbiology & Human Diseases

New 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 at which the TB bacterium becomes resistant to two most powerful first line drugs: rifampin and isoniazid. Herein, we would 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, would 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

Ongoing Collaborations:

- 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

Research Supervision

A.1 Post graduate degrees completed in the year 2018

- **Mr. C.A. Thotawatthage.**
  Supervisors: **Prof. M.A.K.L. Dissanayake,** and **Prof. G.K.R. Senadeera**
  Thesis title:
  Nano structural modifications to photo anodes and electrolytes to improve the performance of dye sensitized solar cells
  ***Ph.D degree**, awarded by Postgraduate Institute of Science, University of Peradeniya*

- **Mr. U.B. Gunatilake**
  Supervisors: **Prof. J. Bandara**
  Thesis title:
  Fabrication of Underwater Superoleophobic and Superhydrophilic Membranes to Purify Oil Contaminated Wastewater
  ***M.Phil degree,** awarded by University of Peradeniya*

- **Mr. H.P.T.S. Hewathilake**
  Supervisors: **Dr. H.W.M.A.C. Wijayasinghe,** Dr. N.W.B. Balasooriya, and Prof. H.M.T.G.A. Pitawala
  Thesis title:
  Development of Sri Lankan Graphite as an Anode Material for Rechargeable Li-Ion Batteries
  ***M.Phil degree**, awarded by Postgraduate Institute of Science, University of Peradeniya*

- **Ms. I.S. Ileperuma Arachchi**
  Supervisors: by **Prof. S.P. Benjamin,** and Prof. P. Samaraweera
  Thesis title:
  Molecular phylogenetic relationships of the selected crab spider genera (Araneae:Thomisidae) with notes on new species from Sri Lanka
  ***M.Phil degree**, awarded by University of Peradeniya*

- **Ms. T. Keerthirathne**
  Supervisors: **Prof. D.N. Magana-Arachchi,** and Dr. S.S. Sooriyapathirana
  Thesis title:
  Rapid identification of non-tuberculous mycobacteria using a SYBR green mediated real time multiplex PCR assay and determination of their drug susceptibility
  ***M.Phil. degree,** awarded by University of Peradeniya*

- **Ms. O.S. Perera**
  Supervisors: **Dr. R. Liyanage,** and Prof. R. Sivakanesan
  Thesis title:
  Modulating of cowpea (Vigna unguiculata L. Walp) incorporated diets on serum lipids and serum glucose concentrations in wistar rats
  ***M.Phil degree,** awarded by Postgraduate Institute of Agriculture, University of Peradeniya*

- **Ms. V. Rizliya**
  Supervisors: **Dr. R. Liyanage,** and Prof. R. Sivakanesan
  Thesis title:
  Interaction of glucose oxidase (GOX) with non-glucose sugars: associated clinical implications and its application in assessing alpha amylase activity
  M.Phil. degree, *awarded by Postgraduate Institute of Science, University of Peradeniya*

- **Mr. V. Ekanayake**
  Supervisors: **Prof. G.R.A. Kumara,** and Prof. R.M.G. Rajapakse
  Thesis title:
  Enhancement of the efficiency of a dye-sensitized solid-state solar cell by eliminating the excess iodine in the CuI hole conductor material
  M.Sc. degree*, awarded by PGIS, University of Peradeniya*

- **K.U.K. Hapuhinna**,
  Supervisors: **Prof. N.D. Subasinghe**, Dr. T.P. Liyanage
  Thesis title:
  Characterisation of Natural Pyrite [FeS2] for Thermometric Applications
  M.Sc. degree, *awarded by PGIS, University of Peradeniya*

- **Mr. A. Heenatigala**
  Supervisors: **Prof. G.R.A. Kumara,** and Dr. A.C.A. Jayasundara
  Thesis title:
  Development of a supercapacitor with activated coconut charcoal electrodes with triethylamine thiocyanate (TAT) as the electrolyte
  M.Sc. degree*, awarded by PGIS, University of Peradeniya*

- **Ms. D.N. Liyanage**
  Supervisors: **Prof. G.R.A. Kumara,** and Prof. A.C.A. Jayasundara
  Thesis title:
  Alkyl-functionalized organic dye for dye-sensitized solid-state solar cells consisting CuI as a hole conductor
  M.Sc. degree*, awarded by PGIS, University of Peradeniya*

- **Ms. A.A.B. Madushani**
  Supervisors: **Prof. G.R.A. Kumara,** and Prof. K. Bandara
  Thesis title:
  Fabrication and characterization of floated graphite/graphene based composite counter electrode for dye-sensitized solar cells
  M.Sc. degree, *awarded by PGIS, University of Peradeniya*

- **Ms. S. Malika**
  Supervisors: **Dr. R.R. Ratnayake,** and Prof. A. Sumanasinghe
  Thesis title:
  Potential of Cyanobacteria Isolated From Different Fresh Water Bodies of Sri Lanka as a Food Supplement
  M.Sc. degree, *awarded by Postgraduate Institute of Agriculture, University of Peradeniya*

- **Ms. P. Sivagnanasundaram**
  Supervisors: **Prof. D.N. Magana-Arachchi**
  Thesis title:
  Quantification and Identification if Airborne Bacterial and Fungal Communities in Selected Areas of Teaching Hospital, Kandy, Sri Lanka
  ***M.Sc. degree**, awarded by University of Peradeniya*

- **Ms. I.W.D.N. Wickramarachchi**
  Supervisors: **Dr. R. Liyanage,** and **Prof. L. Jayasinghe**
  Thesis title:
  In-vitro investigation of anti-diabetic properties of some selected medicinal plants and their chemical profiling
  ***M.Sc. degree**, awarded by Postgraduate Institute of Science, University of Peradeniya*

A.2 PhD research work in progress

Names of the Supervisors	Name of the student	Title of the Research Area	Research Student Type
Prof. Bandara J.M.S.	Mr. Manjceevan A.	Solar Cells	External
Prof. Dissanayake M.A.K.L., and **Prof. Senadeera G.K.R.**	Ms. Kumari J.M.K.W.	Dye/Q-dot sensitized solar cells	NIFS RA
Prof. Dissanayake M.A.K.L., and **Prof. Senadeera G.K.R.**	Mr. Jaseetharan T.	Quantum dot solar cells and IR detectors	External
Prof. Iqbal M.C.M. Prof. Iqbal S.S., and Prof. Priyantha N.	Mr. Dissanayake D.M.R.E.A.	Environmental Science	NIFS RA
Dr. Jayarathna I.P.L., and **Prof. Weerasooriya R.**	Ms. Perera M.G.N.	Membrane Technology	NIFS RA
Prof. Kumara G.R.A., and Prof. Rajapakse R.M.G.	Ms. Kumarasinghe K.D.M.S.P.K.	Solar energy materials	NIFS RA
Dr. R.R. Ratnayake, Prof. C.L. Abayasekara,, and **Prof. S.A. Kulasooriya**	Mr. Mohanan K.	Development of microbial strains and co cultures for efficient production of ethanol from cellulosic materials *Thesis completed*	External
Prof. Subasinghe N.D.	Mr. Suriyaarachchi N.B	Geophysics	NIFS RA
Prof Weerasooriya R.	Samarakoon Y. M. I. B.	Computational Chemistry	External RA

A.3 MPhil. Research work in progress

Names of the Supervisors	Name of the student	Title of the Research Area	Research Student Type
Prof. Bandara J.M.S.	Mr. Abeykoon A.M.K.L.	Solar Cells	NIFS RA

Names of the Supervisors	Name of the student	Title of the Research Area	Research Student Type
Prof. Bandara J.M.S.	Ms. Farhana M.A.	Solar Cells	NIFS RA
Prof. Benjamin S.P., and Prof. Karunaratne W.A.P.	Ms. Bopearachchi D.P.	Molecular Systematics	Grant RA
Prof. Dissanayake M.A.K.L., and Prof. Senadeera G.K.R.	Mr. Umair K.	Dye sensitized solar cells	NIFS RA
Prof. Dissanayake M.A.K.L., and Prof. Senadeera G.K.R.	Mr. Senthuran S.	Dye sensitized solar cells	External RA
Prof. Iqbal M.C.M.	Ms. Karunaratne H.G.M.K.	Plant Biology	NIFS RA
Prof. Jayasinghe L.	Ms. Kumarihami C.A.U.K.	Natural Products Chemistry	NIFS RA
Prof. Jayasinghe L. and **Prof. Adikaram N. K. B.**	Ms. Amarasinghe C. P.	Plant Pathology	Grant RA
Prof. Jayasinghe L. and **Prof. Adikaram N. K. B.**	Ms. Manawadu L.	Microbiology	Grant RA
Prof. Jayasinghe L., and **Prof. Kumar N.S.**	Ms. Dissanayake D.M.	Natural Products Chemistry	Grant RA
Prof. Jayasinghe L., Prof. Kumar N. S., and **Prof. Adikaram N. K. B.**	Ms. Kaushalya H.S.T.	Chemistry	NIFS RA
Prof. Jayasinghe L., Prof. Kumar N. S., and **Prof. Adikaram N. K. B.**	Ms. Nilmini B.M.S.	Chemistry	External
Prof. Jayasinghe L., and Dr. Amarasinghe N. R.	Ms. Sathya S.	Chemistry	Grant RA
Prof. Kumara G.R.A. and Prof. Sirimanne P.M.	Mr. Dissanayake P.N.	Photo chemistry	NIFS RA
Prof. Kumara G.R.A., and Prof. Rajapakse R.M.G.	Mr. Karunarathne D.G.B.C.	Solar Energy	Grant RA
Prof. G.R.A. Kumara, and Prof. R.M.G. Rajapakse	Mr. Malikaramage A.U.	Nanoscience	External RA

Names of the Supervisors	Name of the student	Title of the Research Area	Research Student Type
Dr. Liyanage R	Ms. Deen F.A.	Nutritional Biochemistry	NIFS RA
Prof. Magana Arachchi D.N.	Ms. Ekanayake E.M.U.A.	Molecular Microbiology and Human Diseases	NIFS RA
Prof. Magana-Arachchi D.N., and Dr. R. Wanigatunge	Ms. Samarasinghe D.G.S.N.	Molecular Microbiology	NIFS RA
Prof. Magana Arachchi D.N.	Ms. Weerasinghe M.A.Y.N	Molecular Microbiology and Human Diseases	NIFS RA
Prof. Marikkar N.	Ms. Marasinghe S.S.K.	Food Chemistry	NIFS RA
Prof. Nanayakkara Asiri and Prof. (Mrs.) Gamalath K.A.I.L.	Mr. Jayakody J.A.D.M.N.	Theoretical Physics (Quantum Physics)	NIFS RA
Dr. Ratnayake R.R.	Ms. Dissanayake D.D.M.O.	Estimation & mapping of Soil carbon and other nutrients in some selected Blue Carbon Ecosystem	NIFS RA
Dr. Ratnayake R.R.	Ms. Jayasekara S.K.	Applied Microbiology	NIFS RA
Dr. Ratnayake R.R., and **Prof. Seneweera S.**	Ms. Jayasekara S.D.	Nitrogen uptake and utilization in rice under the influence of cyanobacteria	NIFS RA
Dr. Ratnayake R.R	Miss. Paranavithana T.M.	Development of a base line information system for paddy growing soils in Sri Lanka	Grant RA
Dr. Ratnayake R. R	Miss. Bowange R.W.T.M.R.T.K.	Investigation of genetic diversity of cyanobacteria in different water bodies of Sri Lanka with their taxonomical identification, nutrient profiling and toxin analysis	External RA
Prof. Seneviratne G.	Ms. Gunarathne H.K.S.N.S.	Microbiology & Plant Biology	NIFS RA

Names of the Supervisors	Name of the student	Title of the Research Area	Research Student Type
Prof. Seneviratne G.	Ms. Meepegamage S.W.	Molecular Microbiology & Plant Biology	NIFS RA
Prof. Seneviratne G.	Ms. Rathnathilake A.T.D.	Microbiology & Plant Biology	NIFS RA
Prof. N.D. Subasinghe	Mr. Mahakumara P.	Environmental Science	External RA
Prof. N.D. Subasinghe	Mr. Wijekoon W.M.H.S.	Physics of Materials	External RA
Prof. Subasinghe N.D.and Dr. Malaviarachchi S.P.K.	Mr. Bandara H.M.D.A.H.	Geology and Geophysics	NIFS RA
Prof. Weerasooriya R.	Mr. B.A.Y.B. Jayawardena	Biochar for leachate treatment	NIFS RA
Prof Weerasooriya R.	Ms. Halpegama Jayani Upeksha	Electro Material Chemistry	Grant RA
Prof. Weerasooriya R.	Ms. Rukshagini P.	Water chemistry	Grant RA
Dr. Wijayasinghe A. Dr. H.W.M.A.C. Wijayasinghe, and **Prof. R. Weerasooriya**	Mr. Heshan G.D.K.	Development of materials for water purification	NIFS RA
Dr. H.W.M.A.C. Wijayasinghe, and Dr. N.W.B. Balasooriya since	Ms. Naranpanawa Himashee	Development of local graphite for lithium-ion batteries	Grant RA
Dr. H.W.M.A.C. Wijayasinghe, Dr. N.W.B. Balasooriya, and Dr. T.H.N.G. Amaraweera	Ms. Kanagaratnam J.N.	Development of local graphite for Sodium-ion batteries	Grant RA
Dr. H.W.M.A.C. Wijayasinghe, and Prof. Dissanayake M.A.K.L.,	Mr. Karunaratne Niroshan	Development of electrode materials for rechargeable batteries	Grant RA
Dr. H.W.M.A.C. Wijayasinghe, Dr. N.W.B. Balasooriya, and Prof. H.M.T.G.A. Pitawala	Ms. Senevirathna T.C.	Development of local graphite for Sodium-ion batteries	Grant RA
Dr. H.W.M.A.C. Wijayasinghe, and **Prof. M.A.K.L. Dissanayake**	Mr. Karunarathne R.I.C.N.	Development of materials for battery applications	

Names of the Supervisors	Name of the student	Title of the Research Area	Research Student Type
Prof. Wijesundara D.S.A., Dr. Ranasinghe S., and Dr. Kathriarachchi H.	Mr. Jayasinghe H.D.	DNA Barcoding, Morphological Taxonomy and Phylogeny	NIFS RA
Prof. Wijesundara D.S.A., Prof. Iqbal M. C. M, and Prof. Madawala, H. M. S. P	Mr. Lekamge P.L.C.U.S.B.	Forestry and forest conservation	NIFS RA

A.4 MSc research projects in progress

Names of the Supervisors	Name of the student & affiliated University	Title of the Research Area	Commencement date
Prof. Bandara J.	Mr. Sumithraarachchi S.A.D.A.V. University of Peradeniya	Water Purification	2018-06-18
Prof. Bandara J.	Ms. Rajapaksha M.C.M. University of Peradeniya	Photo catalyst	2018-05-20
Prof. Iqbal M.C.M., and Dr. C.S. Kalpage	Ms. Rajapaksha R.G.C.P. University of Peradeniya	Environmental Science	2018-07-10
Prof. G.R.A. Kumara, and Prof. R.M.G. Rajapakse	Mr. Abeysekara D.A.N.C. University of Peradeniya	Nanoscience and nanotechnology	2018-04-02
Prof. G.R.A. Kumara, and Dr. A.C.A. Jayasundara	Ms. Jayathilaka M.A.Y.U. PGIS, University of Peradeniya	Nanoscience and nanotechnology	2018-03-15
Dr. Liyanage R. , and Prof. Rajapakse R. G. S. C.	Ms. Premaratne U.O. University of Peradeniya	Food and nutrition	2017-10-09
Dr. Liyanage R. , and Prof. Terrence Madhujith	Ms. Ariyarathna W.A.P.M.M. University of Peradeniya	In vitro screening of Sri Lankan Ayurvedic plants for their antioxidant activity	2017-09-18
Dr. Liyanage R. , and Prof. R. Sivakanesan,	Ms. Bangamuwage R.J. Postgraduate Institute of Agriculture, University of Peradeniya	Food and Nutrition	2017-02-09
Prof. Magana-Arachchi D.N.	Thasajini Nagendran, University of Peradeniya	Cyanobacteria	2018-06-11

Names of the Supervisors	Name of the student & affiliated University	Title of the Research Area	Commencement date
Prof. Magana-Arachchi D.N.	Ms. Madamarandawala J.M.P.S University of Peradeniya	Drug Resistant Tuberculosis	2018-04-20
Prof.. Magana-Arachchi D.N and Dr. B. Jayasooriya	Ms. Jayantha E.G.J. University of Peradeniya	Pharmacognosy	2017-12-15
Dr. R.R. Ratnayake,, and Prof. A. Sumanasinghe	Ms. Malika S. Postgraduate Institute of Agriculture, University of Peradeniya	Potential of Cyanobacteria Isolated From Different Fresh Water Bodies of Sri Lanka as a Food Supplement	2017-02-10

B.1. Undergraduate research projects completed:

Names of the Supervisors	Name of the student & affiliated University	Title of the Research Area	Duration
Prof..Dissanayake, M.A.K.L & **Prof. Senadeera, G.K.R.**	Ms. Balasunderam Dushyanthini Open University of Sri Lanka	Performance enhancement of Dye sensitized solar cells by employing triple layered photoanode consisting with Nanofibers of TiO_2 and co-dye sensitization	
Prof..Dissanayake, M.A.K.L & **Prof. Senadeera, G.K.R.**	Mr. Ziyan M.A.M. South Eastern University (SEUSL)	Fabrication & characterization of dye-sensitized solar cells and their efficiency enhancement with an innovative type photoanode of titanium dioxide (TiO_2) nanoparticles/nanofibers composite	
Dr. Liyanage R., and Dr. Kumari, D.W.M.M.M.,	Ms. Herath U.K. University of Rajarata	Effect of in-vitro digestion on antioxidant properties of processed cowpea and mung beans	2018-02-05 to 2018-08-20
Dr. Liyanage, R, and Dr. Jayawaradana, B.C	Ms. Wickramanayaka Saritha University of Peradeniya	Comparison of stimulated digestion on antioxidant properties of raw and boiled legumes in Sri Lanka	2017-08-25 to 2018-01-10

Names of the Supervisors	Name of the student & affiliated University	Title of the Research Area	Duration
Dr. Liyanage R., and Dr. Deshapriya,	Mr. Ranasinghe I.G.L.C. University of Peradeniya	Investigation of accumulation of heavy metals in bovines blood and milk	2017-08-25 to 2018-01-10
Dr.Liyanage.R, and Dr. Jayawaradana, B.C	Ms. Wimalaweera Udeshini University of Peradeniya	Comparison of Fermentative properties in raw and boiled legumes after stimulated digestion	2017-08-25 to 2018-01-10
Dr. R. Liyanage and Dr. S. Vasantharuba	Ms. Amriya M.N.F. University of Jaffna	Screening for anti-diabetic properties and phytochemicals of *hemidesmus indicus*	
Prof. Magana-Arachchi D.N., and Ms. Supeshala	Ms. Bandara A.M.J.E. Northumbria University, UK	Molecular Microbiology	2018-09-26 to 2018-12-10
Prof. Magana-Arachchi D.N., and Dr. E.M.J.M. Rizvi	Mr. Keshura R. Eastern University of Sri Lanka	Molecular Microbiology and Human Diseases	2018-01-15 to 2018-08-31
Prof.. Magana-Arachchi D.N, and Dr. E.M.J.M. Rizvi	Ms. Thajudeen T. Eastern University of Sri Lanka	Molecular identification of bacteria isolated from lung cancer and bronchiectasis patients samples through 16S PCR	2018-01-15 to 2018-08-31
Dr. Ratnayake R.R.	Ms. Karunaratne, S. Faculty of Agriculture, University of Ruhuna	Evaluation of cellulolytic fungi from Sri Lanka for bio stone washing of Denim in comparison with commercial cellulose	
Dr. Ratnayake R.R.	Ms. Karinaratne, D. Faculty of Agriculture, University of Ruhuna	Suppression of Causal Agents of Damping off Disease in Tomato by using Microbial Cellulases	
Dr. Ratnayake R.R.	Ms. Sivappiragasam, N. Faculty of Agriculture, University of Jaffna	Potential to use cyanobacterial strains as bio fertilizer	

Names of the Supervisors	Name of the student & affiliated University	Title of the Research Area	Duration
Dr. Ratnayake R.R.	Balasubbramanium, P. Faculty of Agriculture, University of Jaffna	Formulation of low cost medium for cyanobacteria and assessment of their potential use as a bio fertilizer in paddy	
Prof. Seneviratne G.	Ms. Wickramasinghe D. Rajarata University of Sri Lanka	Role of biofilm bio fertilizer on growth yield and nutrition of rice (Oryza sativa L.)	2018-02-12 to 2018-09-30
Prof. Seneviratne G.	Ms. Amarathunga G. Rajarata University of Sri Lanka	Role of developed microbial biofilms on growth yield and nutrition of rice	2018-02-12 to 2018-09-30
Prof. G. Seneviratne	Ms. Ketipearachchi K.G. University of Ruhuna	Effect of Endophytic diazotrophs on grain yield of Rice with Biofilm Bio-fertilizer Application	2018-08-20 to 2018-12-31

B.2. Undergraduate research projects in progress:

Names of the Supervisors	Name of the student & affiliated University	Title of the Research Area	Date of Commencement
Dr. G. Bowatte	Mr. Priyankara S. University of Peradeniya	Air pollution monitoring and modelling	2018-09-25
Dr. G. Bowatte	Mr. Senarthna M. University of Peradeniya	Air pollution monitoring and modelling	2018-09-25
Prof. M.A.K.L. Dissanayake,and **Prof. G.K.R. Senadeera**	Ms. Farhath M.M. Raazidha South Eastern University of Sri Lanka	Polymer electrolytes for dye sensitized solar cells	2018-10-15.
Prof. Iqbal M.C.M.	Ms. Nirmanee K.T.S. Faculty of Agriculture, Rajarata University of Sri Lanka	Environmental Science	2018-09-25
Dr. Jayarathne I.P.L.	Rajeevan.N, Uva Wellasa university	Chemical synthesis	2018-08-01

Names of the Supervisors	Name of the student & affiliated University	Title of the Research Area	Date of Commencement
Dr. Jayarathna I.P.L.	Ishara. K, Uva Wellasa university of Sri Lanka	Chemical synthesis	2018-08-01
Prof. Kumara G.R.A., and Dr. Herath	Ms. Somarathne G.W.E.G.K. University of Rajarata	Solar energy	2018-11-01
Prof. Kumara G.R.A,and Prof. A.R. Kumarasinghe	Ms. Dahanayake U.D.P.R. University of Sri Jayawardenapura	Expanded graphite	2018-08-13
Dr. Liyanage R. and Dr. Weerakkody, N.S,	Ms.Bopagoda B.H.S.M The Open University of Sri Lanka	Food and nutrition	2018-03-19
Prof. Magana-Arachchi D.N.	Ms. Herath H.M.H.P. Wayamba University of Sri Lanka	Cyanotoxin	2018-12-03
Prof.. Marikkar J.M.N	Ms. Rubini N. Sabaragamuwa University of Sri Lanka	Nutritional Biochemistry	2018-12-01
Prof Weerasooriya R.	Kalathma.N, University of Peradeniya	water chemistry	2018-03-01
Prof. Weerasooriya R.	Ms. Kushanie H., Institute of Chemistry Ceylon	water chemistry	2018-05-01
Prof. Weerasooriya R.	Jayani.B, University of Peradeniya	water chemistry	2018-01-03
Prof. Weerasooriya R.	Ms. Nethmini A. University of Peradeniya	Water quality indexing	2018-03-01
Prof. Weerasooriya R.	Mr. Witharana W.P.S.A University of Peradeniya	Geo-chemistry	2018-03-18

Names of the Supervisors	Name of the student & affiliated University	Title of the Research Area	Date of Commencement
Dr. H.W.M.A.C. Wijayasinghe, and Dr. T.H.N.G. Amaraweera	Ms. Kumari T.D.D. Uva Wellassa University	Development of Ag-graphite composite for batteries	2018-10-01
Dr. H.W.M.A.C. Wijayasinghe, and Dr. T.H.N.G. Amaraweera	Pilapitiya P.G.C.N.T. Uva Wellassa University	Upgrading local quarts for technological applications	2018-10-01
Dr. H.W.M.A.C. Wijayasinghe, and Dr. T.H.N.G. Amaraweera	Mr. Ranasinghe, U.G.K.L.S. Uva Wellassa University	Development of graphite intercalated compounds for rechargeable batteries	2018-10-01
Dr. H.W.M.A.C. Wijayasinghe, and Dr. T.H.N.G. Amaraweera	Siriwardane M.P.S.S. Uva Wellassa University	Upgrading of local minerals for future technological applications	2018-10-01
Prof. Wijesundara D.S.A., and Dr. Nakandala N.	Ms. Wickramasinghe K. University of Ruhuna	Plant taxonomy and plant secondary metabolites	2018-08-20

Awards & Recognitions 2018

Awards:

- National Competitive Award by National Science Foundation for Life-time Achievement Award, received on 2018-10-04:
  Prof. Dissanayake, M.A.K.L.

- Presidential Award for Scientific publications in SCI journals published in 2016 received on 2018.11.06:
  Prof. Bandara, J.M.S.,
  Prof. Dissanayake, M.A.K.L.
  Prof. Kumara, G.R.A.
  Prof. Magana-Arachchi, D.N.
  Dr. Liyanage, R.
  Ms. Gannoruwa G.M.A.U.K.,
  Ms. Jayathilake R.M.G.C.S.K.
  Mr. Kumarathilaka S.M.P.R.,
  Ms. Liyanage, H.M.
  Mr. Manjceevan A.
  Ms. Visvanathan, R.

- NRC Merit Award for Scientific Publications-2016, received on 2018-12-20:
  Prof. Benjamin, S.P.
  Prof. Iqbal, M.C.M.
  Prof. Jayasinghe, L
  Mr. Qader M,

- National Competitive Award by National Science Foundation for Annual Research Awards 2017, received on 2018.11.28:
  Prof. Dissanayake, M.A.K.L.
  Prof. Senadeera, G.K.R.

- National Competitive Award for Support Scheme for Supervision of Research Degrees (SUSRED AWARDS 2017) received on 2018-07-25:
  Prof. Dissanayake, M.A.K.L.
  Prof. Kumar, N.S.
  Prof. Jayasinghe, L
  Prof. Senadeera, G.K.R.
  Dr. Wijayasinghe, H.W.M.A.C.

- NIFS Outstanding Scientists 2017 received on 2018.04.06:
  1st place *Prof. Dissanayake, M.A.K*.L.
  2nd Place *Prof. Jayasinghe, L*
  3rd Place *Prof. Wijesundara, D.S.A.*

- Gold Medal for best thesis presentation at Three Minutes Thesis competition from National Science Foundation on 2018-10-04.2.
  Ms. Thureirajah A.
- Merit Award at Young Scientist Forum Symposium from National Science Foundation on 2018-11-05- Ms. Thureirajah A.

- Fellowships:

  Mr. Bandara, H.M.D.A.H., awarded a Fellowship by Niigata University, Japan from 2018-05-01 to 2018-07-31.

  Mr. Bandara, H.M.D.A.H., awarded a Fellowship by National Science Foundation (NSF), Sri Lanka from 2018-05-01 to 2017-03-07.

- NIFS-Three minutes Thesis Competition (Postgraduate Category):
  1st place- *Ms. Sathya S.*
  2nd Place- *Ms. Weerasinghe, M.A.Y.N.*
  3rd Place- *Ms. Jayasekara S.*

- NIFS- Three minutes Thesis Competition (Undergraduate Category):
  1st place- *Mr. Dissanayake P.N.*
  2nd Place- *Ms. Madamarandawala, J.M.P.S.*
  3rd Place- *Ms. Bowange T.*

Recognition:

- Reviewer for Reviewing a Manuscript for Journal Publication in 2018:

  Prof. Benjamin S.P.
  Journal of Asia-Pacific Entomology
  Raffles Bulletin of Zoology
  Zootaxa

  Prof. Iqbal, M.C.M.
  Environmental Earth Sciences

  Prof. Marikkar, J.M.N.- for…
  LWT-Food Science and Technology
  Food Science and Technology International
  Italian Journal of Food Science

  Prof. Kumara, G.R.A.
  Chemical Physics
  Journal of alloys and Compounds

  Prof. Subasinghe, N.D.
  Journal of Geological Society of Sri Lanka

  Prof. Wijesundara, D.S.A.
  Ceylon Journal of Science
  Journal of the National Science Foundation
  Sri Lanka Journal of Food and Agriculture
  Sri Lankan Journal of Biology (SLJB)
  Wildlanka Journal

  Dr. Liyanage, R.
  Journal of Food Chemistry
  Journal of functional foods
  International Journal of food science & technology

  Dr. Jayarathne, L
  Journal of Colloids and Surfaces
  Journal of Colloids and Interfacial Science
  Iore Journal of Environmental Science

- Reviewer in International Conference in 2018:
  Prof. D.N. Magana-Arachchi
  3rd International Research Symposium on Pure and applied Sciences
  Dr. Liyanage, R.
  PGIA Annual Congress
  Jaffna University International Conference JUICe
  Wayamba International Conference WinC
  Dr. Jayarathne L
  5th International Conference on Nano Science and Technology
  IRCUWU-2018 conference, Uva Wellassa University

- Consultant on reviewing B.Sc (Special) Degrees in Botany at South Eastern University of Sri Lanka on Prof. Kulasooriya, S.A.

- Recognized for the Outstanding Contribution in Reviewing from Elsevier Publishers on 2018-07-02.
  Prof. Kulasooriya, S.A.

- Co-Chair at XVI Asian Symposium of Medicinal Plants, Spices and other Natural Products from 2018-12-12 to 2018-12-14.
  Prof. Wijesundara, D.S.A.

- Editor-in-Chief of the Ceylon Journal of Science**,** A quarterly journal published by University of Peradeniya
  Prof. Dissanayake, M.A.K.L.

- Editor, Agriculture, Ecosystems & Environment (Elsevier, SCI journal).
  Prof. Seneviratne, G

- Life time Fellow of the National Academy of Sciences, Sri Lanka
  Prof. Dissanayake, M.A.K.L.

- Life Time Fellow of the Institute of Physics, Sri Lanka
  Prof. Dissanayake, M.A.K.L.

- Life time member of SLAAS.
  Prof. Dissanayake, M.A.K.L.

- Chairman of the Organizing Committee of the Solar Asia -2018 International Research Conference held from 4th to 6th January 2018 by NIFS
  Prof. Dissanayake, M.A.K.L.

- Chairman of the Editorial Board of the Proceedings of the "Solar Asia 2018" international Research Conference, published by NIFS. 323 pages, 2018
  Prof. Dissanayake, M.A.K.L.

- Session Chair at *PGIS Research Congress* 9-10 November 2018
  Prof. Dissanayake, M.A.K.L.

- Serving in committees:

Prof. Dissanayake, M.A.K.L.: Member of the Board of Governors of the NIFS

Prof. Dissanayake, M.A.K.L.: Member of the National Research Council, NRC

Prof. Dissanayake, M.A.K.L.: Member, Research Advisory Board, NSF

Prof. Dissanayake, M.A.K.L.: Member, Science & Technology Policy Research (STPR) Committee, of NSF

Prof. Dissanayake, M.A.K.L.: Deputy Project Manager of the "Solar EduTraining" Multi University, 4 year national R&D and training project of the Ministry of Science, Technology and Research

Prof. Dissanayake, M.A.K.L.: Member of the Study Group to formulate Basic Science Research Policy for the NASTEC,

Prof. Iqbal, M.C.M. : Member of the Board of Study in Crop Science at Postgraduate Institute of Agriculture, University of Peradeniya from 2018-05-22 to 2022-01-15.

Prof. Iqbal, M.C.M. : Member of the Ethics Committee at Sri Lanka Association for the Advancement of Science on 2018-12-01

Prof. Kulasooriya, S.A.: Member, Standing Committee for Accreditation and Quality Assurance of Non-State Higher Education Institutes at Ministry of Higher Education, Sri Lanka
Member of Board of Management at Postgraduate Institute of Science, University of Peradeniya
Council member at Rajarata University of Sri Lanka

Prof. Seneviratne, G Member, Board of Study of Plant Sciences, Post Graduate Institute of Science, University of Peradeniya.

Prof. Subasinghe, N.D.: Member of the Board of Earth Sciences, PGIS, Peradeniya
President at Geological Society of Sri Lanka (GSSL)

Prof. Wijesundara, D.S.A.: Chairman at Biodiversity and ecosystem services indicators and guideline committee of the Central Environment Authority of Sri Lanka

Dr. Ratnayake, R.R. Member of the Board of study in Biochemistry & Molecular Biology, PGIS, Peradeniya

Dr. Wijayasinhe, H.W.M.A.C: Member, Faculty board, Faculty of Science & Technology, Uva-Wellassa University

- Evaluator/ Examiner

Prof. Dissanayake, M.A.K.L.:	Evaluator of STEM Research Proposals of AHEAD Grant scheme (World Bank) of the Ministry of Higher Education Evaluator for NSF Research Grants Final Reports (2018) Evaluator for Progress reports of NRC Grants (2018) Evaluator for NRC Research Grant Proposals Reviewer for NSF Research Proposals-2018 Evaluator for NSF Research Grants Progress Reports 2018 External examiner for the PhD thesis examination of Ms. Alwani Binti Rafieh, for University of Malaya, Kuala Lumpur, Malaysia
Prof. Magana-Arachchi, D.N.:	Evaluator for NRC Yearly Progress Reports in 2018. Evaluator for UKRI-BBSRC research grant in 2018. Examiner for PhD of Dr. N.H Manamperi. Titling "Host factors in the pathogenesis of cutaneous leishmaniasis due to Leishmania donovani in Sri Lanka' in 2018.
Prof. Iqbal, M.C.M.:	Evaluator for M.Sc and thesis defense of Ms. L.R.C. Premalal Title: Decolourisation of crystal violet and congo red dyes from aqueous solutions by using Salvinia molesta in 2018. Evaluator for PhD thesis and Oral thesis defence of Mr. M.A.P.W.K. Malaviarachchi. Title: Assessing climate resilience of maize and mung bean and increasing their adaptation capacity to long term climate change on upland cropping systems in Sri Lanka in 2018.
Dr. Wijayasinhe, .H.W.M.A.C.:	Evaluator for PhD thesis and Oral thesis defence of Mr. C.H. Manorathna, University of Colombo. Title: Synthesis, Characterization and electrochemical performance of graphene & graphene composites.

- Other recognitions:

Prof. Marikkar, J.M.N.:	Acted as expert to draft a proposal for a Diploma Course for an outside institute on a voluntary basis from INSIGHT Institute for Management & Technology, Colombo on 2018-12-14.
Prof. Marikkar, J.M.N.:	Examiner for Acting as a Member of the Judging Panel for 3 MT Thesis Competition in 2018.
Prof. Marikkar, J.M.N.:	Chief Guest for Annual Prize Giving Ceremony from Hill-Country International School, Madawala Bazaaron
Prof. Kulasooriya, S.A.:	Chief Guest for the stated award ceremony of The Open University of Sri Lanka in 2018.

Newspapers/Magazine articles

- Amaraweera, T.H.N.G., Senavirathne, M.M.K.R.N.D., and Wijayasinghe, H.W.M.A.C**.** (2018-01-03), Bateriye Anagatha Dasuna. *Vidusara sinhala newspaper* p.07.
- Benjamin, S.P. (2018-08-10), Discovering New Spider Spices. *Sunday Lankadeepa* p.47.
- Liyanage, R. (2018-01-07), කුකුළු පීකුදු වල නොදන්න විෂ කථාව. *Mawbima* p.15
- Piyathilaka, P. (2018-01-31), A Productive Future with the new paths of Science. *Vidya- Daily News* p.11.
- Piyathilaka, P. (2018-01-31), Solar Asia International Conference Successful. *Vidya- Daily News,* p.01.
- Piyathilaka, P. (2018-01-31), The Sri Lankan Lass who won with Marine Biology. *Vidya- Daily News* p.10.
- Piyathilaka, P. (2018-02-28), 7th Young Scientists Forum Successful. *Vidya- Daily News* p.01.
- Piyathilaka, P. (2018-02-28), Biology subjects to Guide your life. *Vidya- Daily News* p.14.
- Piyathilaka, P. (2018-04-25), A young Scientist to enlighten Agriculture. *Vidya- Daily News* p.10.
- Piyathilaka, P. (2018-04-25), NIFS Annual Research Review. *Vidya- Daily News* p.3.
- Piyathilaka, P. (2018-05-30), An Outstanding Scientist who rendered a silent service. *Vidya-Daily News* p.10.
- Piyathilaka, P. (2018-05-30), Award Winning Sri Lankan School Science Project. *Vidya- Daily News* p.15.
- Piyathilaka, P. (2018-06-27), 45th School Science Program. *Vidya- Daily News* p.16.
- Piyathilaka, P. (2018-06-27), New Director of NIFS assuming duties. *Vidya- Daily News* p.04.
- Piyathilaka, P. (2018-06-27), Sri Lankan Scientists discover treatment for Influenza. *Vidya-Daily News* p.10.
- Prof. Benjamin, S.P. (2018-06-26), Sri Lankan Research on New Spiders. *Dinamina* p.12.
- Prof. Seneweera, S. (2018-07-22), Climate Change has reduced nutrition value of rice. *Sunday Lankadeepa* p.12.

- Prof. Wijesundara, D.S.A. (2018-03-20), Pollination creates a colorful world. *Travellanka. Vol. 24* p.12-13.

- Ratnayake, R.R., and Rajapaksha, R.P.S.K (2018-11-12), Role of soil in reducing global warming. *Soba, Parisara prakashanaya* p.66-68.

- Senavirathne, M.M.K.R.N.D., and Wijayasinghe, H.W.M.A.C. (2018-10-01), Research on graphite resources of Sri Lanka: Current status. *The Sri Lankan Scientist Magazine* p.13-15.

- Seneweera, S. (2018-09-30), Solution for CKDu from rain water. *Sunday Lankadeepa* p.13.

Training / Participation related to research work

Training

- Mr. H.M.D.A.H. Bandara Trained at an International Programme on Geochemical study of Charnockite Complex in Northern Sri Lanka from 2018-05-01 to 2018-08-31 at Niigata, Japan.

- Miss. Disanayake D. M. D. M., Trained at an International Workshop on Advance Analytical Chemistry from 2018-10-22 to 2018-11-02 at India.

- Ms. S. Gunarathne, and Ms. S.W. Meepegamage Trained at a Programme on Lab demonstration on 2018-08-20 at National Institute of Fundamental Studies.

- Ms. S. Gunarathne, and Ms. S.W. Meepegamage Trained at a Programme on Laboratory demonstration on 2018-08-13 at Microbial Biotechnology Unity, National Institute of Fundamental Studies.

- Prof. D.N. Magana-Arachchi Trained at a Workshop on General awareness training on ISO/IEC 17025: 2017 from 2018-02-21 to 2018-02-23 at Sri Lanka accreditation board, Colombo.

- Mr. T. Jaseetharan Trained at an International Programme on *Research training* from 2018-11-01 to 2018-10-31 at Chalmers University of Technology, Gothnburg, Sweden.

- Miss. T.M. Paranavithana, and Ms. S.D. Jayasekara Trained at a National Workshop on *Short Course on Data Analysis Using R & R Studio*from 2018-12-27 to 2018-12-28 at Faculty of Science, University of Peradeniya.

- Ms. S.D. Jayasekara Trained at a National Workshop on *Isotope Techniques in Water Resources Management* on 2018-12-20 at Central Environmental Authority.

- Ms. S.K. Jayasekara ,A. Thurairajah, S. Meepegamage Trained at a National Workshop on *Training Workshop on DNA sequencing* from 2018-01-26 to 2018-01-27 at Department of Microbiology,Faculty of Medicine ,University of Peradeniya.

Participation

- Ms. E.M.U.A. Ekanayake Ms. M.A.Y.N. Weerasinghe and Ms. J.M.P.S. Madamarandawala Participated at a National Conference on Scientific Sessions of The Sri Lankan Society for Microbiology on 2018-10-26 at Kandy, Sri Lanka.

- Ms. E.M.U.A. Ekanayake Participated at an International Conference on ASM Microbe from 2018-06-07 to 2018-06-11 at Atlanta, USA.

- Prof. M.C.M. Iqbal Participated at a National Workshop on Mainstreaming Sustainable Development Goals into National Budget Plans in Sri Lanka on 2018-10-01 at Grand Monarch Hotel, Thalawathugoda.

- Prof. M.C.M. Iqbal Participated at a National Workshop on Planning for cultivation seasons based on climate and weather factors on 2018-01-16 at Presidential Secretariat.

- Prof. M.C.M. Iqbal Participated at a National Workshop on Public Expenditure Review on Science and Technology on 2018-08-30 at Ministry of Science, Technology and Research.

- Ms. J.N. Kanagaratnam Participated at a National Symposiums on *International Mineral Symposium - 2018* on 2018-10-20 at BMICH, Colombo.

- Ms. J.N. Kanagaratnam Participated at an International Symposiums on *International Mineral Symposium* on 2018-10-20 at Colombo.

- Ms. J.N. Kanagaratnam Participated at a National Symposiums on *Annual Sessions of the Geological Society of Sri Lanka* on 2018-02-23 at University of Peradeniya.

- Ms. J.N. Kanagaratnam Participated at a National Symposiums on *Postgraduate Institute of Science Research Congress* from 2018-11-09 to 2018-11-10 at Postgraduate Institute of Peradeniya.

- Prof. D.N. Magana-Arachchi Ms. E.M.U.A. Ekanayake and Ms. J.M.P.S. Madamarandawala Participated at an International Conference on 1st Sri Lankan ANRAP Regional Seminar (ANRAPSL1) on Herbal Approaches in Combating Diabetes and Common Tropical Diseases from 2018-01-17 to 2018-01-19 at Kandy, Sri Lanka.

- Prof. D.N. Magana-Arachchi Ms. E.M.U.A. Ekanayake and Ms. J.M.P.S. Madamarandawala Participated at an International Conference on South Asian Biotechnology Conference 2018 from 2018-01-28 to 2018-01-30 at Colombo, Sri Lanka.

- Prof. D.N. Magana-Arachchi Ms. M.A.Y.N. Weerasinghe and Ms. J.M.P.S. Madamarandawala Participated at a National Symposiums on “Air That We Breathe” Seventh National Symposium on Air Resource Management in Sri Lanka on 2018-08-08 at Colombo, Sri Lanka.

- Prof. D.N. Magana-Arachchi Participated at a National Programme on 'Delivering a safer world', National Seminar Organized in line with the World Accreditation Day 2018 on 2018-06-21 at Kingsbury Hotel, Colombo.

- Prof. D.N. Magana-Arachchi Participated at a National Programme on "Validation workshop on formulation of intellectual property policy for Sri Lanka on 2018-06-11 at Institute of Policy Studies of Sri Lanka.

- Prof. D.N. Magana-Arachchi Participated at a National Programme on The National policy and governing mechanisms of the National Genome Centre and National Genome Data Repository - Stakeholders' meeting on 2018-05-11 at Sri Lanka Institute of Development Administration (SLIDA).

- Prof. D.N. Magana-Arachchi Participated at a National Workshop on Air quality assessment for health and environment policies on 2018-09-12 at Waters Edge, Battaramulla.

- Prof. D.N. Magana-Arachchi Participated at a Workshop on "In-house seminar to discuss and finalize the draft basic science research policy for Sri Lanka" on 2018-05-16 at National Institute of Fundamental Studies.

- Prof. D.N. Magana-Arachchi Participated at a Workshop on "Water: Planning for the Future" A joint Sri Lankan-South African Seminar on 2018-11-12 at Kandy, Sri Lanka.

- Prof. D.N. Magana-Arachchi Participated at a Workshop on Preparation of Corporate plan - Ministry of Science, Technology & Research from 2018-02-19 to 2018-02-20 at SANASA Campus - Kegalle.

- Prof. D.N. Magana-Arachchi Participated at a Workshop on Second Annual Australia- Sri Lanka Workshop on CKDu on 2018-12-06 at Colombo, Sri Lanka.

- Ms. S.W. Meepegamage Participated at a Training workshop on DNA Sequencing Workshop from 2018-01-26 to 2018-01-27 at Faculty of Medicine, University of Peradeniya.

- Ms. D.G.S.N. Samarasinghe Participated at a National Conference on 38th Annual Sessions of the Institute of Biology, Sri Lanka on 2018-09-28 at Colombo, Sri Lanka.

- Ms. D.G.S.N. Samarasinghe Participated at an International Symposiums on Pure and Applied Sciences (IRSPAS) 2018 on 2018-10-26 at Kelaniya, Sri Lanka.

- Prof. S. Seneweera, Prof. D.S.A. Wijesundera, and Prof. M.C.M. Iqbal Participated at a National Workshop on Green Climate Fund on 2018-12-20 at Ministry of Mahaweli Development and Environment.

- Ms. M.A.Y.N. Weerasinghe Participated at a National Conference on 74th Annual Scientific Sessions of Sri Lanka Association for the Advancement of Science from 2018-12-02 to 2018-12-08 at Colombo, Sri Lanka.

- Prof. D.S.A. Wijesundara Participated at an International Workshop on UNESCO Global Geo Park Workshop from 2018-05-26 to 2018-05-30 at Oki Islands Global Geo Park, Osaka, Japan.

- **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.

- **Prof. D.S.A. Wijesundara** Participated at an International Conference on *Asian Network of Research on Anti-Diabetic Plants (ANRAP) Conference and gave a talk on Medicinal Plants of Sri Lanka – cornerstone of indigenous medicine* on 2018-01-18 at Kandy.

Dissemination of Science

Conferences & Workshops:

- *"International Conference on Solar Energy Materials, Solar Cells & Solar Energy Applications (SOLAR ASIA – 2018)"* was organized by the Condensed Matter Physics and Solid State Chemistry Research project, and Science Education and Dissemination Unit of NIFS at the Oak Ray Hotel Kandy from 2018-01-04 to 2018-01-06 for the Scientific Community (100 participants).

- *"1st Sri Lankan ANRAP Regional Seminar"* was organized by the Asian Network of Research on Anti-Diabetic Plants (ANRAP), Natural Products Research project, and Science Education and Dissemination Unit of NIFS at the Royal Mall, Kandy from 2018-01-17 to 2018-01-19 for the Scientific Community (80 participants).

- *"The Annual Research Review 2017 of NIFS"* was organized by the National Institute of Fundamental Studies, Kandy at the NIFS Premises on 2018-04-02 for the Scientific Community (100 participants).
  Key note address by Dr. Palitha Abeykoon, Chairman, National Authority on Tobacco & Alcohol (NATA).

- *"5th National Workshop on Sri Lankan Lichens"* was organized by Prof. D.S.A. Wijesundara, the Science Education and Dissemination Unit, at the Royal Botanical Gardens, Peradeniya from 2018-12-17 to 2018-12-19 & for the Scientific Community (12 participants). Resource Persons: Dr. Patricia Wolseley Scientific Associate, Natural History Museum, London.UK,Dr. Gothamie Weerakoon Senior Curator, Natural History Museum, London.UK,Dr. Vinitha Thadani Senior Research Scientist, SLINTEC ACADEMY, Sri Lanka,Dr. Sarangi Athukorala Senior Lecturer, University of Peradeniya, Sri Lanka.

- *"Water Planning for the Future, Joint Sri Lankan-South African Seminar"* was organized by the National Institute of Fundamental Studies (NIFS) with the sponsorship of the Ministry of Science, Technology and Research at the NIFS Premises on 2018-11-12 for the Scientific Community (34 participants).
  Resource Persons : Dr.Manthrithilake,H., Dr.Mata,J.I., Prof.Gunawardena,E.R.N., Ms.Gcanga,A., Mr.Lange,F.D., Prof.Chandrajith,R., Dr.Abia,A.L.K., Prof. R. Weerasooriya, Dr. S.K. Weragoda, Prof. C. Sheridan, Dr.Mubarak,A.M., and Prof.Kumar,V.

Speeches:

Keynote Speeches

- **Kulasooriya, S.A.** (2018). *Ecosystem diversity, their values and exploitation*. Open University of Sri Lanka.
- **Kumara, G.R.A.** (2018). *Novel Research Conducted in the Area of Nanotechnology*. Taj Samudra Hotel, Colombo.
- **Kumara, G.R.A.** (2018). *Energy*. CP/Tel Dunhinna Secondary School.
- **Kumara, G.R.A.** (2018). *Physics and Research*, Nalanda Buddhist College, Kundasale, Kandy.
- **Kumara, G.R.A.** (2018). *Research for Energy*. Keynote, Walagamba M.V., Galapitamada, Kagalle.
- **Subasinghe. N.D.** (2018). *Thermoelectric Properties of Graphite Intercalated Compounds*. Keynote, Chongqing, China.

Plenary Speeches

- **Kumara, G.R.A.** (2018). *Use of Nanotechnology for Improved Performance of Dye-sensitized Soalr Cells*. Plenary, National Chung Hsing University, Taiwan.
- **Kumara, G.R.A.** (2018). *Physics and Research*. Teachers Training Center, Gurudeniya, Kandy.
- **Kumara, G.R.A.** (2018). *Physics and Research*. Hecter Kobbekaruwa Agrarian Research Training Institute (HARTI), Wijerama Road, Colombo.
- **Kumara, G.R.A.** (2018). *Current Research Trends towards value addition of Graphite*. Waters edge Hotel, Colombo.

Invited Speeches

- **Dissanayake, M.A.K.L.** was an Invited speaker at the four day international workshop held at Chalmers University of Technology, Gothenburg, Sweden to present the research findings of the 4 year SRC collaborative grant, 31st October-2nd November 2018 in Sweden
- **Dissanayake, M.A.K.L**.(2018). *Fascination of Physics*" NIFS School Science Programme
- **Kulasooriya, S.A.** (2018). *Occurrence of cyanobacteria in freshwater bodies of Sri Lanka: An overview*. Golden Rose Hotel, Colombo.
- **Liyanage, R.** (2018). *Food Research in School Level*. Science Development Centre, Zonal Office at Bandarawela.
- **Liyanage, R.** (2018). *Food Research in School Level*. Invited Speech, Teachers Training Center, Gurudeniya.
- **Marikkar, J.M.N.** (2018). *Food Intake: Overeating and Obesity*. Ayeisha Siddeeqa Institute, Mawanella.
- **Marikkar, J.M.N.** (2018). *Healing Power of Food*. Ayeisha Siddeeqa Institute, Mawanella.
- **Marikkar, J.M.N.** (2018). *Macro and Micro Nutrients of Food*. Insight Institute of Management & Technology, Mawanella.
- **Marikkar, J.M.N.** (2018). *Principal Food Components*., Ayeisha Siddeeqa Institute, Mawanella.
- **Subasinghe. N.D** (2018). *Space-science Applications in Geoscience*. Shangri La Hotel, Colombo, Sri Lanka.
- **Tilakaratne, C.T.K**. (2018). *විද්‍යාත්මක පර්යේෂණයක් සිදු කරන්නේ කෙසේද?*. For school teachers, NIFS Premises.
- **Tilakaratne, C.T.K.** (2018). *විද්‍යාත්මක ක්‍රමය පාසල් සිසුන් තුල ස්ථාපනය කරන්නේ කෙසේද?*. Kothmale Zonal Education Office.
- **Tilakaratne, C.T.K.T.** (2018). *Inculcating Science Processing Skills*, Arachchikattuwa Kanishta Vidyalaya.
- **Wijesundara, D.S.A.** (2018). *Botanical Research in Sri Lanka*., Royal Botanic Gardens, Peradeniya.
- **Wijesundara, D.S.A.** (2018). *IAS National Policy and initiatives in Sri Lanka and Invasive Plants and their Social and Economic Impacts in Sri Lanka*. Uva Development Institute, Uva provincial Council, Palgahathanna, Badulla.
- **Wijesundara, D.S.A.** (2018). *IAS, a threat to biodiversity*. Ministry of Mahaweli Development and Environment, Colombo.
- **Wijesundara, D.S.A.** (2018). *Invasive Plants and their Social and Economic Impacts in Sri Lanka*. Teachers training center Gurudeniya
- **Wijesundara, D.S.A.** (2018). Medicinal Plants of Sri Lanka – cornerstone of indigenous medicine. Kandy.
- **Wijesundara, D.S.A.** (2018). *Morphological Plant Identification*. Plant Quarantine Centre, Katunayake.
- **Wijesundara, D.S.A.** (2018). *Popham Arboretum and ANR*. Patapilikande (Hurulu Foret Reserve), NIFS- Popham Arboretum Dambulla (field visit).
- **Wijesundara, D.S.A.** (2018). *Trees and sustainable cities*. Dilmah Arboretum, Moratuwa, Colombo.
- **Wijesundara, D.S.A.** (2018). *Lichens of Sri Lanka*. Invited Speech, Ministry of Mahaweli Development and Environment at BMICH.
- **Wijesundara, D.S.A.** (2018). *Plant Migrations*. Invited Speech, National Institute of Fundamental Studies, Hanthana Rd., Kandy.

- **Wijesundara, D.S.A.** (2018). *IAS National Policy and initiatives in Sri Lanka and Invasive Plants and their Social and Economic Impacts in Sri Lanka*. Invited Speech, Uva Development Institute, Uva provincial Council, Palgahathanna, Badulla.

Special lectures:

- *"Geno Sensors and Screen Printed Electrodes for Electrochemical applications and Entrepreneurship"* was organized by the Science Education and Dissemination Unit of NIFS, and Condensed Matter Physics and Solid State Chemistry Research Unit at the NIFS Premises on 2018-10-03 for the Scientific Community (34 participants). Resource Persons: Dr. David Hernández Santos Research Scientist University of Oviedo (Spain).

- *"In-House Seminar to Discuss and Finalize Draft Basic Science Research Policy"* was organized by the National Science and Technology Commission, and National Institute of Fundamental Studies, Kandy for the Scientific Community at the NIFS Premises on 2018-05-16 with 63 participants.

- **Seneviratne, G.** (2018). *Biofilm biofertilizer concept: research, development & application*. Special Lecture, South China University of Technology, 381, Wushan, Guangzhou 510640, China.
- **Iqbal, M.C.M.** (2018). *Our Genome – the Good, the Bad and the Ugly*. Special Lecture, NIFS Auditorium.
- **Iqbal, M.C.M.** (2018). *Preparing an Abstract for a scientific paper*. Presentation, Staff Development Centre of the Open university of Sri Lanka, Nawala.

Other Presentations:

- Abeykoon, A.M.K.L. (2018). *Determination of Fundamental Properties of CZTS Semiconductor Material Deposited by the Spray Pyrolysis Method*. Poster, University of Peradeniya.
- Bopearachchi, D.P. (2018). *General Impression Mislead*. Presentation, National Institute of Fundamental Studies.
- Farhana, M.A. (2018). *Extraction and utilization of plant pigments*. Presentation, National Institute of Fundamental Studies.
- Jayasekara S.K (2018). *Evaluation of cellulolytic fungi from Sri Lanka for biostone washing of denim in comparison with commercial cellulases*. Presentation, Kuliyapitiya, Sri Lanka.
- Jayasekara, S.K. (2018). *Coculturing cellulolytic fungi: A method for enhancing cellulase production*. Presentation, Wayamba University, Kuliyapitiya, Sri Lanka.
- Jayasekara, S.K. (2018). *Exploration of cellulolytic fungi as seed treatment agents against, casual organisms of damping off disease in Tomato*. Presentation, Wayamba University, Kuliyapitiya, Sri Lanka.
- Karunarathna K.B.M.D.K (2018). *Suppression of casual agents of damping off disease in tomato using cellulolytic fungi*. Presentation, Galadari Hotel, Colombo.
- Malwalage, S.M. (2018). *Potential of Cyanaobacteria Isolated from Fresh Water bodies of Sri Lanka as a Food Supplement*. Presentation, University of Putra, Putrajaya, Malaysia.

- Thurairajah, A. (2018). *Isolation of fresh water cyanobacteria and screening their potential in nitrate reduction*. Presentation, Wayamba University, Kuliyapitiya, Sri Lanka.

Journal Clubs

Presented by Research Assistants of NIFS, was organized by the Science Education and Dissemination Unit, & Dr. Bowatte, G. for the Scientific Community at the NIFS Premises:

Date	Name of the Research Assistant	Title
2018-02-21	Ms. Ekanayake, E.M.U.A.	A pilot study using Metagenomics sequencing of the sputum Microbiome suggests potential Bacterial Biomarkers for Lung Cancer
2018-03-14	Ms. Visvanathan, R.	Finger-stick glucose monitoring: issues of accuracy and specificity
2018-03-16	Ms. Gunarathne, H.K.S.N.S.	The Inoculation Method Could Impact the Outcome of Microbiological Experiments
2018-03-21	Ms. Jayasekara, S.K.	*Pseudomonas Syringae*: An Overview and its Future as a 'Rain Making Bacteria'
2018-04-04	Mr. Dodangodage, D.R.L.	Four-State Periodic Quantum Walks
2018-04-18	Mr. Jayakody, J.A.D.M.N.	Reversion of Quantum Walks via Interventions on Coin Space
2018-05-11	Mr. Suriyaarachchi, N.B.	Estimation of Sediment thickness using Sub-bottom profiler A case study from Maradankeni, Sri Lanka
2018-07-25	Ms. Bandara, K.M.U.J.	Acaricidal Properties of *Ricinus Communis* Leaf Extracts Against Organophosphate & Pyrethroids Resistant *Rhipicephalus (Boophilus) Microplus*
2018-09-19	Ms. Ekanayake, E.M.U.A.	Variations in oral microbiota associated with oral cancer
2018-10-03	Ms. Perera, G.	Thin Film Nanocomposite Forward Osmosis Membranes on Hydrophilic Microfiltration Support with an Intermediate Layer of Graphene Oxide and Multiwall Carbon Nanotube
2018-11-14	Ms. Dissanayake, D.M.	Selection, isolation, and identification of fungi for bio herbicide production

For School community:

- *45th School Science Programme 2018"* was organized by the Science Education and Dissemination Unit at the NIFS Premises from 2018-08-07 to 2018-08-10 for the School students (113 participants).
  Resource Persons: Prof. Saman Seneweera, Prof. M.C.M. Iqbal, Prof. M.A.K.L. Dissanayake, Prof. V. Kumar, Dr. Jayalath Edirisinghe, Dr. Gayan Bowatte, Prof. D.S.A. Wijesundara

- Zonal Training Programme: *"විද්‍යා පර්යේෂණ පිළිබඳ සිසු පුහුණු වැඩමුලුව"* was organized by the Zonal Educational Office - Haguranketha & Science Education and Dissemination Unit for the School students at the NIFS Premises on 2018-05-18 with 105 participants. Resource Persons: Dr. C.T.K. Tilakaratne, Prof. D.N. Magana-arachchi, Prof. M.C.M. Iqbal, and Dr. R. Liyanage.

- Awareness workshop on solar energy utilization held at the Dept. of Physics, University of Peradeniya for 73 AL students from Ranabima Royal college, 22nd February 2018
  Prof. Dissanayake, M.A.K.L. was a Co-Organizer/Invited presenter

- Awareness workshop on solar energy utilization held at the Dept. of Physics, University of Peradeniya for 78 AL students from Berewearts College, Ampitiya, 11th June 2018
  Prof. Dissanayake, M.A.K.L. was a Co-Organizer/Invited presenter

- Awareness workshop for 73 students from 12th and 13th grades from Nugawela Central College, Nugawela, held at the Department of Physics of the University of Peradeniya, 22nd of October 2018.
  Prof. Dissanayake, M.A.K.L. was a Co-organizer /Invited presenter

Laboratory Visits:

- Thirty Students of the Information Technology leading qualifying course of Naval & maritime Acadamy, Naval base Trincomalee visited the Condensed matter physics research project, Quantum Physics & Applied Electronics, Nanotechnology and Physics of Materials laboratories on 2018-01-11.
  Resource Persons: Prof. M.A.K.L. Dissanayake, Prof. A. Nanayakkara, and Dr. H.W.M.A.C. Wijayasinghe.

- Twenty four students of the WP/KE/Goodshepherd B.M.V.Wattala visited the Condensed Matter Physics & Solid State Chemistry, Nutritional Biochemistry, and Evolution, Ecology & Biodiversity laboratories on 2018-01-26.
  Resource Persons: Prof. M.A.K.L. Dissanayake, Dr. R. Liyanage, and Prof. S.P. Benjamin.

- Team of High Ranking Scientists (10) from the Chinese Academy of Science led by Professor Y.Wei, Deputy Director, visited to seek collaborative research avenues in basic sciences on 2018-03-05.
  Resource Person: Prof. R. Weerasooriya

- Thirty undergraduate students of Department of Botany, University of Peradeniya visited the Bioenergy & Soil Ecosystems laboratories on 2018-04-19.
  Resource Persons: Dr. R. Rathnayake, and Ms. S.K. Jayasekara.

- Twenty three Pharmacy undergraduate students of FAHS (Faculty of Allied Health Science) University of Peradeniya, visited the Environmental Science Research and Natural Products laboratories on 2018-07-26.
  Resource Persons: Prof. R. Weerasooriya, and Prof. L. Jayasinghe.

- Ten Agriculture undergraduate students of Rajarata University of Sri Lanka visited the Microbial Biotechnology laboratories on 2018-08-13.
  Resource Persons: Prof. P.R.G. Seneviratne.

- Twenty BCAS (British College of Applied Studies) Campus Students of the Science Foundation course visited the Microbial Biotechnology, Molecular Microbiology & Human Diseases, and Nutritional Biochemistry laboratories on 2018-08-20.
  Resource Persons: Prof. G. Seneviratne, Prof. D.N. Magana-arachchi, and Dr. R. Liyanage.

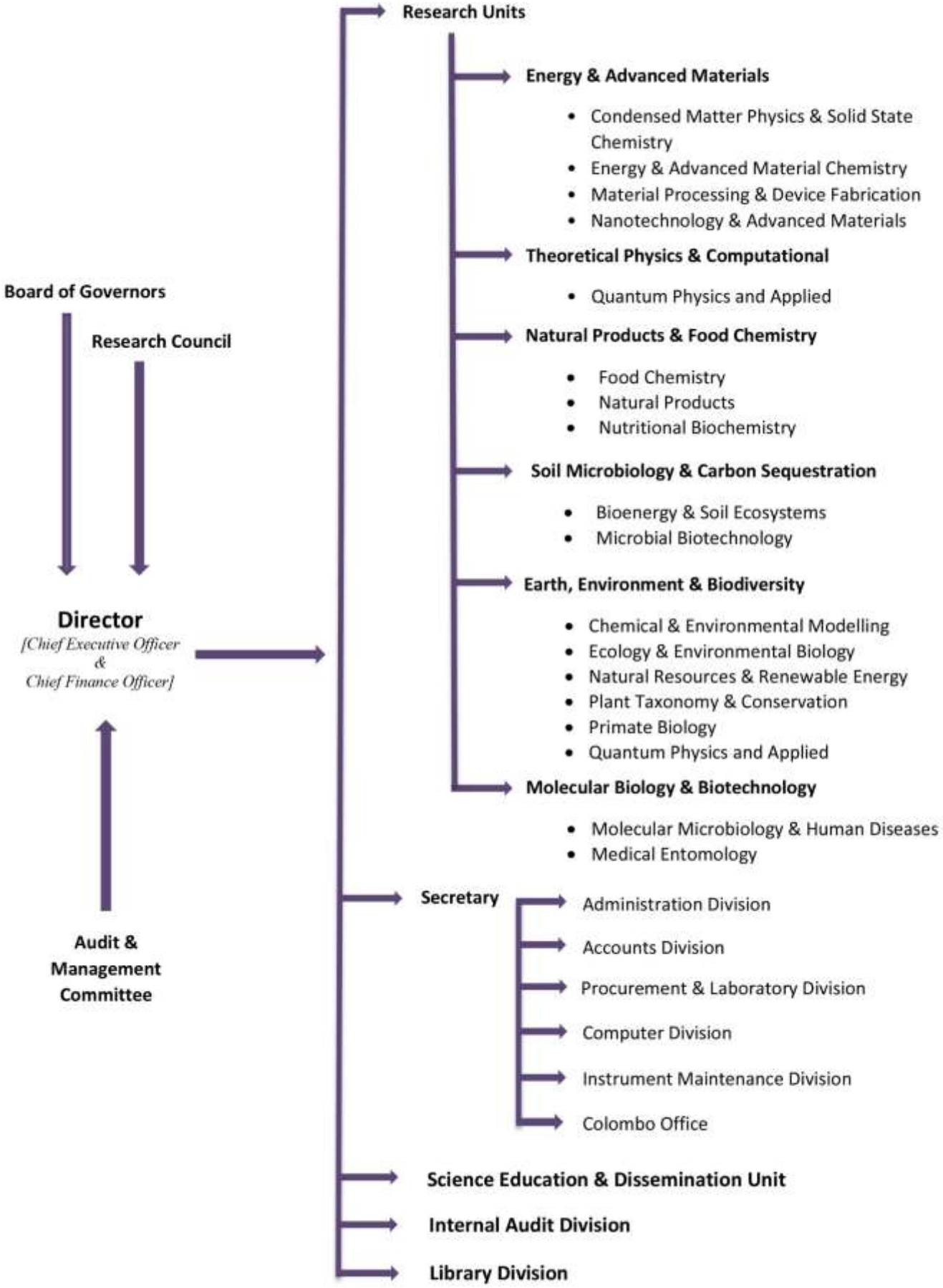
- Twenty seven Naval Personnel trainees visited the Condensed Matter Physics & Solid State Chemistry, Nanotechnology & Advanced Materials, and Material Processing & Device Fabrication laboratories on 2018-11-15.
  Resource Persons: Prof. M.A.K.L. Dissanayake, Prof. G.R.A. Kumara, and Dr. H.W.M.A.C. Wijayasinghe.

Exhibition stall:

Participated in the National Exhibition *"V2025 Enterprise Sri Lanka",* organized by the Ministry of Finance -Sri Lanka at the Monaragala from 2018-09-29 to 2018-09-30 for the General Public (100000 participants).
Resource Persons: Mr. P. Piyathilaka, Mr. G.C.K.S. Bandara, Mr. M. Senevirathne, Ms. R.K.C. Karunaratne, Ms. S. Gunarathne, Ms. S.W. Meepegamage, Mr. S. Ekanayake, Mr. G.P.A.K. Pathirana, and Mr. C. Sadaruwan.

ORGANIZATION

Organizational Chart



Board of Governors 2018

Chairman

Prof. Vijaya Kumar,
Emeritus Professor of 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. M.A.K.L. Dissanayake,
Research Professor/ NIFS

(Member appointed by H.E the President)

Prof. N.G.J. Dias,
Department of Computer Systems Engineering/ University of Kelaniya

(Member appointed by H.E the President)

Dr. W.K.B.N. Prame,
Former Director General
Geological Survey & Mines Bureau

(Member appointed by H.E the President)

Prof. C.P. Deepal W. Mathew,
Department of Biochemistry and Molecular Biology University of Colombo

(Member appointed by the Minister)

Prof. M.J.S. Wijeyaratne,
Senior Professor of Zoology & Environmental Management, Univ. of Kelaniya,
Chairman/ National Science & Technology Commission

(Member appointed by the Minister)

Prof. Namal Priyantha,
Senior Professor,
Department of Chemistry,
University of Peradeniya

(Member elected by the Research Council)

Prof. U.L.B. Jayasinghe,
Senior Research Professor/ NIFS
(up to 28th April 2018)

(Member elected by the Research Council)

Prof. M.C.M. Iqbal,
Associate Research Professor/NIFS
(from 29th April 2018)

(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(appointed on 4th June 2018)

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 (up to 6th October 2018)

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:
Seated Ms. D.M.A.D.E. Liyanage, Ms. O.W.K. Seneviratne, Ms. M.D.J. Kasthuri.
Standing Ms. D.A.S.T.Ranawaka, Mr. A.G.J.S. Bandara, Ms. K.W.M.R.L.Wijerathne, Ms. A.M.A.K.K. Adhikari

Accounts Division

From left:

Seated Mrs. P.S.S. Samarakkody

Standing Ms. K.G.T. Pamukshi, Ms. M.K. Nissanka, Ms. P.H. Wijesuriya, Ms. R.M.V.P. Ratnayaka, Ms. M.P.P. Guruge, Mr. M.K.D. Keshan, Mr. M.A.P. Perera, Mr. G. Ariyarathne, Mr. B.J. Weerasooriya

Administration Division

From left:

Ms. C. Ranasinghe, Mr. U.B.R.S. Udapitiya, Mr. A.V.A.P. Kumara, Mr. D.G.K. Dorakumbura, Ms. R.P.M. Weerasooriya, Ms. C.L.S. Illangakoon, Ms. T.P. Wijewickrama, Mr. A.G.S.T. Gunathilake, Mr. K.A.S.D. Kuruppuarachchi, Mr. T.R. Peiris, Mr. D.M.D.B. Dissanayake, Mr. R.S.K. Gunawardena, Mr. D.G. Gunathilake, Mr. M.A.G. Somananda, Mr. M.P.D.K. Malwewa, Mr. H.A.D.N. Jayasinghe, Mr. K.M. Ariyawansa, Mr. K.G.T.B. Gunasekara

Computer Division

From left: Ms. S.S.K. Sakalasooriya, Mr. W.M.R.B. Weerakoon

Instruments & Maintenance Division

From left: Mr. M.N.B. Kulathunga, Mr. H.M.A.B. Herath

Internal Audit Division

From left: Mr. W.M.I.U.B. Wijesinghe, Ms. K.B.J.B.K. Bandara

Library

From left: Ms. T.C.P.K. Tilakaratne, Ms. R.M.Witharana

Procurement & Laboratory Stores Division

From left:

Seated : Ms. W.D.S.P.Perera

Standing: Ms. D.M.K.L. Kumari, Ms. G.W.R.P. Chandrakanthi, Ms. H.M.T.L. Sumanarathne, Ms.P.R.I.M. Paliyawadana, Ms. E.D.S.M. Alwis

Science Education & Dissemination Unit

From left:

Seated Ms. K.I.K. Samarakoon, Dr. C.T.K. Tilakaratne, Ms. H.M.G.N.N. Herath,

Standing Mr. W. B. Somarathne, Ms. S. I. Rupasinghe, Mr. S.M.C.V.B. Senevirathne, Mr. V.M. Ekanayake, Mr. S.C. Manawaduge, Mr. G.C.K.S. Bandara

NIFS Staff list

(As at 31st December 2018)

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. G. Bowatte
Dr. N. L. B. R. Liyanage
Dr. I. P. L. Jayarathne
Dr. H. W. M. A. C. Wijayasinghe

Visiting Research Professor

Prof. S.A. Kulasooriya
Prof. G.K.R. Senadeera
Prof. N.S. Kumar (*up to 03.08.2018)*
Prof. N.K.B. Adikaram
Prof. W.P.J. Dittus
Prof. Y. Fujimoto (Japan)
Prof. N. Kuhnert (Germany)

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
Ms. S.K. Jayasekara	Research Assistant Gr. II
Mrs. R.P.S.K. Rajapaksha	Research Assistant Gr. II (up to 25.07.2018)

Condensed Matter Physics & Solid State Chemistry Research project

Ms. J.M.K.W. Kumari	Research Assistant Gr. II
Mr. C.A.Thotawatthage	Research Assistant Gr. I (up to 01.03.2018)
Mr. K. Umair	Research Assistant Gr. II
Mr. A.M.J.S.Weerasinghe	Research Assistant Gr. II (up to 01.05.2018)

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

Energy & Advanced Material Chemistry Research project

Mr. A. M. K. L. Abeykoon	Research Assistant Gr. II
Ms. M. A. Farhana	Research Assistant Gr. II

Environmental Science Research programme

Mr. B.A.Y.B. Jayawardena	Research Assistant Gr. II
Ms. M.G.N. Perera	Research Assistant Gr. II
Mrs. W.M.L.S. Weerasundara	Research Assistant Gr. II (up to 08.05.2018)

Evolution, Ecology & Biodiversity Research project

Miss. N. Kanesharatnam	Research Assistant Gr. II(up to 24.07.2018)
Mrs. U.G.S.L. Ranasinghe	Research Assistant Gr. II(up to 31.01.2018)

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. II
Mr. P.N. Dissanayake	Research Assistant Gr. II

Medical Entomology Research project

Mrs. K.M.U.J. Bandara	Research Assistant Gr. II (up to 30.06.2018)

Microbial Biotechnology Research project

Ms. H.K.S.N.S. Gunarathne	Research Assistant Gr. II
Ms. S.W. Meepegamage	Research Assistant Gr. II
Ms. A.T.D. Rathnathilake	Research Assistant Gr. II

Molecular Microbiology & Human Diseases Research project

Ms. E.M.U.A. Ekanayake	Research Assistant Gr. II
Miss. N. Padmanadan	Research Assistant Gr. II(up to 04.05.2018)
Ms. D.G.S.N. Samarasinghe	Research Assistant Gr. II
Ms. M.A.Y.N. Weerasinghe	Research Assistant Gr. II

Nanotechnology & Advanced Materials Research project

Mr. G.D.K. Heshan	Research Assistant Gr. II
Mr. R.I.C.N. Karunaratne	Research Assistant Gr. II(up to 01.06.2018)
Mr. P.A.R.P. Kumara	Research Assistant Gr. II(up to 09.05.2018)

Natural Products Research project

Miss. D.M.D.M. Dissanayake	Research Assistant Gr. II (up to 30.09.2018)
Ms. H. S. T. Kaushalya	Research Assistant Gr. II
Miss. C.A.U.K. Kumarihami	Research Assistant Gr. II (up to 28.12.2018)

Nutritional Biochemistry Research project

Ms. F.A. Deen	Research Assistant Gr. II
Miss. R. Vishvanathan	Research Assistant Gr. II (up to 30.10.2018)

Plant & Environmental Sciences Research project

Mr. D.M.R.E.A. Dissanayake	Research Assistant Gr. II
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. K.V.G.S. Bandara	Research Assistant Gr. II (up to 31.07.2018)
Mr. D.R.L. Dodangodage	Research Assistant Gr. II (up to 15.06.2018)
Mr. J. A. D. M. N. Jayakody	Research Assistant Gr. II

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	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. M.P.D.K. Malwewa	Office Aid

Accounts Division

Ms. P.S.S. Samarakkody	Accountant
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Ms. P.H. Wijesuriya	Accounts Officer *(w.e.f. 2018.01.08)*
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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

Administration Division

Mr. K.A.S.D. Kuruppuarachchi	Administrative Officer
Ms. R.P.M. Weerasooriya	Senior Staff Assistant- Clerical
Ms. T.P. Wijewickrama	Senior Staff Assistant- Stenographer
Ms. C.L.S. Illangakoon	Senior Staff Assistant- Stenographer
Ms. C. Ranasinghe	Senior Staff Assistant- Receptionist
Mr. D.G. Gunathilake	Record Keeper Gr. I
Mr. A.G.S.T. Gunathilake	Management Assistant Gr. III
Mr. A.B.G.W. Jayaweera	Driver- Special Grade (up to 08.09 .2018)
Mr. M.A.G. Somananda	Driver- Special Grade
Mr. K.M. Ariyawansa	Driver- Special Grade
Mr. R.S.K. Gunawardena	Driver- Special Grade
Mr. K.G.T.B. Gunasekara	Driver- Special Grade
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
Mr. U.B.R.S. Udapitiya	Machinist Gr. III
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
Mr. A.D. Gunawardena	Karyala Karya Sahayaka- Driver
Mr. A.G.J.S. Bandara	Office Aid

Computer Division

Mr. W.M.R.B. Weerakoon	Chief Technical Officer
Ms. S.S.K. Sakalasooriya	Chief Technical Officer

Instrument & Maintenance Division

Mr. M.N.B. Kulathunga	Chief Technical Officer
Mr. H.M.A.B. Herath	Chief Technical Officer

Internal Audit Division

Mr. W.M.I.U.B. Wijesinghe	Internal Audit Officer
Ms. K.B.J.B.K. Bandara	Management Assistant

Library

Ms. T.C.P.K. Tilakaratne	Senior Assistant Librarian
Ms. R.M. Witharana	Library Assistant Gr. III

Procurement & Laboratory Stores Division

Ms. W.D.S.P. Perera	Laboratory Manager
Ms. D.M.K.L. Kumari	Chief Technical Officer
Ms. G.W.R.P. Chandrakanthi	Senior Staff Assistant- Stenographer
Ms. H.M.T.L. Sumanaratne	Management Assistant Gr. III

Science Education & Dissemination Unit

Dr. C.T.K. Tilakaratne	Coordinator
Mr. S.D.P.G.P.Piyathilake	Communication & Media Officer (up to 17.11.2018)
Ms. K.I.K. Samarakoon	Stenographer Gr. II
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. D.P.D.M.Senadheera	Audio Visual Assistant (up to 28.02.2018)
Mr. S.M.C.V.B. Senevirathne	Audio Visual Assistant (w.e.f. 25.03.2018)

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

ANNUAL RESEARCH REVIEW 2018

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ISSN 2478-0782