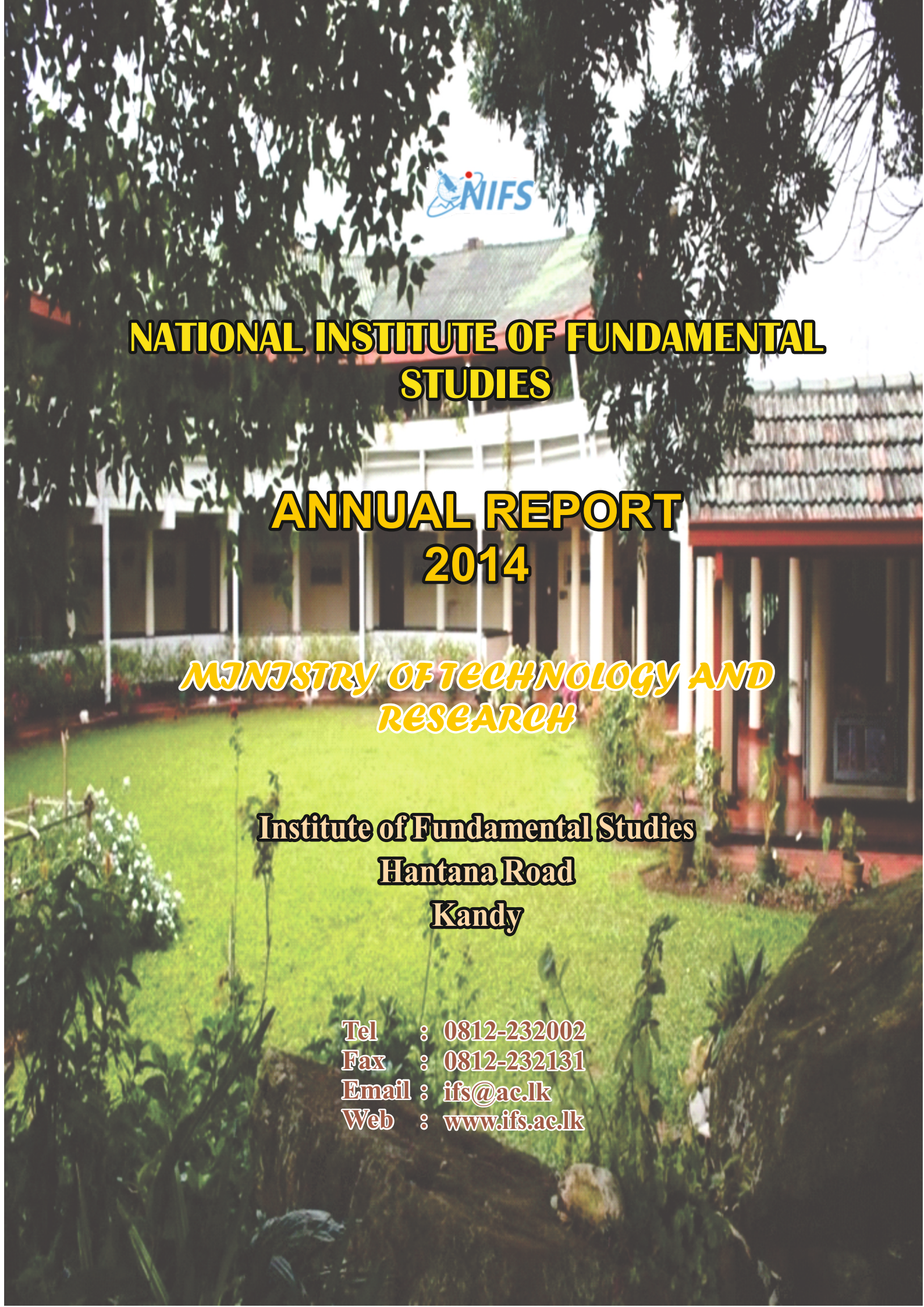

NATIONAL INSTITUTE OF FUNDAMENTAL STUDIES

ANNUAL REPORT 2014

MINISTRY OF TECHNOLOGY AND RESEARCH

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INTRODUCTION

The Institute of Fundamental Studies (IFS) was established by an Act of Parliament in 1981, to promote and conduct fundamental research in the physical sciences, life sciences, social sciences and philosophy.Fundamental research was first conceived by the former president of Sri Lanka, H.E. J. R. Jayawardane in 1979. He invited Prof. Chandra Wickremasinghe from the Cardiff University in the UK, to establish the Institute of Fundamental Studies (IFS).

The aims and objectives of the Institute (as stated in the Act No. 55 of 1981, Part 1 as amended by Act No.5 of 1997, section 3) are to create an interest in and to provide facilities for fundamental and advanced studies and in particular to:

A. initiate, promote and conduct research and original investigations to fundamental studies in general with particular emphasis on mathematics, physics, chemistry, life science, social sciences and philosophy, taken in he broadest sense;

b. arrange lectures, meetings, seminars and symposia in pursuance of its research work and for the diffusion of scientific knowledge;

c. invite scientists in Sri Lanka and from abroad actively engaged in creative work to deliver lectures and participate in its research activities;

d. establish and maintain liaison with scientific workers and scientific institutions in other countries and promote international co-operation in matters relating to the aims and objects of the Institute;

e. Do such other acts and things as may be necessary to promote the aims and objectives of the Institute while taking care to protect and promote the national interest.

The IFS began work in 1981, in a two roomed building at the present Colombo office of the IFS. In 1984, Prof. Cyril Ponnamperuma was appointed as the director of the IFS. The government acquired the Hantana Hotel in Kandy and the hotel rooms were transformed to research laboratories. Advanced research equipment was made available through an outright JICA grant from Japanese Government to the value of US $ 5.7 million. Prof. C.B. Dissanayake succeeded Prof. Ponnamperuma as director in 1991 and carried forward the research activities until 1994. Prof. K. Tennakone was the director from 1994-2008. After the appointment of the present Director, Prof. C.B.Dissanayake in 2009.

The year 2014 saw the Institute achieving national status with a change of name to National Institute of Fundamental Studies. With this change and the amendment to Act, passed by the Parliament, the National Institute of Fundamental Studies now has a new Governing Board comprising mostly of senior academics in the university system. In view of the strong links which we now have with the universities in Sri Lanka, this augurs very well for the future. As a leading research institute in the country, the output of our research activities have been very encouraging and indeed the increasing interest shown by the private sector of our fundamental research findings have borne fruit. With the amendment to the Act empowering the National Institute of Fundamental Studies to work with the private sector if useful applications arise from our fundamental research, a large gap that had existed between the academia and the commercial sector is beginning to be bridged. The Consultative and Collaborative Division (CCD)

has once again performed creditably. It is expected that this trend will in the following year gather even greater momentum. The Science Dissemination and Education Unit (SEDU) has continued its excellent progress and is now one of Sri Lanka's leading science dissemination units. The many awards that they received during 2014 bear ample evidence to their outstanding achievement. The research on biochar proved to be yet another major achievement of the Institute. The leader of the project Dr. Meththika achieved the top 3rd place in biochar research publications in SCI indexed journals in the world. This is indeed a most laudable achievement for a scientist from Sri Lanka working with very limited resources. The near completion of the new four storied building will almost certainly provide a major boost to the institute with new projects planned for the forthcoming year. The training of postgraduate students will also see marked increase in 2015. The dedication and team effort of our scientists, technical staff, administrative officers and others have contributed in no small way towards achieving our targets.

INSTITUTE VISION , MISSION AND OBJECTIVES

VISION

To be a renowned centre 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.

OBJECTIVES

The National Institute of Fundamental Studies (NIFS) is the foremost institution in the country devoted to fundamental (basic) research. Basic scientific research (intended to mean original investigations that are not necessarily goal oriented) is a pre-requisite to scientific and technological advancement. Activities conducted at the Institute are research in specific areas of basic science and work related to promotion of fundamental studies. The research outputs are assessed on the basis of publications in reputed journals, patents and No. of research degrees obtained by RAs and this goal has been satisfactorily achieved. In recent years the Institute had the record of highest per capita annual publications in the country.

BOARD OF GOVERNORS

Prof. Prasad Amaratunga
Chairman of the Board of Governors/NIFS,
*Head/ Department of Oral Pathology, Faculty of Dental Sciences, University of Peradeniya, Perad*eniya

Prof. P.W. Epasinghe
Science Advisor to H.E. the President, Presidential Secretariat, Colombo 01

Prof. Kshanika Hirimburegama
Chairperson, University of Grants Commission, 20 Ward Place, Colombo 07

Prof. C.B. Dissanayake
Director, National Institute of Fundamental Studies, Hantana Road, Kandy

Prof. Leelananda Rajapaksha
Dean/ Faculty of Engineering, University of Peradeniya, Peradeniya

Prof. Shantha K. Hennayake
Deputy Vice Chancellor, University of Peradeniya, Peradeniya

Prof. M.D. Lamawansa
Professor of Surgery, Dean /Faculty of Medicine, University of Peradeniya, Peradeniya

Prof. D.A. Tantrigoda
Chairman, National Science & Technology Commission(NASTEC), No: 31/9,31/10, Dudley Senanayaka Mawatha, Colombo 08

Mr. M.K. Samarasinghe
20/2A, Sri Dharmapala Mawatha, Asgiriya, Kandy

Prof.B.S.B. Karunaratne
Department of Physics, University of Peradeniya, Peradeniya

Prof. U.L.B. Jayasinghe
National Institute of Fundamental Studies, Hantana Road, Kandy

Dr. P.S.B. Wanduragala
Secretary to the Board of Governors, National Institute of Fundamental Studies, Hantana Road, Kandy

RESEARCH COUNCIL MEMBERS

Prof. C.B. Dissanayake (Chairman), Director, National Institute of Fundamental Studies, Kandy

Prof. B.S.B. Karunaratne, Department of Physics, Faculty of Science, University of Peradeniya, Peradeniya

Prof. Christina Shanthi De Silva, Faculty of Engineering Technology, Department of Agricultural Engineering, Open University of Sri Lanka, Nawala,Nugegoda

Prof. Namal Priyantha, Director, Postgraduate Institute of Science, University of Peradeniya, Peradeniya

Prof. Rohan Chandrajith, Department of Geology, University of Peradeniya, Peradeniya

Prof. Rohan Senadeera, Department of Physics, Open University of Sri Lanka, Polgolla, Kandy

Prof. K.A.K.D.D.D. Jayasuriya, Department of Physics, University of Kelaniya, Kelaniya

Prof. P.A. Weerasinghe, Department of Plant Science, Faculty of Agriculture, Rajarata University of Sri Lanka, Puliyankulama, Anuradhapura

Prof. M.A.K.L. Dissanayake, National Institute of Fundamental Studies, Kandy

Prof. (Mrs) N.S. Kumar, National Institute of Fundamental Studies, Kandy

Prof. U.L.B. Jayasinghe, National Institute of Fundamental Studies, Kandy

Prof. A. Nanayakkara, National Institute of Fundamental Studies, Kandy

Prof. J.M.S. Bandara, National Institute of Fundamental Studies, Kandy

Prof. G. Seneviratne, National Institute of Fundamental Studies, Kandy

Prof. S. P. Benjamin, National Institute of Fundamental Studies, Kandy

Dr. M.C.M. Iqbal, National Institute of Fundamental Studies, Kandy

Dr. D.N. Magana-Arachchi, National Institute of Fundamental Studies, Kandy

Dr. N.D. Subasinghe, National Institute of Fundamental Studies, Kandy

Dr. R. R. Rathnayake, National Institute of Fundamental Studies, Kandy

Dr. M.S. Vithanage, National Institute of Fundamental Studies, Kandy

Dr. H.W.M.A.C. Wijayasinghe, National Institute of Fundamental Studies, Kandy

Dr. P.S.B. Wanduragala (Secretary to the Board), National Institute of Fundamental Studies, Kandy

MESSAGE FROM THE DIRECTOR.



The year 2014 has been a memorable one for the Institute. The highlight of the year was the granting of national status to the Institute with a change of name to National Institute of Fundamental Studies through an Amended Act of Parliament.

The National Institute of Fundamental Studies continues to carry-out Fundamental research in the broadest sense. Significantly the new Amended Act also empowers the Institute to work in close collaboration with other public and private sector organizations if applications arise from the fundamental research carried out by the National Institute of Fundamental Studies. After years of research work on some fundamental aspects of bio fertilizers two of our scientists have obtained breakthroughs which resulted in two companies taking on the production of environment friendly bio fertilizers with a much less demand for chemical fertilizers. Another highlight of the year was the outstanding achievement of reaching the third best place internationally on biochar research. We congratulate all these scientists who have brought honor to the National Institute of Fundamental Studies.

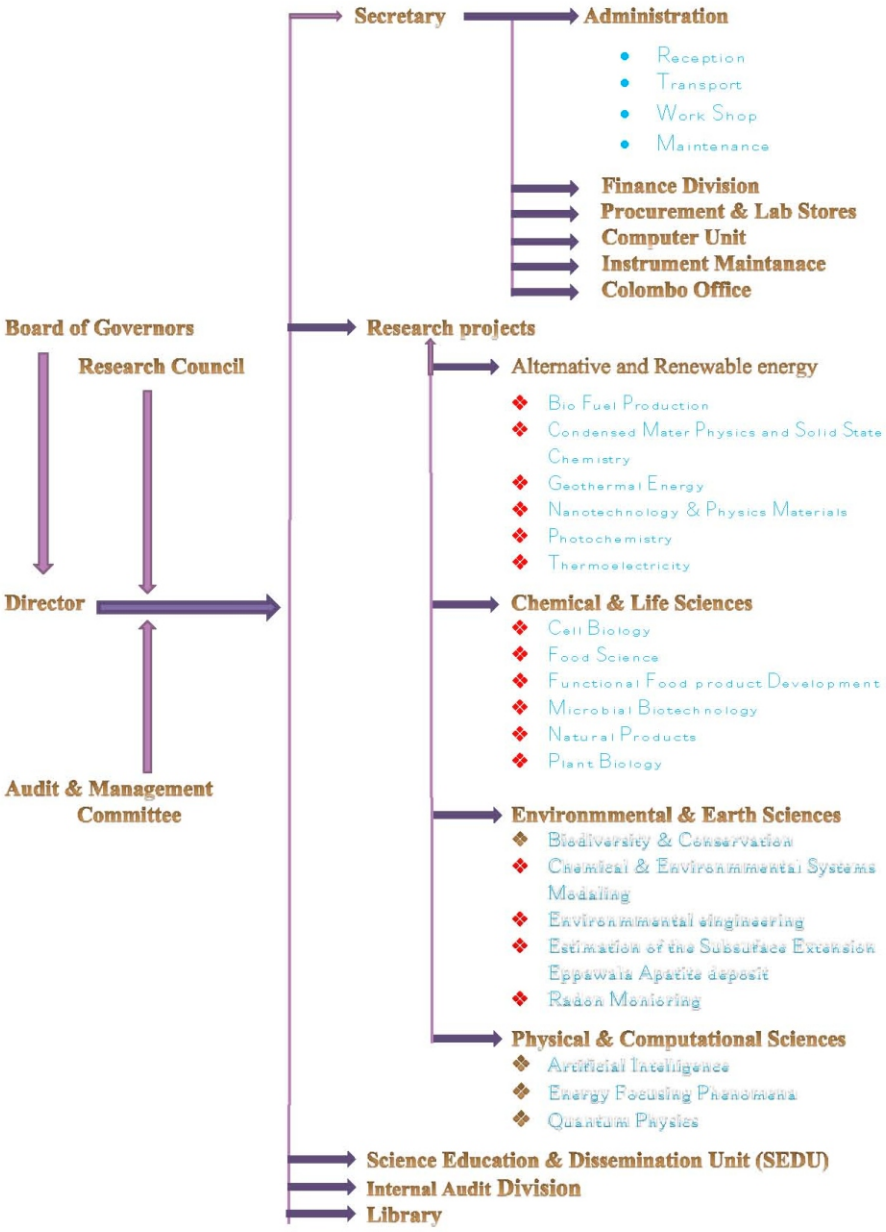
The output of research publications has also shown a marked increase and with the completion of the new building in 2015, we expect a more rapid increase in the number of research Publications in reputed International journals. The Science Education and Dissemination Unit (SEDU) has once again excelled in its activities winning several awards at the e –Swabhimani Awards Scheme. The responses received from teachers and students who have taken part in the SEDU Science workshops have been extremely encouraging. With the expansion of the SEDU in terms of space and materials, the year 2014 portends to be a very significant year for the Science Education and Dissemination Unit. Some of our scientists are recipients of the prestigious Alexander von Humboldt Fellowship of Germany and they have been able to attract grants and equipment to the National Institute of Fundamental Studies.

I wish to thank all those who contributed toward the development of the National Institute of Fundamental Studies.



Prof. C.B. Dissanayake
Director
National Institute of Fundamental Studies

NIFS ORGANIZATION STRUCTRRE



SPECIFIC ACHIEVEMENTS OF THE NIFS

Within the context of fundamental research, the focus of the research activities of the IFS is towards sustainable national development in a broad sense. The IFS is addressing these objectives through the following research programmes.

Energy

Developing a renewable and environmentally friendly energy source would reduce the large amount of foreign exchange spent on fossil fuels, as well as our dependence on foreign countries for our energy needs. The IFS is contributing to our national efforts through research programmes in the physical, chemical and biological sciences to achieve a renewable source of energy.

1. Solar cells Conversion of solar energy in to electrical energy using low cost solar cells is our ultimate objective. Since the production cost of silicon solar cells is very high, finding an alternative low cost solar cell is important. We are investigating low cost solar cells under this project. We have achieved an energy conversion efficiency of about 5% with dye sensitized solar cells using polymer gel electrolytes.

2. Photochemical hydrogen production

Hydrogen has a potential to meet the requirements as a clean fuel. Our objective is to develop a device that can be activated by Ultra Violet, Visible and Infra-Red photons for economic production of hydrogen and oxygen by splitting the water molecule. If this method is developed successfully and is economically viable, it would be the ultimate technology to solve energy problems in the future.

3. Geothermal resources in Sri Lanka

Geothermal energy is a totally environment friendly source of energy and has not been explored at all in Sri Lanka, primarily due to technical know-how. During the period 2009 to present, the IFS initiated Sri Lanka?s first ever geothermal survey using the “Magnetolelluric method”. A team of experts from UK worked with the IFS team. An extensive ground survey was conducted in the Northeast, Northcentral, Eastern and Southern provinces. Data is now being processed and preliminary indications are there could be a major potential for geothermal energy in some parts of Sri Lanka mainly in the Hambantota area and in the Polonnaruwa region.

4. Thermoelectricity Research Programme

Production of thermoelectricity generators (TEG) that can run on any locally available waste energy source (e.g. solar energy, waste heat from cooking or from factories, heat from burning straw, rice husk or dried weeds) will benefit the rural community with no access to the national grid. Producing TEG units as a local or domestic industry (similar to the production of solar water heaters in Sri Lanka) will provide employment to local people. Developing micro and nano level TEG modules for specific applications (e.g. bionic systems, micro electronics and nano-science applications) will improve the local economy.

Biofuels

The biofuel research project was initiated in October 2009 to develop effective methods to use biological resources for the production of biofuels. As a first step towards technology development for low cost biofuel production, experiments are ongoing using cellulosic biomass and screening of species to digest the biomass.

Agriculture Fertilizers

The microbial biotechnology team of the IFS has been able to produce a biofilmed- biofertilizer (BFBF) that will save millions of Rupees in foreign exchange. This biofertilizer has now been patented. The use of BFBFs to cut down chemical fertilizer imports has many implications in national development. First, it will reduce the burden on fertilizer imports and subsidy. It would also reduce the massive wastage of fertilizers used in agriculture and plantations. Diseases caused by chemical fertilizers would also be reduced, thus saving foreign exchange spent on importing pesticides and environmental problems associated with their use. Therefore, the contribution of the introduction of the use of BFBFs to the country towards national development is multifaceted.

Crop improvement

In Sri Lanka mustard (Brassica juncea) is cultivated as a subsistence crop whereas in the Indian sub-continent it is a major oil seed crop. The local mustard accessions have a high level of the undesired erucic acid and glucosinolates. By biotechnology and conventional crossing, we have reduced erucic acid. Work is in progress to eliminate glucosinolates to elevate our mustard form a subsistence to an oil seed crop.

Nutrition from local resources

At present, Sri Lanka is faced with the double burden of under nutrition and overweight. As a developing nation, poor nutrition among people has a high impact on the economy and the development of the country. The prevailing malnutrition problem in Sri Lanka can impede the economic development of the country through reduced productivity, either directly or indirectly and by increasing the health cost. Similarly, the diet related metabolic diseases cause mortality and morbidity of the working population and reduce their productivity. We are investigating the nutritional properties of Moringa oleifera (Sinhala-Murunga) leaves and their possible applications in the food industry in Sri Lanka as a protein and micronutrient supplement to address malnutrition in Sri Lanka. The effect of cowpea on anti-obesity, which is of high prevalence among people in Sri Lanka, is being studied to identify potential alternative food for improvement of health among our people.

Natural products

Identification of new environmentally friendly bioactive extracts and compounds from Sri Lankan fruits and other plant parts, and fungi associated with these fruits and plants is conducted in our Natural Products research group. Identification of new sources will lead to commercial exploitation of naturally occurring compounds and has the potential to contribute to the national economy.

Environmental pollution and mitigation

Clean water is a basic requirement for a healthy nation. Chronic diseases such as chronic renal failure of unknown etiology in the North Central Province of Sri Lanka is attributed to contaminated water sources and published data show that our water bodies are polluted with chemicals. It is a challenge to clean such water using reliable technologies. Heavy metal pollution of water-ways and the soil environment is increasing from industrial and agricultural activities. These are invisible and cause chronic effects.

Phenol is a common contaminant in industrial effluents. There are industries in Sri Lanka where the wastewater effluents are directed to nearby rivers (e.g. Kelani River). Subsequently such waters are treated and distributed as drinking water. Although the water is treated, conventional water treatment methods may not be able to remove organic chemicals (or may generate even more toxic counterparts). Therefore, developing novel technologies such as anodic oxidation of phenol in contaminated water in our research programmes will contribute to providing safe drinking water to our people. The water quality research team of the IFS has produced a special filter that removes the fluoride from the groundwater in the north central regions where dental fluorosis and chronic kidney diseases are very common. The benefit of this research to the poor people of the Dry Zone is extremely significant.

The IFS is conducting projects on monitoring and characterization of water and wastewaters, and pollution remediation studies. We collaborate with other institutes to work on the national problems of groundwater monitoring, landfill leachate characterization, and pollution removal using low cost materials. Bioremediation of heavy metal pollution in the environment are being attempted through low-cost and environmentally friendly means of heavy metals (such as Cr, Pb, Ni) removal using bio-adsorbents and plants.

Social welfare through health

Molecular methods to diagnose chronic diseases

Tuberculosis (TB) had been a dreaded disease in Sri Lanka for centuries. TB, primarily affects the young, between the ages 15 and 54, and the less affluent, who nevertheless, form the backbone of the economy of the country. At present, TB patients in Sri Lanka get free treatment. Early diagnosis of the disease and the rapid identification of resistance to primary anti TB drugs are essential for the efficient treatment and control of multidrug resistant (MDR) strains. The aim of one of our studies is to develop a simple, rapid and inexpensive assay based on PCR methodology for direct detection of MDR strains from patient?s clinical samples. No study has been conducted so far in Sri Lanka to identify the causative organisms in non tuberculous mycobacterial (NTM) diseases. The second project is developing a simple and rapid assay based on PCR methodology and culture for definitive diagnosis of mycobacterial infection. If misdiagnosis is prevented and/or minimized this could lead to considerable savings to the national economy.

Cyanotoxins in water bodies

Cyanobacterial toxins have been well documented to cause adverse health effects to human when exposed in numerous ways. Among the cyanotoxins, microcystins and cylindrospermopsin are predominant toxins in freshwater lakes worldwide and have been implicated in several cases of animal and human intoxications by damaging the liver and kidneys. Therefore, identification of such cyanobacteria in water sources would provide long term objective of providing new, rapid molecular monitoring capability for tracking cyanotoxin producing cyanobacteria that are an emerging threat to water quality. Further, Chronic Kidney Disease of unknown Aetiology (CKDu) is an emerging major health problem in Sri Lanka. The most affected patients belong to the 30–60 year age group. However, the disease is also observed among women and young children in some parts of the affected region. However, the actual cause for CKDu is still unknown. Therefore, identification of the causative agent is an important national health concern. Two projects are identifying and molecular Our research teams are targeting cleaning contaminated water using low-cost yet reliable technologies such as rice husk and other readily available material. Development of such technologies to treat pollutants such as organics and heavy metals present in contaminated water will provide solutions to health issues related to contaminated water and will improve the well-being of the Sri Lankans. characterizing the toxic cynobacterial species in Sri Lankan water bodies and also researching to identify whether cyanotoxins is a risk factor for the CKDu in Sri Lanka. If chronic cases could be identified/ prevented and/or cured this could lead to considerable savings in the national economy.

Assisting patients with neurological and speech disabilities

The Brain-Computer-Interface systems (BCI) are invaluable for patients suffering from severe motor impairments (late stage of Amyotrophic Lateral Sclerosis (ALS), severe cerebral palsy, head trauma, and spinal injuries). Patients with severe physical disabilities can control equipment such as wheel chairs, televisions, etc. and communicate with a computer voice in his or her native language (Sinhala, Tamil or English). Individuals with speech disabilities (non-vocal) need an effective means of communication with the general public. A portable electronic speech system is under development which can produce Sinhala speech, according to the input received from the disabled person.

Plant ecology of the Ussangoda serpentinite site

Studies on this unique site of geo-botanical importance in Ussangoda in the Hambantota district has led to the preparation of a proposal to the UNESCO to declare this as a Geopark, by the Man and Biosphere Committee of the NSF. This would contribute to the socio-economic development of the community in Ussangoda and conservation of this site.

Climate Change studies Carbon fixation in our natural forests

Our biomass estimation studies on the dry forests in the dry zone would contribute to determine the national status of climate mitigation potential of our natural forests. These forests could not be studied earlier due to the conflict in this area. Using past inventory data we have completed an estimation of the above ground biomass and carbon stored in this biomass in 8 forests covering an extent of 495,000 ha.

Generating a Dengue Risk Map

Dengue viral disease is spreading rapidly from urban to sub-urban regions. Socioeconomic and climate related factors are also contributing to the spread. Using Geographical Information System (GIS), we are preparing a Dengue Risk Map to identify hot-spots of spread in the sub-urban towns of Mawanella and Gampola. GIS links information on socio-economics, environment, and climate parameters with hospital records of dengue incidence. The Dengue Risk Map is a tool for decision makers to respond, strategize and create preventive action plans to control dengue transmission.

Soil carbon sequestration

Of all the sinks of carbon, soil is the largest sequester (2500 Gt) that can be managed. Soils are considered as potentially important terrestrial carbon sinks to meet the CO2 emission reduction targets set by the Kyoto Protocol. Studies under this project at the IFS are aimed at minimizing carbon loss and maximizing the retention of carbon in the soil. In addition, enhancing carbon sequestration in agricultural soil would yield a winwin situation of improving local productivity and reducing net emissions of greenhouse gases and mitigating the projected global climate change



Back Row - from left to right

Ms. P.S.S. Samarakkody (Deputy Accountant), Ms. T.C.P. Tilakaratne (Assistant Librarian), Dr. R.R. Rathnayake, Prof. J.M.S. Bandara, Prof. U.L.B. Jayasinghe, Prof. G.K.R. Senadeera, Dr. N.D. Subasinghe, Dr. P.S.B. Wanduragala (Secretary/NIFS), Prof. C.B. Dissanayake (Director/NIFS), Prof. S.P. Benjamin, Dr. W.P.J. Dittus, Prof. S.A. Kulasooriya, Prof. N.S. Kumar

Front Row - from left to right

Dr. D.N. Magana-Arachchi, Dr. R. Liyanage, Dr. C.T.K. Tilakaratne (Head/SEDU), Prof. P.R.G. Seneviratne, Dr. V. Waisundara, Dr. M.C.M. Iqbal, Dr. M. Vithanage, Prof. M.A.K.L. Dissanayake, Dr. H.W.M.A.C. Wijesinghe, Prof. A. Nanayakkara

NIFS STAFF *MEMBERS*.....



PART I
GENERAL REVIEW

7.1 ALTERNATIVE AND RENEWABLE ENERGY

7.1.1 Biofuel Production/Carbon Sequestrationand Management

Dr. R.R. Ratnayake ***(Project Leader & Research Fellow)***

Description of the Project Bio diesel production from fresh water cyanobacteria of Sri Lanka and their morphological and molecular characterization

Biofuels are considered an important means of reducing greenhouse gas emissions and increase energy security by providing a viable alternative to fossil fuels. Algae biomass is a potential source of 3rd generation biofuel that could surpass all the others due to its rapid growth and extremely high yield potential. The other traditional biofuel feedstock must be slowly grown or developed, and can only be harvested at certain times of the year. Algae can double in volume overnight and can be continuously harvested on a daily basis. Therefore, organic component of algae could be used as raw material for biofuel production. Algae are rich in poly unsaturated fatty acids which can enhance their potential as a source for biofuel.This research will examine the possibilities of using cyanobacteria and algal species available in fresh water bodies of Sri Lanka for biofuel production.

Improvement of microbial strains and biofilms for ethanol production from cellulosic substrates Biofuels are promising candidates for alternative renewable energy. Lignocellulosic materials from plants are a rich source of sugars. However, currently their utilization for biofuel production is not economical due to the need for pre-treatment. The biofuel project aims to explore the microbial flora of Sri Lanka to isolate efficient degraders of cellulose, hemicellulose and lignin, study the effect of biofilms and/or co-cultures on degradation and utilize aquatic weeds as substrates

Soil carbon sequestration and management

Many studies on reducing emissions of carbon dioxide and other greenhouse gases have focused to mitigate the danger of global warming. Because artificial techniques are hard to be implemented and very expensive, more attention has been paid to natural processes. Carbon can be stored for hundreds to thousands of years in carbon pools through carbon sequestration, the natural way of absorbing atmospheric CO_2. Forests, soils, oceans and atmosphere are agents for storage of carbon. Among them, soil acts as a significant C sink that absorbs more C than the others. The total soil C pool of 2300 Pg is three times that of the atmospheric pool of 770 Pg and 3.8 times that of the vegetation pool of 610 Pg (Signet al., 2011). But, less attention has been given to the potential for sequestering significant amounts of carbon in the soil as an alternative means of offsetting the effects of future emissions of greenhouse gases to the atmosphere. Three sub projects under soil C sequestration and management will be looking at minimizing carbon loss and maximizing the retention of carbon in soils of different vegetation systems.

Soil Carbon Sequestration in forest and tea plantations

Eucalyptus genus is the most planted hardwood in tropical regions, covering more than 20 million hectares (Forest Stewardship Council, 2012). In Sri Lanka, Eucalyptus is one of the highly grown forest plantation species, because of its high growth rate and adaptability to many environments. Eucalyptus plantations are mainly established in degraded lands in Sri Lanka for their rehabilitation. Other than that, they are grown to obtain sawn timber, transmission poles, railway sleepers and fuel wood. But currently new value is added to these plantation forests because they have been identified as fast-response carbon sinks which would support in mitigating the rising levels of atmospheric carbon dioxide. Many factors that vary along a chronosequence assist in their soil carbon sequestration potential. Since *Eucalyptus grandis* is one of the most grown species in plantation forests in Sri Lanka, we are studying the effect of age on carbon sequestration in *E. grandis* forest plantation. Simultaneously we are comparing the forest plantation carbon sequestration with anadjacent patana

grass land (previous land use of studied sites), natural forest and a tea estate. The information in this study could be important for various governments, industries, private landholders, and the public to investigate commercial uses such as carbon credits, biodiversity, and greenhouse values in assessing the performance of management practices and public policies, guide sustainable development, and forecast the future conditions of forest ecosystems globally. Furthermore, the pattern of variation in soil carbon sequestration over time and space can serve as the basis for future forest management strategies that enable higher carbon sequestration ability not only for Sri Lanka but also for other countries as well. Moreover the results of the carbon stocks in the present study provides evidence of Sri Lanka's contribution to mitigate global warming and climate change.

Land use and carbon sequestration in North Sri Lanka

Most field research programs associated with agriculture have attempted to sequester soil C primarily by enhancing biomass inputs by tillage and residue management. Although the studies on fertilizer management are not available in the tropics, this could play a major role in C sequestration in agricultural soils. C sequestration and post sequestration losses are reported to be influenced by clay and silt concentrations and microbial activity. Therefore more research is needed, especially for the tropics, to capture the impact of region-specific interactions between climate, soil, and management of resources on C sequestration, which are lost in global assessments.The objectives of this study are to quantify and compare the available soil nutrients, soil texture and structural stability under different agricultural land use practices in Northern Sri Lanka and to assess their effects on the organic carbon fractions. The results will help us to understand the behavior of soils in the tropics and manage them effectively.

Assessment and Mapping of Soil C Stocks in Knuckles Forest Region of Sri Lanka

Any vegetation will possess the ability to sequester atmospheric carbon and store it in their above ground biomass. A part of this biomass will eventually fall onto the soil and get sequestered into soil carbon primarily through the continuous microbial activities. Major vegetations of Sri Lanka includes natural and plantation forests, agricultural plantations, farmlands and small holder cultivations, wetland paddies, dry and wet grasslands or patanas, mangroves etc. Natural forest ecosystems play a significant role in regulating the CO_2 concentration in the atmosphere.Knuckles Region, covering an area of approximately 320 km^2 is a part of the Hill Country of Sri Lanka. The wide range of climatic and landscape features in the Knuckles region has resulted in a variety of natural and man made vegetation types. This study aimed to assess carbon sequestration capacity in Northern flank of Knuckles Region, Sri Lanka. The study sites included Sub Montane forests (SM), Moist Monsoon forests (MM), Grasslands (GL), Open and Sparse forests (OS) and Forest Plantations (FP). Preparation of a soil C storage map with major vegetation and soil types in Knuckles Forest using GIS technology will be a fulfillment for the lack of sources including much knowledge regarding C storage capacity in soils of Knuckles Forest.

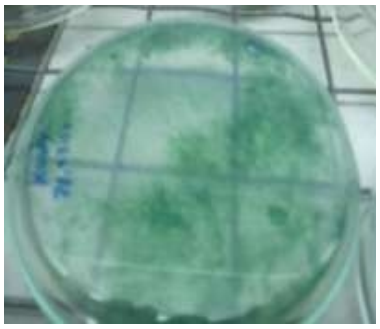
Assessment and Mapping of Soil C Stocks in rice based cropping systems in Sri Lanka

The great potential of carbon sequestration has now been recognized for world agriculture by enhancing soil C stocks through sustainable land management. Greenhouse gas emissions and carbon sequestration in agricultural soils therefore have unique roles in determining the net carbon balance within agriculture systems, and in off-setting emissions from other sectors. Crop rotations, soil tillage, fallow periods, and water management are some cultivation practices that could either reduce or increase soil C sequestration. As more productive croplands, paddy fields are reported to have higher soil organic C (SOC) storage and sequestration capacity when compared to drier croplands. Maintenance of SOC in rice cropping system is important not only for improving agricultural productivity but also for reducing carbon emission. This research will quantify and compare soil organic C fractions and C stocks in tropical rice based cropping systems. A specific objective is to investigate their variation as affected bycrop rotation with upland crops. Preparation of a soil Cstorage map of paddy soils in Sri Lanka using GIS technology will also be an objective of this project.

Scientific Expertise: Professor S.A. Kulasooriya

Project Staff: K. Mohanan, M.M.S.N. Premathileka, R.P.S. Kumari Rajapaksha, Fuad Hossain

Research Activities in Progress











Collaborators: Ms. Manori Gunaratne, Sustainability Manager, Finlays Tea Estates Lanka (Pvt) Ltd.
Dr. N. Gnanavelrajah, Faculty of Agriculture, University of Jaffna
Prof. Wasantha Kumara, Faculty of Agriculture, University of Ruhuna

Human Resource Development

a) Research Assistants who have completed post graduate studies

S. Premathillaka – Thesis title: Soil C sequestration in *Eucalyptus grandis* forest plantations of Sri Lanka along a chronosequesnce of forest age (PhD submitted) 2014, PGIS, University of Peradeniya

b) Research Assistants registered for post graduate studies

1. K. Mohanan (M.Phil.), Thesis title: Development of microbial strains and biofilms for efficient production of ethanol from cellulosic materials
2. R.P.S. Kumari Rajapaksha (M.Phil.), Thesis title: Assessment and Mapping of Soil C Stocks in Knuckles Forest Region of Sri Lanka
3. Md. Fuad Hossain (Ph.D.), Thesis title: Bio diesel production from fresh water cynobacteria of Sri Lanka andtheir morphological & molecular characterization

c) Research students (M.Sc., B.Sc.) and Trainees

1. Bimali Kangaraarrachchi (MSc. Student- PGIS, University of Peradeniya)
2. V. Sawthini (B.Sc. Student – University of Jaffna)
3. T. Abiramy (B.Sc. Student – University of Jaffna)
4. M.V.U.M. Jayasinghe (B.Sc. Student – University of Ruhuna)
5. Chandrasekara (B.Sc. Student – BMS, Colombo)
6. Dilani Dissanayake (HARDI, Ampara, Industrial training)
7. Jathukula Lingeswaran (University of Jaffna, Industrial training)
8. Rohini Sivagnanabanu (University of Jaffna, Industrial training)
9. Madamarandawala (Pre university research student)

7.1.2 Condensed Matter Physics and Solid State Chemistry

Condensed Matter Physics

Prof. M.A.K.L. Dissanayake *(Research Professor & Project Leader)* Dr. G.K.R. Senadeera (*Visiting Associate Research Professor*)

Description of the Project

During 2014, the research activities of the Condensed Matter Physics project were focused on (a) synthesis and characterization of "polymer free" gel electrolytes and their use in dye sensitized solar cells and (b) Optimization of CdS films prepared by chemical bath deposition method for possible use in CdS/CdTe p-n junction solar cells.

Under the first project, we have been successful in obtaining "polymer free" gel electrolytes using tetrapropyl ammonium iodide and potassium iodide dissolved in ethylene carbonate/propylene carbonate co-solvent and incorporating fume silica ($EC:PC:Pr_4NI:KI:I_2:SiO_2$). This electrolyte composition has been optimized for the iodide salt concentration and fume silica content to obtain the gel electrolyte with highest ionic conductivity. Dye sensitized solar cells incorporating this electrolyte and nanoporous TiO_2 anode exhibited a power conversion efficiency of 5.32% under the illumination of 100 mW cm^{-2} (AM 1.5).

The second project on optimization of cadmium sulfide (CdS) films for possible use in CdS/CdTe p-n junction solar cells was supported by the National Science Foundation. CdS thin films have been grown by chemical bath deposition (CBD) technique. Energy band gap, optical absorption and sheet resistance were studied as a function of the film thickness and annealing temperature and time. Indium doped CdS films and also CdS films grown on TiO_2 buffer layer were studied in detail to determine their effect on energy band gap. According to our observations, the energy band gap values increase with In substitution as well as with TiO_2 buffer layer. CdS/CdTe thin film solar cells will be fabricated using modified CdS films.

Solid State Chemistry

Prof. M.A.K.L. Dissanayake *(Research Professor & Project Leader)* Dr. G.K.R. Senadeera (*Visiting Associate Research Professor*)

Description of the project

During 2014, Solid State Chemistry research focused on three projects: (a) Efficiency enhancement by mixed cation effect in dye-sensitized solar cells with liquid based electrolytes, (b) Solid state magnesium batteries with polyethylene oxide based gel polymer electrolyte and SnO_2 cathode and (c) Efficiency enhancement of dye sensitized solar cells by TiO_2 photo-anode modification with silver and gold nano particles.

For project (a) solution electrolyte was prepared by using ethylene carbonate (EC), propylene carbonate (PC), acetonitrile (ACN), potassium iodide (KI), tetrapropyle ammonium iodide (Pr_4NI) and iodine (I_2) The electrolyte was sandwiched between a TiO_2 photoanode and platinum counter electrode. The current-voltage (I-V) characteristic of the cells was measured using simulated sunlight with 100 mW cm^{-2} (AM 1.5). The solar cell containing the electrolyte with composition KI 33.3% W/W shows 7.22 % efficiency, while the solar cells contain only KI and only

Pr_4NI showed efficiencies of 5.77 % and 4.02 %, respectively. Therefore it is clear that the mixed cation effect can be used to enhance the DSSC efficiencies in solution electrolyte based dye sensitized solar cells. Under project (b), SnO_2 was used as the cathode material in rechargeable magnesium batteries fabricated with Mg^{++} ion conducting, quasi solid (gel) polymeric electrolyte based on polyethylene oxide (PEO) as the host matrix. Batteries fabricated with cell configuration $Mg/PEO:EC:PC:Mg(CF_3SO_3)_2/SnO_2$ exhibited a discharge capacity of 220 mAh/g with 1.90 V open circuit voltage.

Under project (c) we have studied the use of silver nanoparticles (Ag NPs) incorporated TiO_2 photoanode, for the enhancement of the photocurrent of the DSSC by the surface Plasmon effect. It was found that the energy conversion efficiency of the DSSC was strongly dependent on the amount of Ag NPs incorporated into the TiO_2 matrix. The conversion efficiency of the DSSC increased from 5.00 % to 6.12% due to the incorporation of Ag NPs. This efficiency enhancement has been attributed to the increase of the short circuit photo current density of DSSCs by the Plasmon effect of the metal nanoparticles.

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Members of the Condensed Matter Physics and Solid State Chemistry research groups of the National Institute of Fundamental Studies (NIFS), Kandy (2014)

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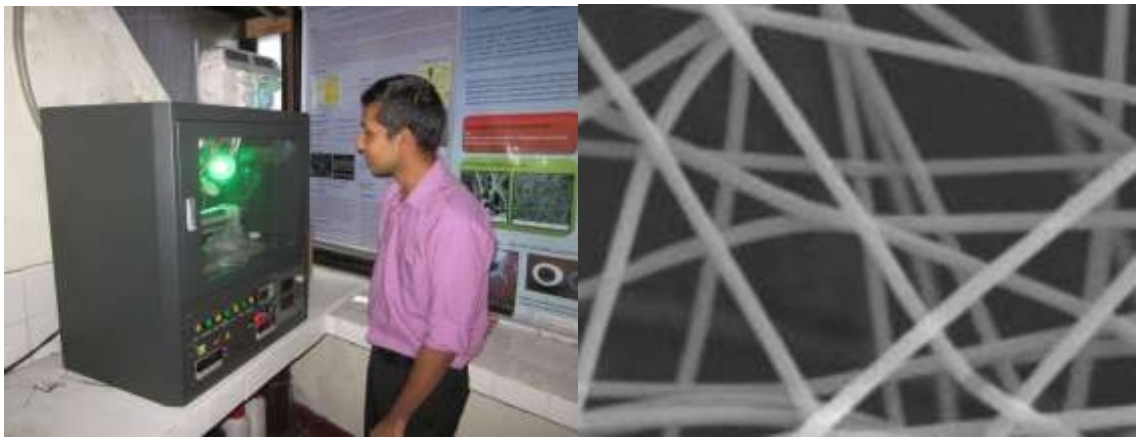
Condensed Matter Physics & Solid State Chemistry group research students at work…



Chathuranga Thotawatthage is measuring current voltage characteristics of solar cells (Left) and Kalpani Wasana Kumari is preparing silver and gold nanoparticles (Right)



Manel Sarangika is analyzing performance of Magnesium ion batteries (Left) and Kohila Paramanathan is preparing cadmium sulfide thin films for CdS/CdTe solar cells



Janith Weerasinghe is preparing polymer nanofibres by electrospinning method (Left) and Electrospun PAN nanofibres prepared at NIFS to be used for solar cells (Right).

Project Leaders: Prof. M.A.K.L. Dissanayake *(Research Professor & Project Leader)*
Dr. G.K.R. Senadeera (*Visiting Associate Research Professor*)

Collaborators: Dr. V.A. Seneviratne, Department of Physics, University of Peradeniya
Prof. B.-E. Mellander and Dr. Ingvar Albinson, Chalmers University of Technology, Gothenburg, Sweden
Prof. S. Sivananthan, University of Illinois at Chicago, USA & Sivananthan Laboratories, Inc. Bolingbrook, IL,, USA
Prof. I.M. Dharmadasa, Sheffield Hallam University, UK
Prof. Arof Karim and Prof. M.A. Careem, Center for Solid State Science, University of Malaya, Malaysia
Prof. Piyasiri Ekanayake, Faculty of Science, University of Brunei Darussalam
Dr. T.M.W.J. Bandara, Department of Physical Science, Rajarata University
Prof. P. Ravirajan, Department of Physics, University of Jaffna

Research Assistants: Mr. C.A. Thotawatthage (NIFS Research Assistant) Ms. J.M.K.W. Kumari (NIFS Research Assistant)
Mr. A.M.J.S. Weerasinghe (NIFS Research Assistant)
Ms. Ms. H.M.N. Sarangika (Lecturer from SabaragamuwaUniversity)
Ms. K. Paramanathan (NSF Research Student)

Human Resource Development

Ph.D, M.Phil., M.Sc. students, undergraduate students trained during 2014 with their affiliations, completed graduated during 2014

Postgraduate students trained/supervised by Prof. M.A.K.L. Dissanayake and Dr. G.K.R. Senadeera during 2013/2014:

1. Ms. W.N.S. Rupasinghe, IFS Research Assistant, M.Phil. (PGIS, University of Peradeniya) completed in 2014. Thesis Title: *Synthesis, characterization and applications of polyethylene oxide (PEO) based nano-composite polymer electrolytes and their applications in dyesensitized solar cells and other devices*

2. Ms. S.L. Jayaratne, IFS Research Assistant, M.Phil. PGIS, University of Peradeniya, Thesis under preparation; Title: *Efficiency Enhancement in Dye – Sensitized Solar Cells with blend polymer electrolytes*

3. Ms. H.K.D.W.M.N.R. Divarathne, NRC Research Student, M.Phil. PGIS, University of Peradeniya, Thesis completed during 2014: Title: *Dye sensitized solar cells with polymer nanofibre based electrolytes and TiO_2 nanofiber based photoanode*

4. Mr. P.M.P.C Ekanayake, NRC Research Student, M.Phil. PGIS, University of Peradeniya, Thesis under preparation; Title: *Synthesis of polymer nanofibers and design and testing of a polymer nanofiber, antimicrobial water filter*

5. W.J.M.J.S.R.Jayasundara (Student from PGIS/Rajarata University, (M.Phil. PGIS, University of Peradeniya, completed in 2014). Title: "*Effect of cations on the performance of dye sensitized solar cells using polyacrylonitrile based plasticized polymer electrolytes containing quaternary Ammonium iodides"*

6. Ms. H.M.N. Sarangika (Probationary Lecturer from Sabaragamuwa University) Ph.D. PGIS, University of Peradeniya, training continued.Title: *Development of novel quasi solid (gel) polymer electrolytes and their applications in electrochemical power sources".*

7. Ms. K. Paramananthan (NSF Research Student, M.Phil PGIS, University of Peradeniya, training continued in 2014. Title: "*Optimization of the growth process of cadmium sulfide (CdS) semiconductor thin films for efficiency enhancement in CdS/CdTe solar cells"*

8. Mr. C.A. Thotawatthage (NIFS Research Assistant, M.Phil. PGIS, University of Peradeniya)

9. Ms. J.M. Kalpani Wasana Kumari (NIFS Research Assistant, M.Phil. PGIS, University of Peradeniya.

10. Mr. A.M.J.S. Weerasinghe (NIFS Research Assistant, M.Phil. PGIS, University of Peradeniya)

11. Mr. A.M.G.D. Alahakoon, (M.Sc. student from PGIS, University of Peradeniya, carrying out the research project) Period: 6 months

12. A.P.A.H. Jayarathne (M.Sc. student from PGIS, University of Peradeniya, carrying out the research Project) Period: 4 months.

Undergraduate students trained during 2014 (period: 2-3 months):

1. Ms. Jayendrika Kumari Tiskumara. Undergraduate from University of Peradeniya completed her research project on dye sensitized solar cells

2. Mr. G. Shathitharan from University of Jaffna completed the undergraduate research project on CdTe electrode position.

3. Ms. Dulanjalee Adhikari from University of Peradeniya completed her undergraduate project on quantum dot sensitized solar cells

4. Ms. Senali Dissanayake from University of Peradeniya completed her undergraduate project on polymer nanofiber gel electrolyte based dye sensitized solar cells

5. Ms. Apsara Tennakone from University of Hong Kong completed an undergraduate project on natural dye based dye sensitized solar cells.

6. Ms. Roshani Awanthika Jayarathne from Uva Welassa University, completed her undergraduate project on solar cells

7.1.3 Mapping Geothermal Sources in Sri Lanka

Dr. N.D. Subasinghe ***(Project Leader & Senior Research Fellow)***

Description of the Project

Geothermal mapping project was initiated with the intention to produce a detailed and complete data base of the geothermal resources of Sri Lanka. Although Sri Lanka is not situated on an active geothermal area, i.e. closer to an active plate boundary, there are clear indications of low-enthalpy activities as evidenced by the presence of thermal springs. Generally, all of the known thermal springs are located at a close proximity to the Highland-Vijayan (H/V) lithological boundary. This has led to the hypothesis that H/V boundary could be playing a role in the formation of geothermalresources.

A detailed geophysical survey was conducted using state-of-the-art techniques such as Magnetotelluric (MT) to investigate the deep structures and possible heat sources. Although the underlying structures, fractures and the possible hydrological pathways were identified, no heat source has so far identified. Further observations revealed the association of dolerite dikes with the thermal springs. Since the dolerite dykes are relatively very young (less than 150 MY), the origin of the thermal springs may have some relationship with the intrusion of dolerite dykes.

In addition to MT, some other geophysical techniques such as Time-Domain Electromagnetics (TDEM), magnetic methods and resistivity techniques are employed during this research project.

Preliminary results indicate that the water-bearing fractures run deep into the earth, connecting with major, large scale fracture systems, which may run through the heat-bearing intrusive bodies such as dolerite dyke. A schematic diagram of the proposed model is shown in figure 01.

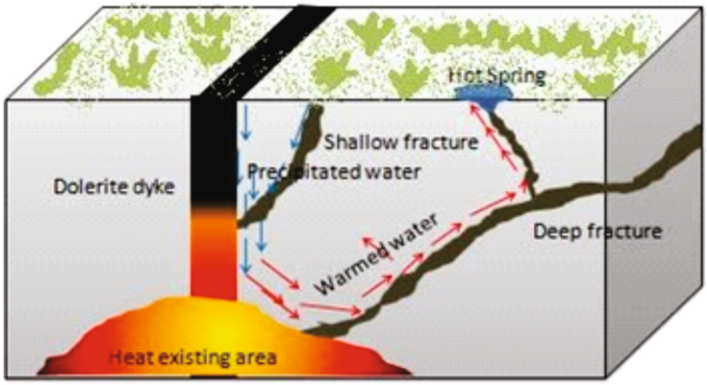


Fig: 1 Schematic diagram of the proposed hot spring water channeling path model

Reference

[1] Hobbs, B.A.; Fonseka, G.M.; Jones, A.G.; De Silva, S.N.; Subasinghe, N.D.; Gawes, G.; Johnson, N.; Cooray, T.; Wijesundara, D.; Suriyaarachchi, N.; Nimalsiri, T.; Premathilake, K.M.; Kiyan, D.; Khoza, D. Geothermal Energy Potential In Sri Lanka: A Preliminary Magnetotelluric Survey of Thermal Springs. *Journal of Geological Society of Sri Lanka.* **2013,** *15*, 69-83.



Collaborators : Dr. S.P.K Malaviarachchi, University of Peradeniya Mr. Nalin de Silva, Geological Survey and Mines Bureau

Project Leader : N.D. Subasinghe

Reasearch Assistants: T.B. Nimalsiri - till April 2014
N.B. Suriyaarachchi - till April 2014
S.A. Samaranayake - from April 2014 to date

Senior Staff Technical Officer: Sanath Opatha

Human Resource Development

T.B. Nimalsiri, NIFS - (Completed M.Phil degree at PGIS, Uni. Peradeniya)
Thesis Title**:** Characterization of thermal springs in Sri Lanka; A combined geological, geophysical and geochemical approach

N.B. Suriyaarachchi, NIFS - MPhil (Registered at PGIS, Uni. Peradeniya)

7.1.4 Nanotechnology and Physics of Materials

Dr. H.W.M.A.C. Wijayasinghe *(Project Leader & Research Fellow)*

Description of the Project

Nanotechnology and Physics of Materials are two of the most progressive branches in the Materials Science and Technology field. Among them, the nanotechnology is considered as a key technology for the future to create many new materials and devices with a vast range of applications.

Sri Lanka is well known for processing a variety of economically useful minerals, which are mainly being exported as cheap raw materials but playing a main role in global materials based industry. Proper value addition to our economically useful local materials has almost been lacking, due to dearth of advanced scientific research conducting in the country. However, the recently endorsed National Nanotechnology Initiative facilitates scientists to investigate into applications in nanotechnology with a view to add value in practically every aspects of our exports hence achieving technological progress and competitiveness.

The Nanotechnology and Physics of Materials Project of NIFS commenced its work in January 2013. At present, the following two sub projects, which emphasize on the basic and fundamental scientific aspects on advanced synthetic materials and advanced materials derived from Sri Lankan minerals, are carried out under this project.

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

Preliminarily, the effect of the precursor on crystal growth in nano particle formation is investigated in order to understand the mechanisms to control the size of the particles from sub micron to nano scales. The gain knowledge is extended to prepare advanced transition metal semiconducting materials with appropriate particle size. Further, fundamental scientific investigations are carried out to study the mechanism and the effect of dopents on electrical and electrochemical property enhancement of these advanced transition metal semiconducting materials. The long term objectives of this sub-project are twofold as follows. Development of efficient mechanisms and techniques for synthesizing nano particles. Introduction of performance enhanced advanced transition metal semiconducting materials for electrochemical energy conversion applications such as Li-ion, Na-ion and Mg-ion rechargeable batteries.

nvestigation of ion intercalation in advanced materials derived from Sri Lankan minerals

Primarily, investigations on deriving advanced materials out of abundant Sri Lankan minerals are carried out under this sub project. These advanced materials derived from the local minerals will then be subjected to fundamental investigations on structural modification in atomic/nano scale. Furthermore, advanced scientific investigations on ion intercalation/de-intercalation mechanisms and electrochemical behaviour of these intercalated materials will be carried out.The long term objective of this sub-project is the conversion of Sri Lankan natural minerals in to highly upgraded advanced materials such as high purity graphite, surface modified graphite, extended graphite, graphene and nano-carbon composites…etc, which are pricey materials for a number of advanced nano technological and high-tech industrial applications. Moreover, application oriented performance enhancement of these developed materials are carried out specially aiming for energy conversion applications such as in rechargeable batteries.

Collaborators: N.W.B. Balasooriya, Senior Lecturer, Physical, Sciences, Faculty of Applied Sciences, South Eastern University South Eastern University

Research Assistants: N. Karunarathna (since June 2014)
N. Rathnayake (since July 2014)

Senior Staff Technical officer: W. G. Jayasekara **Human Resource Development**

a) Undergraduate trainees

A. Dissanayake, Applied Science, University of Peradeniya (3 months)

N. Jayaraman, Natural Science, Open University of Sri Lanka (12 months)

S. Karunarathna, Materials Technology, Uva-Wellassa University (3 months)

G. Gajamugan, Minerals Technology, Uva-Wellassa University (3 months)

R. Amiyangoda, Mineral Technology, Uva-Wellassa University (3 months)

A. Weerasinghe, Mineral Technology, Uva-Wellassa University (3 months)

U. Somarathna, Mineral Technology, Uva-Wellassa University (3 months)

b) Volunteers

T.H.N.G. Amaraweera (HETC scholarship holder, Uva-Wellassa University), PGIS, University of Peradeniya. (3 years)

S. Hewathilake, (under the innovative research grant-2013 of Ministry of Higher Education) (2 years)

N. Rathnayake, (M. Sc.) PGIS, University of Peradeniya (6 months)

T. Pathirana, (M. Sc.), PGIS, University of Peradeniya (6 months)



7.1.5 Photochemistry

Harnessing Solar Energy by Artificial Photosynthesis as an Alternative Energy

Prof. J. Bandara (*Project Leader & Research Professor)*

Description of the Project

Finding alternative energy sources is vital for human being as the fossil fuel is depleting rapidly. It has been estimated that the present fossil fuel reservoirs just enough for about 100 years and it often produces environmental pollutants that are harmful to human health and greenhouse gases that threaten the global climate [1].

Out of the possible alternative energy resources, solar energy is found to be one of the prime targets to achieve the global energy requirements. As solar resources are widely available and have a benign effect on the environment and climate, making it an appealing alternative energy source. Solar driven production of environmentally clean electricity, hydrogen and other fuels, is considered as the only sustainable solution for global energy needs. The challenge is to raise its conversion efficiency by factors of five or ten which requires understanding the fundamental conversion phenomena at the nanoscale.

In natural photosynthesis, carbon dioxide is converted to sugar by green plants by series of chemical reactions. Photosynthesis, has long been studied to reveal how its natural mechanisms could be mimicked to apply to produce energy for human society. However, there are considerable challenges, with the first being to mimic the functioning of natural photosynthetic systems, the enzyme complex in the leaves of plants that splits water into hydrogen equivalents and oxygen via a catalyst comprising four manganese atoms along with some calcium.

As explained, by mimicking the natural photosynthesis, solar energy can be converted into electricity and chemical energy. The Photochemistry group at IFS is actively involving in investigation of conversion of solar energy into useful energy resources by artificial photosynthesis.

The Photochemistry group at IFS conducts research on conversion of solar energy into electricity, fuel and removal of water pollutants:

Currently the following projects are in progress.

1. Extending and adapting current photovoltaic technology mainly dye-sensitized and polymer solar cells to generate electricity directly from solar radiation.
2. Constructing 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.
3. Chemical, Electrochemical and Photochemical methods for the purification of water.

Group members:

J. Akilavasan	Working on DSSC based on 1-D nanostructures (Ph.D. student Research Assistant)
D. Aluthpatabedi	Working on Water purification techniques (senior staff technical officer)
A. Annapayan	Working on DSSC based on Q-dot (Volunteer PhD student)
J. Bandara	Project leader

N.S. Abeysooriya	Working on water purification (Volunteer Rearch Assistant)
D. Darmawickrame	Working on hydrogen production (Volunteer Research Assistant)
R. Delan	Working on hydrogen production (M.Sc student, Volunteer Research Assistant)
A. Gannoruwa	Working on hydrogen production (M.Phil student, on leave from UWU)
K.U.B. Gunatilake	Working on Water purification (M.Phil student, Research Assistant, NSF)
K.M.S.D.B. Kulatunge	Working on DSSC based on 1-D nanostructures (M.Phil student, Research Assistant)
L.N.D. Silva	Working on hydrogen production (Research Assistant)
A.Manjceevan	Working on DSSC based on Q-dot (Ph.D. student Research Assistant)
S.M. Wasana	Working on CKDu (Ph.D. student, Research Assistant)
B.Senanayake	Working on DSSC based on 1-D nanostructures (Volunteer Research Assistant)

Research summaries: The main long-term goal of the project is to find a feasible solution to energy crisis. Objective of the project is to investigate and research on alternative energy resources. Photochemistry project involves mainly in the field of renewable energy research and the project focused its research on development of new materials for photoconversion of solar energy into chemical and electrical energies. The Photochemistry project also involves investigation of low cost purification methods for abatement of industrial pollutants by using sunlight.



Human Resource Development
PhD, M.Phil., M.Sc. students, undergraduate students

a) J Akilavasan – submitted PhD thesis and presently a PhD student in Max Flank Institute in Germany
b) K. Wijerathne, M.Phil, thesis to be submitted and presently a PhD student in Sweden
c) A. Gannoruwa, completed M.Phil degree

7.1.6 Thermoelectricity

Dr. N. D. Subasinghe *(Project Leader & Senior Research Fellow)*

Description of the Project

Thermoelectricity project was initiated at the 1National Institute of Fundamental Studies with the intention to introduce this timely research area to the country. This project has several aspects. As per majority of researchers in the field, first and main objective is to improve the Figure of Merit of the thermoelectric devices. Secondly, a theoretical approach is made to understand the fundamental aspects of the phenomenon. Thirdly, there will be attempts to build low-cost thermoelectric modules for local applications

.

Heat energy can be converted to electricity directly by using the thermoelectric effect or *Seebeck effect*. When a conductor is subjected to a temperature difference, a current is generated between the cold and hot regions due to the difference of electron energies. By connecting two different materials, this electrical energy can be utilized.

Although modern semiconductor based thermoelectric modules provide the highest outputs, they are expensive and not affordable to the low-income people. To overcome this high cost, NIFS is experimenting to produce low-cost thermoelectric modules made of the recycle and locally available materials.

Three industrial grade materials (Iron, Brass, Aluminum metal sheets) were used in different combinations and tested for relative output and efficiency. The results are as follows.

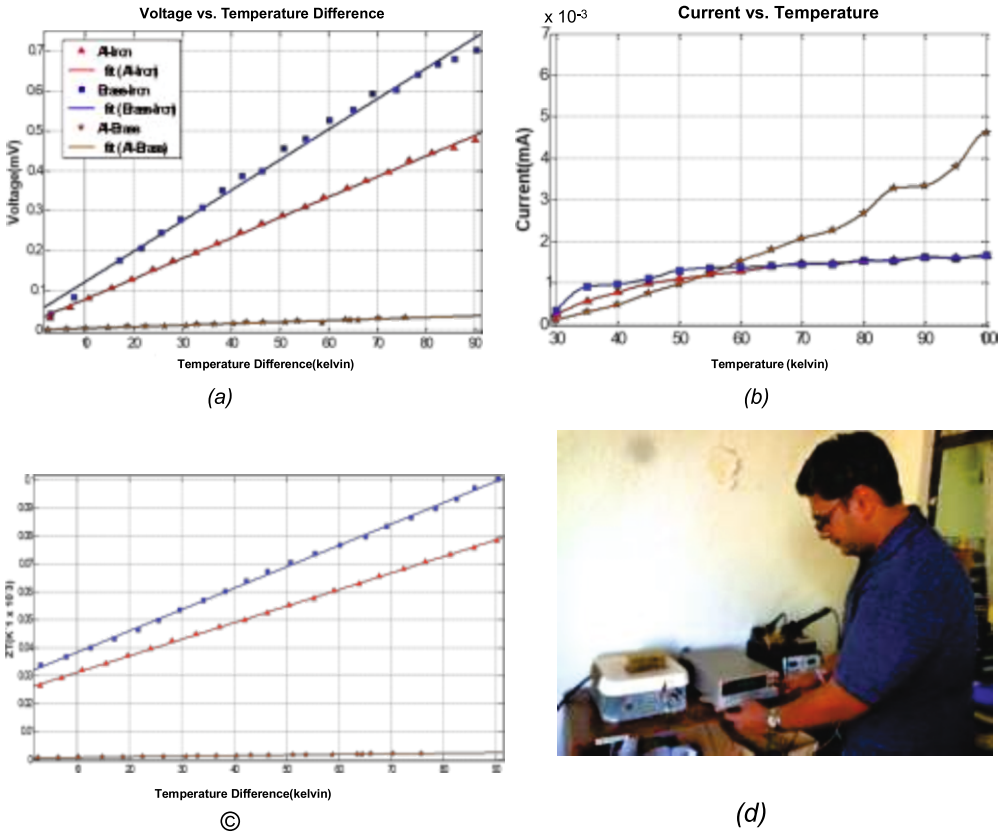


Figure 1: (a) Output voltage of metals and alloys (b) Output Current; (c) Figure of merit

References

[1] Bejenari, I.M.; Kantser, V.G. Thermoelectric Properties of n-Type Bi_2Te_3 Wires. *Moldavian Journal of the Physical Sciences*, **2004**, *3,* 94-99.

Project Leader: Dr. N.D. Subasinghe, NIFS

Research Assistant : Mr. Kanishka Kobbekaduwa, NIFS– recruited in April 2014

7.2. CHEMICAL AND LIFE SCIENCES

7.2.1 Cell Biology

Dr. D.N. Magana-Arachchi ***(Project Leader & Senior Research Fellow)***

Description of the Project

The Plant Cell Biology project, which was initiated in 2001, was renamed as Cell Biology in 2009. In 2014 research was focused on three main areas: cyanobacteria, pulmonary diseases and on human gene expression analysis.

Cyanobacteria, previously referred to as blue-green algae, are a diverse group of microorganisms that inhabit a wide range of ecological niches and are well known for their toxic secondary metabolite production. The cyanobacterial toxins are potential human health hazards and these are known to occur widely in drinking water sources. Knowledge of the evolution and dispersal of these microorganisms is still limited, and further research to understand such topics is vital. The first study provided information on the enormous diversity and wealth of cyanobacteria and archaea in Sri Lanka. In the second study, we targeted the cyanotoxins as a biological contaminant to establish the value of using molecular, biochemical and bioassay techniques to determine the presence of cyanotoxins in water bodies. Based on cyanobacterial research a PhD was obtained by a Research assistant and another submitted a PhD thesis to the University of Colombo in December 2014.

Mycobacterial strain typing by means of molecular methods has become an important instrument for tuberculosis (TB) surveillance, control and prevention. The study focused on the characterization of *Mycobacterium tuberculosis* isolates, obtained from patients attending the Central Chest Clinic Kandy, Bogambara prison and from estate workers by Mycobacterial Interspersed Repetitive Unit Variable Number Tandem Repeat (MIRU-VNTR) typing system and Spoligotyping to study the person-to-person transmission of pulmonary TB among different populations. The project is in the final stages of completion and based on the study, an M.Phil thesis was submitted to the Faculty of Medicine, University of Peradeniya in November 2014. A typical mycobacterium is one of the common infections causing organism, which affect immuno suppressive patients and patients with pre-existing lung diseases. From our studies, we were able to optimize a real time PCR assay to differentially detect slow growing and rapidly growing non tuberculous *Mycobacteria* (NTM) directly from sputum specimens. Currently antibiotic sensitivity testing is being carried out to determine the drug susceptibility patterns of the identified mycobacteria.

The expressions of genes which lead to protein synthesis are known to be influenced by environmental factors. Equally, studying the gene expression of certain tissues could lead to identifying the possible environmental sources influencing them. As such, the expression patterns of certain genes in tissues of chronic kidney disease patients of unknown etiology (CKDu) were studied and compared to the expression patterns in chronic kidney disease patients having known etiology of diabetes or hypertension (CKD) and healthy individuals, to deduce the possible causative agents. We are conducting a pilot study to determine the gene expression patterns for selected genes (drugs, xenobiotics, environmental factors, oxidative stress, heavy metals, diabetics etc. using Microarrays, and Real Time PCR arrays with RNA expressions on human control and diseased patients using blood as the testing tissue. The identification of gene expression patterns (potential biomarker patterns) that are associated with progression of CKDu, will enable us to determine the possible risk factors.

Collaborators: Names and Affiliations

1.	Dr. N.V. Chandrasekaran	(University of Colombo)
2.	Prof. V. Thevanesam	(University of Peradeniya)
3.	Dr. D. Madegedara	(General Hospital, Kandy)
4.	Dr. S.D.S.S. Sooriyapathirana	(University of Peradeniya)
5.	Dr. L. Gunarathne	(District Hospital, Girandurukotte)
6.	Dr. N. L. A. Dissanayake	(General Hospital, NuwaraEliya)
7.	Dr. T. Abeysekara	

Human Resource Development

a. Names and affiliations of the Ph.D., M. Phil, and M.Sc. students

1. R.P. Wanigatunge (NIFS-till August 2014), Faculty of Science, University of Colombo
2. H. M. Liyanage (NIFS – till August 2013), Faculty of Science, University of Colombo
3. D.K. Weerasekera (NIFS), Faculty of Medicine, University of Peradeniya
4. S. Sayanthooran (NRC), PGIS, University of Peradeniya
5. T.P. Keerthirathne (NIFS), PGIS, University of Peradeniya
6. E.G.C.K. Priyadarshika (NIFS)
7. R.W.K. Amarasekera (NSF)

b. Title of thesis completed -PhD

R.P. Wanigatunge. Identification and characterization of cyanobacteria in different climatic zones of Sri Lanka using 16S rRNA genes and detection of toxin producing cyanobacterial species using molecular markers. Ph.D. thesis (2014). University of Colombo: Sri Lanka.

c. Undergraduate trainees

1. S. Amarasekera, Faculty of Science, University of Peradeniya. - one year
2. W.P.E.H. Hemamali, Faculty of Science, University of Peradeniya- two months
3. D.U.B. Amarathunga, Business Management School (BMS), Colombo- one month
4. N. Roofin, Business Management School (BMS), Colombo - 3 months

d. Volunteers

1. M. Weerasinghe- nine months
2. M.M.F. Fara- nine months
3. J. Hagen - one month



7.2.2 Nutritional Biochemistry Project

Dr. Ruvini Liyanage (*Project Leader & Research Fellow)*

Description of the Project

This project commenced activities from January 2011. The aim of this project is to uplift the nutritional status of people in Sri Lanka. Studies involve conducting research on various food items to ensure their quality as well as studying the effects of various types of diet on the body chemistry and to explore the links between food nutrition and well being. At present in Sri Lanka noncommunicable diseases are the leading cause of death causing more death than the all the other courses combined. Main non communicable disease such as cardiovascular diseases and diabetes are caused by life style related factors such as, poor diet, lack of exercises etc. Thus the prevention of onset of these diseases are important and it's important to identify a food based approach within a context of Sri Lankan food habits and cultural practices. In this project we conduct research to identify suitable dietary sources as dietary interventions and this encourages the use of locally grown nutritious food commodities promoting local agriculture.

To address the above problems several studies were conducted to investigate the potential of different dietary sources *in vivo* and *in vitro*. Effect of processed mung bean on lipid and glucose metabolism was invetsigated in experimental animal model. Further, the aerial parts of Cucumerina (snake gourd) and seeds of Millet (Kurakkan) were evaluated for functional and nutritional properties. Another study was conducted to invesetigate the Spirulina incorporated experimental diets on meat quality parametrs and growth perfomances of broiler chicken. All these studies were conducted in collaboration with department of Animal Science, Faculty of Agriculture, and University of Peradeniya.

Collaborators: Dr. Janak Vidanaarchchi, Department of Animal Science, Faculty of Agriculture, University of Peradeniya
Dr. Barana Jayawardana, Department of Animal Science, Faculty of Agriculture,University of Peradeniya
Dr. Palika Fernando, Veterinary Research Institute,Gannoruwa

Research Assistants: C. Jayathilake R. Visvanathan

Senior Staff Technical Officer: Iranganie Thumpela **Human Resource Development**

Postgraduate students

1. O.S.Perera, Reading for a M.Phil degree in Food and Nutrition, Postgraduate Institute of Agriculture, University of Peradeniya
2. H.K.S.N.S Gunarathne, Reading for a MSc in Biotechnology, Postgraduate Institute of Science, University of Peradeniya
3. C.Jayathilake, Reading for a MSc in Food & Nutrtion, Postgraduate Institute of Agriculture, University of Peradeniya.
4. R.Visvanathan , Reading for a MSc in Clinical Biochemistry, Postgraduate Institute of Science, University of Peradeniya.

Undergraduate students

1.	V.H.H.Nadeeshani	Final year student, Department of Food Science & Technology, Faculty of Agriculture, University of Peradeniya (4 months)
2.	K. Chaturanga	Final year student, Department of Animal Science, Faculty of Agriculture, University of Peradeniya (4 months)
3.	P.M.K.A.H. Keerthikumara	Final year student, Department of Animal Science, Faculty of Agriculture, University of Peradeniya (4 months)
4.	L.H.M.P.R. Lansakara	Final year student, Department of Animal Science, Faculty of Agriculture,Universiy of Peradeniya(4 Months)
5.	Dilanka Chandrasekara	Final year student, Department of Animal Science, Faculty of Agriculture,Universiy of Peradeniya (4 Months)
6.	K.S.Madusanki	Final year student, Uva Wellassa University of Sri Lanka (3 months)
7.	K.A.M. Samanthi	Final year student, Rajarata University of Sri Lanka (one week)
8.	K.G.S.Madushanka	Industrial training placements,Uva Wellassa University of Sri Lanka

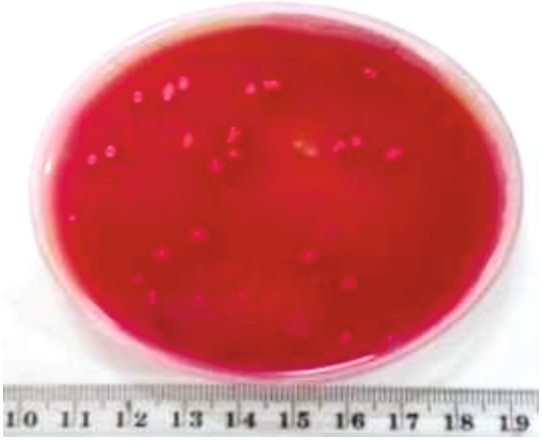
Volunteer Research Assistants

R.W.M.C.P.K. Weerasekara (6 months)


BÜHLMANN



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7.2.3 Functional Food Product Development

Dr. Viduranga Waisundara ***(Project Leader & Research Fellow)***

Description of the Project

Functional food can be defined as a food capable of providing additional health benefits which may reduce disease risk and/or promote good health. The functional food product development project initiated in April 2013 with the intention of retaliating against disease conditions which are significantly prevalent among the population of Sri Lanka. The primary focus of the research group is the identification of bioactive components which are in existence in food items which are already part of the local diet, so that they may be advocated among the locals as having therapeutic effects. A noteworthy disease condition in this aspect which is on the rise is diabetes. Given Sri Lanka's recent entry into the second world group of countries, the elevation of status has brought about changes in lifestyle and food consumption habits. It is the objective of the project to facilitate these changes from a fundamentally scientific perspective, where knowledge on bioactive component functionality of food products can be used as means of advocating a healthy lifestyle and consumer behavior.

Significant progress was made by the project in the year 2014. A research grant was awarded by the National Research Council for a period of 3 years, from August 2014 onwards for the *in vitro* assayguided identification of functional food and nutraceuticals from Sri Lankan plant products. In addition, 8 journal papers have been published along with 7 conference papers.

Analysis of thetherapeutic properties of edible plants in Sri Lanka

The antioxidant and starch hydrolase inhibitory properties of eighteen selected edible plant material was initiated during the commencement of the functional food product development project in April 2013. Through this aspect of research work, findings were achieved where the most potent of edible plants were identified with anti-diabetic properties. The bioaccessibility of the therapeutic properties of these plant material were also verified using an *in vitro* digestion model.

Fermentation as a means of increasing bioaccessibility of therapeutic compounds

Out of all food processing methods, fermentation has been identified to be the safest and most biologically compatible when it comes to the production of therapeutic agents. The process has also been recognized as a means of increasing the bioaccessibility of therapeutic compounds, especially polyphenols. The research group has been working on the fermentation culture of 'Kombucha' or 'tea fungus', which is a combination of bacteria and yeasts. It is typically used for the fermentation of tea (*Camellia sinesis*). However, these microorganisms are also being used for fermentation of other types of liquid products such as coffee and herbal teas. Thus, the research team has been involved in the production of various fermented beverages using the Kombucha culture in order to generate or enhance existing therapeutic properties. The enhancement has been associated with the increased release of polyphenol compounds from the cellulosic backbone of the substrate being used which is of plant origin.

Collaborators: Miss Lee Yian Hoon – Temasek School of Applied Science, Temasek Polytechnic, Singapore.
Associate Professor Dejian Huang – Food Science & Technology Programme, National University of Singapore, Singapore.

Human Resource Development

Registered for M.Phil.

- Mrs. Chaminie Gunawardhana, Postgraduate Institute of Science, University of Peradeniya
- Miss N. Nilakshi Jayawardena, Postgraduate Institute of Agriculture, University of Peradeniya
- Miss Mindani I. Watawana, Postgraduate Institute of Agriculture, University of Peradeniya



7.2.4 Microbial Biotechnology

Development of biofilmed biofertilizers (BFBFs) for applications in agriculture

Prof. G. Seneviratne *(Project Leader & Research Professor)*

Description of the Project

Several research projects, including basic research have been conducted so far at the IFS, which have yielded promising formulations of BFBFs for tea, rice, maize, vegetables, strawberry, potato and floriculture crops. After extensive research conducted in collaboration with the Tea Research Institute of Sri Lanka, Biofilm-T, the BFBF for tea has now been commercialized in the country by Lanka Bio Fertilizers (Pvt) Ltd. It was distributed to about 10,000 acres of tea cultivation during 2014. This can cut down 50% of chemical fertilizers used in tea cultivation. This biofertiliser technology is now being extended to other crops in agriculture and the plantations. It is hoped that this can save billions of rupees in foreign exchange by reducing fertilizer imports to the country reduce pollution and also the environment.

Project Staff

G. Seneviratne	-	Research Professor
S.A. Kulasooriya	-	Visiting Research Professor
Research Assistants:	-	S. Ekanayake
		M. Seneviratne
		P. Wijepala
Senior Staff Technical Officers:		R.C.K. Karunaratne
		A. K. Pathirana
Collaborators (other):		Prof. Ivan Kennedy, University of Sydney, Australia

Human Resource Development

Reading for Ph. D.

A. Hemagamage and D. Sinhalage (Uva Wellassa University)

M. Phil. Research projects (on-going)

R.D.A. Gunasekara (University of Ruhuna)

Undergraduate trainees

D.M.T.U. Bandara, W.M.L.S. Weerasundara (University of Sabaragamuwa, January-July 2014)

I. S. Manawasinghe (University of Rajarata, December 2013- December 2014) N.A.D. Lakmali (University of Uwa Wellassa, April-June 2014)

Volunteers trained

S.Gunaratne (February 2012- to date)

S.U. Welmillage (December 2012- June 2014),

L. A. M. A. N. Abeyrathne (March 2013 – March 2014)

W. A. D. I. Perera (March 2013 – March 2014)
A. M. Y. Y. Eriyagama (March 2013 – February 2014)
W. A. M. M. Wijesooriya (April 2013 – February 2014)
R.P.D.S.B. Dissanayake (March 2014- November 2014)



Members of the Biotechnology group at the NIFS, Kandy

7.2.5 Natural Products Project

Prof. U.L.B. Jayasinghe ***(Project Leader & Research Professor)***
Prof. N.S. Kumar ***(Project Leader & Research Professor)***

Description of the Project

Research activities of the Natural Product Project 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, fruits and edible spices using Liquid Chromatography – Mass Spectrometry (LC-MS). The overall objective of these projects is the identification bioactive extracts and compounds from natural sources, as potential resources for control of human and plant diseases.

The bioactivities of extracts and compounds are assessed using bioassays such as 2,2'-diphenyl-1picrylhydrazyl [DPPH] radical scavenging assay to detect the presence of natural antioxidants; the brine shrimp (*Artemia salina*) lethality assay to detect cytotoxicity lettuce (*Lactuca sativa*) seed germination assay to detect the presence of phytotoxic and allelopathic compounds and TLC bioautography method to detect the presence of antifungal compounds.

Naturally occurring enzyme inhibitors are important in the field of drug research and are biochemical tools that have potential utility in the treatment of diseases. These inhibitors interact with enzymes and block their activity towards their corresponding natural substrate. Inhibitors of ?-amylase, ?gluosidase, and lipase are drug targets for the treatments of diabetes, obesity and hyperlipidemia.

Enzyme assays to detect the presence of naturally occurring ?-amylase, ?-glucosidase and lipase inhibitors respectively, are being used in the recognition of natural sources that may be of importance in the identification of extracts/compounds that can find application in the formulation of health and food related products. For example, ?-amylase, ?-glucosidase and lipase inhibitors are drug targets for the treatment of diabetes, obesity and hyperlipaemia, and may eventually be of use in drug research leading to the development of new therapeutic products. During 2014 the establishment of assays to detect the presence of inhibitors of urease and chymotrypsin enzymes is in progress.

The accidental discovery of the first antibiotic Penicillin from the mould *Penicillium notatum* led to the age of antibiotics and research on fungal metabolites. Some endophytic fungal strains produce natural products that are either identical or closely related to those produced by the host plant. Taxol, an anti-cancer drug obtained from the Pacific Yew tree *Taxus brevifolia*, was also produced by the endophytic fungus *Taxomyces andreanae* from the bark of *T. brevifolia*. Isolation of endophytic fungal strains from some Sri Lankan fruits (*F. indica*, *Musa* sp., seeds of *Pouteria campechiana)* and leaves of allelopathic plants has resulted in the isolation of some unusual bioactive metabolites. Compounds isolated from the leaves of *Aspergillus niger* included polyketide naphthopyrones rubrofurarin, foncesin, aurosperone, fonsecinone A and also ergosterol. Studies on metabolites produced by the Ambrosia fungus *Monacrosporium ambrosium*, ectosymbiotic fungus of the Shothole borer beetle (*Xyleborus fornicatus*) of tea, are in progress.



Members of the Natural Product Research Group at the NIFS, Kandy

Research Scientist: Dr. K.G.N. P. Piyasena (*NSF Project*)

Research Assistants:
Ms. G.G.E.H. De Silva (*until Sept., 2014*)
Ms. C.L. Kehelpannala
Mr. G.R.N.Ratnayake
Ms. D. Thanabalasingam
Mr. M.M. Qader
Ms. T. Sritharan (*NRC*)
Ms. H.M.S.K.H. Bandara (*until June, 2014- NSF*)
Ms. D. Kanatiwela (*from July, 2014 – NSF*)
Ms. D.M.D.M. Dissanayake (*from October, 2014*)
Ms. M. Vindya Kanthi (*from November, 2014 - NSF*)

Senior Staff Technical Officer: Mr. D.S. Jayaweera

Collaborators :

1. Prof. B.M.R. Bandara, Faculty of Science, University of Peradeniya.
2. Dr. K.A.N.P. Bandara, HORDI, Gannoruwa.
3. Dr. G. Panagoda, Faculty of Dental Sciences, University of Peradeniya.
4. Dr. Kumudu Perera, Faculty of Medicine, University of Peradeniya.
5. Prof. VasanthiThevanesam, Faculty of Medicine, University of Peradeniya.
6. Dr. W.A.R.T. Wickramaarachchi, HORDI, Gannoruwa.
7. Prof. M.P.B. Wijayagunawardane, University of Peradeniya 8. Prof. D. Yakandawala, Faculty of Science, University of Peradeniya.
9. Prof. Y. Fujimoto, Tokyo Institute of Technology, Japan.
10. Prof. N. Kuhnert, Jacobs University Bremen, Germany.





















Human Resource Development

Title of Theses completed with names of RA

Name	:	Ms. H.M.S.K.H. Bandara
Degree	:	M.Phil.
Title of the thesis	:	"Isolation, structures and biological screening of metabolites from *Aspergillus niger* associated with *Musa* sp."
Year	:	2014
University	:	University of Peradeniya

Name	:	Mr. D.S. Jayaweera
Degree	:	M.Phil.
Title of the thesis	:	"Chemistry and bioactivity of some edible seeds"
Year	:	2014 (*Thesis submitted*)
University	:	University of Peradeniya

Name	:	Ms. G.G.E.H. De Silva
Degree	:	M.Phil.
Title of the thesis	:	"Chemistry and bioactivity of the secondary metabolites isolated from the fruits of *Aegle marmelos* and *Garcinia quaesita*."
Year	:	2014 (*Thesis submitted*)
University	:	University of Peradeniya

Name : Ms. R.M.W.C.K. Karunarathna
Degree : M.Sc.
Title of the thesis : "Chemistry and bioactivity of the fruits of *Averrhoa bilimbi*"
Year : 2014 University : University of Colombo

Registered for Ph.D./M.Phil, University of Peradeniya

Ms. A.G.A.W. Alakolanga (*M.Phil.)*
Ms. D.M.D.M. Dissanayake (*M.Phil*)
Ms. M. Vindya Kanthi (*M.Phil*.)
Ms. C.L. Kehelpannala (*M.Phil.)*
Ms. C. Liyanaarachchi (*Ph.D.)*
Ms. D. Niyangoda (*M.Phil.)*
Ms. K.G.E. Padmathilake (*M.Phil*.)
Mr. M.M. Qader (*M.Phil.)*
Mr. G.R.N. Ratnayake (*M.Phil*.)
Ms. T. Sritharan (*M.Phil*.)
Ms. D. Thanabalasingam (*M.Phil*.)

Undergraduate trainees

Ms. J.M.S. Jayamaha (Uva-Wellassa University)
Ms. S.P.R.R. Samarasinghe (Uva-Wellassa University)
Ms. T.W.M.V.J. Weerasinghe (BMS – Colombo)

Volunteers

Mr. Chamath Jayakody (Pre-University Student)

7.2.6 Plant Biology

Dr. M. C. M. Iqbal *(Project Leader & Senior Research Fellow)*

Description of the Project

Three research projects are conducted under the Plant Biology project.

Dry forest ecology: A comparative study on floristic diversity, structure and dynamics studies the phyto-sociology and socio-ecologyis conducted in the Hurulu and Nuwaragala forest reserves. Except for a handful of grey literature, so far no comprehensive phyto-sociological study linking with socio and forest restoration has been done in the dry zone of Sri Lanka. The rising socio-economic impacts from development activities, human settlements, irrigation systems, agricultural projects, wild fires and alien plant introductions have extensively fragmented and degraded the evergreen dry mixed forests of Sri Lanka. Hence, forest restoration studies are also urgently needed to restore the degraded dry forests. This is demonstrated in our NIFS-Popham arboretum in Dambulla.

Biology and Diversity of aquatic predators of *Aedes* larvae: Dengue is a viral disease assuming epidemic levels in the post monsoon seasons with reported cases steadily increasing in the last few years. The vector, *Aedes aegypti,* breeds in and around urban households. Copepods, a freshwater living crustacean, was successfully used as a predator of *Aedes* larvae in Vietnam, Thailand and several other countries. We are determining the biology and diversity of copepods found in Sri Lankan water bodies for their potential use as predators. In addition other potential predators being studied are small fish species and nymphs of dragon flies.

Removal of heavy metals and textile dyes using natural adsorbents: Textile dyes and heavy metals are major pollutants that are released to the environment by the Small and Medium sized industries. Contamination from textile dyes significantly affects the water quality where it can change the colour of the water body at concentrations of less than 1 mg L^{-1}. Dyes increase the Chemical Oxygen Demand (COD) of the aquatic system, reduce penetration of light in water bodies and affects the growth and survival and micro fauna and flora. Though adsorption techniques yield high dye removal, their preparation needs capital investment which SMEs are reluctant to invest. Our research project seeks to develop adsorbents prepared from natural materials such as minerals and non-living biological materials as an economical method to treat waste water. Biological adsorption materials prepared from *Asplenium nidus* L leaves and *Mimosa pigra* L. pods showed high adsorption percentages of 45%-95% for Ni (II) and Pb(II). *M. pigra* adsorbed 85% of the textile dye, fuchsine while mineral material (feldspar) showed low adsorption percentage of 35%. Bio-char prepared from *Gliricidiasepium* sawdust removed 99% of crystal violet dye from aqueous solutions. Bone char prepared from cattle bone removed 90% of fluoride from an aqueous system.

Collaborators:

Prof. H. M. D. N. Priyantha, Director, Postgraduate Institute of Science, University of Peradeniya, Peradeniya.

Prof. S.H.P.P. Karunarathna, Department of Zoology, University of Peradeniya, Peradeniya.

Dr. S.M.W. Ranwala, Department of Botany, University of Colombo, Colombo.

Prof. S. S. Iqbal, Department of Chemistry, Faculty of Natural Science, Open University Sri Lanka, Nawala.

Dr. M. Vithanage, Chemical Modeling Laboratory, National Institute of Fundamental studies, Hanthan Rd., Kandy.

Dr. J. Gunetilake, Department of Geology, University of Peradeniya, Peradeniya.

Research Assistants registered for Mphil Degree

1. Ms. W. T. Awanthi, National Institute of Fundamental Studies
2. Mr. D.M.R.E.A. Dissanayake, National Research Council
3. Mr. A.W.W.M.B. Medawatte, National Institute of Fundamental Studies
4. Ms. A. Ratnayake, National Institute of Fundamental Studies

M.Sc. Students

Ms. Batagalla, B.W.S.N.K,	Postgraduate Institute of Science, University of Peradeniya
Ms. Wijerathne, H.M.S.M,	Postgraduate Institute of Science, University of Peradeniya
Mr. SivanesanK. S,	Postgraduate Institute of Science, University of Peradeniya

Theses completed

1. P.K.D. Chathuranga. Uptake of Heavy metals by non-living biomass and removal of metals by selected plant species. 2013. University of Peradeniya.
2. D.M.R.E.A. Dissanayke. Removal of Pb(II) aqueous solutions by *Hydrilla verticillata* using a fixed bed column: Biosortion and desorption studies. 2013. University of Peradeniya.

Undergraduate trainees

1. Timesha Gunathilake (Oct 2014-Dec 2014). Dept. of Agriculture Biology, Faculty of Agriculture, University of Peradeniya
2. Dhanuka Nawarathna (Sep 2014- Dec 2014).Dept. of Crop Science, Faculty of Agriculture, University of Peradeniya

Volunteers

1. W. M. K. E. H. Wijesinghe (Dec 2013- Feb 2014)
2 S.H.K. Bokalawella (Jan 2014May 2014)
3 RP.DS.Bhagya issanayake
4 W.A.Sudarshani Wijesuriya

7.3 ENVIRONMENTAL AND EARTH SCIENCES

7.3.1 Biodiversity and Conservation

Dr. Wolfgang Dittus ***(Project Leader and Visiting Senior Scientist)***

Description of the Project

This is an overview of our research program that has been ongoing for many years. The program involves observational studies of monkeys (primates) in their natural forest habitats, especially at Polonnaruwa. Our aims are: (1) to contribute new knowledge to the understanding of the evolution of social behavior in primates (and by extension in humans); (2) to provide a scientific basis for the effective management and conservation of natural populations of primates and other organisms; and (3) to disseminate our newly found knowledge through scientific publications as well through high quality documentary films, produced professionally, with an eye towards - not only educating and entertaining, but also gaining public support for conservation efforts in the local and international spheres. Our films also contribute positively to the image of Sri Lanka as a tourist destination.

Primates are but one taxon, but our interests in conservation are far broader. This year, for example, we reviewed the taxonomic status of all Sri Lankan mammals. We outlined the scientific grounds for the need to focus conservation efforts at the level of the subspecies of Sri Lankan mammals. This recommendation is a radical departure from the usual national and international IUCN Red List emphasis on species only. Sri Lanka is a biodiversity hot-spot in its own right, distinct from that of the Western Ghats with which Sri Lanka is usually cited as "sharing" this hot spot status. Mammalian subspecies diversity in Sri Lanka contributes substantially to the nation's overall biodiversity and should be taken into account by policy makers and institutions responsible as the caretakers of Sri Lanka's flora and fauna.

Regarding our practice of primate research to investigate the phenomenon of social evolution we have identified more than four thousand macaque individuals (living plus dead), distributed among 34 different social groups at our study site. For each macaque, we have traced its behavioural, genealogical, ecological and demographic history. Our methods are similar to those of actuaries; linking variables of behaviour and environment to those of survival. To this end, we require large samples over extended periods of time to assure statistical soundness. Some years ago we have begun similar investigations of the gray and purple-faced langur at our research site at Polonnaruwa. New studies focus on the slender loris as well.

Our research has practical applications relevant to Sri Lanka's national development. For example, we have shown (in collaborations with veterinarians from the University of Peradeniya) the important relation between human and primate diseases, such as dengue fever, toxoplasmosis, cryptosporidium and other infectious diseases. At another levelwe also are proactive in nature conservation and in outreach educational programs to local communities. We have assisted the local and national governments, and their institutions in mitigating the conflict between humans and monkeys.

Collaborators:

- Prof. R.P.V. Jayanthe Rajapakse, Professor of Parasitology and Head of the Department of Pathobiology, University of Peradeniya, Peradeniya.
- Dr. Ashoka Dangolla, Faculty of Veterinary Medicine and Animal Health, University of Peradeniya.
- Professor Peter Nuernberg, Cologne Center for Genomics CCG, University of Cologne, Germany

- Professor S. W. Kotagama- Chair, Environmental Sciences, University of Colombo, and Adviser to the Minister of Wildlife Resources Conservation.
- Dr. R. Rudran, Scientist Emeritus, Smithsonian Institution, Washington DC

Human Resource Development

- We carried out several local school conservation education programs with local schools in the Polonnaruwa District.
- W. Dittus provided guidance and assistance to Surandranie Cabral in the M. A. dissertation work at the University of Colombo. She is now doing her Ph. D. in the UK.

7.3.2 Chemical and Environmental Systems Modeling

Dr. Meththika Vithanage ***(Project Leader & Research Fellow)***

Description of the Project

The Chemical and Environmental Systems Modeling Research Group works on understanding chemical processes in solid solution interface, assess, characterize, monitor water and soil pollution, salt water intrusion and model the systems in order to find solutions for human benefit.

Perchlorate mobilization of metals and organics; Implications for Martian regolith

This research was initiated in 2013. Perchlorate, a powerful oxidant, does not readily absorb to minerals or organic surfaces. Martian soils show higher concentrations of perchlorate (0.4 – 1 % ClO_4^-) than that on Earth. From 1976, scientists were trying to find organics from Mars surface and several missions were placed but not successful. Therefore, the aim of this study is to understand perchlorate interactions in soil as an environmental hazard on metal mobilization as well as its capability of destroying organics in Martian regolith using model soils. Prof. Christopher Oze collaborates on this research and conducts part of the analysis at the University of Canterbury, New Zealand.

Monitoring landfill leachate and its treatment for Volatile Organic Compounds (VOCs)

This study was started in 2014 and is ongoing. Various organic pollutants detected in leachate from landfills are of environmental concern. One type of such hazardous compounds is Volatile Organic Compounds (VOCs). VOCs are carcinogenic compounds, and their presence in the landfills may pollute the atmosphere and water sources through volatilization and dissolution. No studies are conducted in Sri Lanka to assess the types and concentrations of VOCs in landfill leachate. Hence, this study focused on assessing the different types of VOCs and their quantities and use biochar to see the potential for VOC removal. This research is partly supported by the JICA-SATREPS project.

Biochar for environmental remediation

Biochar research was started in 2012 and ongoing. The focus of this research is to investigate characteristics of different biochars produced by various waste resources in Sri Lanka for remediating pollutants and improving soil quality. Ms. S.S. Mayakaduwa, MPhil student supported by the Ministry of Technology and Research, works on pesticide remediation whereas Mr. Indika Herath works on the plant uptake of heavymetals. Two undergraduate students from Rajarata and Sabaragamuwa Universities were supported for their final year research work and both of them were awarded as the best presenters at their University sessions. Other than the pesticides, pharmaceuticals and heavy metal remediation were also studied for different biochars as a collaborative project with the Kangwon National University, South Korea.



Collaborators:

Prof. Y.S. Ok (Director, Korea Biochar Research Center, Environmental Remediation and Restoration Laboratory, Kangwon National University, Korea)

Dr. Christopher Oze (Department of Geological Sciences, University of Canterbury, New Zealand)

Dr. Dinesh Mohan (School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, India)

Prof. Nishanta Rajakaruna (College of Atlantic, Bar Harbor, ME, USA)

Prof. Ken Kawamoto (Graduate School of Science and Engineering, Saitama University, Japan)

Prof. B.F.A Basnayake, Dr. A. Karunaratne and Dr. M.I.M. Mowjood (Department of Agriculture Engineering, University of Peradeniya, Sri Lanka)

Prof. S.P. Indraratne (Department of Soil Science, University of Peradeniya, Sri Lanka)

Collaborative research projects

- Biochar for the remediation of pollutants from soil and wastewaters: A research collaboration with the Kangwon National University, Korea (ongoing).
- SATREPS (Science and Technology Research Partnership for Sustainable Development): UoP, Saitama University, UoR – JICA – JST grant for 5 years on Waste Dumping Sites in Sri Lanka (ongoing).
- Indo-Sri Lanka Bi-Lateral Research Project on tea residue biochar for pesticide remediation in water and soil for 3 years (ongoing).

Human Resource Development

Post graduate degrees obtained in 2014

Mr. PHMIDK Herath (MSc, 2014-PGIS, University of Peradeniya)

Thesis title: Effects of Biochar on metal ion release and phytotoxicity reduction in heavy metal contaminated soils in Sri Lanka

Ms. HMAG Thilakarathne (MSc, 2014-PGIS, University of Peradeniya)

Thesis title: Sorption properties of rice husk and tea waste biochar for carbofuran removal in aqueous media

Research Assistants

Mr. SSRMDHR Wijesekara (MPhil, 2013-PGIS, University of Peradeniya)

Mr. SMPR Kumarathilaka (MPhil Student, PGIS, University of Peradeniya)

Mr. PHMIDK Herath (MSc Student, PGIS, University of Peradeniya)

Ms. SS Mayakaduwa (Indo-Sri Lanka grant, MPhil Student, PGIS, University of Peradeniya)

Mr. DMTU Bandara (Research Assistant)

Mr. BAYB Jayawardhana (Research Assistant, JICA)

Ms. WMLS Weerasundara (Research Assistant, NSF Grant)

MSc Students

Mr. S. Wijebahu (PGIS, University of Peradeniya)

Mr. N. Wickramasinghe (PGIS, University of Peradeniya)

Ms. WGK. Senanayake (PGIS, University of Peradeniya)

Undergraduate Trainees

Mr. DMTU. Bandara	(Department of Export Agriculture, Sabaragamuwa University of Sri Lanka)
Ms. HBJ. Kumari	(Department of Agricultural Engineering and Soil Science, Rajarata University of Sri Lanka)
Ms. T. Yathavan	(Department of Agricultural Engineering, University of Jaffna)

7.3.3 Ecology and Environmental Biology

Dr. Suresh P. Benjamin ***(Project Leader & Associate Research Professor)***

Description of the Project

The loss of quality habitats due to anthropogenic causes like over population, habitat degradation and climate change demands the urgent attention of biologists. The focus of our project is thus the study of the mega diverse fauna and flora of Sri Lanka. The primary focus however is the largely unchartered fields of invertebrate and small plant biodiversity. The invertebrate fauna of our country remains largely unexplored, with most studies originating during the colonial period. Most studies on the flora of Sri Lanka are incomplete. Arthropod diversity estimates can be useful as indirect assays of ecosystem function or productivity oras direct estimators of ecosystem responses to human induced change. The groups of our focus are pseduoscorpions, spiders, bees and orchid, groups of high conservation necessity.

Most research projects commenced in or around June 2009. The study of goblin spiders was initiated in 2012. The studies on bee behavior was initiated in 2014. Most projects focus on the collection and characterization of soil invertebrates with a worldwide focus. Currently we are undertaking fieldwork in various part of the island. Methodology includes traditional alpha taxonomic as well as molecular methods.
One post doctoral scientist, one research assistants and several volunteers from all over the island are being trained as part of these projects. Research collaborations have been established with local as well as international research institutes (University of Rajarata, Sri Lanka; University of Peradeniya, Sri Lanka; University of Kelaniya, Sri Lanka; University of New Hampshire, USA; University of Arizona, USA; Zoologisches Forschungsmuseum Alexander Koenig, Germany).



Project Leader: Dr. Suresh P. Benjamin
Post-doctoral Research Fellow: Dr. Crisenthiya I. Clayton
Research Assistant: Ms. Sasanka L. Ranasinghe
Technical Officer: Mr. Namal Atukorala

7.3.4 Environmental Engineering

Dr. N.D. Subasinghe ***(Project Leader & Senior Research Fellow)*** **Dr. N. Nanayakkara**
(Senior Lecturer, Faculty of Engineering, University of Peradeniya)

Description of the Project

Phenol (C_6H_5OH) is a known hazardous aromatic hydrocarbon which is produced through both natural and anthropogenic processes. Recently, phenolic compounds have been detected in ground and surface water as contaminants. Moreover, they have a potential to impact on human health and ecology even at low concentration due to high toxicity, high oxygen demand and low bio degradability. As such, it is important to degrade them into harmless species. Hence, a great deal of attention has been paid on contamination of water by phenol. There are different treatment techniques to recovery or destruction of phenol in water such as photo-catalytic oxidation, biological treatment, chemical oxidation, electrochemical oxidation and adsorption. Since each technique has its own drawback, the most convenient technique among them gets the highest attention. Recentlythe electrochemical process (EC) has been popular among these treatment techniques.

The ideal anode material for the oxidation of organic pollutant (phenol) must be highly active towards organic oxidation while low activity towards secondary reactions such as oxygen evolution reactions. In addition, both stability in electrolyte medium and the inexpensiveness are needed. On the other hand, varying the anode material can generate different oxidizing agents and which would modify the oxidation pathway.

The main aim of the research work is to develop an electrochemical method is capable of treating specific organic contaminant; phenol in water. The specific objectives of the projectare:

1. To develop and optimize the anode materials of the electrochemical reactor cell to oxidize phenolin contaminated water.
2. To provide insight into the mechanisms of anodic oxidization

Reference

[1] Song, S.; Zhan, L.; He, Z.; Lin, L.; Tu, J.; Zhang, Z. *J.Hazard Mater.* **2010**, *175,* 614-621.

Project Leaders: Dr. N.D. Subasinghe, NIFS
Dr. N. Nanayakkara, Dept. Civil Engineering, University of Peradeniya

Research Assistant: Ms. P. B. Jayathilake, NIFS

Human Resource Development

Ms. P.B. Jayatilake, NIFS– Completed MPhil degree at PGIS, Uni. Peradeniya.
Thesis Title: Anodic oxidation of phenol in contaminated water on dimensionally stable anode

Volunteer

Ms. B.M.C.S. Wickramasinghe – University of Peradeniya

7.3.5 Estimation of the subsurface extension of Eppawala apatite deposit

Dr. N.D. Subasinghe ***(Project Leader & Senior Research Fellow)***

Description of the Project

Phosphate deposit at Eppawala is one of the major mineral resources in Sri Lanka. Although the exploitation has been carried out over several decades, and many geochemical and mineralogical studies have been done, no detailed geophysical investigation had been conducted until this project. We use the fact that magnetite is always associated with the phosphate deposit, due to its igneous origin. Due to the presence of magnetite, phosphate body has a unique magnetic signature, which is distinctively different from the surrounding country rocks. In this research, a magnetic survey is conducted to obtain the magnetic signals from rocks and establish the characteristic magnetic signatures of the country rock, parent rock and secondary phosphate rock.

Total magnetic intensity of the area was obtained using a proton precision magnetometer. After filtering the noises, data were processed to produce the magnetic anomaly map of the area. Phosphate deposit can be demarcated using the sharp magnetic anomaly.





Reference

[1] Subasinghe N.D.,; Charles W.K.D.G.D.R.; De Silva, S.N. Analytic signal and Reduction to pole Interpretation of Total magnetic field data at Eppawala Phosphate Deposit. *Journal of Geoscience and Environment Protection*. **2014,** *2*, pp 181-189.

Project Leader : Dr. N.D. Subasinghe, NIFS
Research Assistant : Mr. D.R. Charles, NSF
Technical Officer : Mr. A. Tennakoon, NSF

Collaborators : Mr. Nalin de Silva - Geological Survey and Mines Bureau

Research Grants : National Science Foundation Grant No: RG/2012/NRB/03 Continued

Human Resource Development Mr. D.R. Charles, NIFS

Undergraduate Trainees - MPhil (Registered at PGIS, Uni. Peradeniya)
Ms. H.P.V. Hansika Erandi - UvaWellassa University (Final year undergraduate)
Ms. Sangeetha Rajapaksha - Rajarata University (Undergraduate)

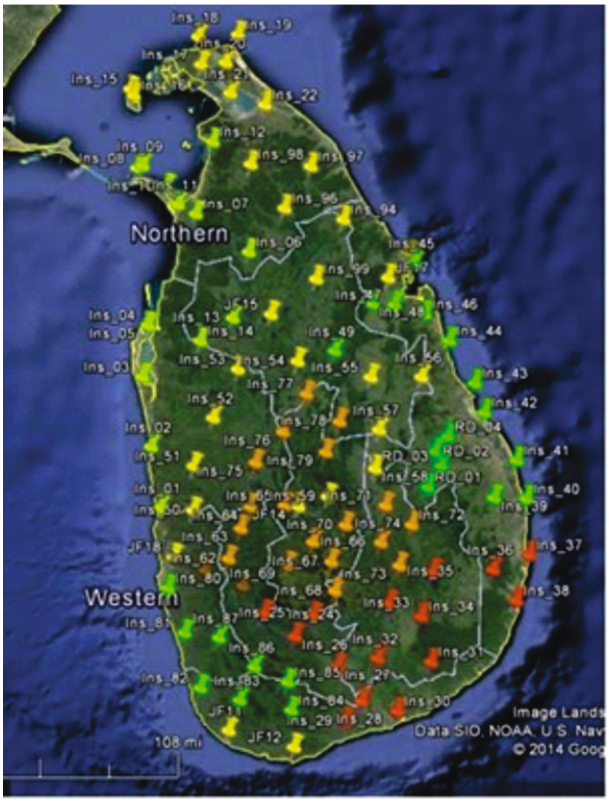
7.3.6 Radon Monitoring

Dr. N. D. Subasinghe ***(Project Leader & Senior Research Fellow)*** **Prof. C.B. Dissanayake** ***(Project Leader & Research Professor)***

Description of the Project

Radon is a naturally occurring, radioactive element, usually produced as the result of uranium or thorium decay. However, unlike other radioactive elements, radon is a gas – the heaviest naturally occurring noble gas. Due to its radioactivity, radon is considered a health hazard. It is estimated that inhaling radon is the leading cause of lung cancer, after smoking. Since radon is a heavy gas continuously emitted from the ground and is short-lived, its concentration varies temporally and spatially, depending on several factors. Many countries have produced radon concentration maps while some countries have imposed a law that a report showing radon levels should be produced when a property is sold. However in Sri Lanka, no attempt had been made to measure the radon levels or to produce a radon map. We took the initiative to produce a preliminary radon map of Sri Lanka. In addition to pinpointing the potentially hazardous locations, elevated radon levels will indicate the mineral deposits rich in U and Th. In-situ and ex-situ radiation measurements of air, soil and water were taken at selected locations for comparison. Preliminary results identified certain areas with high background radiation in Sri Lanka.

Radon mapping programme was started with 50 passive radon detectors donated by Japan. They were used for outdoor monitoring. This was followed by another 2 batches of 50 detectors from Japan and 50 indoor detectors from International Atomic Energy Agency (IAEA) in Austria. In addition, active measurements of radon is also conducted around the country.



Sampling locations





Passive radon detectors used in the survey

Collaborators : Prof. T. Iimoto, Tokyo University, Japan
Project Leader : N.D. Subasinghe, NIFS

Human Resource Development

P.D. Mahakumara, Atomic Energy Authority - PhD (Registered at PGIS, Uni. Peradeniya)

7.4 PHYSICAL AND COMPUTATIONAL SCIENCES

7.4.1 Artificial Intelligence

Prof. A. Nanayakkara ***(Project Leader &Research Professor)***

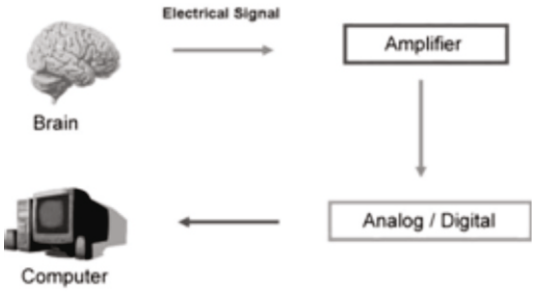
7.4.1.1 Brain Computer Interface

Description of the Project

A Brain–Computer Interface (BCI) sometimes called a direct neural interface is a direct technological interface between a brain and a computer. It is a system that uses electric, magnetic or hemodynamic brain signals to control external devices such as switches, wheel chairs, computers or neuroprosthesis. BCI systems are especially invaluable for patients who suffer from severe motor impairments (late stage of Amyotrophic Lateral Sclerosis – ALS, severe cerebral palsy, head trauma, and spinal injuries).

The BCI project aims at building high performance hardware and software system, which provides a communication link between the human brain and the computer. Using such a system, a person can control any equipment or interact with outside world using his or her thoughts alone without any physical involvement. This way, patients who are with severe physical disabilities can control equipment such as wheel chairs, televisions, etc and communicate with the computer voice in his or her native language (Sinhala, Tamil or English).

Certain actions in a normal human brain can generate various responses such as metabolic activities or electromagnetic signals which can be detected by appropriate sensors and hence can be used for controlling BCI systems. As an example, brain activity can produce magnetic fields that can be detected using Magneto encephalography (MEG). Certain brain activities may produce electrica lsignals that can be detectable on the scalp Electron encephalography (EEG) or cortical surface or within the brain Electro corticography (ECoG). At present, EEG and ECoG are more popular as equipment needed for detection of other effects such as MEG is prohibitively expensive.



Although compared to MEG or functional Magnetic Resonance Imaging (fMRI) machines, EEG systems are much cheaper, still they are quite expensive for most of the people in Sri Lanka and hence they cannot afford to own EEG equipment. Therefore, one of the aims of this project is to design and develop low cost software and hardware needed for BCI. Another aim is to develop a real-time BCI system which could be used by severely physically disabled people in Sri Lanka. This includes development of new techniques to extract thoughts from EEG signals and carrying out activities according to thoughts.

Human Resource Development
Registered for M.Phil Degree in Electronics
Vibodha Bandara, (Department of Physics, University of Colombo)

7.4.2 & 3 Energy Focusing Phenomena and Quantum Physics

Prof. A. Nanayakkara ***(Project Leader & Research Professor)***

This project covers two main areas of research;

(a) Computational and Experimental Investigations of Energy Focusing Phenomena (Single Bubble Sonoluminescence (SBSL))

(b) Quantum Physics

7.4.2.1 Single-Bubble Sonoluminescence

Single-Bubble Sonoluminescence (SBSL) is observed when a single gas bubble, which is acoustically levitated in a liquid, under goes non linear oscillations in synchrony with the applied sound field and emits sub-nano second flashes of light at the point of maximum implosion. This is one of the examples of spontaneous energy focusing phenomena. As the bubble collapses, vibrational energy gets concentrated by at least a factor of $4x10^{11}$ to produce flashes of light in the UV range. These flashes of ultraviolet light have durations much shorter than a Nanosecond. At the latter stages of the collapse, both the temperature and the pressure inside the bubble reach extreme values such as 20,000K and 3,500 atm respectively. Also the bubble wall reaches acceleration over10^{11}g near the maximum implosion. SBSL is observed by only with the bubbles having ambient radii between 1 μm to 10 μm and during the collapse, radii of these bubbles come down to 0.1 μmto 1μm.

The spectrum of SBSL is fairly broad, extending from above 700 nm to below 190 nm. The intensity of emitted light increases with decreasing wave length up to the ultraviolet cut off of water (about 200 nm, though anything below 250nm is attenuated). In water, the spectrum of SBSL fits blackbody radiation with surface temperatures in the range 6000K–20 000 K for sound frequencies between 10 and 50 kHz. On the other hand spectrum of SBSL of an isolated bubble driven at 1MHz sound frequency agrees well with thermal bremsstrahlung from a 10^6 K plasma [1].

There have been a large number of theoretical and experimental investigations carried out to explore, understand and predict the above mentioned exotic physical conditions which take place inside the SBSL bubbles at the time of light emission [2]. Most theoretical/computational models have been based on continuum fluid mechanics (e.g. Euler equations or Navier- Stokes equations) [2] and they were able to simulate some of the experimental results successfully. Since the majority of the models are based on fluid equations and during the last stages of the collapse, the speed of the bubble wall exceeds the speed of sound in water (or the liquid) and other extreme physical conditions can be observed inside the bubble, the validity of these models is questionable [3]. Further, all these fluid approaches are limited in their predictive power by the need to represent transport processes and the equation of state.

SBSLhas been, and continues to be, the subject of considerable experimental and theoretical research since light emission mechanism has not been fully understood yet. Also SBSL has attracted many scientists' attention due to its potential in producing unlimited clean energy via cold fusion. The light emitting mechanism in SBSL is one of the unsolved problems in Physics at the moment.

References

[1] Camara, C.; Putterman, S.; Kirilov, E. *Phys. Rev. Lett.* **2004**, *92*, 124301

[2] Brenner, M.P.; Hilgenfeldt, S.; Lohse D. *Rev. Mod. Phys*. **2002**, *74*, 425 and references therein.

[3] Ruuth, S J.; Putterman S J.; Merriman B. *Phys. Rev*.E **2002**, *66*, 036310

7.4.3 Quantum Physics

Prof. A. Nanayakkara ***(Project Leader & Research Professor)*** **T. Mathanaranjan**

Description of the Project

In recent years, the manifestation of chaos in quantum mechanics has been of great interest. In particular, quantum systems which are classically chaotic have been investigated intensively. In order to study the signature of chaos in quantum mechanics, we have been developing various theoretical and computational methods for multi dimensional systems which bridge classical mechanics with quantum mechanics in a transparent manner. Also, we have been investigating quantum mechanical quantities which contain information on chaos in the corresponding classical system. We have investigated the behavior of multi dimensional systems in the semiclassical limit. (i.e. limit between quantum mechanics and classical mechanics) and classical,semiclassical and quantum mechanical behavior of both Hermitian and non-Hermitian Hamiltonian systems. Based on the results of this project, two papers have been published.

Human Resource Development

Registered for Ph.D./M.Phil., PGIS, University of Peradeniya (All have completed their research work and (1) and (3) have completed thesis writing as well)

1. Mr. Thilagarajah Mathanaranjan - Ph.D. (in Mathematics)
2. Mr. Prabhath Herath – M.Phil. (in Physics)
3. Mr. Manoj Wijesingha – M.Phil. (in computational Chemistry)

8. COLLABORATIVE AND CONSULTATIVE DIVISION (CCD)

Coordinator: Prof. S. A. Kulasooriya *(Visiting Research Professor)*

Co-coordinators: Prof. Gamini Seneviratne and Dr. Renuka Ratnayake

Descriptions given in this section will be confined mainly to the interactions between the collaborating institutions and individuals while research results will be presented by the corresponding scientists under their respective research projects. Since the Rhizobial Inoculant Research and Production Facility (RIRPF) and the Spirulina Tank Farm project operated directly under the CCD, some details of their activities are presented in this section.

Projects continuing from previous years

2. **Collaboration with Lanka Biofertilizer's (Pvt) Ltd on Biofilm-Biofertilizers***

Prof. Gamini Seneviratne and Prof. S. A. Kulasooriya (NIFS)
Collaborators: Mr. Samantha Kumarasinghe and Mr. Samuditha Kumarasinghe

Biofilm-biofertiliser for tea developed by the Microbial Biotechnology Unit of the NIFS was commercialized under Lanka Bio Fertilizers (Pvt) Ltd. formed in March 2014 as a subsidiary company of Nature's Beauty Creations (NBC) on a royalty payment to the NIFS. Its first product named 'Biofilm-T' has now been introduced to about 10,000 acres of tea cultivation in the country after extensive research conducted in collaboration with the Tea Research Institute of Sri Lanka. Application of Biofilm-T can cut down 50% of chemical fertilizers (NPK) used in tea cultivation. Biofilm- biofertiliser technology is now being extended to other crops in agriculture and plantations in the country. It is hoped that this product can save billions of rupees in foreign exchange by reducing fertilizer imports to the country, while minimizing environmental pollution that is affecting the health of the people, the farming communities in particular.

For more information please see www.biofilm.lk

9. **Rhizobial Inoculant Research and Production Facility (RIRPF)***

1. <u>Rhizobial inoculants for Pasture Legumes</u>
   Prof.S.A. Kulasooriya, Mr.E.M.H.G.S. Ekanayake, Mr.R. G. K.Kumara (NIFS)
   Collaborator: Mr.Sarath Bandara, General Manager, Ambewela Farms (Pvt) Ltd

Continuation of the field trials conducted in pasture lands at Ambewela Farms have shown that the application of rhizobial inoculants improved the growth of clover and associated grasses. There is a possibility to replace the mineral nitrogen fertilizer application for pasture lands and further field trials are in progress to confirm these results..



Taking crop cuts from clover plots



Clover uninoculated (left) and inoculated (right)

A new inoculant developed at the NIFS profusely nodulated field grown white clover plants in small plots and this will be further field tested on a large scale experiment.

2. **Rhizobial Inoculants for Vegetable Bean (Field demonstrations)**

Prof.S.A. Kulasooriya, Mr.E.M.H.G.S. Ekanayake, Mr.R.K.G.K. Kumara(NIFS)

Participants: Three individual farmers at Nugathalawa and three individual farmers at Kudaoya

Filed demonstrations were conducted at Nugathalawa and Kudaoya areas. Plant growth were comparable under both inoculated and fertilizer applied treatments. Yield data are yet to be collected.



Laying out demonstration trial



Demonstration trial in progress

3. **Rhizobial Inoculants for Green Gram and Maize Intercropping system**

Prof.S.A. Kulasooriya, Mr.E.M.H.G.S. Ekanayake, Mr.R.K.G.K. Kumara (NIFS)

Collaborator: Mrs W.M.N.D. Gunathilaka, Research officer, Department of Agriculture, Agunukolapallassa.

This experiment was conducted on the fields at Agunukolapallassa Research Center during Maha 2013/ 14 and it was observed that inoculation has positively affected the seed yield of Maize

4. **Rhizobial Inoculants for Green Gram**

Prof.S.A. Kulasooriya, Mr.E.M.H.G.S. Ekanayake, Mr.R.K.G.K. Kumara (NIFS)

Collaborator: Mr.H.M.A.C.Gunarathna, Assistant Manager, Research and Development, Plenty foods (Pvt) Ltd.

Field trials are in progress to compare N fertilizer application and rhizobial inoculation in farmers' fields at Tiissamaharama and Sooriyawawa areas. Inoculation appears to have improved nodulation and plant growth. Seed yield is yet to be taken



Early flowering stage



Inoculated plot showing better growth

With the diversification of rhizobial inoculants for several crops and expansion of extension activities to many locations it has been realized that the RIRPF will not be able to manage large scale operations including the island wide marketing of inoculants. A memorandum of understanding was therefore signed to hand over the commercialization, extension and marketing of inoculants to a private company "Oasis Marketing (Pvt) Limited". The NIFS will continue basic studies such as improvement and development of novel inoculants for diverse crops while Oasis will multiply and market them with a royalty payment to the NIFS.

10. **Establishment of a Spirulina Tank Farm at Wattegedera, Kurunegala Dsitrict***

Prof. S. A. Kulasooriya (NIFS)
Technical Assistant: Mr. Anura Tennekone
Collaborator: Major General (retired) W. J. T. K. Fernando

Outdoor mass cultivation of *Spirluina* was expanded to 20 tanks (10 ft x 5 ft). Periodic stirring of cultures (twice daily), harvesting, collecting and drying the slurry were mechanized to minimize handling that could lead to contamination. A maximum production level of 2Kg per tank per day was obtained. General Fernando is currently negotiating with several private companies to market his product in the form of dried *Spirulina* powder. He is also in the process of establishing a bigger tank farm close to the army headquarters at Panagoda.



Mechanical harvesting



Harvested slurry

11. **Collaboration with Kurunegala Plantations Limited**

Prof. Gamini Seneviratne (NIFS)
Collaborator: Mr. S. M. M. Samarakoon

A biofilm biofertilizer formulated from initial isolates was obtained from coconut seedlings and will be tested with the out planting of young plants.

Projects commenced in 2014

1. Purification of Sri Lankan natural vein graphite for novel technological applications

Dr. H. W. M. A. C. Wijayasinghe (NIFS)
Research Staff: Mr.P.T.S. Hewathilake (Research Assistant under Innovative Research Grant-2013) Volunteer Research ssistant:
Mr. R.M.U.M. Somarathna Senior Staff Technical Officer:
Mr. W.G. Jayasekara Collaborator:
Dr. N. W. B. Balasooriya (South Eastern University of Sri Lanka)

A research grant (Innovative research grant -2013) was awarded by the University Grant Commission of Sri Lanka for this joint project between SEUSL and the IFS. Under that a research assistant, Mr. P.T.S. Hewathilake, was recruited to the project with effect from 01.02.2014. Mr. Hewathilake was registered for a M. Phil. Degree at the Post Graduate Institute of Science, University of Peradeniya. Also he has been given training on *Graphite mining* at the Kahatagaha Graphite Mines and *Graphite processing* at the University of Moratuwa.

The research work of this joint project was commenced on 1st of January 2014. Already, natural vein graphite samples of different structural varieties have been obtained from the Kahatagaha mines and natural flake graphite samples were collected from abundant pits in Kegalle district. At present, the purification and surface modifications studies on the selected graphite varieties are successfully going on with the aim of starting the electrode fabrication together with cell studied from the beginning of 2015.

2. Collaboration with the Sri Lanka Institute of Nanotechnology (SLINTEC) on Development of Sri Lankan natural vein graphite for nano-technological applications

Dr. H.W.A.C. Wijayasinghe (NIFS)
Collaborator: Dr. D. Jayasundara (SLINTEC)

The agreement was signed on 18th August 2014 and the Non Disclosure Agreement is presently being prepared.

3. Collaboration between NIFS and Geological Survey and Mines Bureau (GSMB)

Dr. Deepal Subasinghe (NIFS)
Work is in progress on geophysical investigations on Eppawala phosphate deposit and the surrounding areas. A new general MoU has been finalized for further collaborative activities on dolerite dykes, geothermal energy iron ores and serpentine ores.

Human Resource Development

- Ms. C.S. Hettiarachchi, co-supervised by Prof. S. A. Kulasooriya has submitted her PhD thesis to the PGIS, University of Peradeniya
- Ms. Buddhika Perera co-supervised by Prof. S. A. Kulasooriya is preparing her M. Phil thesis.
- Ms. M.M.S.N. Prematileke supervised by Dr. Renuka Ratnayake and co-supervised by Prof. S.A. Kulasooriya submitted her thesis to the PGIS.
- Mr. K. Mohanan supervised by Dr. Renuka Ratnayake and Prof. S. A. Kulasooriya has commenced writing his thesis.
- Ms. Champa Seneviratne co-supervised by Prof. S. A. Kulasooriya is progressing with her M. Phil. work.

PART II

ABSTRACTS

7.1 ALTERNATIVE AND RENEWABLE ENERGY

7.1.1 Biofuel Production/Carbon Sequestration and Management

7.1.1.1 Soil Carbon sequestration in *Eucalyptus grandis* forest plantations of Sri Lanka along a chronosequence of forest age

M.M.S.N. Premetilake, R.R. Ratnayake*, S.A. Kulasooriya[2], G.A.D. Perera

[1]*Uva Wellassa University, Badulla, Sri Lanka*

[2]*National Institute of Fundamental Studies, Kandy, Sri Lanka*

[3]*University of Peradeniya, Peradeniya, Sri Lanka*

Managing forest plantations to sequester atmospheric carbon in soil has drawn the scientific attention as a way of reducing global warming and improving soil quality. In Sri Lanka, the area of forest plantations has substantially increased over the past few decades and, more than 20 % of these are represented by *Eucalyptus* species. However, carbon sequestration in Sri Lankan *Eucalyptus* forest plantations, especially focussing on soil, has not been fully understood. Therefore, soil carbon sequestration potential of *Eucalyptus grandis* forest plantations of Sri Lanka were studied over a chronosequence of age (4, 10, 19 and 27 years) and compared with patana grassland, a natural forest and a tea plantation in the same zone. The factors that affect soil carbon sequestration were also examined. Six 20 m x 20 m experimental plots were established in eachland use. Overstorey and understorey parameters were studied and recorded. The stocks of major carbon fractions in soil were measured. Although there was no statistical significance, the aboveground carbon stocks showed a tendency to increase with stand age. The declining trend in nutrient levels of litter after crown closure could influence slow mineralization of litter leading to increased carbon sequestration in soil. Soil moisture content, soil acidity and α- Pinene concentration in soil increased significantly with stand age improving carbon sequestration potential of *E. grandis* plantation soil. Most of the soil nutrients displayed a declining trend up to a certain level, but were gaining their concentrations afterwards with stand age.Although comparatively low when compared to natural forest, the total organic carbon stock in 0-15 cm soil layer of 27 year old plantation was 4 fold higher than that of patana grassland and 3 fold higher than tea plantation. From an overall view, it could be concluded that the *E. grandis* plantations increase soil carbon storage along a chronosequence of age. Therefore, in the perspective of carbon sequestration, the presence of *E. grandis* plantations are advantageous, especially when the trees get older.

7.1.1.2 Soil carbon sequestration and nutrient status in Northern flank of Knuckles Region, Sri Lanka

R.P.S.K. Rajapaksha[1], R.R. Ratnayake[*1], H.M.S.P.M. Weerasinghe[2], S.K. Gunathilake[3]

[1]*National Institute of Fundamental Studies, Hantana Road, Kandy, Sri Lanka,*

[2]*Dept of Botany, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka*

Dept of Natural Resources, Facaulty of Applied Sciences, Sabaragamuwa University of Sri Lanka, Belihuloya, Srilanka

Global Warming has now Become a serious Environmental Problem, facing the wold community.In order to mitigate the risk of resultant global climate change, many studies have focused on reducing emissions of CO_2 and other greenhouse gases. Atomospheric CO_2 can be reduced by increasing the carbon strge in soil; a significant C sink. Forest soils play an important role in the global C cycle because of the large areas involved at regional/global scale. The objective of this study was to assess caron seqestrtion capacity in Northern flank of of Knuckles Region, Sri Lanka. The study sites.

included Sub Montane forests (SM), Moist Monsoon forests (MM), Grasslands (GL), Open and Sparse forests (OS) and Forest Plantations (FP). For this purpose, soil pH, conductivity, moisture content, carbon fractions such as total organic carbon (TOC), microbial biomass carbon (MBC), water soluble carbon (WSC), $KMnO_4$ oxidizable carbon (OC) and soil available macro nutrients were analyzed in two depth levels 0-15 cm and 15-30 cm. Total organic carbon, MBC, WSC and OC ranged between 0.04-4.99 %, 0.0002- 0.14 %, 0.0005-0.17 % and 324.59-739.81 mg/kg, respectively. Available macro nutrients namely NO^-_3, NH^+_4 and PO_4^{3-} ranged between 0.01-3.70 mg/kg, $7.0\times10^{-7}5.0\times10^{-4}$ mg/kg, 0.008-1.32 mg/kg. As well, soil pH, conductivity and moisture content were ranged between 3.67-6.59, 7.21-82.7 µS/cm and 2.24-49.49 % respectively. The results showed that the TOC were higher in SM and OS forest types, where MBC is lower, than others. Grasslands showed the highest MBC value. Top layer has a high percentage of carbon due to the leaf litter on the forest floor. Contrary to this, WSC in SM and FP has accumulated in deeper layers due to its high mobility through the soil. The study indicated that soil carbon fractions and nutrient availability varied significantly among vegetation types in Northern flank of Knuckles Region.

7.1.1.3 Soil carbon sequestration and nutrient status of rice based cropping systems in the dry zone of Sri Lanka

R.R. Ratnayake[1*], B.M.A.C.A. Perera[2], R.P.S.K. Rajapaksha[1], E.M.H.G.S. Ekanayake[1], R.K.G.K. Kumara[1], H.M.A.C. Gunaratne[3]

[1]National Institute of Fundamental Studies, Hantana Road, Kandy, Sri Lanka,

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Carbon sequestration increases soil fertility and also contributes to reduce global warming by storing atmospheric carbon in soils. This research aimed to quantify and compare soil organic C fractions and C stocks in tropical rice based cropping systems and to investigate their variation as affected by crop rotation with upland crops. Soil nutrient availability and the relationship with C fractions were examined. Total organic C, microbial biomass C, water soluble C, $KMnO_4$ oxidizable C, pH, moisture and available macronutrients were analyzed at 0-15 and 15-30 cm depth in Rice-Rice, Rice-Soya, Rice-Tobacco and Rice–Onion rotations in Sri Lanka. Carbon fractions and nutrient availability among the cropping systems varied significantly showing high contents in 0-15 than 15-30 cm depth. Except water soluble C which showed a higher content at 15-30 cm depth, all the other fractions show higher content at 0-15 cm depth. Water soluble C is the most mobile form of organic C which can easily be leached out or moved down into deeper layers as observed. Correlation analysis between C fractions and macronutrients showed that soluble C fractions such as microbial biomass and water soluble C correlate significantly with Ca^{2+} possibly due to the chelating effect of organic matter on metal ions. Nutrients showed a positive trend with carbon fractions showing that organic matter act as a source for nutrients and enhance nutrient retention. Crop rotation between rice-soya maintained the highest soil organic C stocks (65.18 kg/ha) while rice-onion maintained the lowest (43.41 kg/ha). The cropping system changes from rice- rice to rice-soya enhanced soil carbon sequestration. Cropping changes to other annual crops such as tobacco and onion reduced soil carbon sequestration compared to rice-rice. The differences in soil C stocks clearly reflected the differences of remaining crop residues in soil. No residues will remain after harvesting onion as the whole crop is removed at the harvest while only below ground parts will remain after harvesting tobacco. It is confirmed that tropical rice based cropping systems have a great potential in storing and maintaining C in soils and thereby to facilitate nutrient availability. Further, crop rotation with upland soya enhanced soil carbon sequestration than rice alone.

7.1.1.4 Isolation, identification and screening of microbial strains and development of biofilms/co-cultures for lignocellulose degradation

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Lignocellulosic materials are potential raw materials for biofuel production. The costs of pretreatment and enzymes reduce the economic viability of the process. The aim of the present study was to isolate micro-organisms with high enzyme activities from the environment and to study the effect of biofilm or co-culture formation on the enzyme activities. The objectives for the past year were studying the degradation of *Eichhornia crassipes* with selected fungal co-cultures, studying degradation of lignin in *Panicum maximum* by enzymes from selected basidiomycetes, isolation of anaerobic cellulolytic bacteria from the environment, identification of selected isolates by molecular methods and studying the effect of pH control on cellulase production at high substrate concentrations. Total sugar concentrations were measured by using dinitrosalicylic acid reagent (Miller, 1959). Lignin content was measured gravimetrically after acid hydrolysis (Crawford *et al*, 1988). Selected fungal isolates were identified based on ITS sequences. To study the effect of pH control on cellulase production, bromophenol blue was added to the production medium as an indicator and pH was adjusted at daily intervals to 4 when it lowered below 4. Enzymes from the coculture of the strains *Trichodema reesei* (F118) and *Eupenicillium* sp. (FM13) resulted in significantly higher degradation of *E. crassipes* compared to the monocultures ($P<0.05$). Enzymes from the basidiomycetes M6 (unidentified) and M39 (*Favolus* sp.) resulted in significant degradation of lignin in *P. maximum*. Control of pH in the cellulase production medium containing 2% (w/v) cellulose resulted in continuous secretion of cellulase by *T. Reesei* (F118) and *Eupenicllium* sp. (FM13) up to 14 days, resulting in higher cellulase activities (0.32 FPU/ml and 0.24 FPU/ml respectively).

7.1.1.5 Growth Optimization of Cyanobacteria and Micro Algae Isolated from Fresh Water Bodies of Sri Lanka towards Biodiesel Production

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Cyanobactieriea, with their superio photosynthesis capabilities can convert up to 10% of the sun's energy into biomass, compared to the 1% recorded by conventional energy crops duch as corn or sugarcane, or the 5% achieved by algae. photosynthetic microorgainisms like cyanoacteria and microalgae can potentially be employed for the production of bifuels in an economially effective and environmentally sustainable manner to replace a substantial faction of the use of fossil fules. The present study was carried out to optimize the growth condition of cyanobacteria and micro-algae isokated from differnt fresh water bodies of srilanka towards biodiesel production.water sample from six frsh water bodies was collected and was cultured in three different midia (BG-11, Go and ASN-111). Cultures wer maintaned under different pH (7.0 7.5, 8.0 and 8.5) different light intensity (10001500 Lux and 2000 Lux) and different shaking condition (0 rpm, 200 rpm and 300 rpm).Fast growing media was determined in terms of days taken to appear bluish-green growth in sample water. Growth concentration was detrmined by measuring the sum of chlorophyll-a and pheophytin-a pigment. Uni-algal culture was obtained by repeted sub-culturing in liquid and solid media supplemented with agar which was identified morphologically under microscope. Algal growth was

recorded from all six samples in BG-11 media while growth appeared from three water bodies in GO media. However, in ASN-III media growth was recorded from two samples. Best growth was recorded in BG11 media compared to other which was significantly different from GO and ASN-III. Best pH level was 7.5 which showed significant difference only for BG-11 medium, compared with other treatments. At the same time, highest growth was recorded under 2000 Lux light intensity whereas 1000 Lux was the lowest. Under different shaking condition, 200 rpm was most effective. The present study also revealed that, GO media was selective only for those who form heterocyst and BG-11 was a common media for all cyanobacterial and micro-algal cultures.

7.1.2.1 Efficiency enhancement by mixed cation effect in dye-sensitized solar cells fabricated with solution electrolyte

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Nano-porous TiO_2 based dye sensitized solar cells (DSSCs) are emerging as a low cost alternative to expensive silicon based p-n junction solar cells. For widely used DSSCs the electrolyte usually consists of a I_3^-/I^- redox couple dissolved in an organic solvent. In this work we have used two iodide salts with two dissimilar cations instead of a single iodide salt in a solution electrolyte in order to study the "mixed cation effect" on solar cell performance. For preparing the electrolyte samples, the weight of EC (0.4 g), PC (0.4 g) and ACN (0.1 g) was kept unchanged while the total weight of KI and Pr_4NI was kept at 0.06 g. The weight of I_2 was calculated maintaining the ratio $[I_2]:[XI] = 1:10$. Photo anode was prepared by grinding 0.2 g of TiO_2 (Digussa P25) with 12 drops of acetic acid, 1 drop of triton X 100 and about 3 ml of ethanol. The creamy paste was spread on pre-cleaned conducting glass plate using the doctor blade method and sintered at 450 °C for 45 min. Dye absorption was carried out by immersing the above anode in an ethanolic dye solution containing 0.3 mM Ruthenium dye (N719) for 24 hours. The electrolyte was placed between the photo anode and the platinum counter electrode to make the solar cell. The current-voltage (I-V) characteristic of the cells was measured using simulated sunlight with 100 mW cm^{-2} (AM 1.5). The solar cell containing the electrolyte with KI 33.3% W/W + Pr_4NI 66.6% W/W shows 7.22 % efficiency, while the solar cells containing only KI and only Pr_4NI as the iodide salt had efficiencies of 5.77 % and 4.02 % respectively. Therefore, it is clear that the mixed cation effect can be used to enhance the efficiency of DSSCs.

7.1.2.2 Efficiency Enhancement in Dye Sensitized Solar Cells by TiO_2 Photo-Anode modified with Silver Nano particles

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Dye sensitized solar cells (DSSCs), which are one of the most potential photovoltaic devices, have attracted interest as an alternative technology for future renewable energy production due to their high solar energy conversion efficiency as well as relatively low fabrication cost [1]. These devices mainly consist of a nanocrystalline wide band gap n-type semiconductor such as TiO_2 coated with dye molecules, a redox mediator and a counter electrode, usually a thin Pt film. The efficiencies of these devices essentially depend on the properties of the semiconductor, dye and electrolyte. Nanocrystalline TiO_2 is a wide band gap semiconductor material with photocatalytic properties suitable for DSSCs. It has been proposed that the efficiency of nanocrystalline TiO_2 based DSSCs can be further enhanced by surface doping of TiO_2 with metal nanoparticles [2]. In this study, we investigated the use of silver nanoparticles (Ag NPs) incorporated in to the TiO_2 photoanode leading to the enhancement of the photocurrent of the DSSC by the surface Plasmon effect. Ag NPs with 4060 nm size were synthesized as a nanoparticle colloidal suspension. Photo-anodes were prepared by the Doctor Blade technique, starting from P25 TiO_2 Digussa powder by mixing with Ag NP colloidal suspension. The effect of Ag NPs on the DSSC were investigated using IPCE spectroscopy, UV-VIS

spectroscopy, J-V characteristic, EIS analysis and Dark I-V measurements. It was found that the energy conversion efficiency of the DSSC was strongly dependent on the amount of Ag NPs incorporated in the TiO_2 matrix. The best conversion efficiency of the DSSC without NPs as 5.00 %, and with Ag NPs as 6.12%. This 22% enhancement in the efficiency is essentially due to the increase of the short circuit photo current density of DSSCs owing to the Plasmon effect of the metal nanoparticles.

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7.1.2.3 Novel Polymer free, Quasi Solid State Electrolyte for Dye Sensitized Solar Cells based on Fumed Silica

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Solar energy is widely accepted as a green energy source with negligible environment impact. 90% of the solar cell devices presently used world wide belongs to the first generation silicon based solar cells. Dye sensitized solar cells are outstandingly cost effective compared to silicon solar cells and emerging as a viable alternative to silicon cells. Dye sensitized solar cells are primarily composed of a nanaocrystalline titanium dioxide (TiO_2) layer, a dye which acts as a photosensitizer, an electrolyte with a redox couple and a counter electrode. Initially photo excitation occurs on the dye and an electronis injected into the conduction band of the semiconducting TiO_2 layer. Oxidized photosensitizing dye regenerated by the electrons is transferred from the external circuit to the counter electrode via the redox mechanism of the electrolyte. In this study we have fabricated a "polymer free" quasi solid state (or gel), electrolyte composed of ethylene carbonate (EC) and propylene carbonate (PC) as plasticizers, fumed silica, an iodide salt mixture and Iodine. A binary iodide salt system consisting of tetrapropyl ammonium iodide (Pr_4NI) and potassium iodide (KI) was used instead of a single iodide salt. Fumed silica was used as the gelling agent to obtain a polymer-free gel electrolyte. A short circuit photocurrent density of 12.8 mA cm^{-2}, an open circuit voltage of 686.9 mV, a fill factor of 60.1% and an overall efficiency of 5.29 % were observed under simulated sunlight of 100mW cm^{-2} for the solar cell. This suggests the possibility of using "polymer-free" gel electrolytes instead of electrolyte solutions or polymer based gel electrolytes in DSSCs.

7.1.2.4 SnO_2 as a Cathode Material for Solid State Magnesium batteries with Polyethylene Oxidebased Gel Polymer Electrolyte

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Conventional energy sources such as fossil fuels is limited to meet the ever increasing energy consumption of the world. Therefore, finding alternative, environmental friendly, renewable energy sources and energy storage devices has become an important area of research. In the energy storage scenario, rechargeable batteries, especially those based on lithium, appears to be one of the best solutions for this problem. Due to the heavy demand for rechargeable batteries, and the limited availability of lithium, the cost of lithium batteries are expected to escalate in the coming years. Magnesium is positioned next to lithium in the electrochemical series and therefore, its electrochemical characteristics are comparable with neighboring lithium. In view of the natural abundance of magnesium, its low cost, low molecular weight and safety, Mg rechargeable battery systems are considered to be one of the most suitable replacements for expensive Li systems.

In this study we have explored the possibilities of using SnO_2 as the cathode material in rechargeable magnesium batteries fabricated with Mg^{++} ion conducting, quasi solid (gel) polymeric electrolyte based on polyethylene oxide (PEO) as the host matrix. Electrolyte was characterized by AC impedance spectroscopy, cyclic voltammetry (CV) and DC polarization method. Ionic conductivity of the electrolyte was 2.52×10^{-3} S/cm at room temperature for the composition of PEO (12.20 wt%), $Mg(CF_3SO_3)_2$ (14.6 wt%), EC (36.6 wt%), PC (36.6 wt%). The estimated value of Mg^{2+} ion transference number and total ionic transference number were found to be 0.20 and 0.98, respectively. Fabricated batteries with cell configuration $Mg/PEO:EC:PC:Mg(CF_3SO_3)_2/SnO_2$ exhibited a discharge capacity of 220 mAh/g and 1.90 V open circuit voltage. The charge/discharge characteristics were found to be satisfactory for laboratory cells.

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7.1.2.5 Optical properties of Indium substituted CdS Thin Films prepared by Chemical bath deposition

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Optimizing the growth process of CdS thinfilms is important to enhance the efficiency of CdS/CdTe solar cells.CdS thin films with a direct band gap of 2.42 eV are generally used as the window material in CdS/CdTe solar cells. For window material, low resistivity and high optical transmittance is highly desirable for high efficiency solar cells. However, undoped CdS thin films generally show high electrical resistivity and low optical transmittance. It is difficult to prepare undoped CdS thin films with both low resistivity and high transmittance purely by controlling preparation conditions. In this work, In was substituted in CdS to obtain thin films with low resistivity and high optical transmittance. Transparent, homogenous In substituted $Cd_{1-x}In_xS$ thin films with x = 0, 0.05, 0.1, 0.2, and 0.3 were deposited by chemical bath deposition (CBD) technique on microscopic glass substrates using a chemical bath containing cadmium chloride, indium chloride, ammonium chloride, ammonium hydroxide and thiourea. The optical absorbance and transmittance were measured by using a UVVIS- 2450 (SHIMADZU) spectrophotometer in the wave length range from 190 nm to 1100 nm. Optical transmittances of In substituted samples were higher than CdS thin films. From optical measurements, it was observed that the optical energy band gap values of $Cd_{1-x}In_xS$ thin films increased with increasing concentration of In up to $Cd_{0.8}In_{0.2}S$ and then decreased with further increase of In concentration. The increase in optical energy band gap in the In substituted material may be due to the increase in the carrier concentration with doping and the decrease in energy band gap may be due to replacement of larger number of cadmium ions in the cubic structure by In ions. The higher optical energy band gap and higher optical transmittance are advantageous features of $Cd_{0.8}In_{0.2}S$ thin films to be used as a window layer in CdS/CdTe solar cells.

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7.1.2.6 A highly efficient Dye-Sensitized Solar Cell with a Pan-Based Gel Polymer Electrolyte containing triple Iodides

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Polyacrylonitrile (PAN) based gel polymer electrolytes (GPEs) containing three iodide salts, namely tetrapropyl ammonium iodide (Pr_4NI), 1-butyl-3-methylimidazolium iodide (BMII) ionic liquid and lithium iodide (LiI), and iodine have been used to improve the performance of quasi-solid-state dye sensitized solar cells (DSSCs). First the GPEs containing only Pr_4NI were optimized for conductivity

and then they were further optimized by adding various amounts of LiI and BMII. While theoptimized Pr_4NI+LiI electrolyte showed a conductivity of 2.91 mS cm^{-1} at room temperature, the optimized electrolyte with BMII had a higher conductivity of 4.38 mS cm^{-1}. The high conducting GPE had the composition: PAN (0.3 g), EC (1.245 g), PC (1.155 g), Pr_4NI (0.1329 g), BMII (0.03764 g), LiI (0.1329 g) and I_2 (0.039 g).

The optimized GPEs without and with BMII were first tested in N3 dye based DSSCs having only porous TiO_2 layers prepared with P25 particles. While the GPE without BMII produced an efficiency of 5.00 %, the electrolyte with BMII increased the efficiency to 5.83 %. In order to improve the efficiency further a TiO_2 compact layer made with smaller P90 particles was introduced to the photoelectrode. The compact layer improved the efficiency only by 3.2 % when the GPE did not have the BMII but increased the efficiency to 6.18 % (corresponds to an enhancement of 11.7 %) when BMII was present in the electrolyte, illustrating the necessity of the compact layer when ionic liquids are used in the electrolyte to get better performance. When 0.5 M 4-tert-Butylpyridine (TBP) dissolved in propylene carbonate was added to the GPE with BMII, the efficiency reached the highest value of 7.2 % with J_{sc} = 16. 77 mA cm^{-2}, V_{oc}= 0.66 V and FF = 0.65. This is the best efficiency reported so far for a DSSC with PAN based gel electrolyte.

7.1.2.7 Extending the spectral response of CdTe solar cell using Titanium dioxide (TiO_2) as a window layer

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Cadmium telluride (CdTe) thin film solar cell has been recognized as a leading photovoltaic candidate dueto its high efficiency. The use of CdTe as an absorber material is commercially cheap in terms of fabrication, processing and stability. Cadmium sulfide (CdS) thin film is the most commonly used window material for CdTe thin-film solar cells. However, spectral response of CdS/CdTe has been limited due to strong optical absorption of CdS window layer due to its low band gap (2.4 eV). Replacement of window layer by a suitable material with high bandgap may lead to improve the performance of CdTe solar cell. This work focuses on use of a wide bandgap (~ 3.2 eV) Titanium dioxide (TiO_2) as an electron transporting window material instead of low bandgap CdS layer. Measurement of internal quantum efficiency and optical absorbance shows that TiO_2 broadens the external quantum efficiency spectra of the CdTe solar cells due to transparent nature of the wide bandgap of TiO_2. However, the fill factor of the device with TiO_2 is lower than the device with CdS. Studies are in progress to optimize fabrication condition of TiO_2 layer for CdTe solar cells.

7.1.3 Mapping Geothermal Sources in Sri Lanka

7.1.3.1 Feasibility of Finding Geothermal Sources in Sri Lanka with Reference to the Hot Spring Series and the Dolerite Dykes

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Sri Lanka is situated away from active plate boundaris.Potential geothermal resources in Sri Lanka are indicated mainly around the Highland-Vijayan (H/V) boundary, by hot spring series. Although it was suggested thatH/V boundary as the potential source of hot spring, recent research conducted in the hot spring series indicated no clearly visible heat source. Magneto-telluric (MT) and other geophysical methods are utilized to study the geothermal resources and to investigate any possible relationship with the H/V boundary as well as the dolerite dykesbeneath the hot springs. However, dolerite dykes were observedat close proximity to the hot springs at almost all the hot spring locations. This study is mainly focused on finding the possibility of an existence of a relationship between the hot springs and the dolerite dykes and thereby investigating the dyke as a source of heat and a potential source for geothermal power generation. The magnetic surveys, resistivity surveys and the geological mapping were conducted in the study sites related to the hot springs and the dolerite dykes. The results implied that there could be some relationship between the hot springs and the dykes. Most of the times a dyke could be seen and they have been interconnected by deep fractures. This study gives a better idea about the relatedinterconnecting paths of channeling hot springs. MT results clearly imply that it is not possible to find the geothermal source exactly beneath the hot spring. Most of the time the hot water comes through the fractures connected to the deep driven fractureswhich are connected to a dolerite dyke. In some cases the root of the hot spring directly links to the dolerite dyke. It is possible that dolerite dykes play a huge role in geothermal potential in Sri Lanka.

7.1.4 Nanotechnology and Physics of Materials

7.1.4.1 Investigation of Sri Lankan natural vein graphite for nano-technological applications

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The global demand for graphite is rapidly growing mainly due to novel nano-technological and hightech industrial applications, such as preparation of extended graphite (EG), graphene oxide (GO), carbon nano-tubes (CNTs), carbon nano-composites (CNCs), ..etc. Sri Lanka is the only commercial producer of highly crystalline natural vein graphite, however, our natural graphite has to be highly developed and modified to be suitable for those specific advanced applications. Worldwide researchers are attempting to convert graphite into GO, which is the base material for a number of important nano-technological entities including CNT and CNC. Similarly, expanding the interlayer distance by structurally modifying graphite to prepare extended graphite (EG) is also getting higher priority, aiming to intercalate larger ions like Na and Mg into graphite for their upcoming rechargeable batteries. Extending this effort to Sri Lankan natural vain graphite will be an important step in higher value addition to our mineral resources. Therefore, this study was based on the synthesis of EG and GO out of Sri Lankan natural vein graphite. Under that, the effect of the four different structural varieties of Sri Lankan natural vein graphite on the conversion to EG and GO was also investigated. Improved Hummer's method was employed to produce EG from highly purified natural graphite. For that, sulphuric and phosphoric acids were used for the acid treatment together with potassium permanganate as the oxidizing agent. Conversion of EG to GO was carried out using hydrazine mono-hydrate as the reducing agent. Fourier Transformed Infrared Spectroscopy confirmed the successful formation of the intended EG and GO. The X-ray diffraction phase analysis further confirmed the formation and the successful expansion of the interlayer distance of graphite from around 0.3 nm up to about 0.9 nm when converted to EG. Among the four different structural verities of natural vein graphite, the shiny slippery fibrous graphite showed the highest GO yield.

7.1.4.2 Investigation of transition metal oxides electrode materials for Na-ion rechargeable batteries

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Compounds that contain multivalent ions have the potential for electronic conductivity due to intrinsic nonstoichiometry or by further enhancement of conductivity through doping. From the viewpoint of cost and efficiency, semi-conductive transition metal oxides are the best practical electrode materials for rechargeable batteries. At present, there is a huge demand for viable electrode materials for Na-ion rechargeable batteries, which has attracted attention over expensive Li-ion rechargeable batteries. Sodium transition metal layered oxides such as $NaMO_2$ (M = metal additive) are regarded as potential candidates for the Na-ion battery cathode electrode. These additives are expected to enhance the electrochemical performance and the stability of the cathode. The anode electrode is another troublesome component of Na-ion battery since graphitic carbons are inapplicable. However, layered $NaTiMO_2$ compounds have recently been identified as potential anode materials and it requires further investigations. Therefore, this work was carried out to develop sodium transition

metal oxide based cathode and anode electrode materials for rechargeable Na-ion batteries. For that, $Na_xM_{1x}O$ and $NaTiMO_2$ (where M = Mn, Co, Fe, Al, Cu, Mg, …) were synthesised for the cathode and anode, respectively. Advanced but low-cost techniques such as hydrothermal synthesis, solid state sintering and wet-chemical synthesis, which results nano particles, were employed for material synthesis. The phase analysis conducted by the X-ray diffraction confirmed the formation of appropriate sodium transition metal oxide phases in the synthesized materials. The D.C. four-probe electrical conductivity study indicated the semi-conducting nature of the prepared materials with sufficient electrical conductivity for the intended electrode applications. Among them, the $Na_{0.75}Co_{0.25}O$ material showed the highest room temperature electrical conductivity of about 1 S/cm. Electrode fabrication of the selected cathode and anode materials was done by the standard doctor blade method and test cells were assembled with sodium metal foils and $NaPF_6$ as the electrolyte. The cycle life cell testing of the assembled Na-ion rechargeable cells are now being carried out.

7.1.4.3 Development of Sri Lankan natural vein graphite for the rechargeable Li-ion battery anode

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Vein type graphite deposits in Sri Lanka are considered as a unique occurrence because of high purity, extensive mineralization and restricted occurrence. These vein graphite deposits are categorized into four structurally distinct varieties namely, shiny-slippery-fibrous graphite (SSF), coarse striated-flaky graphite (CSF), coarse flakes of radial graphite (CFR) and needle-platy graphite (NPG). Graphite with 95-99% of carbon is found in each structural type depending on the mode of occurrences and nature of graphite vein. Meanwhile, our preliminary investigations indicated Sri Lanka vein graphite as potential candidates for the anode of rechargeable Lithium-ion batteries (LIB). However, before employing in LIB anode application, our graphite should be highly upgraded to the battery grade by purifying over 99.9% carbon content and surface modification. Therefore this study was performed by addressing the concerns of purity enhancement and surface modification of Sri Lankan natural vein graphite for LIB anode application. Under that, the effect of the four different structural varieties on upgrading and the performance of LIB anode were also examined. For purification, low-cost chemical processes such as leaching with HCl, roasting with NaOH and digestion with a mixture of HF, HNO_3 and H_2SO_4 were investigated. This purification was followed by surface modification through the processes of thermal oxidation and alkali coating. Overall, the acid digestion method was more effective and graphite with initial purity of 95-98 % could be upgraded to 99.99 % purity while modifying the surface simultaneously. Further, a strong dependence of purity enhancement and surface modification on the structural type of natural graphite could be observed. The selected graphite samples were fabricated into electrodes and assembled into CR2032 coin cells with lithium metal foil electrodes and 1M $LiPF_6$ electrolyte. The electrochemical performance of the developed NPG graphite electrode showed an initial charge-discharge coulombic efficiency of 87 % and discharge capacity of 327 $mAhg^{-1}$ indicating the possibility of using Sri Lankan natural vein graphite for LIB anode.

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7.1.4.4 Performance of Li-ion rechargeable batteries assembled with electrodes developed at NIFS

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With the rapid growth of electrical vehicles and portable electrical items, the upcoming demand for portable energy sources cannot be met with conventional batteries. This is presently addressed up to some extent with the introduction of rechargeable Li-ion batteries (LIB). However, the presently used very expensive electrode materials of $LiCoO_2$ and synthetic graphite obstruct the reach of LIB to the common mass as a cheaper and reliable portable power source. This abstract presents a performance investigation study of a rechargeable lithium ion battery assembled with the anode fabricated from developed Sri Lanka natural vein graphite and the cathode fabricated with locally synthesized lowcost $Li(Ni_{1/3}Co_{1/3}Mn_{1/3})O_2$ transition metal oxide at the NIFS. For the anode of LIB, Sri Lankan natural vein graphite was purified with a cost effective acid leaching process developed at NIFS. Xray diffraction, scanning electron microscopy and carbon content analysis showed the effectiveness of the developed acid leaching purification process to remove sulphide and carbonate impurities at very low acid concentrations at low temperatures. Further, the purified graphite shows sufficient electrical conductivity for the anode application. The $Li(Ni_{1/3}Co_{1/3}Mn_{1/3})O_2$ cathode material was synthesized by the low-cost wet-chemical glycine nitrate process. The material characterization revealed the formation of quasi-spherical, sub-micron size secondary particles formed by nano-scale primary particles with appropriate layered phase of R3m structure. Electrodes were fabricated by tape casting the developed materials onto current collectors by doctor blade method. Then, the electrodes were assembled into lithium ion coin cells in an argon-filled glove-box with a porous polypropylene separator in an non-aqueous electrolyte, 1M $LiPF_6$ in ethylene carbonate/diethyl carbonate/dimethyl carbonate mixture. The cell performance were very promising with 128.8 $mAhg^{-1}$and 98.8 $mAhg^{-1}$ of first cycle charge and discharge capacity, respectively. The coulombic efficiency was 76.6 %. at C/5 rate between 3 and 4.2 V with 94 % capacity retention after the 10th cycle.

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7.1.4.5 Low-cost household water purifier developed at NIFS with locally available materials

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Presently, our country is facing tough challenges in providing clean and safe drinking water, specially in the North Central region. It is believed that a main reason behind the CKDU reported in that area is the inferior quality of the drinking water with high hardness. To provide safe drinking water to those in need, point-of-use household water treatment, such as household column water filters, has emerged as a complementary solution to centralized water supply systems. Sri Lanka is well known for possessing a variety of cheaper minerals and related materials already identified for water purification. However, for very effective water purification, the related properties of these materials should be enhanced through morphological changes or material treatments. In addressing this

concern, this project focused on two areas of research and developments, initially developing identified locally available minerals and related materials for water purification using modern materials processing techniques. It was then followed by designing and construction of a low-cost column filter with the developed materials to improve the quality of drinking water for household use. Locally available minerals and related materials, which were reported in the literature as potential candidates for water purification (such as kaolinite, bentonite, garnet, quarts, clay bricks, wood charcoal, activated carbon, cattle bone ash … etc.) were initially upgraded through purification. The purified materials were then formed into porous but strong structures by subjecting to advanced materials fabrication techniques, such as pelletizing, extrusion, compositing, thermal treatment.. etc, mainly to enhance effective surface area hence for better purification, filtration and the durability. The fabricated materials were then examined individually for their effectiveness on water purification. It was done by passing water samples of predetermined ion concentrations through the layers of fabricated materials and analysing the filtration by the Atomic Absorption Spectroscopy. Finally a working model of the column filter was designed and constructed with suitable low-cost materials.

7.1.4.6 Development of transition metal oxide cathode materials for Li-ion rechargeable batteries

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NMC compositions such as $Li[Ni_{1/3}Mn_{1/3}Co_{1/3}]O_2$ are presently being commercialized as cathode materials for rechargeable Li-ion batteries (LIB). However, with very expensive cobalt content in the cathode, batteries having NMC compounds are limited to consumer electronics and still too costly for vehicular applications. Hence it is worthwhile to investigate $Li[Ni_{1/3}Mn_{1/3}Co_{1/3}]O_2$ based system, by fully or partially substituting expensive Co with other cheaper elements to reduce the material cost of LIB cathode but without compromising the performance. Accordingly, this work is based on development of $Li(Ni_{1/3}Mn_{1/3}Co_{(1/3-x)}M_x)O_2$, M = Na, Mg, Ba, Al, Fe, Cu, Zn and x = 0 - 0.33, for the LIB cathode. Material synthesis was done by the low-cost wet chemical synthesis of Pechini method and Glycine Nitrate Combustion technique, which results in appropriate sub-micron and nano-scale particles. X-ray diffractometry, scanning electron microscopy and thermo gravimetric analysis were used for the materials characterization. Sintered dense solid pellets were used for electrical characterization by d.c. four probe technique. Composite $Li(Ni_{1/3}Mn_{1/3}Co_{1/3-x}M_x)O_2$ electrodes were fabricated via tape casting employing the doctor-blade technique. The electrochemical properties were examined with CR2032 coin cells using lithium metal foil as the counter and reference electrode with 1M $LiPF_6$ electrolyte. The cells were charged and discharged in a voltage range of 2.5 - 4.6 V. The phase analysis revealed the formation of solid solutions of appropriate layered $Li(Ni_{1/3}Co_{1/3}Mn_{1/3})O_2$ phase of R3m structure in the prepared compositions over x = 0.11, except with Ba and Mg. The synthesized powders were quasi-spherical, sub micron size secondary particles formed by aggregating nano-scale primary particles. Further, most of these compositions showed higher electrical conductivity than the base material (where it was 8.0×10^{-7} S/cm). In cell studies, the Na substituted materials with x = 0.04, showed a promising high discharge capacity of 175 $mAhg^{-1}$. Hence this study revealed the possibility of preparing cheaper $Li(Ni_{1/3}Mn_{1/3}Co_{(1/3-x)}M_x)O_2$ cathode materials suitable for the LIB.

7.1.5 Photochemistry

7.1.5.1 Fabrication of Underwater Superoleophobhic Stainless Steel mesh for Oil/Water Separation

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Oil- water separation is recently become a major water treatment challenge in industrial pollution in water systems. Underwater superoleophobic interfacial materials, including metal oxides, hydrogels, conducting polymers, colloidal crystals and nanocomposites have been developed for oil/water separation applications. Underwater superoleophobic materials can separate oil and water due to the repellency of the oils from the material and the attraction of water towards to the material. In this study, an underwater superoleophobic stainless steel mesh is prepared through layer by layer coatings of modified TiO_2 nanoparticles and a hydrogel polymer. The wettability of the prepared layer by layer TiO_2/ hydrogel coated mesh is characterized and evaluated through the contact angles given by the Youngs equation. The TiO_2/ hydrogel coated mesh exhibits extremely high underwater oil static contact angle over 150° and extremely low oil static contact angle around 0°-5° in air. As well as, the mesh shows very low adhesion force towards to the oils under water. Extremely high oil/water separation efficiency (> 98%) can be obtained in the filtration process due to the strength of the multilayered TiO_2/ hydrogel nanocomposite coating. The TiO_2/hydrogel coated mesh can be introduced as a promising technique of the physical reactors in oily polluted wastewater treatment plants.

7.1.5.2 PbS/CdS based panchromatic sensitized quantum dot solar cells

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Quantum dot sensitized solar cell is an interesting energy device due to their characteristic features like easily tunable band gap, high extinction coefficient, large intrinsic dipole movement and cheap production cost. In the quantum dot sensitized solar cells, quantum dots act as light absorbing materials. Theoretical values of efficiency of quantum dot sensitized solar cells are higher than the dye sensitized solar cell. However, the efficiency of quantum dot sensitized solar cells are well below the efficiency of dye sensitized solar cells due to their narrow absorption range and recombination of quantum dot-electrolyte interface. In this study PbS/ CdS quantum dot solar cells were fabricated by anchored PbS/ CdS quantum dots with TiO_2 mesoporous photoanode by successive ionic layer adsorption and reaction (SILAR) method and achieved 5.7 % efficiency with polysulfide electrolyte which is exceed the reported values of efficiency of solar cells fabricated with same sensitizer.

7.1.5.3 Hydrothermally synthesized TiO_2 nanotubes for 1-D based DSSC devises

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As a promising energy harvesting device, research on Dye Sensitized Solar Cells have been great attractions. The devises mainly sandwiched with two electrodes of working and counter. In DSSCs working electrode is the major part and it is made with semiconductor nanoparticle layer on transparent conductive substrate. This is sensitized with light adsorbing dye which is adsorbed visible part of radiation from sunlight and get exited loosely bounded electrons of dye molecules and the electrons are injected to conduction band of the semiconductor and subsequently pass to external circuit through the conductive substrate. Whereas, oxidized dye molecules are regenerated through the redox mediator which is introduced in between two electrodes. To address the drawback of recombination of injected electrons, one dimensional (1-D) semiconductor material such as nanotube, nanofiber, nano rods have been investigated. Up to now the highest efficiency of 6.72 and 7.6 have been achieved for pristine and $TiCl_4$ treated TiO_2 nanotube films. In our investigation, fluorine doped titania nanotubes were synthesized and using asprepared material DSSCs was fabricated without any post treatment and 7.1 efficiency with 14.26 mA cm^{-2}, 734.6 mV, and 68.2 % of short circuit current density (J_{sc}) Open circuit voltage (V_{oc}), and fill factor respectively were obtained under incident light intensity 100 W cm^{-2} with 1.5 AM filter. The dye used to sensitize was 3 mM of N719 and the electrolyte used was I_3^-/I^- based redox couple. External Quantum efficiency of 55% was observed for the solar cell.

7.1.6 Thermoelectricity

7.1.6.1 Thermoelectric Properties of Industrial Grade Low Cost Materials

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The thermoelectric effect or *Seebeck effect* provides a means by which thermal energy can be converted into electricity.It occurs when a voltage appears between two different types of materials (Conductor or Semiconductor) that are joined together and its junction is heated. While most efficient materials are Semiconductors these are expensive, thus, research into thermoelectric properties of industrial grade materials is very useful for fabrication of low cost devices. Two major objectives of the project are to **s**tudy the thermoelectric properties of materials and their behaviour due to changes in design and physical parameters, and to study the output and efficiency of TEG modules produced with low cost materials as well as cheap industrial grade metals.Three industrial grade materials (Iron, Brass, Aluminium metal sheets) were used in different combinations and tested for relative output and efficiency. Experiments were conducted using the modules made with aluminium-iron, brass-iron and aluminium-brass combinations. Temperature differences were maintained at different values up to 100 k. The highest voltage output and the highest *Figure of Merit* were achieved by the brass-iron combination, while the lowest values came from the aluminium-brass combination. However, above 60 k temperature difference, the highest current output was produced by the aluminium-brass combination.

7.2. CHEMICAL AND LIFE SCIENCES

7.2.1 Cell Biology

7.2.1.1 A case study of a co-infection with a *Mycobacterium chelonae- Mycobacterium abscessus* group (MCAG) and RIF and INH resistant *Mycobacterium tuberculosis* (MTB) strains presenting with untreatable pulmonary infection

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Mycobacteria have a spectrum of virulence and different susceptibilities to antibiotics. As conventional techniques consume time, currently DNA amplification has allowed great progress in the rapid and accurate diagnosis of infections. The objective of this study was to identify the causative organisms of a patient who was suffering with an untreatable pulmonary infection. In June 2014, a male estate worker from Nuwara Eliya district was referred to Welisara Chest Hospital, his sputum sample was sent to The National Institute of Fundamental Studies, Kandy for further investigations. The sputum was subjected to 4% NaOH treatment and was concentrated by centrifugation and cultured on Lowenstein Jensen (LJ) media containing P-nitrobenzoic acid (PNB), thiophen-2carboxylic acid hydrazide (TCH) and a control LJ tube and was incubated under light and dark conditions at 28^0C and 37^0C. When the growth was detected, Acid Fast Stain was carried out to confirm the presence of Acid Fast Bacteria (AFB). The AFB positive isolates were subjected to DNA extraction using the standard N-Cetyl-N,N,N-trimethyl ammonium bromide (CTAB) method. Conventional Polymerase Chain Reaction (PCR) was carried with two sets of primers Pt8 /Pt9 and INS1/INS2 to confirm the presence of *Mycobacterium tuberculosis* complex (MTC). SYBR Green mediated Multiplex real time PCR (RT-PCR) was performed using primers specific for MTC, *M. chelonae-M.abscessus* group (MCAG) and for the genus AFB. Drug sensitivity tests (DST) for isoniazid (INH) and rifampin (RIF) were carried on 7H11 medium, using the 1% agar proportion method. The RT-PCR confirmed the presence of bacteria belonging to AFB, non-tuberculosis *mycobacteria* (NTM) belonging to MCAG and *mycobacteria* belonging to MTC. The conventional PCR also confirmed the presence of MTC. DSTconfirmed the MTC isolate was resistant to both INH and RIF. In conclusion, the patient was found to be co-infected with a multidrug resistant (MDR) strain of MTC and a strain of NTM belonging to MCAG.

7.2.1.2 MIRU-VNTR typing system and spoligotyping for molecular epidemiological studies of tuberculosis in three distinct population groups

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The worldwide threat of tuberculosis to human health emphasizes the need to develop novel approaches to global epidemiological surveillance. The objective of this study was to characterize *Mycobacterium tuberculosis* (MTB) isolates by spoligotyping and Mycobacterial Interspersed Repetitive Unit-Variable Number Tandem Repeat (MIRU-VNTR) typing to understand how MTB

strains transmit among the population. A total of 150 sputum specimens were obtained from the general population suspected of having TB attending the Chest Clinic, Kandy (n=78), patients having TB in Bogambara prison, Kandy (n=22) and estate workers having TB (n=50). The extracted genomic DNA was subjected to MIRU-VNTR and spoligotyping and a total of nineteen distinct families were observed including East-African-Indian (EAI-55.7%), Haarlem (20%), Beijing (8.6%), Central European family T (6.5%), European Family X (5.2%) and Central and Middle-Eastern-Asian (CAS0.6%). A few sub-lineages of MANU, EAI3-IND, EAI6-BGD1 and *M. tuberculosis* S were also identified. The predominant group among the isolates of MTB corresponded to EAI which was also the pre-dominant strain among the general population (46%). It was previously described as a major world-wide epidemic strain which belonged to the predominant ancestral genotypic lineage in India. Beijing strain was only identified among the general population (n=12; 15.38%). MANU1 and MANU2 strains were significant (36.36%) among the prisoners who had clustered with the MANU strains of the general population indicating contact cases and a possible transmission index within a particular geographical area. Haarlem3 (34%) was the pre-dominant strain among the estate workers. There was a close epidemiological relationship between the prisoners and the estate workers in the population studied. This is the first study in Sri Lanka in which MIRU-VNTR pattern of MTB strains in conjunction with spoligotyping in a population has been examined. The use of 15 loci MIRUVNTR typing combined with spoligotyping is feasible for a country with a moderate TB incidence such as Sri Lanka.

7.2.1.3 Cyanobacteria and cyanotoxins in well waters in the dry zone, Sri Lanka

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Cyanobacteria are a diverse group of aquatic photosynthetic prokaryotes, which produce potent toxins such as microcystins (MCs), cylindrospermopsins (CYNs) and nodularins (NODs). Concern about cyanobacterial blooms in dry zone water sources of Sri Lanka has grown due to numerous negative health impacts. Further, an epidemic of Chronic Kidney Disease of unknown etiology (CKDu) prevailing in the dry zone and other health impairments associated with water have increased the concern of cyanobacteria in water bodies. The study examined water samples from wells of CKDu and CKD patients in Girandurukotte and control samples from other parts of Sri Lanka. The water samples were analyzed for cyanobacteria and their toxins. MC and CYN producing cyanobacteria were morphologically identified from most samples. Except ten, well water samples of 64 CKDu patients had cyanobacterial growth. Among them, 13 genera were potential MC producers while *Anabaena, Raphidiopsis and Lyngbya* species were potential CYN producers. In 11 water samples of CKD patients, seven genera were potential MC producers while in two samples *Anabaena* and *Lyngbya* species were potential CYN producers. In comparison to Girandurukotte patients, cyanobacterial diversity was found to be less in well waters of healthy individuals. Of 25 water samples from healthy, one did not have any cyanobacterial growth. Of the rest, seven genera were potential MC producers while *Lyngbya* spp. was the only potential CYN producer in one sample. Among toxin producers, *Phormidium* spp. in CKDu patients' well waters were found to be significant (P=0.004) compared to other two populations. Presence of cyanobacteria and potential toxin producing cyanobacteria were confirmed by molecular analysis with gene specific DNA amplifications. From molecular analysis, presence of CYN producers and NOD producing *Nodularia* species in well waters of CKDu patients were significant ($p < 0.05$). Therefore, the presences of MC, CYN and NOD in well waters, under study, have the potential to cause health impairments.

7.2.1.4 Gene expression analysis to identify biomarkers of chronic kidney disease in the dry zone of Sri Lanka

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Many hypotheses have been postulated for the etiology of the chronic kidney disease found among farming communities in the dry zones of Sri Lanka; however, none have yet been confirmed. Identifying particular biomarkers for the disease would not only help in finding the cause of the disease but also aid in developing a treatment protocol specific for the disease. This project studied the expression of a selected panel of genes related to drug metabolism (CYP2D6, CYP2C19), diabetes and cardiovascular disease (KLK1, IGFBP1, IGFBP3), oxidative stress (GSTM1, GCLC, G6PD), and kidney damage (FN1, KIM1) in chronic kidney disease patients to investigate their potential as biomarkers for the disease. Blood samples were collected from chronic kidney disease patients attending the renal clinic of the District Hospital, Girandurukotte. Ten patients with chronic kidney disease of unknown etiology (CKDu), four chronic kidney disease patients diagnosed with diabetes and/or hypertension (CKD), and three healthy individuals were taken for the study. RNA was extracted from whole blood and reverse transcription quantitative PCR (RT-qPCR) was carried out using hydrolysis probes for fluorescent detection. Fold changes were calculated using the "Delta Delta CT" method relative to healthy individuals, with B2M and GAPDH used as reference genes. Statistically significant fold changes were seen in GCLC (glutamate-cysteine ligase catalytic subunit; 0.35; $p<0.05$), FN1 (fibronectin; 2.57; $p<0.05$) and KIM1 (kidney injury molecule; 0.37; $p<0.1$), of which the differential expression of GCLC is common to both CKD as well as CKDu, suggesting oxidative stress susceptibility in these patients. Both FN1 and KIM1 have potential as screening biomarkers for CKDu, whereas the regulation of KIM1 should be further studied to understand the pathology of the disease. Results of the study however need to be further validated with a statistically significant study population.

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7.2.2 Nutritional Biochemistry Project

7.2.2.1 Investigatini the effect of processed mung bean (*Vignaradiata* L.) powder incorporated experimental diets on serum lipid and glucose concentrations in Wistar rats (*Rattusnorvegicus*)

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High serum cholesterol level is a major risk factor for cardio vascular disease (CVD). CVD is the most important single cause of non-communicable disease in the world. Legume plays an important role in modulating the serum lipid and serum glucose level. The purpose of this study was to determine *in vivo* hypocholesterolemic and hypoglyca emic effect of raw and processed mung bean powder (Variety MI 6) incorporated high cholesterol diet with the comparison of the control diet in rats. Seven weeks old 20 male Wistar rats were randomly allocated into groups (n=5) and fed with experimental diets *ad-libitum* for 5 weeks. Diets were prepared according to the ANI-93G semi purified rodents diet and 5% cholesterol was added to obtain high cholesterol diet. 5% cholesterol + 30% raw mung bean (RMD), 5% cholesterol + 30% boiled mung bean (BMD), 5% cholesterol + 30% sprouted mung bean (SMD) and 5% cholesterol + 10.15% casein powder (CD) were given as treatments. Blood was collected from rats at the beginning and at the end of the experiment and serum total cholesterol (TC), Low density lipoprotein (LDL) cholesterol, High density lipoprotein (HDL) cholesterol, triglycerides, glucose and insulin concentration were measured. At the end of the experiment rats were sacrificed and liver and cecal weight, kidney fat index, cecal pH were measured. *Coliform* count in cecal content was enumerated. Serum LDL cholesterol concentration in rats fed with SMD and BMD diets were significantly ($P<0.05$) lower than that in the CD fed group. *Coliform* count was significantly ($P<0.05$) higher in CD than mung bean incorporated diets. Serum glucose and insulin concentration in rats fed RMD and BMD were significantly ($P<0.05$) lower than CD diet. These results indicate that boiled mung bean incorporated diets modulate both serum lipids and glucose while sprouted mung bean incorporated diets modulate only serum lipids in rats.

Key words: cholesterol, hypoglycaemic effect, hypocholesterolemic effect, mung bean, Wistar rat

7.2.2.2 Dietary Supplementation of Dried *Spirulinaplatensis* on Growth Performances and Meat Quality of Broiler Chicken

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Sri Lanka has a rising demand for broiler chicken products compared to other animal products. However, the cost of broiler production is comparatively high in Sri Lanka. Although Spirulina platensis is one of the cost effective feed resource with high nutritive value which can potentially be utilized in broiler feed industry, the effect of supplementing dried Spirulina on growth and meat quality parameters in broiler chicken has not been adequately evaluated. Therefore, the present study was undertaken to determine the effects of supplementing dried Spirulina on growth performances and meat quality of broiler chicken. Sixty male Cobb 500 day old chicks were randomly allotted into

3 treatment groups as control (commercial broiler feed), 4% *Sprulina* + commercial broiler feed and 8% *Spirulina* + commercial broiler feed. Each treatment group consisted of 4 replicates with 5 birds per replicate. Feed intake was measured daily, while body weight of each bird was measured weekly. At 35th day, blood was collected and birds were sacrificed. Then the weights of carcass and giblet, weights and lengths of parts of the digestive tract were measured. Ileal content was collected from 12 birds, one from each replicate. Meat quality parameters were analyzed by using the breast muscle stored under refrigerated conditions (4 °C). Both 4% and 8% *Spirulina* supplemented groups obtained, significantly (P<0.05) higher live weights, weight gains, water holding capacity, crude protein %, yellowness in meat and significantly (P<0.05) lower FCR than control group. Four percent *Spirulina* supplemented group obtained, significantly (P<0.05) lower cooking loss, total serum cholesterol and significantly (P<0.05) higher ileal crude protein digestibility than control group. Eight percent *Spirulina* supplemented group obtained significantly (P<0.05) lower crude fat % in meat than control group. In conclusion, supplementation of *Spirulina* (mainly at 4%) showed advantageous in relation to growth and meat quality parameters.

Key words; *Spirulina platensis*, broiler chicken, growth performances, meat quality

7.2.2.3 Determination of Bioactive and Nutritional Properties of Aerial Parts of *Trichosanthes cucumerina* Linn

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Snake gourd (*Trichosanthes cucumerina* Linn.) is one of the medicinal plants grown in tropical Asia. Aerial parts of Snake gourd are often used in Sri Lankan traditional systems of medicine for the preparation of formulations to treat a variety of disease conditions while they are in the use as vegetables. In this study, aerial parts of *Trichosanthes cucumerina* (TA-2 variety) were evaluatedfor total phenolic content, flavonoid content, antioxidant and free radical scavenging activity, α-amylase inhibitory activity, mineral and dietary fibre content by Folin-Ciocalteu's method,Aluminium chloride colorimetric assay,2, 2-Diphenyl-1-picrahydrazyl (DPPH) radical scavenging capacity assay, 2,2'-azinobis (3-ethyl-benzothiazoline-6-sulfonic acid) (ABTS) assay, and 3,5-dinitrosalicylic acid (DNSA) method,Atomic absorption spectrophotometry and Enzymatic gravimetric method, respectively. Water extracts of freeze dried samples were used in determination of bioactive properties. Antioxidant activity, total phenolic and flavonoid contents were significantly (P<0.05) higher in leaf samples than flowers followed by fruits. Total phenolic and flavanoid content were further correlated (P<0.05) with antioxidant activity measured by ABTS assay and values being (r^2 = 0.986) and (r^2 = 0.995), respectively. Total phenoilc content and total flavanoid content were further correlated (P<0.05) with antioxidant acivity measured by DPPH assay and values being(r^2 = 0.985) and (r^2 = 0.971), respectively. Aerial parts of *T. cucumerina* did not possess α-amylase inhibitory activity. Significantly (P<0.05) higher soluble and insoluble dietary fiber contents were observed in fruitsthan in flowers and leaves. Significantly (P<0.05) higher Ca, K,Mg,Fe and Zn contents were observed in leaves than fruits and flowers in fresh weight basis. This study shows that leaves of *T.cucumerina* possess higher bioactivity, phytochemical potency and nutritional properties than other aerial parts while fruits possess the highest dietary fibre content. In conclusion, *Trichosanthes cucumerina* can be regarded as a promising candidate with manybioactive properties and high nutritive value.

Keywords: *Trichosanthes cucumerina* Linn.; Antioxidant activity; α-Amylase inhibitory activity; phenolic content; flavonoid content; Dietary fiber

7.2.2.4 Comparative Study on Nutritional Composition and Health Related Functional Properties of *Eleusinecoracana* (Finger Millet) and *Oryza sativa* (Rice) *In Vitro*

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The purpose of this study was to determine the therapeutic effect of finger millet (FM) compared to rice, to encourage its future applications as a functional food. To investigate this, nutritional composition, antioxidant activity, alpha amylase inhibitory activity and fermentation ability of Rawana and Oshada FM varieties were measured against Basmati and BG-300 rice varieties under *in vitro* conditions. The results showed that both soluble and insoluble dietary fiber (DF) contents were higher ($P<0.05$) in Rawana and Oshada than Basmati and BG-300. Moreover, soluble and insoluble DF contents of Oshada (0.44±0.04% and 11.62±0.35%, respectively) were higher ($P<0.05$) than Rawana (0.38±0.02% and 10.67±0.19%, respectively). Total flavonoid content (TFC) of Rawana was similar to Basmati and BG-300. However, Oshada had the highest TFC (1.05±0.08 Catechin equivalent mg/g). Total phenolic contents (TPC) of both FM varieties were higher ($P<0.05$) than both rice varieties. Oshada had a higher ($P<0.05$) TPC than Rawana (8.08±0.17 and 6.40±0.09 Gallic acid equivalent mg/g, respectively). Both FM varieties showed a higher ($P<0.05$) 2, 2-diphenyl-1picrylhydrazyl (DPPH) scavenging activity than BG-300 and Basmati. Similarly, 2, 2'-*azino-bis-3ethylbenzothiazoline-6-sulphonic acid* (ABTS) scavenging activity was higher ($P<0.05$) in both FM varieties than Basmati and BG-300. Furthermore, ABTS scavenging activity was higher ($P<0.05$) in Oshada than Rawana. Alpha amylase inhibitory activity of Rawana and Oshada were higher ($P<0.05$) than Basmati and BG-300. However, the IC_{50} values of both FM varieties were greater ($P<0.05$) than acarbose which is a drug used to treat type II diabetes. The results of the microbial fermentation study revealed that Rawana and Oshada produced a higher amount of hydrogen and carbon dioxide than rice varieties during the incubation at 39ºC with unadapted caecal microflora. Therefore, these results indicate that both FM varieties, particularly Oshada variety has more beneficial nutritional and health related protective effects than Basmati and BG-300 rice varieties *in vitro*.

Keywords: *Eleusinecoracana*, *Oryza sativa*, Functional properties, Nutritional composition, *in vitro*

7.2.3 Functional Food Product Development

7.2.3.1 Assessment of Eighteen Commonly Consumed Edible Plants as Functional Food Based on their Antioxidant and Starch Hydrolase Inhibitory Activities

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Eighteen commonly consumed edible plants (*Adhathoda vasica*, *Amaranthus viridis*, *Alternanthera sessilis*, *Annona muricata*, *Artocarpus heterophyllus*, *Asparagus racemosus*, *Centella asiatica*, *Coccinia grandis*, *Costus speciosus*, *Desmodium gangeticum*, *Gymnema sylvestre*, *Ipomoea aquatica*, *Mimosa pudica*, *Momordica charantia*, *Psidium guava*, *Sesbania grandiflora*, *Solanum americanum* and *Wattakaka volubilis*) were screened for their antioxidant potential based on the Oxygen Radical Absorbance Capacity (ORAC), 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity, total phenolics and vitamin C contents. The inhibitory activities of the plant extracts against the enzymatic activities of α-amylase and α-glucosidase and the breakdown of seven starches which were exposed to these two enzymes were also assessed. The ORAC and DPPH radical scavenging EC_{50} values varied between 298 – 1984 Trolox equivalents per gram fresh weight and 91 – 533 mg per kilogram fresh weight, respectively. The total phenolics and vitamin C contents varied between 32 – 125 mg gallic acid equivalents per gram fresh weight and 96 – 285 μg per gram fresh weight. As for the starch hydrolase inhibitory activities, *Coccinia grandis, Asparagus racemosus, Costus specious, Amaranthus viridis* and *Annona muricata* displayed the highest inhibitory activities against the starch hydrolases. These extracts were the most efficient against the breakdown of starches exposed to the two enzymes as well. However, statistical analysis revealed the relative standard deviation of αamylase and α-glucosidase inhibitory activity for all extracts to be less than 20%, suggesting that variability of the sources of starch had no effect on the inhibitory activities of any of the extracts.Although the parameters used in the study were not disease-specific, quantification of properties such as the antioxidant and starch hydrolase inhibitory potentials will be able to serve as a guide to the usage of these plants for diseases associated with ROS.

7.2.3.2 Evaluation of the Total Antioxidant Capacity, Polyphenol Contents and Starch Hydrolase Inhibitory Activity of Ten Edible Plants in an *In Vitro* Model of Digestion

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Polyphenol consumption has been associated with several health benefits such as reducing the incidence of diabetes and its related complications, cancer and cardiovascular diseases. It is believed that this effect is achieved by cumulative biological exposure to antioxidants which are able to quench the proliferation of radical oxygen (ROS) and reactive nitrogen (RNS) species which are implicated in the pathology of these diseases. However, a major obstacle in evaluating the role of individual food components in modifying disease risk is the scarcity of information on factors that influence their bioavailability and bioaccessibility. Measurement of total antioxidant capacity (TAC) before and after *in vitro* digestion offers a method of ranking food products (especially those of plant origin) in order of their therapeutic capabilities. Thus, the aim of this research was to quantify polyphenol contents, TAC and starch hydrolase inhibitory activity of the aqueous extracts of 10 commonly consumed edible plants (*Acacia arabica*, *Aegle marmelos* flower, *Aegle marmelos* root bark, *Aerva lanata*, *Asteracantha longifolia*, *Cassia auriculata*, *Hemidesmus indicus*, *Hordeum vulgare*, *Phyllanthus emblica* and *Tinospora cordifolia*) and assess the stability of these parameters after the gastric and

duodenal digestion phases of an *in vitro* model. The TAC was evaluated using the ORAC assay, ferric reducing antioxidant power (FRAP) and DPPH and 2, 2-azinobis-(3-ethylbenzothiazoline-6sulfonic acid) (ABTS+) radical scavenging assays. Characterization and quantification of five polyphenol compounds which were previously identified to be present in all the selected plants were carried out. None of the extracts showed a decrease in the total phenolics content or the ORAC and FRAP values following digestion. None of the quantified phenolic compounds had decreased during any of the digestion phases – an observation which was deemed as beneficial in terms of therapeutic properties. Overall, the parameters analyzed were relatively stable throughout the digestive process in all the extracts.

7.2.3.3 Evaluation of the Free Radical Scavenging Abilities and Starch Hydrolase Inhibitory Activities of Five Types of Kombucha Tea during Fermentation

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Considering the therapeutic potential of herbal teas, whether this antioxidant potential can be enhanced by natural or artificial means has been the concern of many studies and investigations. Thus, a beverage known as Kombucha has been the basis for scientific evaluations for this purpose alone. The antioxidant and starch hydrolase inhibitory properties of Kombucha beverages prepared using Chinese black tea, oolong tea, green tea, Sri Lankan black tea and Rooibos tea were investigated. The bacterial strains present in the tea fungal mat used for this study were verified and authenticated as *Acetobacter aceti* (MTCC 2945), while the yeast components were identified as *Zygosaccharomyces bailii* (MTCC 8177) and *Brettanomyces claussenii* (MTCC 7801). The fermentation process was carried out for 7 days following which radical scavenging and ?-amylase and ?-glucosidase inhibitory activity assays were carried out. The pH and titratable acidity (TA) of all Kombucha teas were also measured, where the pH was observed to decrease during the period of analysis with the increase in the TA. There was no statistically significant difference (P<0.05) between all teas in terms of the TA at any point of analysis. All teas had an increase in the total phenolics content and antioxidant potential following the initiation of the fermentation process. The starch hydrolase inhibitory activities also increased in a similar fashion. All five Kombucha teas were displayed to inhibit ?-amylase better than ?-glucosidase, which could be deemed as a vital aspect in terms of the starch breakdown process. Out of all five teas, Sri Lankan black tea and Rooibos tea displayed the highest potential in all these aspects thereby ascertaining its potency as better therapeutic beverages than the rest of the teas, while their efficacy as Kombucha beverages are being investigated in this study for the first time.

7.2.3.4 Enhancement of the Antioxidant Activity, Polyphenol Contents and Starch Hydrolase Inhibitory Activity of Ten Selected Edible Plants by Addition of the Kombucha 'Tea Fungus'

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The antioxidant activity, polyphenol contents and starch hydrolase inhibitory activities of ten selected edible plants (*Acacia arabica*, *Aegle marmelos* flower, *Aegle marmelos* root bark, *Aerva lanata*, *Asteracantha longifolia*, *Cassia auriculata*, *Hemidesmus indicus*, *Hordeum vulgare*, *Phyllanthus emblica* and *Tinospora cordifolia*) which are commonly consumed throughout the world as herbal teas were subjected to fermentation by addition of the Kombucha 'tea fungus' for 7 days. In addition to pH and TA, the study investigated the enhancement of the antioxidant potential and changes to the phenolic compounds as compared with their unfermented counterparts. All teas had an initial pH value of between 6.0 and 8.0 prior to fermentation, while the pH of the teas were between 4.0 and 6.0 by day 7. The TA of all the teas had an initial values ranging from 0.1 – 0.5 g/mL. However, by day 7, the values ranged between 2.5 and 5.0 g/mL, where all the beverages had statistically significant increases ($P< 0.05$). Out of all the phenolic compounds, gallic acid was observed to statistically significant increase ($P< 0.05$) in almost all of the samples by the end of the fermentation period. Vanillic acid was observed to have the least statistically significant increases ($P< 0.05$). With the exception of *Aegle marmelos*, the ORAC assay indicated none of the remaining Kombucha beverages had statistically significant increases in the ORAC values at day 1 or 7 of the fermentation process. As for the starch hydrolases, the fermentation process was able to enhance the ?-amylase inhibitory activity better than the ?-glucosidase inhibitory activity of the unfermented tea samples. Overall, study was able to identify the enhancement of the antioxidant and starch hydrolase inhibitory potential of the ten edible plant extracts by adding the tea fungus.

7.2.4 Microbial Biotechnology

7.2.4.1 Developing biofilmed biofertilizer for strawberry

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The objective of this study is to develop a biofilmed biofertilizer (BFBFs) formulation for strawberry. Initially, a study was conducted to investigate the effect of cultivated and wild strawberry rhizosphere microbes on the growth of strawberry (var. Chandler) in a glasshouse experiment. Four bacterial (B1 - B4) and three fungal (F1 - F3) strains isolated from the cultivated strawberry rhizosphere and two bacterial (B5 and B6) strains isolated from the wild strawberry rhizosphere were used in the experiment. Recommended dosage of chemical fertilizer was the reference treatment while the control was maintained without microbes or chemical fertilizer. Growth, pH and nitrogenase activity of the strains were measured. All strainsshowed acidic pHs. Only B2 showed nitrogenase activity. Total plant and shoot biomass of strawberry were significantly ($p < 0.05$) improved by B1, B2, B4 and F2 whileB2 and B4 significantly ($p < 0.05$) improved root biomass. Petiole length was significantly higher ($p < 0.05$) with B1, F1 and F2. The findings of this study clearly indicate the efficacy of rhizosphere isolates as biofertilizers in strawberry to improve the early vegetative growth. Thus, the rhizosphere originated microbial cultures can be recommended as good sources of inoculants to be used to improve the early growth of strawberry. Grant: UGC grant (UGC/ICD/RG/02/2012/10).

7.2.4.2 Evolution of an introduced biofilmed biofertilizer in a microbial environment

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Conventional agriculture has disrupted the natural biodiversity and ecosystems necessitating sustainable methods of agriculture to restore them. Recent studies have used microbial biofilms (BF) as biofilmed biofertilizers to reinstate biodiversity of degraded agro-ecosystems. Present study investigates the improvement of microbial diversity and functionality after introducing BF to a microbial environment and the effect of BF on root endophytic colonization. The first experiment included three treatments (BF, soil solution, and BF with soil solution) and a control (biofilm formation medium) with five replicates laid in a Completely Randomized Design. Fourier Transformed Infrared (FTIR) spectra were recorded for exudates and microbial cultures isolated from diluted treatments at the beginning and after seven days of incubation. The second experiment used hydroponically grown rice under sterile conditions as the test plant. The hydroponic medium with the test plant was inoculated with BF whereas the control had no BF. Root biomass was measured after three weeks. Endophytes were isolated to obtain colony diameter and FTIR spectra. It was found that amides content in exudates of BF plus soil solution was significantly higher than that of BF or soil solution alone ($p =$

in microbial environments in the presence of BF. Rice root biomass ($p = 0.02$) and endophytically isolated bacterial colony diameter ($p = 0.00$) were significantly higher in the BF treatment than the others, possibly due to endophytic biofilm induction. Cluster analysis demonstrated the emergence of 6-10 new types of microbes in BF plus soil solution, and 1-3 new rice endophytes in BF treatment, possibly due to dormancy breaking of endophytic microbial seed bank by biofilm specific biomolecules. Therefore, the application of BFBFs to soil could induce soil microbial and root endophytic diversity and their functionality.

7.2.4.3 Effect of substrate on biochemical expression of bacterial biofilms

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This study was conducted to investigate the effect of substrate on biochemical expression of bacterial biofilms developed on a biotic fungal surface and two abiotic surfaces *viz* glass wool and metal fiber.Control wasmaintained with only nutrient medium used for culturing microbes. There were three replicates for each treatment. The experimental units were arranged in a Complete Randomized Design. Temporal variation in biochemical expression of the bacterial biofilms was evaluated using Fourier Transform Infrared (FTIR) spectroscopy under six spectral regions; Fatty acid I, Fatty acid II, Amide, Polysaccharide, Mix and Fingerprint. It was found that the metal surface-attached bacterial biofilm showed a significantly higher absorbance than the other two surfaces for Fatty acid region II after 1 week ($P < 0.004$) as well as Fatty acid region I after 2 weeks ($P < 0.005$) of incubation. Glass wool-attached bacterial biofilm showed a significantlyhigher absorbance than the other two surfaces for Amide region after 1 week ($P < 0.008$) of incubation. The fungal surface-attached bacterial biofilm produced a wider variety of compounds, as a result of molecular interactions between the fungus and the bacterium, thus enabling the association to produce new compounds which could not be synthesized by the fungus or the bacterium alone. Those new compounds were not seen with the other two surfaces. This study concludes that the biochemical expression of the bacterial biofilms is substrate specific, and further the biotic interaction of the fungal surface-attached bacterial biofilm has apparently led to enhanced gene expression of the counterparts.

7.2.4.4 A novel microbial biofilm for bioremoval of Ni from aqueous media

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This study evaluated the efficiency of a microbial biofilm on the removal of Ni ion in aqueous media. The biofilm was developed incorporating a garden soil fungus with a bacterium isolated from Ni rich serpentine soil. Biofilm was characterized using microscopic, scanning electron microscopic, FTIR investigations, Boehm and potentiometric titrations. Ni removal was determined using batch experiments as a function of pH, Ni concentration and time. The adsorption isotherm assay was conducted with varying Ni concentrations from 25 to 500 mg/L for 4 days. Isotherm and kinetic modeling was applied to the experimental data to understand the mechanisms of Ni removal. The zero

point charge at pH = 4.5, indicated the pH values greater than 4.5 is favorable for Ni adsorption. Acidic nature of the biofilm was reflected from Boehm titration data resulting in higher number of acidic groups than the basic groups. With the increase in initial Ni concentration, the uptake increased from 3.43 to 38.16 mg/g. After 4 days, the adsorption rate reached an equilibrium with a maximum sorption of ~30 mg/g for an initial concentration of 100 mg/L. Kinetic model fitting with Power function further demonstrated the chemisorptive interaction of Ni with the biofilm surface. A clear involvement of functional groups of the biofilm in Ni bonding was observed from ATR- FTIR mg/g. Hill, the best fitted isotherm model indicated a maximum adsorption capacity of 165.37 spectrum. Microbial biofilm showed an efficient, but slow removal of Ni from aqueous media.

7.2.4.5 Role of biochar and biofilm amendments on enzymatic activities in heavy metal contaminated soils

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Serpentine surrounding soil systems rich in heavy metals are unfavorable environments for crop growth and agriculture. The application of biofilm (BF) and biochar (BC) was examined as potential bioamendments on the activity of soil microorganisms, carbon fraction and Ni bioavailability in serpentine soil. The BCs (300BC, 500BC, 700BC) were prepared by slow pyrolysis of *Gliricidia sepium* biomass at three different temperatures (i.e. 300, 500, 700 ^{o}C) with a holding time of 2 hours. Pot experiment was conducted with tomato by adding BCs at three different percentages, 1, 2.5, 5% (w/w) with or without fungal-bacterial BF. Tomato plants grown in the 5% 500BC showed 10-fold higher biomass than that of the control. The bioavailability of Ni and polyphenol oxidase activity showed a decrease with BCs of increasing temperature. The maximum bioavailability reduction of Ni in 5% 700BC was 90% compared to the control, whereas the addition of BF showed no considerable change on the bioavailability. Dehydrogenase activity showed no pattern and the maximum was found in 2.5% 300BC treatment which was about 91-fold increase compared to the control. The maximum total organic carbon (TOC) and microbial biomass carbon (MBC) were observed in 300BC and 500BC at 5% amendments, respectively. Results suggested that the addition of BC at high percentages together with BF into serpentine soil immobilizes heavy metals significantly, however decreased soil enzyme activities, but increased soil TOC and MBC. Enzyme activity was shown to be inversely proportional to the pore volumes of BCs. The reason may be the enzymes or microorganisms may disperse into the pores of BCs and thereby the activity is reduced. Overall results suggested that the addition of BF and 1% 300BC + BF to the serpentine soil improved soil quality by increasing soil enzymatic activities.

7.2.4.6 Biosolubilization of Eppawala rock phosphate in soil by microbial biofilms

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Phosphorous (P) is an essential element for plant growth and development. Sri Lanka has a large P deposit at Eppawala. But due to its low solubility it fails to increase the bioavailability of P. Since it is evident that low pH conditions increase solubility of Eppawala Rock Phosphate (ERP), microbes, especially fungi and their biofilms can be used to increase its solubility, as they create acidic conditions. In order to test the feasibility of biofilms or fungi to increase the solubility of ERP, four treatments were applied in this experiment; soil only (as the control), untreated ERP mixed soil, biofilm treated ERP mixed soil, and Triple Super Phosphate (TSP) mixed soil. Treated soils were incubated for three weeks. Completely Randomized Design (CRD) was used. Different Pfractions were evaluated after different time periods. Maize was used to study plant P uptake pattern. Water solubilized P in biofilm treated ERP added soils showed a similar changing pattern as of plant P uptake. TSP added soils showed an opposite changing pattern from plant P uptake. The untreated ERP was not significantly different from the control. The highest inorganic and organic P concentrations were reported with biofilm treated ERP, while TSP illustrated more or less a constant changing pattern. TSP had a lower amount of organic P than the other ERP added treatments. This study showed that the biofilm treatment improved P solubility in ERP in such a way that it synchronized with the plant P uptake. The P losses were also minimized with the biofilm treated ERP.

7.2.4.7 Conventional agriculture is a wrong approach

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Any ecosystem is composed of a food web-based network of interactions of organisms. Nutrients are conserved in natural, undisturbed ecosystems, leading to sustainability, particularly due to their cycling in the producers-consumers-decomposers loops of the food web. As long as all the interactions are intact, the ecosystem is equilibrated and sustainable. Among those microbes and fauna (particularly insects) in natural forest ecosystems, there are some individuals, which contribute to structure or stratify trees, by feeding on seedlings of the same species growing at high densities on the forest floor and thereby thinning them, thus allowing the other species too to emerge, leading to remarkable diversity (Bagchi et al., 2014). Thus, those microbes and insects play an extremely important role in forest structuring and diversifying. In forest conversion to conventional agriculture, stress factors like forest clearing, tillage and chemical inputs reduce biodiversity of functional flora, fauna and microbes. Most of the disappeared biodiversity enter into an inactive or dormant phase to bypass the stress factors, by forming 'seeds', which are stored in the soil seed bank. Then, their contribution to the ecosystem functioning in agroecosystems is lost, and hence the natural food web is collapsed. Consequently, those remnant forest structuring and diversifying microbes and insects start feeding on our crops in the absence of their conventional foods. Then, we name them as pathogens and pests attacking our crops. This is how pathogens and pests originate in agroecosystems. In conventional agriculture, we address the above issue by killing pests and pathogens, by increasing chemical fertilizer use with yield decline etc., which contribute to further depletion of biodiversity. As one can understand, what we should have done, was to reinstate the lost biodiversity for reestablishing ecosystem functioning and sustainability of agroecosystems. Thus, in this manner,

conventional agriculture is a wrong approach. With this understanding, biofilm biofertilisers (BFBFs) have been developed for reinstating biodiversity of degraded agroecosystems (Seneviratne and Kulasooriya, 2013). Their major role after field application is to increase soil biodiversity through breaking dormancy of the soil seed bank that was developed under the stress conditions. This increase of the biodiversity leads to improve ecosystem functioning, which in turn reinstates sustainability of degraded agroecosystems. In addition, the BFBFs application increases endophytic colonization of microbes (G. Seneviratne, unpublished), which helps improve environmental stress tolerance of plants (Naveed et al., 2014).

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7.2.5 Natural Products Project

7.2.5.1 Search for Bioactive Compounds Produced by Endophytic Fungi of Some Medicinal Plants

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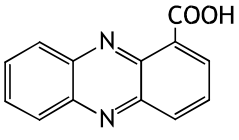
Endophytes are considered to be a rich source of secondary metabolites with novel structures and interesting bioactivities. Endophytes are found in the inner tissues or even in the cells of their host while epiphytic fungi grow on the surface of the host. A large number of small molecule natural products produced by microorganisms represent a rich source of structurally diverse biologically active metabolites. These metabolites have extensive applications as agrochemicals, antibiotics, immunosuppressants, antiparasitic 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*.

In a continuation of our studies on the search for bioactive compounds from Sri Lankan flora, we are currently studying the secondary metabolites produced by the endophytic fungi isolated from some medicinal plants –*Camellia sinensis* (Tea), *Coccina grandis* (Kowakka), *Costus speciosus* (Thebu), *Passiflora edulis* (Passion fruits), *Piper nigrum* (Gammiris). Secondary metabolites produced by fungal species were studied using the following general procedure. A segment of triple sterilized leaf/plant part was placed on PDA media in a petri-dish. Emerging fungi were isolated after 4-6 days and sub cultured to obtain pure cultures of each endophytic fungus. Large scale culturing of each fungus was carried out by inoculating a pure culture of each fungus in PDA media in to 1 L conical flasks (x 20), allowed to stand (10 days), and then incubated at room temperature while shaking every other day on a laboratory shaker. Media were filtered after 4 weeks and the filtrate was partitioned with EtOAc/H_2O to give the EtOAc extract. The residual mycelium was sequentially extracted with EtOAc and MeOH. Each extract was screened for antioxidant activity, phytotoxicity, brine shrimp toxicity, antifungal and enzyme inhibitory activities (α-glucosidase, α-amylase, pancreatic lipase). Extracts were chromatographed over silica gel, PTLC, Sephadex LH-20, RP-silica and RP-HPLC respectively. Compounds with a variety of structural features and bioactivities were isolated. Some of these compounds produced by endophytic fungi isolated from the respective plants have been identified as phenazine-1-carboxylic (**1**) and phenazine-1-carboxamide (**2**) from *Coccinia grandis*, helminthosporal acid (**3**) and helminthosporol (**4**) from *Costus speciosus*. Structures of compounds were established using NMR and MS spectral data. Bioassays of pure isolates are in progress.



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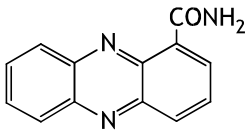

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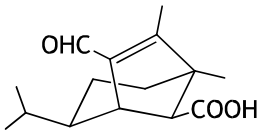

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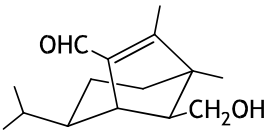

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7.2.5.2 Bioactive Metabolites Produced by Fungi Associated with some Edible Fruits

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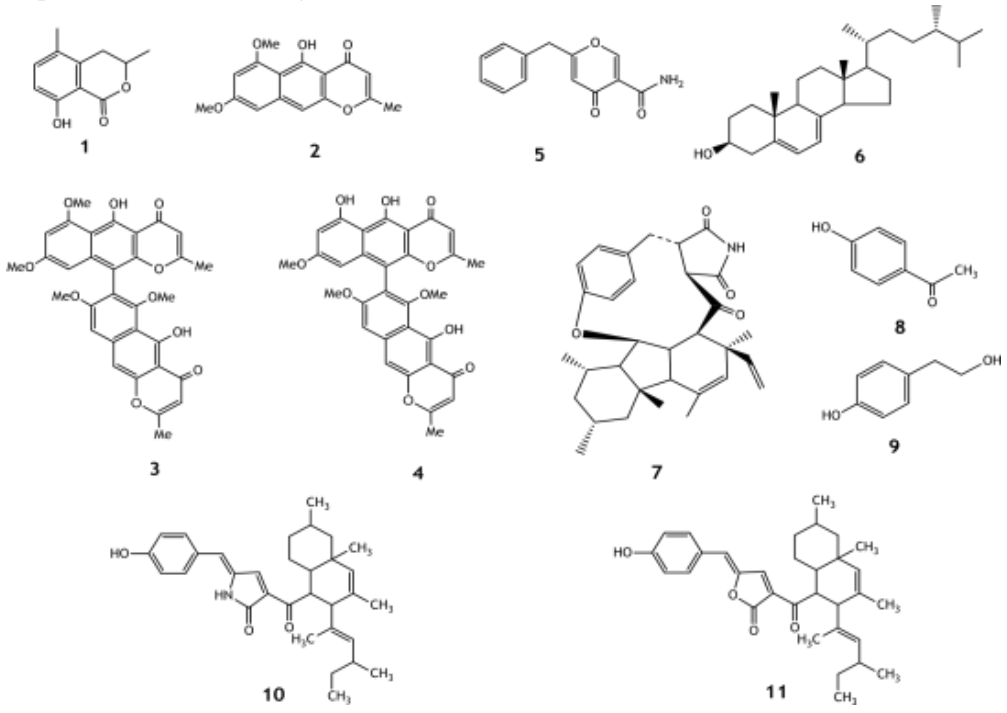
As a continuation of our studies directed towards the search for bioactive compounds from natural sources, we are currently studying the secondary metabolites produced by fungi associated with some popular edible fruits of Sri Lanka. Fungi are promising sources for the isolation of bioactive compounds. The accidental discovery of penicillin, the first broad spectrum antibiotic during World War II paved the way to worldwide scientists to discover hidden bioactive compounds in the fungal world. The fungal kingdom includes many species with unique and unusual biochemical pathways. The product of these pathways includes important pharmaceuticals such as penicillin, cyclosporine and statins as well as potent poisons including aflatoxins and trichothecenes. Popular edible fruits *Artocarpus altilis* (local name: Del), *Averrhoa carambola* (Kamaranga), *Carica papaya* (Papol), *Flacourtia inermis* (Lovi), *Garcinia mangaostana* (Mangostin), *Manilkara zapota* (Sapodilla), *Musa* sp. (Banana), *Pouteria campechiana* (Lavulu), *Phyllanthus edulis* (Rata nelli) and *Syzygium samarangenes* (Jambu) are some of the edible fruits selected for current study. Isolation of pure cultures of fungi associated with edible fruits, preparation of extracts on a large scale, determination of bioactivity of crude extracts, isolation of secondary metabolites in extracts were carried out as described previously. Some of the compounds produced by endophytic fungi isolated from the respective fruits have been identified as: 5-methylmellemin (**1**) from *Averrhoa carambola*; rubrofusarin B (**2**), aurasperone A (**3**), aurasperone D (**4**) and carbonarones A (**5**) from *Carica papaya*; ergosterol (**6**) and GKK1032 (**7**) from *Garcinia mangostana*; 4-hydroxyacetophenone (**8**), Tyrosol (**9**), Taloroconvolutin A (**10**) and the furanone analogue (**11**) of Taloroconvolutin A**10** from *P. campechiana*. Structures of compounds were established using NMR and MS spectral data. Bioactivity of isolates have been deteremined.



Partial support by the National Science Foundation of Sri Lanka (RG/2012/BS/02) is acknowledged.

7.2.5.3 Metabolites from Endophytic fungi isolated from some Allelopathic plants: Structures and Bioactivity

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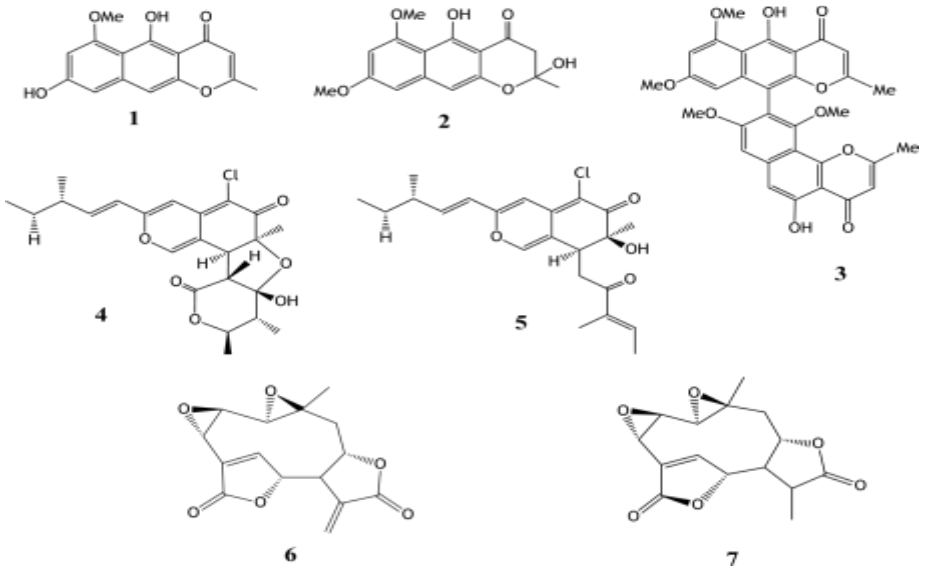
Allelopathy is defined as the direct or indirect harmful or beneficial effects of one species (plant, fungi, and bacteria) on another through the production of chemical compounds that escape into the environment. As a continuation of our studies on the search for bioactive compounds from Sri Lankan flora, we are currently studying the secondary metabolites produced by the endophytic fungi of some plants exhibiting allelopathy: *Amaranthus viridis* (kurapala), *Bacella alba* (nivithi), *Cardiospermum halicabum* (penela), *Makania scandens* (wathupalu) and *Thitonia diversifolia* (walsooriyakantha). Seven fungal strands were isolated from these plants. Three fungal strains isolated from *B. alba* were identified and confirmed as *Aspergillus niger, Cladosporium cladosporioides* (from *T. diversifolia*) and *Chae romium globasams* (from *A. viridis*) using molecular analysis. Large scale culturing of each fungus (five fungi) was carried out by inoculating a pure culture of each fungus in PDA in to 1L Erlenmeyer flasks (x 20), allowed to stand (28 days), and incubated at room temperature. The resulting culture broth was filtered and extracted with EtOAc/MeOH. Each extract was screened for antioxidant activity, phytotoxcity, brine shrimp toxicity, antifungal and enzyme inhibitory activities (?-glucosidase, ?-amylase, pancreatic lipase). Extracts were chromatographed over silica gel, PTLC, Sephadex LH-20, and RP-silica.Compounds with a variety of structural features and bioactivities were isolated. Six compounds isolated from *Aspergillus niger* were identified as rubrofusarin B, TMC 256A1 (**1**), foncesin B (**2**), aurasperone A, fonsecinone A (**3**) and ergosterol. Three compounds isolated from *Chaetomium globosum* were identified as chaetomugilin A (**4**), chaetomugilin J (**5**) and ergosterol. Two compounds mikanolide (**6**) and dihydromikanolide (**7**) were isolated from the fungal strain NP-M1 from *Mikania scandens*. Structures of these compounds were determined by analysis of NMR and MS spectral data. It is noteworthy that compounds **4** and **5** showed significant phytotoxicity towards radicle growth of lettuce seeds in the germination assay.



This work was supported by the National Science Foundation (RG/2012/BS/06).

7.2.5.4 Phytochemical Properties of the Genus *Monochoria* ('Diyahabarala') in Sri Lanka

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'Diyahabarala' is a freshwater aquatic herb of the genus *Monochoria* and is represented by two species in Sri Lanka. According to traditional medicine, the plant is known as a food which cools the body. The plant is documented as used for treating many ailments including toothache, asthma, cough, cold and fever, stomach and liver problems, general debility, hemorrhage, hepatitis, anaemia, scurvy, gastropathy, hepatopathy, odontalgia and diabetes. Consumption of the plant leaves either as porridge ('kola-kenda') or salad ('mellun') is recommended. Inquiries regarding the plant material used in local medicine from ayurvedic and traditional physicians revealed that a distinction is not made between the two species, *M. hastata*or and *M. vaginalis,* when these two plants are considered for their medicinal properties. However, morphological studies have identified three phenetic groups within *M. vaginalis* and interestingly one group possessed idioblasts (red glands) in the palisade layer of the leaves. The present study was carried out to compare some biological properties of leaf extracts of different phenetic groups of *M. vaginalis* and *M. hastate* and detect their possible toxicity and membrane disruptive activity. Plant material was air-dried and sequentially extracted with hexane, ethyl acetate and methanol. Brine shrimp lethality and haemolysis assays were used to assess cytotoxic and membrane disruptive activity. Antioxidant activity was determined against DPPH free radicals and α-amylase inhibition by plant extracts was assayed using the 3,5-dinitrosalicylic acid method.

All plant extracts displayed antioxidant activity against DPPH free radicals and inhibited α-amylase enzyme activity, supporting their medicinal properties. In addition the phenetic group within *M. vaginalis* that possessed idioblasts showed a very high brine shrimp lethality/toxicity and haemolytic activity. The identification of the compounds present in the phonetic group with idioblasts is in progress. The results emphasise the importance of correct identification as an essential prerequisite for safety and efficacy in the use of medicinal plants.

7.2.5.5 Edible Fruits as a Source of Bioactive Compounds

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Edible fruits have been used as a source of nutraceuticals from ancient times and knowledge of their efficacy has passed been from generation to generation. With this understanding and experience, edible fruits are a potential source for the isolation and identification of environmental friendly bioactive compounds, since safety and toxicological issues are remarkably less than those associated with compounds from other natural sources. As a part of our study towards the search for bioactive compounds from edible fruits of Sri Lanka we are currently studying fifteen popular edible fruits for their chemistry and bioactivity. The following fruits were selected for this study: *Aegle marmelos* (local name: beli), *Anacardium occidentale* (kajupuhulan), *Artocarpus altilis* (del), *Averrhoa bilimbi* (bilin), *Averrhoa carambola* (kamaranga), *Carica papaya* (papol), *Citrullus lanatus* (komadu),

Elleocarpus serratus (veralu), *Flacourtia inermis* (lovi), *Flacourtia indica* (uguressa), *Garcinia cambogia* (goraka), *Hylocereus undatus* (dragon fruit), *Limonia acidissima* (divul), *Manilkara zapota* (sapodilla), *Nephellium lappaceum* (rambutan), *Phyllanthu sembilica* (nelli), *Passiflora edulis* (passion fruits).

The edible part of each fruit was blended, juice and residue were separated, and the juice was sequentially extracted with *n*-hexane and ethyl acetate (EtOAc). Residues were sequentially extracted into *n*-hexane, EtOAc and MeOH. MeOH extracts were partitioned with *n*-butanol and water. Extracts were subjected to antioxidant activity (DPPH radical scavenging activity), cytotoxic activity (*Artemia salina* lethality assay), phytotoxic activity (inhibition of *Lactuca sativa* seed germination), enzyme inhibitory (α-amylase and lipase) assays, antifungal activity (TLC bioassay against *Cladosporium cladosporioides*) and anticandidal activity against five standard isolates of *Candida* species: *C. albicans* (ATCC 90028), *C. parapsilosis* (ATCC 22019), *C. glabrata* (ATCC 90030), *C. krusei* (ATCC 6258) and *C. tropicalis* (ATCC 13803). Some of the bioassay results were reported in previous annual reports. Based on the bioassay results extracts of the fruits of *A. marmelos*, *A. occidentale*, *F. inermis, F. indica, G.queasita* (goraka) were selected for further studies. Fruits of *A. marmelos* furnished several compounds including coumarins, amides and alkaloids. Some of these compounds showed antioxidant, phytotoxic, antifungal, ?-amylase and brine shrimp toxic compounds. Fruits of *A. occidantale* furnished five major compounds as analysed by TLC. However NMR and MS studies suggested that these are mixtures of anacardic acid, of which some of showed antioxidant, antifungal, phytotoxicity, *a*-amylase activity and brine shrimp toxicity. Fruits of *Garcinia quaesita* furnished six polyisoprenylated benzophenones with antioxidant activity. Thirty five phenolic compounds were detected and characterized by LC-MS analysis of *F. inermis* and *F. indica* extracts on the basis of their unique fragmentation pattern in the negative ion mode tandem MS spectra.

This work was partially supported by NSF (RG/2012/BS/02) and NRC 12-032.

7.2.6 Plant Biology

7.2.6.1 Remediation of Crystal violet dye from aqueous solution by Gliricidia biochar

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The removal of synthetic dyes from effluents of the textile industry is an emerging concern due to its potential adverse effects on the environment and public health. Synthetic dyes are highly toxic and can be bio-accumulated and biomagnified through the food chain. Color suppresses sunlight penetration into water and affects the aquatic biota. Adsorption by active carbon is a promising technique for dye removal; however, it is not economically viable. Thus, it is essential to find substitutes to obtain a sustainable solution for dye removal. Biochar is an effective biosorbent for remediation of organic and inorganic contaminants. The objective of this study is to investigate the adsorption of the basic dye, crystal violet, from an aqueous solution on to biochar derived from *Gliricidia sepium* wood, a by-product from a bioenergy plant.*G. sepium* was pyrolysed at 300 °C, 500 °Cand 700 °C. The adsorption process was investigated through batch experiments by varying the initial dye concentration, adsorbent dose, and contact time. The effect of pH was determined through the edge experiments. The equilibrium data was analyzed using the Langmuir, Freundlich, and Hill isotherm models. The kinetic data obtained was analyzed using pseudo-first-order and pseudo-secondorder equations. Gliricidia biochar pyrolysed at 700 °C gave a higher removal efficiency of 99% at 20 mg L^{-1} and maximum adsorption capacity was at 30.4 mg g^{-1} at 30 °C. Optimal adsorbent dose was 2 gL^{-1} and optimum pH range was 7-8. The experimental data fitted well with the pseudo-secondorder kinetic model. This study implies that the pyrolysis temperature of *G. sepium* is a crucial factor in the adsorption process of crystal violet and high pyrolysis temperatures are more favorable for crystal violet removal.The results indicate that Gliricidia biochar pyrolysed at 700 °C could be utilized as a low cost alternative for the commercial activated carbon in wastewater treatment for the removal of crystal violet dye.

7.2.6.2 Biosorption of Ni(II) and Pb(II) by *Asplenium nidus* L. leaves and *Mimosa pigra* L. pods

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The use of heavy metals in industries and their subsequent release of untreated effluents is a hazard to the natural environment. Among these heavy metals, Pb(II) and Ni(II) are used in battery manufacture, alloy preparation, paints and metal plating. Effluents from these industries contain Pb(II) and Ni(II) beyond the accepted levels for the health of biodiversity and human life. Hence it is necessary to remove heavy metals from effluents before releasing to environment. We investigated the leaves from *Asplenium nidus* L. and pods from *Mimosa pigra* L. as a potential biosorbent to remove Pb(II) and Ni(II) from aqueous systems. *A. nidus* plants were collected from a domestic

garden and *M. pigra* from the Mahaveli river bank in Kandy. Plant materials were washed with deionized water and air dried for 48 h. After drying in an oven for 48 h at 70 °C, plant materials were ground and sieved (250-350 µm). Dried biomass of 0.2 g was introduced in to 100 mL of 5.0 mg L^{-1} metal solution at 27 °C. Suspensions were shaken in an orbital shaker at 100 rpm. At pre-determined time intervals suspensions were removed, filtered and analyzed in an Atomic absorption spectrophotometer. The procedure was repeated by varying the experimental parameters initial pH, initial metal concentration and shaking speed. Dried biomass of *A. nidus* adsorbed 95% of Pb(II) and 50 % of Ni(II) after 75 min and 30 min, respectively. *M. pigra* adsorbed 65% of Pb(II) and 45% of Ni(II) after 90 min and 30 min, respectively. Kinetic studies showed that the adsorption process followed pseudo 2nd order kinetic model, with rate constants of 13.77, 0.12, 5.49 and 0.56 g mg^{-1} min^{-1} respectively. The adsorption process depended on the solution pH and was in the range 4-6. Isotherm study showed that the adsorption of Pb(II) on to *A. nidus*, and Ni(II) adsorption on to both biosorbents followed the Langmuir isotherm model and Pb(II) adsorption on to *M. pigra* followed Freundlich isotherm model. This study indicated that adsorbents prepared from *A. nidus* and *M. pigra* could be used as cost effective and environmentally friendly biosorbents to remove Pb(II) and Ni(II) from contaminated aqueous environments.

Acknowledgement: NRC grant 13-087 for funding the research.

7.2.6.3 Exotic *Khaya senegalensis* as nurse-trees for the natural regeneration of dry forest

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Due to land development, agriculture and shifting cultivation, most dry zone forests in Sri Lanka have disappeared leaving many forest fragments and degraded lands. These degraded lands have been colonized by fire prone successionally arrested plant (SAP) communities. Encroachment of SAP communities into degraded forest areas poses a major problem for dry forest natural regeneration. The use of exotic tree plantations as nurse-trees to restore degraded areas with SAP is a new forest conservation approach practiced in the wet zone of Sri Lanka. We determined the effect of overstorey exotic tree plantations on forest tree regeneration in the dry zone. Eighty one plots (1 m x 1 m) were established randomly to quantify regenerated dry forest tree seedlings richness, diversity and density within three treatment types: reforested land with *Khaya senegalensis* (Desr.) A. Juss. and *Tectona grandis* L.f. plantation while a SAP community as control was located closer to a forest edge in the Habarana area. Data collection was done in the dry season of the year, 2014. We also quantified the density of grass species in the plots. Collected data were analyzed using the R statistical software with the Biodiversity package. Mean dry forest tree seedling richness, diversity and density were significantly greater under the reforested land with *K. senegalensis* than *grandis* plantation and the SAP community ($P<0.05$). Having light-weighted, wind-dispersed seeds, *Pterospermum canescens* showed the most abundant regenerated dry forest tree species under *K. senegalensis* plantation while exotic invasive grasses of *Panicum maximum* Jacq. (Guinea grass) was most abundant in the SAP community and *grandis* plantation. Fire prone, highly competitive Guinea grass dominated SAP community may suppress the regeneration of dry forest tree species and additionally increase fuel loads in the forest edge, and consequently boost fire intensity, thereby reducing fire susceptible dry forest tree species regeneration. We suggest that *K. senegalensis* tree plantations can be used as nurse-trees for dry forest restoration and conservation, resulting in a negative feedback on expansion of fire prone SAP communities. However, further studies should investigate the long term consequences of pruning and thinning the *K. senegalensis* plantation on the sapling growth of dry forest tree species seedlings.

7.2.6.4 Biology and Diversity of Copepods in Sri Lanka and Their Potential Use as a Predator of *Aedes* Larvae

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Dengue is a mosquito borne viral disease transmitted by the female *Aedes* mosquito, a container breeder in the tropics. The diurnal behavior of the blood feeding female mosquito and hardy eggs has made the control of the disease difficult. Chemical control was not successful as the vector develops resistance. Cleaner environment is the easiest and most promising for prevention, though the communities are not much supportive to this. A reliable alternative is Integrated Pest Management, where biological control is a component. Natural predators such as larvivorous fish species, dragonfly nymphs, aquatic bugs, and copepods can be used. Advantages of this method are the low cost and absence of resistant development. Out of these, copepods have a higher potential as a bio-controlling agent. Our objective is to determine the biology and diversity of copepods and their potential to control *Aedes* larvae under laboratory and field conditions. Copepods were collected from water bodies by sieving through a 50 micron net and samples were brought to the laboratory. Naked eye observation helps to separate out gravid females and each were placed in labeled containers to develop mono cultures. *Paramecium* cultures were used to feed the captured copepods.

Aedes larvae were captured form their natural habitats and from egg rafts, and emerging adult mosquitoes were kept in cages. To observe predation, 10 larvae were kept with one copepod and observations were made after 24 hours. Observations indicate that plastic containers are more preferred by the copepods. The copepods found in the Kandy region do not feed on the mosquito larvae where as the copepods from Hurulu do eat them. That may be because of the larger body size of the copepods from Hurulu. Studies are in progress with copepods from other regions in Sri Lanka and also other predators of the *Aedes* larvae such as larvivorous fish species and dragonfly nymphs.

Grants: National Research Council, Dengue Mega Project TO 14-04.

7.3 ENVIRONMENTAL AND EARTH SCIENCES

7.3.1 Biodiversity and Conservation

7.3.1.1 Subspecies of Sri Lankan Mammals as Units of Biodiversity Conservation, with Special Reference to the Primates

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Subspecies embody the evolution of different phenotypes as adaptations to local environmental differences in keeping with the concept of the Evolutionary Significant Unit (ESU). Sri Lankan mammals, being mostly of Indian-Indochinese origins, were honed, in part, by the events associated with the separation of Sri Lanka from Gondwanaland in the late Miocone. The emerging new Sri Lankan environment provided a varied topographic and climatic stage and impetus for new biotic adaptations. This history is manifest nowhere as clearly as in the diversity of non-endemic and endemic species and subspecies of Sri Lankan mammals that offer a cross-sectional time-slice (window) of evolution in progress: 22.3% (19 of 91 species) are endemic, but incorporating subspecies, the majority 69 (63.3%) of 109 Sri Lankan land living mammals are diversified as endemics. These unique forms distinguish Sri Lankan mammals from their continental relatives. Regardless of the eventual fates of individual subspecies or ESU's they are the repositories of phenotypic and genetic diversity and the crucibles for the evolution of new endemic species and genera. Their importance is highlighted by recent taxonomic studies that have identified more than 20% of infra-specific populations as new endemic species. Such “hidden species diversity” validates not only the policy to conserve the “potential for evolution” as manifest by infra-specific diversity, but also, to prioritize the conservation of subspecies over their precise taxonomic definitions. The conservation of biodiversity in practice, therefore, involves firstly the official acknowledgement of the existence and importance of infra-specific diversity, especially in taxa such as primates where it is well expressed; and secondly, the protection of highly threatened natural habitats that constitute the only realistic life-supporting environments for the conservation of Sri Lanka's diversity in mammals and many other life forms.



Figure 1. The chevrotain, or mouse-deer, *Moshiola* (*Tragulus*) *meminna*, is an ancient form of hooved ruminant dating back to the Miocence. It was formerly considered as a single species common to India and Sri Lanka. Closer attention to differences in morphology between populations (subspecies) point to three new species:

one in the Eastern Ghats of India (*Moshiola indica*), and two new species endemic to Sri Lanka, *Moshiola meminna* of the dry zone, and *M. karthygre* in the wet zone. The taxonomic work by Groves and Meijaard (2005) underscores the importance of attention to population differences in the conservation of Sri Lankan mammals and IUCN Red Lists (Dittus, 2013). The photograph illustrates the dry zone form *M. meminna* whose camouflage pelage serves to hide its body in the undergrowth of the natural forest of the dry zone of Sri Lanka, but when this habitat is disturbed, the chevrotain's pelage makes them conspicuous and vulnerable to predation.

Cited: Groves, C. P. and Meijaard, E. Interspecific variation in *Moshioloa*, the Indian chevrotain. Raff. Bull. Zool. 2005, 12, 413-421.

7.3.2 Chemical and Environmental Systems Modeling

7.3.2.1 Effects of woody activities biochar derived from a bioenergy industry, Sri Lanka on immobilization of heavy metals and soil enzyme in serpentine soil

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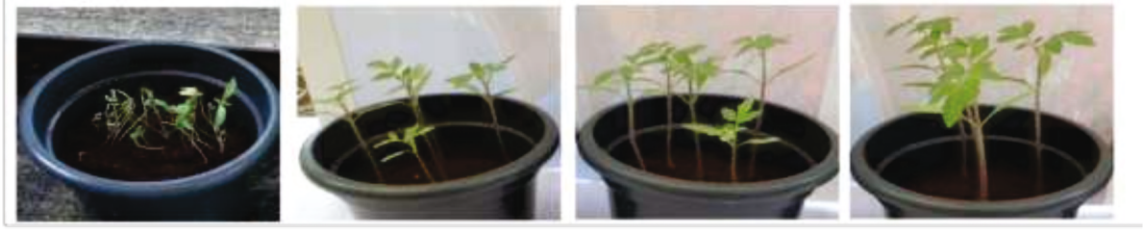
Serpentine soils derived from ultramafic rocks release elevated concentrations of toxic heavy metals into the environment. Hence, crop plants cultivated in or adjacent to serpentine soil may experience reduced growth due to phytotoxicity as well as accumulate toxic heavy metals in edible tissues.We investigated the potential of biochar (BC), a waste byproduct of bioenergy industry in Sri Lanka, as a soil amendment to immobilize Ni, Cr, and Mn in serpentine soil and minimize their phytotoxicity. The BC used in this study was a waste byproduct obtained from a Dendro bioenergy industry in Sri Lanka. This BC was produced by pyrolyzing *Gliricidia sepium* biomass at 900 °C in a closed reactor. A pot experiment was conducted using tomato plants (*Lycopersicon esculentum L.*) by adding 1, 2.5, and 5% (w/w) BC applications to evaluate the bioavailability and uptake of metals in serpentine soil. Sequential extractions were utilized to evaluate the effects of BC on bioavailable concentrations of Ni, Cr, and Mn as well as different metal fractionations in BC-amended and BC-unamended soil. Postharvest soil in each pot was subjected to a microbial analysis to evaluate the total bacterial and fungal count in BC-amended and BC-unamended serpentine soil.Polyphenol oxidase, catalase, and dehydrogenase enzyme activities were determined by idometric, potassium permanganate oxidisable and spectrophotometric methods respectively. Tomato plants grown in 5% BC-amended soil showed approximately 40-fold higher biomass than that of BC-unamended soil, whereas highly favorable microbial growth was observed in the 2.5% BC-amended soil. Bioaccumulation of Cr, Ni, and Mn decreased by 93–97% in tomato plants grown in 5% BC-amended soil compared to the BCunamended soil. Sequentially extracted metals in the exchangeable fraction revealed that the bioavailabile concentrations of Cr, Ni, and Mn decreased by 99, 61, and 42%, respectively, in the 5% BC-amended soil. Enzymatic activities of polyphenol oxidase, catalase, and dehydrogenase reduced significantly in 5% BC- amended soil compared to control soil. Results suggested that the addition of BC to serpentine soil as a soil amendment immobilizes Cr, Ni, and Mn in serpentine soil and reduces metal-induced toxicities in tomato plantswhile masking the soil enzyme activities.



7.3.2.2 Green remediation of insecticide carbofuran using tea waste-derived biochars

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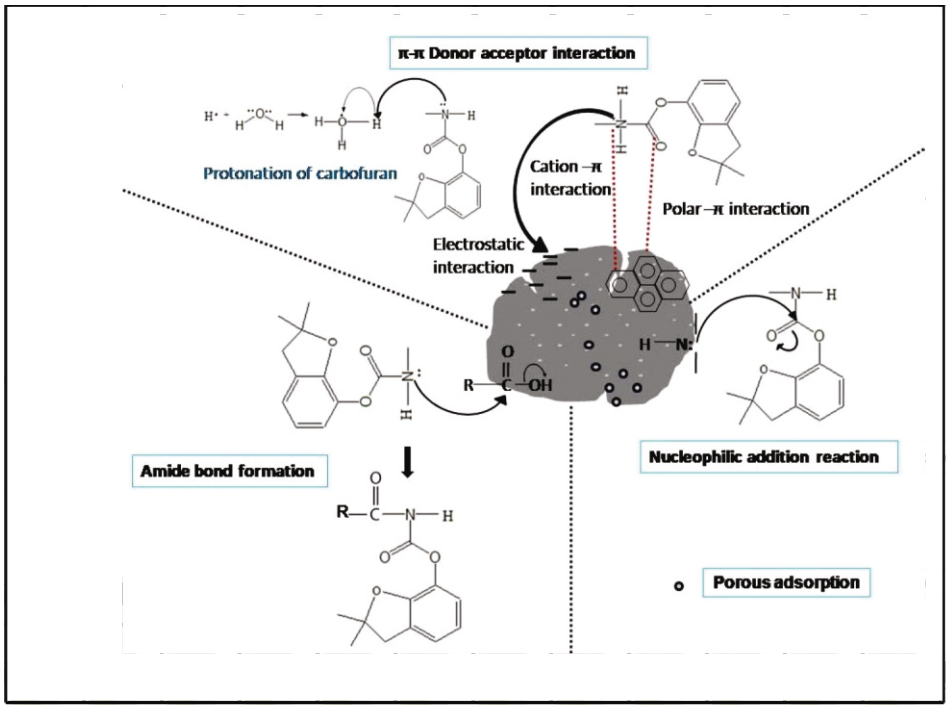
The use of chemical pesticides to ensure better harvest has become a common practice around the world. Carbofuran is a broad spectrum systemic pesticide used in many crop cultivations. The use of carbofuran has become of environmental concern because it is toxic, carcinogenic, recalcitrant present in water and soil. This study evaluates the effectiveness of biochars produced from rice husk and tea residues for remediation of carbofuran in water. Attention has been given to investigate the biochar properties produced at different pyrolytic temperatures together with adsorption capacities. Locally collectedinfused tea waste was pyrolyzed at 300, 500 and 700 °C at the rate of 7°C min^{-1} with a holding time of 3 h. Developed BCs (TWBC300, TWBC500 and TWBC700, respectively) were characterized through elemental analysis, proximate analysis and FTIR. All the studies were conducted by a batch method to determine isotherm parameters using at 1.5 g/L biochar dose. The Langmuir and Freundlich equations were applied to model isotherm data. Maximum adsorption occurred in the pH range of 3-5. Adsorption decreased with rise in pH. The sorption equilibrium data obtained from batch studies were best described by Freundlich indicating chemisorption dominating mechanism with electrostatic interactions between carbofuran molecule and heterogenous surface of the TWBC. Experiments will becontinued to characterize and evaluate the performance of biochars produced from rice husk at 300, 500 and 700 °C on adsorption of carbofuran.



Possible mechanisms for carbofuran adsorption

7.3.2.3 Mobilization of heavy metals in serpentine soil under influence of perchlorate; Implications for Martian regolith

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Perchlorate (ClO_4^-) is a persistent compound in the environment. It has been reported at elevated concentrations (0.4–1 Wt. %) in the top ten centimeters of Martian regolith. An indirect hazard of perchlorate in soils and rocks is the accelerated and enhanced leaching of heavy metals. Hence, the unusual abundance of perchlorate may act as an environmental hazard via heavy metal mobilization in Martian regolith. As a result, it may become a potential hazard for future human habitation. Here, we assess interactions between perchlorate and an analogous Martian regolith (i.e., serpentine soil) in order to understand the fate of heavy metals in the presence of perchlorate. Pre-characterized serpentine soil collected from Yudhaganawa (latitude 7° 71' 67" N and longitude 80° 93' 33" E) and Ussangoda (latitude 6° 05' 54" N and longitude 80° 59' 11" E), Sri Lanka, was used for kinetic and incubation experiments. A Kinetic experiment was performed with three perchlorate concentrations (1, 0.75 and 0.5 w/v) at incremental time intervals up to 11 days. The incubation experiments were performed with same concentrations for 3 weeks. Sequential extractions were followed to evaluate solid phase metal fractionation in serpentine sediments. Kinetic experimental data showed an increase of Ni, Mn and Co concentrations with increasing perchlorate concentrations: (1) Ni release was high in all soils >1.10 mg kg^{-1} hr^{-1} and the highest release of 2.67 mg kg^{-1} hr^{-1} was observed in 1 w/v perchlorate (2) Mn release was also high in all soils recording 0.94 mg kg^{-1} hr^{-1} with the highest release of 3.78 mg kg^{-1} hr^{-1} in 1 w/v perchlorate (3) similar results were shown for Co with a high release in all soils >0.11 mg kg^{-1} hr^{-1} and the highest was 0.47 mg kg^{-1} hr^{-1} in 1 w/v perchlorate. Incubation experiments showed that the exchangeable fraction of Ni, Mn and Co increased with increasing perchlorate concentrations. The exchangeable fraction of Ni, Mn and Co in all soils ranged between 1.8–2.5, 1.3–37.5 and 1.4–5.1 times more than the control, respectively reporting the least at lowest and most at the highest perchlorate concentration. Overall, this study illustrates that the release and bioavailability of Ni, Mn and Co is accelerated/increased with increasing perchlorate concentrations. Further, these findings indicate that perchlorate in Martian regolith may present additional challenges to current Martian life studies and the future human habitation of Mars.

7.3.2.4 Assessment of volatile organic compounds (VOCs) present in landfill leachate and potential use of municipal solid waste biochar to remediate toluene

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Municipal landfills act as a source for a wide range of compounds associated with environmental and human health concern. Volatile organic compounds (VOCs) which maygenerate from industrialand household wastes in municipal landfills are considered to be carcinogenic as well as mutagenic. Toluene is considered as one of frequently found carcinogenic VOCs in landfill leachate which may originate from household cleaners, lubricating oil, motor oil, paint, adhesives, gasoline and nail polish. No attempts have still been taken on the assessment of VOCs and their remediation techniques in Sri Lankan open dumping sites. Hence, this study was aimed to assess the variation of different VOCs present in landfill leachate at the Gohagoda municipal solid waste dumpsite, Kandy, Sri Lanka on a dry and wet day and also, to understand the potential of a bioamendment like biochar produced fromfibrous organic fractions of municipal solid waste (MSW) to remediate VOCs including particularly toluene present in the Gohagoda dump site. The leachate samples were collected at the dump for detecting different VOCs present in landfill leachate by using the head space GC-MS. Batch adsorption experiments were conducted with different dosages of MSW biochar (1, 2.5, 5 and 10 g L^{-1}) at different time intervals (4, 12 and 24 hr) and remaining concentrations of toluene were analyzed by GC-MS. Results indicated that overall 37 different VOCs are detected in landfill leachate including 35 and 6 VOCs in the dry and wet days, respectively. The concentrations of toluene were recorded in the range of 20 – 25 µg/L in both dry and wet days. Furthermore, results suggested that the occurrence of a less number of VOCs during the wet season is mainly due to dilution effects caused by rain. In the batch adsorption experiment the total concentration of toluene was detected at 25.52 µg L^{-1} in the control leachate sample. Removal of toluene increased with increasing MSW biochar dosage and the maximum removal efficiency was 88.3% in the presence of 10 g L^{-1} of MSW biochar after 24 hr. The overall results suggested that MSW biochar can successfully be applied in order to remediate toluene in landfill leachate to a considerable extent. More studies will be undertaken to quantify and remediate other VOCs present in this dumpsite.

7.3.3 Ecology and Environmental Biology

7.3.3.1 Systematics, Biogeography and Evolution of Stephanopinae Crab Spiders (Araneae: Thomisidae)

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Spiders (Araneae) are the second largest order after Acari, within Arachnida. Crab spiders, family Thomisidae, is a specious family which includes 2123 described species in 175 genera. Recent fieldwork, conducted around the globe (Sri Lanka, Madagascar and South America) by various institutions suggests that this is only a fraction of its true diversity. Crab spiders are mainly active during the day and ambush insects with their well-adapted first and second pairs of legs. Thomisids are behaviorally versatile, exhibiting complex behaviors, like their remarkable ability to change color, myrmecomorphism, and sociality. Understanding the phylogenetic structure of this large family has always been problematic. Most published papers on higher-level thomisid relationships present poorly substantiated relationships. Their conclusions are based mostly upon inductive reasoning. Through this Project, we aim to provide a stable phylogenetic hypothesis for the family Thomisidae by analysis of morphological and DNA sequence data. This study will also form the basis of future revisionary work of the family, its biodiversity and conservation. As a part of this project the genus Pharta have been revised and one new genus and three new species described. Further, the monophyly of Australasian *Stephanopis* is supported for the first time.

This study is funded by the Alexander von Humboldt Foundation and Zoological Research Museum Alexander Koenig, Bonn, Germany.



7.3.3.2 Diversity and distribution of Goblin spiders (Family: Oonopidae) in Sri Lanka

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Dwarf hunting spiders or goblin spiders (Family Oonopidae) number over 600 described species in 102 genera worldwide. Members of this family are small (1-4 mm), haplogyne, six eyed species that dwell in litter or in the canopy. They do not build webs. Sri Lanka hosts a large diversity of spider families, including oonopidae, with 23 species in 8 genera known. So far, no specific extensive study has been done for oonopids in Sri Lanka. The present study is aimed at assessing the diversity of the Oonopidae spider family in the country.

Sample collection was conducted by sifting litter and beating method in 80 selected sites within 20 districts in Sri Lanka. The collected spiders were examined using a stereomicroscope and then sorted into genera, preserved in alcohol and identified morphologically using recently published international revisionary studies. For further studies, male palps (left) were dissected and immersed in methyl salicylate about 4-5 hours under room conditions, slide mounted, observed and illustrated with an Olympus BX51 compound microscope attached with a drawing tube.

Our collections consist of 253 oonopid spider specimens of the genera *Aprusia, Brignolia,Xestaspis, Camptoscaphiella, Orchestina, Ischnothyreus* and *Opopaea*. Of these genera, *Orchestina* and *Ischnothyreus* were reported in Sri Lanka after 1893 and genus *Opopaea* is reported in Sri Lanka for the first time. Nineteen specimens cannot be sorted in to generic level according to the literature and were tentatively labeled as genus 01 - 09. From *Xestaspis* drawings, four new species were classified other than *X. kandy*. *Aprusia kerala* was identified, which is a new report in Sri Lanka. Of the 26 *Orchestina* specimens, their drawings suggested only 2 species for the genus. Drawings of genera 01, 06, 07 also confirmed that they do not belong to above identified genera. The present study records seven genera of the spider family Oonopidae and a few new genera from the country. This working hypothesis will be tested using DNA barcodes in further work

This study is funded by the Institute of Fundamental Studies with additional funding coming from a fellowship from the Alexander von Humboldt Foundation. We wish to thank the Department of Wildlife Conservation and the Department of Forest Conservation for permits, other genera found among 187 sorted specimens.



Dorsal view of male goblin spiders (x5) a) *Aprusia* sp., b) *Xestaspis* sp.,c) *Brignolia* sp., d) *Camptoscaphiella* sp., e) *Orchestina*sp., f) *Ischnothyreus* sp., g) *Opopaea* sp.

7.3.3.3 Taxonomic revision of the genera Dendrobium and Bulbophyllum (Orchidaceae) of Sri Lanka

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Orchidaceae is one of the largest plant families in Sri Lanka found in all terrestrial vegetation types. Seventeen field visits were undertaken to study the species of *Dendrobium* and *Bulbophylllum*. This year we were able to record *D.panduratum* and *D.macathiae*.Field work and data analysis of this project have now been completed. We were able to cover 47% of the photo documentation (62% of *Dendrobium* and 36% of *Bulbophyllum*). We have found six species of *Dendrobium* out of eight and seven *Bulbophyllum*out of eleven species reported for Sri Lanka. A further objective of this survey is to determine host plant specificity of our study species, which has now been completed.

Vegetative traits of all specimens were measured using a caliper and a measuring tape and dissected floral parts were drawn with the aid of a stereomicroscope equipped with a camera lucida. Vegetative and floral morphometric data will be analyzed using the delta software package. Result of this project have been reported in two manuscripts that are currently under review.

7.3.3.4 Biodiversity of soil scorpions and pseudoscorpions

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Sri Lanka possesses a highly diverse endemic fauna and flora and is a reservoir of unique evolutionary history. Unfortunately, Sri Lanka's diverse invertebrate fauna remains largely unexplored. Several taxonomic studies on both vertebrates and invertebrates were published during British rule of the island. The standard work on Sri Lanka's invertebrate fauna was published as a part of the monographic series “Fauna of British India, including Ceylon and Burma”, during this time. However, it did not treat many smaller arachnid orders like pseudoscorpions. Spiders were only partially covered, with the smaller species being overlooked. We are currently carrying out an islandwide survey of pseudoscorpions and spiders using a range of collection methods to sample a set of diverse habitats around the island.Our survey of pseudoscorpions produced 51 species belonging to 23 genera of which eight species might be new to science. The family Cheiridiidae was discovered in the island for the first time. Out of the 51 species, 20 species (40 %) are endemic to Sri Lanka. A checklist of Pseudoscorpions of Sri Lanka was published in the international peer-reviewed journal, ZOOTAXA.



7.3.3.5 The effect of six pesticides on development, behavior and immune response in the Asian hive bee, *Apis cerana*

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Honeybees are an ecological and agricultural commodity, in that they are responsible for 80% of insect pollination of agricultural crops. However, declines in global bee populations have been observed lately, with adverse ecological, agricultural and economic consequences. Recent studies have implicated pesticides as a key contributor to the decline in bee population (Brown & Paxton, 2012). Such pollinator/pesticide research has been conducted mainly on *Apis mellifera*, a honey bee species that is non-native to Sri Lanka. A study of how Sri Lankan bee species, such as *Apis cerana*, are affected by imported pesticides has yet to be conducted.

The aim of the proposed project is to analyse the effects of six pesticides on *Apis cerana* development, behavior, reproduction and honey production, at both the colony level and at the individual level. Colony composition is a key aspect of colony success. An increased number of workers results in more foragers as well as more individuals to care for the brood. If worker mortality increases or the queen produces less workers, less pollen will be collected and there may be insufficient care of the brood. At an individual level, memory is important to bees because it aids in foraging. Worker foraging performance, if inefficient, leads to a decrease in the volume of pollen collected. Aberrations in the bees' 'waggle dance' (Punchihewa *et al.* 1985) will also be assessed. Previous studies have demonstrated a trade-off between memory and immune reaction (Mallon, Brockmann & Schmid-Hempel, 2003). The final aspect of this study is to observe if different pesticides affect the trade-off between memory and immunity in different ways.

By conducting the proposed studies, we will have tangible data that demonstrates the effect of pesticides on *A. cerana*. This data can aid in the long-term increase of Sri Lankan agricultural output. The benefits are not limited to increasing the agricultural output of farmers who grow crops that rely

predominantly on natural pollinators, but also individuals who harvest honey and those in the beeswax industry.

Apis cerana is not only a vital part of our ecosystem but also a part of our Sri Lankan heritage and we must contribute to the conservation of this versatile species.

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7.3.4 Environmental Engineering

7.3.4.1 Anodic oxidation of Phenol in Contaminated Water on Dimensionally Stable Anode

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In electrochemical oxidation, high the chemical stability and good electro catalytic activity of anodes are mainly concerned and all these properties are closely related to the anode surface material. Therefore, various types of metal oxides have been researched on their catalytic activity.Moreover, since the overall performance is determined by the interaction of different parameters (i.e. current density, temperature), the selected anode has to be optimized to obtain economical efficient degradation. However, limited studies have been reported in literature towards the development and optimization of anode materials for specific contaminants such as phenol in water. Identification of optimized conditions is required for the effectiveness and efficiency of electrochemical process. Optimum performance not only depends on operational parameters such as pH, conductivity, current density and voltage, but also its electrode materials have significant effect on it.Specific objectives of the work presented here is to develop and optimize the anode materials of the electrochemical reactor cell to oxidize phenol/ phenolic compounds in contaminated water.Experimental results were found to be in good agreement with the predicted model. Therefore, RSM and CCD tools were successfully used in anode material optimization.The optimization study concluded that the anodes' optimum stability, electrochemical active area and removal efficiency were resulted when its' Ir and Sb contents are 0.08964 g/L and 0.924 g/L, respectively. The optimized anodes Chemical Oxygen Demand (COD) removal percentage was 83.1%.

7.3.5 Estimation of the subsurface extension of Eppawala apatite deposit

7.3.5.1 Magnetic anomalies and subsurface extent of the Eppawala phosphate deposit

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The phosphate deposit at Eppawala is one of the major economic mineral deposits in Sri Lanka. Despite its importance, no systematic survey has been done to estimate the extent of the deposit, since the first preliminary borehole survey carried out over four decades ago. This research project will employ methodology based on modern geophysical techniques to estimate the sub-surface extent of the phosphate deposit. Economic phosphate deposit which is currently mined for rock fertilizer is a secondary mineral deposit developed over an igneous body, commonly known as carbonatite. Rocks with considerable amounts of magnetic minerals generate magnetic anomalies. Magnetite is present in Eppawalacarbonatite, the parent rock, as well as in the phosphatic rock in considerable amounts so that these rocks generate magnetic anomalies, which can be mapped using magnetometers. Main objective of this project is to develop a geophysical methodology to differentiate the phosphatic ore from the surrounding country rocks and employ it to estimate subsurface extent of the Eppawla phosphate deposit. Total magnetic intensity of the area was obtained using GSM-19 Overhouser Proton precision magnetometer with integrated GPS, as shown in Fig. 01. After filtering the noises, data were processed to produce the magnetic anomaly map of the area (Fig. 02). Phosphate deposit can be demarcated using the sharp magnetic anomaly.

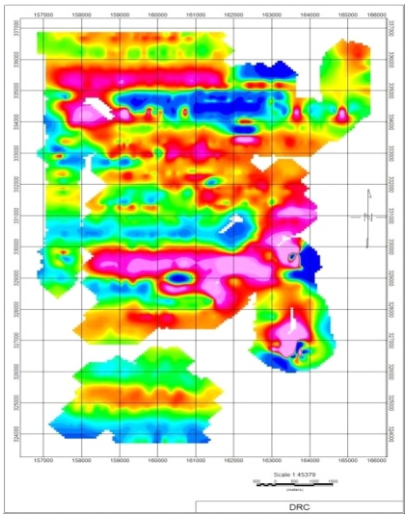

Figure 01: Total magnetic data before processing and noise filtering

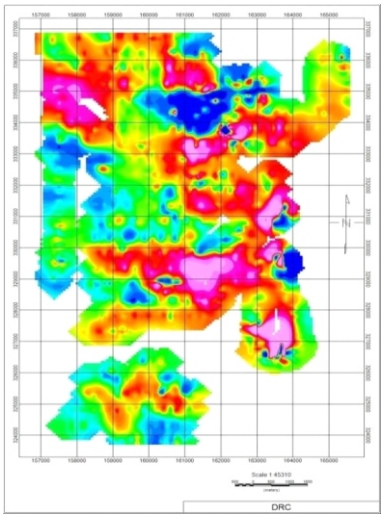

Figure 02: Magnetic anomaly of the area, after data processing and noise filtering.

7.3.6 Radon Monitoring

7.3.6.1 Radon mapping program in Sri Lanka

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Radon (Rn) is the heaviest naturally occurring noble gas and is produced by radioactive decay of uranium and thorium in rocks and soils. Radon itself is radioactive with its most stable isotope having a half-life of about 3.8 days. Radon concentration can vary from point to point to point, depending on various factors. It is known that the radon concentrations are higher in fractures, faults and any other deep structures and openings into the earth. Waters from the deep ground water springs are generally rich in radon due to the fact that water collects more radon while percolating through the deep underground rocks. Any higher than normal radon concentrations around the thermal springs is an indication that the water comesfrom within deep fractures. Radon mapping programme was initiated in collaboration with the Atomic Energy Authorityin Sri Lanka. First batch of 50 passive radon detectors were placed at predetermined locations around the country. Locations were selected on the basis of geology, deep structural features as well as the proximity to the hot springs. In-situ and exsitu radiation measurements of air, soil and water were taken at selected locations for comparison. Preliminary results identified certain areas with high background radiation in Sri Lanka. Gamma dose measurements and sample collection for laboratory gamma spectroscopy analysis were conducted at selected locations to study the distribution pattern of Radium (Ra-226 & Ra-224), the parent nuclides of Radon/ Thoron. Most of the high background values were recorded at river outfall locations. For example the highest value so far was recorded at Kumana, where Kumbukkan Oya outfalls to the sea, having over 29.6 millisievert (mSv) per year. Some of the other high-background radiation areas include Kalutara (28.9 mSv/yr), Uswetakeyyawa (22.8 mSv/yr), Pulmodai (20.7 mSv/yr) and Dikwella (15.8 mSv/yr). The worldwide average background dose for a human being is about 2.4 mSv/yr.

7.4 PHYSICAL AND COMPUTATIONAL SCIENCES

7.4.2.1 Computational investigation of Single Bubble Sonoluminescence

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Most theoretical and computational models of Single Bubble Sonoluminescence (SBSL) have been based on continuum fluid mechanics (e.g. Euler equations or Navier- Stokes equations) and they were able to simulate some of the experimental results successfully. Especially, the computational models developed by Yasui and others were able to simulate some sonochemical reactions correctly. Bubble collapse in SBSL can also be studied with Molecular dynamics (MD) and Monte Carlo methods. Two of the research groups; Puttermann's group at UCLA in USA and Kwak'sgroup at Chung-Ang University in Seoul, Korea have developed software based on MD methods to simulate the bubbles with 50000000 particles. However, realistic bubbles usually contain 10^8 -10^{10} particles. The aim of this project is to understand the mechanism which produces light in SBSL. In order to find out what is going on inside the bubble when it emits light, we use computers to simulate the physical situation inside the bubble during the collapse. The software based on the hydro-dynamical model developed in our laboratory for studying thecollapse stage of the bubble was used for investigating the temperature dependence of SBSL in liquids with various physical properties. Effects of driving pressure on SBSL light intensity of He/Ar and He/ Xe mixtures in water were investigated. A manuscript based on this work will be submitted for publication shortly.

7.4.2.2 Ab initio investigation of Sonochemical Reactions

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Using computational chemistry techniques, we studied sonochemical reactions which may take place inside the bubble and investigated how they may affect the overall behavior of the bubble and the light emission. Reaction mechanisms involving SO + NO and their reaction rates at the temperature 200K- 2000K are investigated using ab initio molecular orbital and transition-state theory calculations. The species involved in these reactions are optimized at CCSD levels with basis set ccPVTZ. The potential energy surface is determined computationally by MP2/6-31G (d,p) method. Further CCSD/cc-PVTZ levels of theory are employed to locate stationary points, which are then characterized by calculation of vibrational frequencies to identify the transition states. In this investigation, it was found that the possible products in the ground state are cis-SONO, SNO_2, transSONO, cis-NOSO, t-NOSO, NSO_2, cis-OSNO, trans-OSNO, S + NO_2 and N + SO_2 by mixing of SO + NO reactants. All intermediate states of the reaction SO + NO are positive energy of formation relative to its reactants. According to the reaction profiles of SO + NO, the molecular structures of the reactants are shifted to S + NO_2 (49.02 kcal/mol) via the four transition structures, shifted to N + SO_2 (25.22 kcal/mol) via the four transition structures and also shifted to trans-OSNO (13.39 kcal/mol) via the three transition structures. Calculated rates involving the reactions of SO + NO using variational transition state theory indicates that for temperature range 200K-2000K three parameter Arrhenius equation provides reaction rates with a higher accuracy. A manuscript based on this work will be submitted for publications shortly.

7.4.2.3 Experimental investigation of single bubble sonoluminescence

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Intensity of light emitted by the SBSL bubble depends on the physical properties of the host liquid as well as the external conditions such as dissolved gas concentration, ambient pressure, ambient temperature, acoustic driving pressure, and driving frequency. For water based SBSL, many experimental investigations have revealed that the total intensity of light emission increases with decreasing ambient temperature and the light intensity observed at 0 degrees was 100 times brighter than at 30 degrees. Among all the liquids tested so far, sulfuric acid produces the most intense SBSL flashes. Until now, it has never been investigated experimentally how the intensity of light produced by SBSL in sulfuric acid solutions varies due to changes in ambient temperature. Nevertheless, few years ago, it has been theoretically predicted that temperature dependence of light emission in H_2SO_4 is quite opposite to the same observed in water. Through computational simulations, they have found that in fact light intensity decreases as ambient temperature of H_2SO_4 solution decreases. This remarkable result has never been tested experimentally so far. We have experimentally investigated the temperature dependence of the light emission in H_2SO_4 and confirm the theoretically predicted results. Further we found that SBSL spectrum in 85% wt H_2SO_4 solution shows higher spectral density in the visible region at lower temperatures and moves towards UV as temperature increases. This behavior is completely opposite to what has been observed for water and no theoretical predictions have been made so far.

8. COLLABORATIVE AND CONSULTATIVE DIVISION (CCD)

8.1 Growing *Spirulina* to Fight Malnutrition in Sri Lanka

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Spirulina is a cyanobacterium that stimulates good health and is used as a food supplement especially against malnutrition. The aim of this pioneer project was to investigate large scale cultivation of *Spirulina* under outdoor conditions of Sri Lanka. The inoculum required to commence experimentation was initially obtained from India. This original material was purified through subculturing in Zarouk's medium at the NIFS laboratories, semi-mass cultured in the green house and these mother cultures were used as inoculants for the outdoor cultivations at Kanugala, Kurunegala District. Sterile mother cultures were also maintained in conical flasks and glass containers to adapt them to ambient conditions at Kanugala. They were multiplied in glass tanks and used to inoculate the concrete lined outdoor tanks each of 2m x 4m. A low cost medium similar to the one used in India for mass production was used initially. Each tank was covered with a net to prevent insects and debris falling into them. UV filtering plastic sheets were also used to cover pairs of tanks which protected them from litter fall and bird droppings. The pH of the medium maintained between 8.5 to 11.0 prevent the growth of other algae. The average ambient temperature of 35°C was favorable for rapid growth. Each culture tank was stirred manually four times a day to facilitate exchange of gases and dispersal of material and nutrients. After 18 months, 20 outdoor tanks were established in the tank farm. The harvested material had 10% dry weight, 63% protein and 13.2 mg/g chlorophyll. Dried and powdered material were tested at the ITI for protein content, vitamins, heavy metal contents especially arsenic, cadmium, lead and mercury. A comparison of growth and quality of *Spirulina* in a Swiss medium conducted in glass tanks showed 13% dry weight, 67% protein and 13.5 mg/gm chlorophyll but it is necessary to evaluate the economic cost of using this medium on a large scale. These results show that *Spirulina* can be cultivated successfully in Sri Lanka under controlled and clean conditions.

8.2 Preliminary field assessment of rhizobial inoculants for vegetable bean (*Phaseolus vulgaris*)

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Coir dust based inoculants for vegetable bean *Phaseolus vulgaris* developed by isolation, screening and selection from several rhizobial strains initially isolated from diverse bean cultivations were field tested in farmers' fields at Doragala, Hanguranketha and Rikillagaskade. As our intention was to test the performance of inoculants under the conditions used by the farmers, inoculations were done under farmers' practices. Therefore plot sizes, fertilizer types and applications varied in the different localities. The plot sizes were: Doragala (1m x 12m), Hanguranketha (2m x 3m) and Rikillagaskade (4m x 4m). The treatments were: control without fertilizer additions and inoculation, fertilizer application without inoculation and the application of inoculants without fertilizer. While visual observations on growth and nodulation on randomly uprooted plants were made, data were recorded from five bean harvests taken during one season. Plant growth was better and nodulation increased under inoculation. The results clearly show that both fertilizer application and inoculation have recorded yield increases over the control treatments but there is no difference between the two former treatments. It can be inferred that inoculation can improve the yield of bean to the same extent as fertilizer application. Therefore rhizobial inoculants have the potential to reduce the cost of fertilizer as well as minimize environmental pollution due to the application of fertilizer. Further field trials are in progress to confirm these preliminary findings.

8.3 Rhizobial inoculants on clover in the highland pastures of Sri Lanka: A preliminary study

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[1] *National Institute of Fundamental Studies, Kandy, Sri Lanka*
[2] *Ambewela Farms, Ambewela, Sri Lanka*

A field assessment of inoculating clover plants was carried out for the first time in Sri Lanka in the highland pastures of Ambewela Farms. The objectives of these studies were to develop a low cost technology to improve biological nitrogen fixation in pasture lands and minimize the use of Nfertilizers that pollutes the environment of these pristine highland watersheds of Sri Lanka. Inoculants were prepared from several rhizobial isolates obtained from naturally growing clover plants and screening and selecting the more efficient strains. Field testing was done by applying inoculants and urea fertilizer to monocultures of *Trifolium subterraneum* (white clover) as well as mixed cultivations with grass under different levels of N-fertilizer. Treatments under monoculture were: No urea fertilizer and no inoculation (control); recommended level of urea fertilizer; seed inoculation with coir based inoculants and liquid inoculants at planting. The clover-grass mixed culture had the following treatments: Control without application of urea and inoculants, and a series of urea applications at 0, 25%, 50%, 75% and 100% of the recommended levels with and without inoculation. Application of urea and liquid inoculants was also done 5 days after each crop cut taken at 45d and 28d intervals respectively for the monoculture and mixed culture experiments. Treatment plots were 2m x 3m, randomly arranged with 3 replicates per treatment on each site. Both trials were conducted on three different sites to represent differences in land topography. Biomass production monitored for 12 months showed no difference between clovermonoculture under N-fertilization and inoculation but both were better than the control. It can be inferred that inoculation has the potential to replace N-fertilizer application. Results of the mixed culture trial were not so clear but showed that inoculation could replace N-fertilizer to some extent. Further work is in progress to confirm the results.

PART III

STAFF NEWS

09. AWARDS, RECOGNITION, PATENTS

1. **Prof. M.A.K.L. Dissanayake**
   - Invited Speaker at the Asian Conference on Solid State Ionics (ACSSIS-2014) held at National University of Singapore.
   - Presidential Awards for research publications in SCI journals in 2010, 2011 and 2012 (Awarded in November 2014).

2. **Dr. W.P.J. Dittus -** Listed in Wikepedia:http://en.wikipedia.org/wiki/Wolf_Dittus

3. **M.C.M. Iqbal**
   NRC Merit Award for Scientific Publications (2011)

4. **Prof. U.L.B. Jayasinghe -**Presidential Award for Scientific Publications 2012

5. **Prof. A. Nanayakkara -** Presidential awards 2011, 2012, 2013

6. **Prof. G. Seneviratne -** Presidential Awards 2011

7. **Dr. G.K. Rohan Senadeera**
   - Presidential Awards for research publications in SCI journals in 2010, 2011 and 2012 (Awarded in November 2014).
   - Annual Research awards 2012/2013, in the discipline of Natural Sciences ,The Open University of Sri Lanka (Awarded in November 2014).
   - National Research Council Merit awards for research publications in SCI journals in 2010, 2011 and 2012 (Awarded in December 2014).

8. **Dr. M.S. Vithanage**
   - Presidential Awards for Scientific Publications for 2012
   - Received the Commendation Award for Popularization of Science by National Science Foundation, 2014
   - Received SUSRED awards for 2013 from the National Science Foundation, Sri Lanka for the supervision of MPhil degrees of Mr. S.S.R.M.D.H.R. Wijesekara graduated from PGIS (2013) ? Received NRC Merit Award for Scientific Publications for 2011

9. **Dr. ViduangaWaisundara**
   - Chairperson of two conference sessions of the 17th International Union of Food Science andWorld Congress in Montreal, Canada.
     - Concurrent Session 3.5: Industrially-Relevant Products & Issues – Sodium & Sugar Reduction on 18 Aug 2014.
     - Concurrent Session 10.6: Chemistry – Food Bioactives: Identification, Characterization & Efficacy II on 21 August 2014.
   - Invited to serve as a member of the jury of the Institute of Food Technologists (IFT) AchievementAwards 2015 by the Office of the President ofIFT, USA.
   - Developing Country Sponsorship Award to attend the 17th International Union of Food Science & Technology World Congress in Montreal, Canada.

10. **Dr. A. Wijayasinghe**
    Inclusion under the Ten Thrust Tecnological (3T) areas:
    The proposed research on *Development of Sri Lankan natural vein graphite for rechargeable batteries* has been recognized under the Mineral Resources Focus Area in National Research and Development Investment Framework for 2015-2020.

12. **Mr. C.A. Thotawatthage**
    NRC Merit Awards for research publications in SCI journals in 2011 and 2012 (Awarded in 31st October 2014).

13. **Science Education and Dissemination Unit (SEDU)**

- SEDU Team of OSCEM (ViduNenaHawula-Science Message service) won a National Award under the category of e-Learning & Education at the e-Swabhimani, National Best e-content award 2014.

- The e-Swabhimani is an initiative of the Information Communication Technology Agency (ICTA) of Sri Lanka aimed at recognizing excellence in digital content creation. The eSwabhimani Award process is being conducted along the lines of the World Summit Award.

10. DISSEMINATION OF SCIENCE

10.1SCIENCE EDUCATION AND DISSEMINATION UNIT

Objectives:

A. Foster the exchange of Technical and Scientific information for the Scientific community

B. Promote public understanding of science

A SPECIAL SESSIONSFOR THE SCIENTIFIC COMMUNITY

A.1 Special Lectures & Research meetings at the NIFS Auditorium, Kandy

"Climate change and water resources", 19th March, 2014
Dr. JayanthaObeysekera, Chief Modeler, South Florida Water Management, Florida, USA.

- **"A comparative study on floristic diversity,structure and dynamics of tropical dry mixed Evergreen forest in Sri Lanka"**, 19thApril, 2014 *Mr. A.B. Medawatte, Research Assistant, NIFS.*

- **"Biofuel Production from lignocellulosic materials",** 19th May, 2014 *Mr. M. Kathiragamanathan, Research Assistant, NIFS.*

- **"Improving thermoelectric systems and materials"**,17th July, 2014
Prof. Bastian, Georg/ Faculty of Technology and Bionics, Rhein-Waal University for Applied Science, Germany.

- **"CKDU Revisited"**,18th July, 2014
Prof. R.M.G. Rajapakse, Senior Professor in Chemistry, Faculty of Science, University of Peradeniya.

- **"An optimized MIRU-VNTR typing system and spoligotyping for population –based molecular epidemiology studies of tuberculosis"**,29th July, 2014
Ms. DulanthiWeerasekara, Research Assistant, NIFS.

- **National workshop on "Investigating bioactive metabolites from natural sources**", 13th to 17th October, 2014
Natural Products Research Group, NIFS

- **"Nuclear Education for Young Generation Focusing on Radiation –Introduction to Experience of Japan**", 10th December, 2014.
Prof. T. Iimoto,NationalInstitute of Radiological Science, Japan.

A.2 Laboratory Training for Undergraduate Students

- University of Ruhuna, Sri Lanka
  Fifteen undergraduate students of Agricultural Biology special degree programme visited IFS labs to improve their practical knowledge related to Plant biology, Microbiology and Agricultural science on 17th June 2014.
- University of Peradeniya
  Ten undergraduate students of Botany special degree programme visited IFS labs to improve their practical knowledge related to Plant biology, Microbiology and Agricultural science on 16th October 2014.
- Rajarata University of Sri Lanka
  Ten undergraduate students of Agriculture engineering and Soil science special degree visited IFS labs to improve their practical knowledge related to Plant biology and Microbiology 21st November 2014.

B. PROMOTION OF PUBLIC UNDERSTANDING OF SCIENCE

Special Projects carried out during the year 2014

B.1 Inculcating Science towards an Innovative Future (ISTIF)

Funded by UNESCO

Collaborator: Department of Education, Central Province

The first phase of the project ?Inculcating Science towards an Innovative Future' (ISTIF) granted by United Nations Educational, Scientific and Cultural Organization (UNESCO); Inculcating scientific methodology and novel teaching techniques for the level of Junior Secondary Education was successfully completed. This was conducted as a series of workshops that consisted of 14 workshops in Sinhala and Tamil with the participation of 1160 science teachers of the central province. The second phase of this project; a competition for teachers is now in process while the third phase will be completed during the first half of the year 2015.
http://istifs.blogspot.com/

B.2 ViduNenaDasunaYoutube Channel-VND

Funded by National Science Foundation, Sri Lanka

Project team : Dr. KumariTilakaratne (Team leader)
Mr. Ashan Ginige (Technical Assistant)
Mr. DinushaNawaratne (Junior Research Assistant)

The project – Vidu Nena Dasuna Youtube Channel was launched with the aim of demonstrating science lessons and experiments to students in Sinhala and making science a simple and interesting subject. This project is funded by the National Science Foundation from 2014 and currently consists of about 20 short videos covering different lessons & experiments included in the G.C.E. O/L and A/L syllabuses as well as other experiments that can be done by students themselves. Vidu Nena Dasuna has received positive feedback throughout the few months that passed and is being viewed by thousands of students islandwide. www.youtube.com/user/IFSVND

B.3 Vidu Nena Hawula./Open Science Circle in Electronic Media (OSCEM)

Project team: Dr. Kumari Tilakaratne (Team Leader)
Mr. VirajEkanayake (Technical Officer)
Ms. DineshiThalakiriyawe (Junior Research Assistant)

ViduNenaHawula Science Message Service, also known as OSCEM (Open Science Circle in Electronic Media) was launched in January 2012 with the aim of improving the science literacy and scientific temperament of Sri Lankans.
OSCEM offers a combination of services to its members to improve scientific knowledge as well as to develop the inquiring minds, and the enthusiasm about science among the school community and the general public. It provides a daily Science message service via text messages (sms), e-mails and social networks such as facebook and twitter, a Science Blog in Sinhala and also a question and answer section. In addition, it provides an open forum for the subscribers to discuss their problems related to science behind day-to-day activities with the scientific community. This free service is provided on all weekdays except on government holidays via text messages, e-mails and social networking websites. http://vidunenahawula.sciencerays.com

Marking a grand milestone of OSCEM, the 500th Science Message was sent by the honourable minister of Technology and

Research, Minister PataleeChampikaRanawake on 15th July 2014.

Ms.TharushiRanawake was the top ranker of this service for the year 2013/2014 and the Gold Medal and certificate was awarded to her by UNESCO Laureate Prof. Atta-Ur-Rahaman on 13th October, 2014 at National Institute of Fundamental Studies.

OSCEM is the first Science Message Service in South Asia and the service is provided free of charge. It has also won a National award in the category of e-learni i National Best E-content Award 2014 and is being continued successfully.



B.4 MASS project (Mobile Applications for Science Students)

Project team : Dr. Kumari Tilakaratne (Team leader)
Mr. VirajEkanayake (Technical Officer)

MASS is the first ever known Mobile Application project that creates mobile applications in Sinhala to enable Sri Lankan students to learn science in a novel and more exciting manner. The first Application of this project "Periodic Elements"which is created in the form of an interesting educational game, not only makes it easy for the students to memorize the properties of the chemical elements that are included in their syllabuses, but also gives them the opportunity to learn chemistry as a new & unique adventure. This project too will be updated with more apps and games during the upcoming years.

https://play.google.com/store/apps/details?id=com.virajlive.cardgame

B.5 Sinhala Science Web Site: Vidumanpetha

Project team : Dr. Kumari Tilakaratne (Team leader)
Mr. Gayan C.K. Bandara (Technical Officer)

The website "Vidumanpetha"was launched with the intention of providing a reliable source of scientific information in Sinhala. This website contains many scientific articles written by scientists, scientific games, interesting scientific experiments, a scientific glossary etc.Vidumanpetha is the first ever Sinhala Science web site and has also won a juror's Special Merit award in the category of Elearning and Education at the e-Swabhimani National Best E-content award 2012 and is being continued successfully.
http://www.vidumanpetha.com/

B.6 World ScienceWeek 2014

In celebration of the World Science Week 2014, a project that consisted of a workshop, competitions for students and a Public Awareness programme was organized in collaboration with the Foundation of Astronomical Studies and Space Exploration.

An introductory session f vareness programme was held on 14th October 2014 at the I rom about 10 different schools in Kandy



- A workshop was held for School students on 11th November 2014 at the IFS premises with the participation of about 70 students. This workshop consisted of a Lecture on "Mysteries in Science"conducted by Professor AsiriNanayakkara, and included many Inter-school Competitions and Activities.

  Competition 1-"Space Technology, in a nutshell"
  In this competition, students were asked to prepare short videos or Power Point presentations under the theme "Space Technology, for the benefit of human beings".

  The second and third places of this competition were won by students of Sri Chandananda Buddhist College and Girls'High School Kandy respectively who were awarded trophies and certificates. The first place was not awarded since none of the presentations were up to the expected standards of the jury.

  Competition 2- "Life in Space"
  This competition was based on an activity that students were assigned at the workshop. Students were expected to provide solutions to overcome difficulties that they would have to face if they were to live in another celestial body.

  The first, second and third places of this competition were won by students of MahamayaGirls'College, Girls'High school and PeradeniyaCentralCollege respectively and they too were awarded with trophies and certificates.

  Competition 3- "SpaceConqueror"
  The winners of the space model creating competition, "SpaceConqueror"were also awarded at this programme and their models too were displayed at the exhibition. The first place of this competition was won by students of Sri Chandananda Buddhist College and the second and third places were won by students of Peradeniya Central College.

- The public awareness programme on "Space Technology for the benefit of human beings"was conducted at the Kandy City Center on 15th of November 2014. Over 1500 people participated in this programme which consisted of an exhibition, demonstrations of space models, and special events for kids etc.





B.7 Nanotechnology awareness programme:

As a continuation of Nanotechnology awareness programme we conduct lectures on request.
Dr. KumariTilakaratne conducted a series of lectures on Nano Technology in the following occasions.

- For 200 students of Ratota Divisional secretariat on 06th May,2014at ParakramaVidyalaya.
- For 100 students of Panvila Divisional secretariat on 17th September, 2014 at Panvila Rajasinghe Vidyalaya.
- For 100 students of Elkaduwa Divisional secretariat on 22ndDecember, 2014 at Elkaduwa Sinhala MahaVidyalaya.

B.8 Science Day programmes at Education zones & schools

Dr. KumariTilakaratne was invited as the Chief Guest for the following Science day programmes and delivered the following keynote lectures:

- Lecture on "Biomimicry",23rd June,2014 at Holy Family B.M.V., Kurunegala
- Lecture on "The importance of learning Science" on 30th September,2014at Dunhinna Secondary School,

Teldeniya.

Dr. KumariTilakaratne was invited for the judging panel of "Student Science competition" at the Science day programme of Kotmale Education Zone held on 04th July 2014.
Science day programme of Kotmale Education Zone held on 04th July 2014.

B.9 Science camp

A Science camp was conducted by the SEDU team for 965 students of grade 6,7 and 8 of MahamayaGirls'College on 25th June 2014. The workshop consisted of a lecture by Dr. KumariTilakaratneon?The importance of scientific observation"and simple scientific experiments were demonstrated.

B.10 Young Leaders Workshop

A special programme was conducted on the 20th of June 2014 for the "Young Leaders"of the National Science Foundation. The programme consisted of two lectures, lab visits and some other activities to enhance their science communication skills.

B.12 School Science Programme 2014 (SSP)

The School Science Programme (SSP) is one of the most important programmes annually conducted for the dissemination of science among the younger generation. The primary goal of the SSP is to expose young students to a few selected frontier areas of science and to provide an opportunity for them to interact directly with scientists actively engaged in research.

This programme was successfully held for the 41st time this year with the participation of 120 students from all over the country.

Tuesday 16th December

Use Your Time Effectively For a Bright Future
Dr. JayalathEdirisinghe, Senior Lecturer - Civil Engineering / Director- Centre for Distance and Continuing Education, University of Peradeniya
Rocks and Health
Prof. C.B. Dissanayake,Director, National Institute of Fundamental Studies

Wednesday 17th December

The Science of Food: Chemical and Sensory Aspects
Dr. Viduranga Waisundara,Research Fellow, NIFS
Che Magic
Prof. J. Bandara,Research Professor, NIFS

Thursday 18th December

Field Visit to Randenigala Power Station

Friday 19th December

Mysteries in modern Physics
Prof AsiriNanayakkara,Research Professor, NIFS
The Limits of Science
Dr. M.C.M. Iqbal,Senior Research Fellow, NIFS

Collaborators:

Department of Education,Central Province for the United Nations Educational, Scientific and Cultural Organization

(UNESCO), **project No. 6651137004SRL"**Inculcate Scientific Methodology and Novel teaching techniques for the level of Junior Secondary Education in Sri Lanka**"**.

Human Resource Development

Training: Pre University Research Assistants

Ms. Navindra Keerthisinghe (upto 31st of January 2014)
Ms. DineshiThalakiriyawe (from 1st of February to date)
Mr. DinushaNawaratne (from 20th January 2014 to 31st October 2014)
Mr. SachinthaWanigasekara (from 11th September to date)
Ms. SareethaKarunathilake (from 1st October 2014 to date)

Trainee-Information Technology

Mr. VirajEkanayake (upto 9th April 2014)
Mr. A.R. Ginige (upto 31st March 2014)

Trainee- Personal Secretary

Ms. ThiliniSumanarathne (16th January to date)
Ms. UshaniAbeyratne (7th August to 6th September 2014)

Volunteers

Ms. ManjanaJayaratne(24thNovember 2014 to date)

10.2 DISSEMINATION OF SCIENCE BY RESEARCH GROUPS

a) Physical and Computational Sciences

All the members of our group conducted laboratory sessions for the students participating in the NIFS School Science Programme (SSP)-2014, 16th - 19thDecember 2014. Number of school students participated: 100

b) Nanotechnology & Physics of Materials

- World science week 2014 introduction program, 14.10.2014
- School competition and school astronomical workshop, 11.11.2014
- Exhibition, Space technology for the benefit of human beings, 15.11.2014

c) Natural Products

- Prof. U.L.B. Jayasinghe, Prof. N.S. Kumar, Resource Persons, *National Workshop on Investigating Bioactive Metabolites from Natural Sources: Enzyme Inhibitory Studies, NMR &LC-MS Interpretation, National* Institute of Fundamental Studies, 13th – 17th Oct., 2014.
- Prof. U.L.B. Jayasinghe, Prof. N.S. Kumar, Resource Persons, *Workshop on "An introduction to HPLC & its applications in Natural Product Analysis"* -Palmyrah Research Institute, Jaffna.20th Dec., 2014.
- Mr. D.S.Jayaweera. Technical Support, *Workshop on "An introduction to HPLC & its applications in Natural Product Analysis"* -Palmyrah Research Institute, Jaffna. 20th Dec., 2014.

d) Biodiversity and Conservation Human-Monkey Conflict:

- Sri Lanka National Science Foundation: Workshop on Human-Monkey Conflict, held in Colombo on 10th April, 2014.
- Ministry of Wildlife Resource Management: Workshop to Mitigate Human- Monkey Conflicts and Conserve Sri Lanka's Non-Human Primates, held in Colombo on 15-16 November, 2014.

International Documentary Films: Much of our time was devoted to "global conservation education" by way of assisting in the production of a film by Disney Productions, regarding the behavior of macaques at Polonnaruwa. This film, with its entertaining and educational qualities reaches an audience in the millions of people globally with an imbedded subtle message of a need for the conservation of nature.
Disney Productions (USA): "Monkey Kingdom" See trailer

http://www.youtube.com/watch?v=LmspxQvCUrY

e) Cell Biology Project
- School Science Program, 18th December 2014, 150 students
- Young Leaders workshop, 20th July 2014, 22 students

f) Geothermal Energy Project

Number of participants - about 120.

Ms. S.A. Samaranayake, Mr. K. Kobbakaduwa and Mr. SanathOpatha conducted demonstrations and lectures at school science program.

g) Plant Biology Project
- School Science Research Project organized by the National Science Foundation, September – December 2014. Three students from Methodist College, Kollupitiya.
- Demonstrations at the Annual School Science Program organized by National Institute of Fundamental Studies. December 2014.
- Lecture on '*Limits of Science*' at the Annual School Science Program organized by National Institute of Fundamental Studies. December 2014.
- Awareness program on biodiversity conducted by Mr. A. Medawatte at Hindu College Digana, Rajawella. 200 students, 20 June 2014.

11. LIBRARY

Our Mission:

The Mission of the NIFS library is to assist research staff and students to acquire the relevant literature for their research.

Services:

User Services, Technical Services and Reference Services

- Keep current records on resources, literature and selected publications in the library collection.
- Ordering and acquisition of books, journals and miscellaneous publications.
- Org[illegible] information aler[illegible]
- Col[illegible]





Our Collection includes Books & Periodicals
Photographs
Correspondence
Newspapers articles
CD's Video's and electronic materials
Maps, Posters
Government documents (gazettes, circulars)
Architectural documents
Data on public works
Text and Ephemera Directories
Biographies
M.Phil.and Ph.D. theses

Special Collections

Prof. A. Kovoor's collection, Prof.Stuiver's collection, Mr. Lionel Liyanage's collection, Mr. V. Manoharan's collection, Professor Tissa R. Herat's collection, Prof. S. A. Kulasooriya's collections and the Sri Lanka Collection.

Present collection of the IFS library:

Collection	Added during2013 January-December	Total as on 31st December 2013
Books	73	6500
Theses	-	105
CDs	13	381
Maps	56	535
Reports	18	523
Subscription to journals Exchange	12	>1000
Base journals	18	>1000
Reprints	39	767
Newspaperarticles	30	142

Following multidisciplinary journals are available on line / print version.

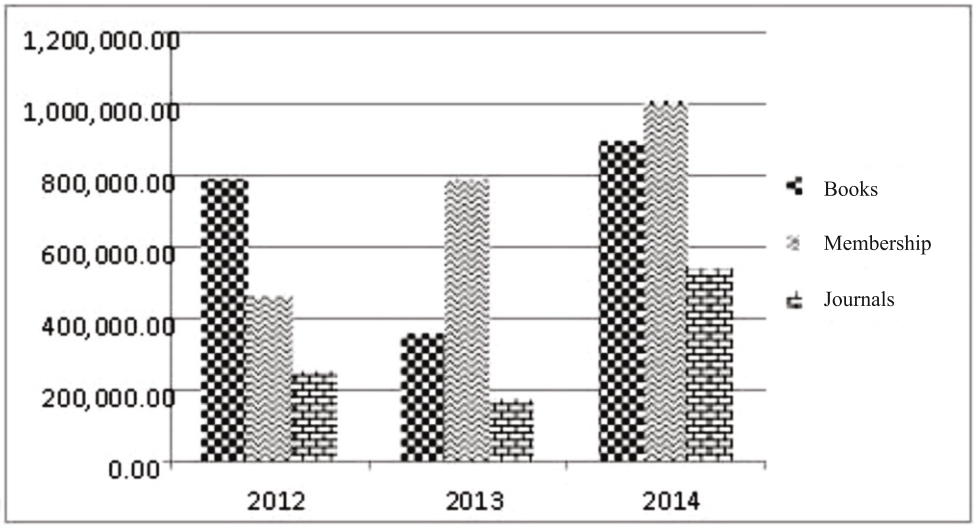
	Journals	**Periods**
01.	Chemistry in Sri Lanka	1984-2014
02.	Current Science	1999-2014
03.	Economic Review Sri Lanka	2010-2014
04.	JARQ-Japan Agricultural Research Quarterly	1998-2014
05.	Journal of National Science Foundation of Sri Lanka	1973-2014
06.	Journal of the Institute of Engineering, Sri Lanka	1994-2014
07.	National Geographic	2008-2014
08.	Nature	1962-2014
09.	New Scientist	1982-2014
10.	Resonance: Journal of the Science Education	2000-2014
11.	Science	1955-2014
12.	Scientific American	1951-2014

The Library also provides access to the OARE data base through subscription. OARE provides online access to one of the world's largest collections of environmental science research over 5710 peer-reviewed scientific journal titles and 1119 online books, owned and published by over 350 publishers.

This library as well provides online subscriptions to specialized journals to individual scientists. Currently the 40 specialized journals are available online through this scheme.

Reader Services Statistics 2014

Total book circulation	561
Total Journal circulation	186
Provided on line journal articles	190
Number of Visitors	7



Budget allocation Rs. for the past few years

Library Networks

Member of the SLSTINET and AGRINET

Current Research

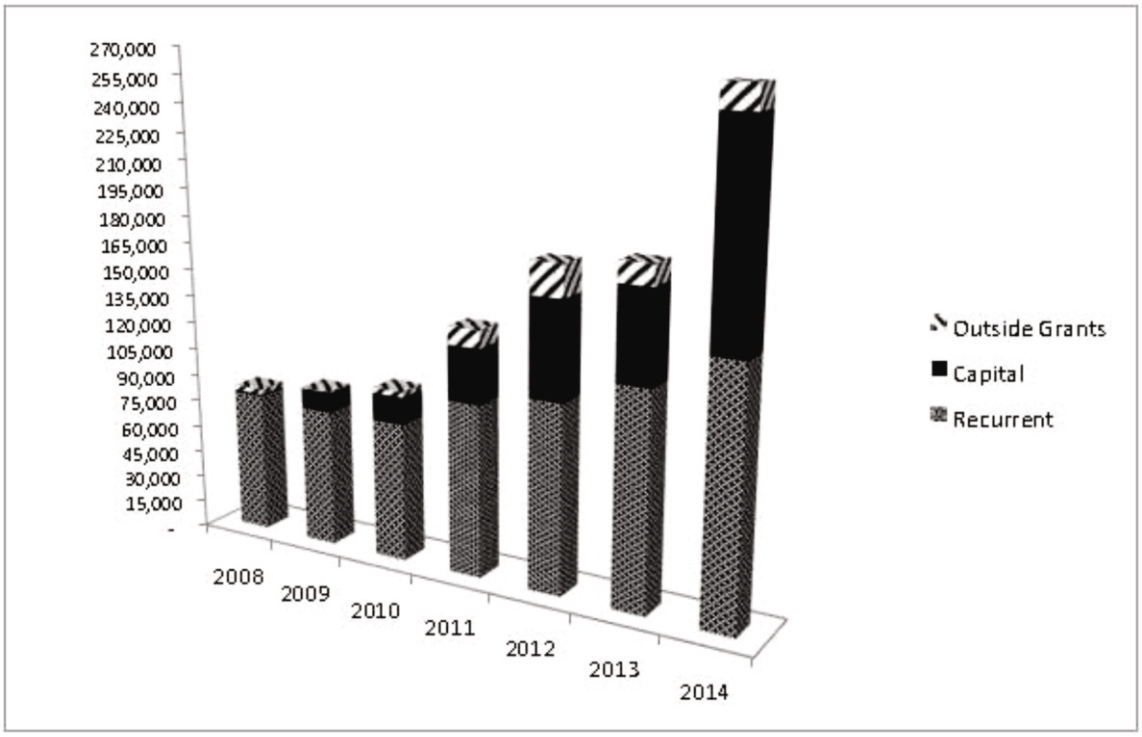
- Information needs and information seeking behavior of Geoscientists in Sri Lanka.

Other Activities

Made presentation on "Improving reading habits in children and introduction of Library System

- Perawatha /UdadelthotaKanishtaVidyalaya and Shiva ShakthiVidyalaya, Deltota, Kandy. September 22,2014
- Badi-Ud-Din Mahmud Girl's College, Kandy, Library Day, November 5, 2014 (Participation 500 Students)
- PilvalaMahaVidyalaya, Pilwala, Kandy, November 14, 2014
- UdudumbaraPradesiyasabava, Kandy,PalathPalanaSathiya, June 19, 2014

Item	2008	2009	2010	2011	2012	2013	2014
Recurrent							
Personal Emoluments	56,107	48,826	51,945	64,723	71,734	84,561	88,317
Travel Expenses	591	338	570	531	581	532	1,295
Supplies	5,355	7,822	6,763	7,484	8,952	10,018	16,491
Maintenance Expenses	4,165	6,035	5,063	5,454	3,796	2,891	8,496
Contractual Services	11,618	6,043	9,817	12,488	13,540	14,258	16,396
	237	6,992	2,509	4,042	4,306	5,185	6,497
Recurrent Expenditure	78,073	76,056	76,667	94,722	102,909	117,445	137,492
Capital							
Capital Expenditure	1,344	11,216	15,123	29,731	52,644	49,210	111,897
	1,344	11,216	15,123	29,731	52,644	49,210	111,897
Outside Grants	2,893	536	2,996	9,752	17,425	11,068	12,512
	2,893	536	2,996	9,752	17,425	11,068	12,512
Total	82,310	87,808	94,786	134,205	172,978	177,723	261,901



Total Annual Expenditure for the past seven years

13. IFS STAFF NEWS – 2014

13.1 RECRUITMENTS

The following staff were recruited to the NIFS in 2014:

Mr. A.Manjceevan	- Research Assistant Gr.I
Mr. G.R.N.Rathnayaka	- Research Assistant Gr.II
Ms. D.Thanabalasingham	- Research Assistant Gr.II
Mr. M.M.Qader	- Research Assistant Gr.II
Ms. W.T.Awanthi	- Research Assistant Gr.II
Ms. R.M.A.S.Ratnayake	- Research Assistant Gr.II
Ms. S.A.Samaranayake	- Research Assistant Gr.II
Mr. K.P.V.B.Kobbekaduwa	- Research Assistant Gr.II
Mr. A.M.J.S.Weerasinghe	- Research Assistant Gr.II
Mr. R.I.C.N.Karunaratne	- Research Assistant Gr.II
Ms. M.I.Watawana	- Research Assistant Gr.II
Ms. N.N.Jayawardena	- Research Assistant Gr.II
Ms. P.C.Wijepala	- Research Assistant Gr.II
Ms. R.Vishvanathan	- Research Assistant Gr.II
Ms. R.M.G.C.S.K.Jayathilake	- Research Assistant Gr.II
Mr. D.M.V.Y.S.Bandara	- Research Assistant Gr.II
Mr. K.N.L De Silva	- Research Assistant Gr.II
Ms. R.M.N.M.Rathnayake	- Research Assistant Gr.II
Ms. D.M.D.M.Dissanayake	- Research Assistant Gr.II
Ms. H.M.S.Wasana	- Research AssistantGr.II
Ms. E.G.C.K.Priyadharshika	- Research Assistant Gr.II
Mr. D.M.T.U.Bandara	- Research Assistant Gr.II
Mr.M.P.D.K.Malwewa	- Office Aide
Mr.A.G.S.T.Gunathilake	- Management Asst. Gr.III
Mr.B.J.Weerasooriya	- Management Asst. Gr.III
Ms.L.N.M.D.S.K.Nishshanka	- Accounts Officer
Mr.V.M.Ekanayake	- Technical Officer Gr.III
Mr.G.C.K.S.Bandara	- Technical Officer Gr.III
Mr.H.A.D.N.Jayasinghe	- Driver Gr.III
Ms.R.M.Witharana	- Library Assistant Gr.III

13.2 International/National Committees

Prof. M.A.K.L. Dissanayake

- Served as a member of the Ministerial Committee on Emerging Technologies (2014) for developingthe S&T strategy for Sri Lanka for the next 10 years.
- Served as a member of the Ministerial Committee on S&T Framework (2014)
- National Point of Contact (NPC) of Asian Physics Education Network (ASPEN, UNESCO) 2014.
- Member, Board of Management of the National Institute of Fundemantal Studies (2014)
- Member, Board of Management of the Postgraduate Institute of Science (PGIS), University of Peradeniya (2014)
- Member, Faculty Board of Science, University of Peradeniya (2014)
- Member of the Committee on International Liaisons, and Member of the Committee on S&T Policy Research.
- Member of the National Science Centre of the National Science Foundation (NSF), Sri Lanka (2014).
- Reviewer for Journal of Power Sources (Elsevier), and ElectrochemicaActa (Elsevier) (2013) and Journal of the National Science Foundation (JNSF), Sri Lanka (2014).
- Reviewer for several Research Grant Proposals from NSF, NRC and Universities.

Dr. W.P.J. Dittus
Editorial Board and Reviewer for Journal of Primatology

Dr. M.C.M. Iqbal
- Member of the Council of the Royal Asiatic Society of Sri Lanka
- Member of the General Research Committee, Sri Lanka Association for the Advancement of Science
- Member of the Science and Technology Advisory Committee of the Sri Lanka Association for the Advancement of Science.
- Member of the Working Committee on Environment and Biodiversity of the National science Foundation, Sri Lanka

Prof. U.L.B. Jayasinghe
- Fellow, National Academy of Sciences, Sri Lanka.
- Member, Governing Board of Institute of Fundamental Studies,
- Member, Research Committee of the Faculty of Science, University of Peradeniya.
- Committee Member, Sri Lanka Association of the Alexander von Humboldt Fellows.
- Member, Editorial Board, *Ceylon Journal of Science*.

Dr. RuviniLiyanage
Reviewer to following Journals**:**
- British Journal of Nutrition
- Bioscience, Biotechnology, and Biochemistry
- Asian Journal of Agriculture and Food Science
- PGIA, University of Peradeniya

Prof.N.S. Kumar
- Fellow, National Academy of Sciences, Sri Lanka.
- Member,Technical Advisory Committee on Good Laboratory Practices, Sri Lanka Accreditation Board.

Dr. D.N. Magana Arachchi
- Committee member; Board of Study in Biochemistry & Molecular Biology, Post Graduate Institute of Science (PGIS), University of Peradeniya, Sri Lanka
- Committee member; Sri Lankan Society for Microbiology (SSM)

Dr. G.K.R. Senadeera
- Editorial Board Member, Journal of Solar Energy Research Updates, Avantipublishers.com
- Reviewer for Journal of Photochemistry and Photo Biology A . Chemistry

Prof. G. Seneviratne
Journal editor: G. Seneviratne is an Associate Editor, Agriculture, Ecosystems and Environment, which is an SCI journal, published by Elsevier.

Dr. C.T.K. Tilakaratne
- Team Leader [Science & Technology for kids], National Science Centre,Sri Lanka.
- Member, National Science Foundation, Working Committee on Science Popularization, Sri Lanka

Dr. Viduranga Waisundara
Reviewer
Conferences and Curricula
- Reviewer of the curriculum of the degree programme in Food Science & Technology – Sabaragamuwa University of Sri Lanka.

- Institute of Food Technologists, USA, Expo and Congress 2015 Scientific Program track team reviewer for the areas of Food Health & Nutrition and Food Chemistry.

Journals

- Food Science & Human Wellness. Elsevier Ltd.
- Phytotherapy Research. John Wiley & Sons.
- Agricultural & Food Science journal – The Scientific AgriculturalSociety ofFinland.
- Evidence-Based Complementary & Alternative Medicine. HindawiPublishing Corp.
- Malaysian Journal of Nutrition. Nutrition Society of Malaysia.
- Chiang Mai Journal of Science, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand.

13.3 Dr. H.W.M.A.C. Wijayasinghe

Memorandum of Understanding (MOU) has been signed with the Sri Lanka Institute of Nanotechnology (SLINTEC) for Research collaboration on *Development* of *Sri Lankan natural graphite for advanced technological applications.*

13.4 PARTICIPATION IN INTERNATIONAL / NATIONAL WORKSHOPS/TRAINING PROGRAMS/SEMINARS/CONFERENCES BY PROJECT LEADERS, RAS AND TAS

Prof. M.A.K.L. Dissanayake made an Invited presentation on Optimization of Iodide Ion Conductivity In Electrolytes For Dye Sensitized Solar Cells at the ACSSI-2014 conference in Singapore (June 2014)

Condensed Matter Physics and Solid State Chemistry Project:

The following research assistants and collaborators participated at the Asian Conference on Solid State Ionics (ACSSIS-2014) research conference held at National University of Singapore

Dr Varuni Senevirathne (University of Peradeniya and IFS (Collaborator)
Ms. Vinishiya Amarasinghe (University of Peradeniya and IFS (Collaborator)
Ms. Thilini Ekanayake (University of Peradeniya and IFS (Collaborator) Ms. Manel Sarangika (IFS)

Mr. C.A. Thotawattage completed a six weeks research training programme on dye sensitized solar cells at the Center of Ionics, University of Malaya, Kuala Lumpur, Malaysia from Oct. 1st to Nov.15th 2014 under a MoU between NIFS and University of Malaya.

Ms. Kohila Paramanathan participated and presented a research paper at the Int. Conference on Materials Science & Technology (ICMST) in Indonesia (October, 2014)

Herath, P. Kumarathilaka, H. Wijesekara, S. Mayakaduwa and Dr. MeththikaVithanageparticipated the Peradeniya University International Research Sessions (iPURSE), University of Peradeniya, Sri Lanka. 4-5 July 2014.

P. Kumarathilaka, H. Wijesekara, Y. Jayawardana and M. Vithanage participated The 5th International Conference on Sustainable Built Environment, Kandy, Sri Lanka. 12-15 December 2014.

Herath, P. Kumarathilaka, S. Mayakaduwa, T. Bandara, L. Weerasundara were members of the organizing commity of the international symposium on "Driving Research Towards Economy, Oppotunities and Chalanges"organized by Sri Lanka Acadamy of Young Scientists (SLAYS) at the National institute of Fundamental Studies (NIFS), Kandy, Sri Lanka.

Dr. Meththika Vithanage deliviered a lecture as a resourse person of the workshop organized by National Science and Technology Commission (NASTEC) on Reviewing research articles: Road to Success Date: 25th Aprial, 2014 at Industrial Technology Institute, Colombo 7.

Dr. Meththika Vithanage deliviered a lecture as a resourse person of the workshop organized by the Research

and Development Center for Mathamatical Modeling at the University of Colombo on Variable density flow and transport modeling: impact of tsunami in Sri Lanka at the Workshop on

Introduction to Modeling Water Resources, International Forum for Mathamatical Modeling, 13th March, 2014, University of Colombo.

I. Herath, P. Kumarathilaka, H. Wijesekara and S. Mayakaduwa attended a short course on "Statistics for Environmental Sciences" organized by the National Institute of Fundamental studies, Kandy, Sri Lanka.

Dr. H.W.M.A.C. Wijayasinghe

- Lithium battery power 2014, Capital Hilton, Washington DC, USA, 2014.
- 14th Asian Conference on Solid State Ionics (ACSSI 2014), Singapore, 2014.
- 31st Sessions of Geological Society of Sri Lanka, Colombo, 2014
- 70th Annual sessions, Sri Lanka Association for Advancement of Science, 2014.
- Annual research symposium of Uva-Wellassa University of Sri Lanka, 2014. ? Annual research symposium of South Eastern University of Sri Lanka, 2014.
- PGIS Research Congress, University of Peradeniya, 2014.
- HETC Symposium, Ministry of Higher Education of Sri Lanka, 2014.

Dr. N.D. Subasinghe

- 3rd International Conference on Energy and Environmental Protection (ICEEP2014), XiAn, China 2628 April, 2014 and presented the following paper: "Study of thermal water resources in Sri Lanka using time domain electromagnetics (TDEM)"
- 3rd International Conference on Geology and Geophysics (ICGG 2014), Beijing, China. 13-15 June 2014.
- Workshop on Science, Technology and Innovation (STI) Policy Making for Developing Countries. Kish Island, Iran. 28 Nov. – 02 Dec. 2014.

Mr. D.R. Charles

Geophysical Training conducted by Geol. Survey & Mines Bureau, Buttala, Eppawala and various locations& several occasions in 2014.

Ms. B. Jayatilake

- Third International Symposium on Water Quality and Human Health. Postgraduate Institute of Science, University of Peradeniya, Sri Lanka, 27- 28 June 2014
- International Conference of Pradeniya University of Sri Lanka 2014, University ofPeradeniya, Sri Lanka, 4-5 July 2014
- PGIS research congress, Postgraduate Institute of Science, University of Peradeniya, Sri Lanka, 11 October 2014.

Prof G. Seneviratne

- AusAID/DFAT Public Sector Linkage Project: MicrobialBiofertilisers for an Improved Economy & Environment in Sri Lanka (Workshop 4), Faculty of Agriculture & Environment, University of Sydney, Australia, June 21-28, 2014.
- SLCARP International Agricultural Research Symposium, Sri Lanka Foundation Institute, Colombo, 11-12 August 2014.
- Third Summit of Science Academiesof South Asia and General Assembly of Association of Academies and Societies of Sciences in Asia, New Delhi, India, 14-17 October 2014.
- International Symposium on Organic Coconut Farming, Coconut Research Institute, Lunuwila, 28 Novermber 2014.

Ms. M. Seneviratne- Research Assistant

- Peradeniya University Research Sessions, Peradeniya, 4-5 July 2014.
- 2nd International Symposium of Sri Lanka Association of Young Scientists, Kandy, 13-14 November 2014.
- 5th International Conference on Sustainable Built Environment, Kandy, 12-15 December 2014.

Ms. R.C.K. Karunaratne, Mr. A. K. Pathirana- Senior Staff Technical Officers AusAID/DFAT Public Sector Linkage Project: Microbial Biofertilisers for an Improved Economy & Environment in Sri Lanka (Workshop 4), Faculty of Agriculture& Environment, University of Sydney, Australia, June 21-28, 2014.

Dr. Suresh P. Benjamin: participated in the 28th European Congress of Arachnology, August 24-29, 2014 in Turin, Italy.

Dr. Crisenthiya I. Clayton

- Participated in the International Symposium on Conservation and Management of Pollinators for Sustainable Agriculture and Ecosystem Services *(New Delhi, India)*
- Participated in the Wayamba International Conference *(Wayamba, Sri Lanka.* (WinC-2014) (29-30 Aug 2014) at Wayamba University of Sri Lanka.
- Participated in the Bee keeping training programme*(Bindunuweva, Sri Lanka)*

Ms. Sasanka L. Ranasinghe

- Participated in the BOBLME-Wayamba University Science Presentation Workshop in preparation for Wayamba International Conference 26-28 Aug 2014, Katunayake, Sri Lanka.
- Participated in the Wayamba International Conference (WinC-2014) (29-30 Aug 2014) at Wayamba University of Sri Lanka.
- Participated in the National Workshop on Scientific Writing (Dec 4-5) PGIS, University of Peradeniya ? Participated in the workshop on "Experimental Designs" (11 Sep 2014) PGIA, University of Peradeniya

Prof. N. S. Kumar, Invited Lecture. "Natural Product Chemistry: Bioactive metabolites from plant and fungal sources" at the Atta-ur-Rahman, Institute for Natural Product Discovery, UniversitiTeknologi Mara, Malaysia (18th June, 2014)

Prof. U.L.B. Jayasinghe, Participant, 2nd Humboldt Kolleg: The voice of Asian Researchers in conjunction with: International Conference on Natural Sciences (ICONS) 2014, Ma Chung, Indonesia (25th–28th Sept. 2014).

Prof. N.S. Kumar, Invited Lecture. "Separation of Biological molecules by gel filtration chromatography", *National workshop on investigating bioactive metabolites from natural sources: Enzyme inhibition, NMR and LC-MS interpretation*, IFS, Kandy, 13th-17th Oct, 2014.

Prof. U.L.B. Jayasinghe, Invited Lecture, "Saponins - Structure, Isolation and Identification" *National workshop on investigating bioactive metabolites from natural sources: Enzyme inhibition, NMR and LC-MS interpretation*, IFS, Kandy, 13th- 17th Oct, 2014

Mr. D.S. Jayaweera, Two day training Seminar on "Safety in chemical and microbiological laboratories" Fostering Industries towards the new millennium, ITI, (29th-30th Oct. 2014).

U.L.B. Jayasinghe, N.S. Kumar, K.G.N. P. Piyasena, H.M.S.K.H. Bandara, G.G.E.H. De Silva,K.G.E. Padmathilake, R.M.W.C.K. Karaunarathna, R.N. Rathnayake, C.L. Kehelpannala,D. Thanabalasingam, M. M. Quader, D.S. Jayaweera, T. Sritharan, participatedin*IPURSE*– 2014, University of Peradeniya.

K.G.N.P.Piyasena, D.S. Jayaweera, K.G.E Padmathilake, C.L. Kehelpannala, R.M.W.C.K. Karunarathna, T. Sritharan, G.R.N. Rathnayake, D. Thanabalasingam, M. VindyaKanthi, D. Dissanayake participated in *National Workshop on Investigating Bioactive Metabolites from Natural Sources: Enzyme Inhibitory Studies, NMR & LC-MS Interpretation*, Institute of Fundamental Studies,
(13th –17th Oct., 2014)

Dr. Dittus submitted an abstract entitled "Subspecies of Sri Lankan Mammals as Units of Biodiversity Conservation" that was accepted for oral presentation at the World Biodiversity Congress held in Colombo 24-27 November 2014. Dr. Dittus did not attend the congress.

R. R. Ratnayake participated in "20th World Congress of Soil Science 2014: 7-13 June, 2014in Jeju Island, Korea.

Dr. VidurangaWaisundara

- 17thInternational Union of Food Science & Technology Congress, 17 – 21 August 2014, Montreal, Canada.
- University of Peradeniya International Research Sessions (iPURSE), 4 – 5 July 2014.
- Wayamba University International Conference, 28–29 August 2014.
- National Workshop on Investigation Bioactive Metabolites from Natural Sources: Enzyme Inhibitory Studies, NMR and LC-MS Interpretation, National Institute of Fundamental Studies, Kandy, 13–17 October 2014.
- Second International Conference of the Sri Lanka Academy of Young Scientists, 13–14 November 2014, National Institute of Fundamental Studies, Hantane Road, Kandy.
- 41st School Science Programme, 16–19 December 2014, National Institute of Fundamental Studies, Hantane Road, Kandy.

Miss MindaniWatawana and Miss NilakshiJayawardena participated in the National Workshop on Investigation Bioactive Metabolites from Natural Sources: Enzyme Inhibitory Studies, NMR and LC-MS Interpretation, National Institute of Fundamental Studies, Kandy, 13 – 17 October 2014.

Miss MindaniWatawana and Miss NilakshiJayawardena participated in the University of Peradeniya International Research Sessions (iPURSE), 4 – 5 July 2014.

Dr.D.N. Magana-Arachchi

- Technical seminar on Accreditation 'Delivering Confidence in the provision of Energy' held on 9th June 2014 at BMICH, Colombo, Sri Lanka.
- Review of Sri Lanka National Quality Policy', Seminar for Central Province held on 3rd October 2014 at Devon Hotel, Kandy, Sri Lanka.
- National Laboratory Conclave on Accreditation: Delivering Confidence in Laboratory Testing' held on 25th November 2014 at BMICH, Colombo, Sri Lanka.
- National Workshop on 'Investigating Bioactive Metabolites from Natural Sources: Enzyme Inhibitory Studies, NMR and LC-MS Interpretation' held from 13th-17th October 2014 at the National Institute of Fundamental Studies, Kandy, Sri Lanka.
- Workshop on 'Intellectual Property and Patents' Organized by Postgraduate Institute of Science (PGIS) with the collaboration of National Intellectual Property office of Sri Lanka (NIPO) on 19th December 2014 held at Postgraduate Institute of Science, University of Peradeniya, Sri Lanka.
- Consultation workshop with stakeholders on Curriculum revision'. Organized by Department of Biological Sciences of the Faculty of Applied Sciences of Rajarata University held on 3rd April 2014 at Hotel Topaz, Kandy, Sri Lanka.
- International symposium on water quality and Human Health. 27th& 28th June 2014, Postgraduate Institute of Science, University of Peradeniya, Sri Lanka.
- 3rd Annual Scientific Sessions of the Sri Lankan Society for Microbiology (SSM) held at Postgraduate Institute of Agriculture, University of Peradeniya, Sri Lanka, on 24th October, 2014.
- 2nd International symposium of The Sri Lanka Academy of Young Scientists (SLAYS) in partnership with National Institute of Fundamental Studies (NIFS) and coordinating secretariat for science , technology and innovation (COSTI) on the 13-14th November 2014 at the National Institute of Fundamental Studies, Kandy, Sri Lanka.
- Peradeniya University International Research Sessions(iPURSE)on 4-5thJuly 2014, Faculty of Science, University of Peradeniya.

R.P. Wanigatunge

- Wayamba University International Conference, WinC 2014 on 29th-30th August 2014, held at Wayamba University of Sri Lanka.

H.M. Liyanage

- International symposium on water quality and Human Health. 27th& 28th June 2014, Postgraduate Institute of Science, University of Peradeniya, Sri Lanka.

D.K. Weerasekera

- National Workshop on 'Investigating Bioactive Metabolites from Natural Sources: Enzyme Inhibitory Studies, NMR and LC-MS Interpretation' held from 13th-17th October 2014 at the National Institute of Fundamental Studies, Kandy, Sri Lanka.
- 2nd International symposium of The Sri Lanka Academy of Young Scientists (SLAYS) in partnership with National Institute of Fundamental Studies (NIFS) and coordinating secretariat for science , technology and innovation (COSTI) on the 13-14th November 2014 at the National Institute of Fundamental Studies, Kandy, Sri Lanka.
- 3rd Annual Scientific Sessions of the Sri Lankan Society for Microbiology (SSM) held at Postgraduate Institute of Agriculture, University of Peradeniya, Sri Lanka, on 24th October, 2014.

S. Sayanthooran

- Workshop on 'Laboratory animal management for research purpose' organized by the Sri Lanka Association for Laboratory Animal Science (SLALAS), held from 6th-7th October 2014 at the Medical Research Institute, Sri Lanka.
- National Workshop on 'Investigating Bioactive Metabolites from Natural Sources: Enzyme Inhibitory Studies, NMR and LC-MS Interpretation' held from 13th-17th October 2014 at the National Institute of Fundamental Studies, Kandy, Sri Lanka.
- 2nd International symposium of The Sri Lanka Academy of Young Scientists (SLAYS) in partnership with National Institute of Fundamental Studies (NIFS) and coordinating secretariat for science , technology and innovation (COSTI) on the 13-14th November 2014 at the National Institute of Fundamental Studies, Kandy, Sri Lanka.
- 3rd Annual Scientific Sessions of the Sri Lankan Society for Microbiology (SSM) held at Postgraduate Institute of Agriculture, University of Peradeniya, Sri Lanka, on 24th October, 2014.
- Peradeniya University International Research Sessions(iPURSE)on 4-5th July 2014, Faculty of Science, University of Peradeniya.

T. Keerthirathne

- National Workshop on 'Investigating Bioactive Metabolites from Natural Sources: Enzyme Inhibitory Studies, NMR and LC-MS Interpretation' held from 13th-17th October 2014 at the National Institute of Fundamental Studies, Kandy, Sri Lanka.
- 2nd International symposium of The Sri Lanka Academy of Young Scientists (SLAYS) in partnership with National Institute of Fundamental Studies (NIFS) and coordinating secretariat for science , technology and innovation (COSTI) on the 13-14th November 2014 at the National Institute of Fundamental Studies, Kandy, Sri Lanka.
- 3rd Annual Scientific Sessions of the Sri Lankan Society for Microbiology (SSM) held at Postgraduate Institute of Agriculture, University of Peradeniya, Sri Lanka, on 24th October, 2014.

R.W.K. Amarasekera

- Workshop on "The Integrated Conference of Better Air Quality 2014 and Intergovernmental 8th Regional Environmental Sustainable Transport Forum", organized by United Nations Centre for Regional Development, Government of Sri Lanka, Ministry of the Environment Japan, Clean Air Asia held at BMICH, Colombo, Sri Lanka on 19th – 21st November, 2014.

Ms. W.T. Awanthi and Mr. D.M.R.E.A. Dissanayake,

- Workshop on YRF Carrier Development, organized by Young Researchers' Forum (YRF)/ Postgraduate Institute of Science (PGIS),University of Peradeniya, 28th Jan 2014.
- Workshop on Effective research proposal writing, organized by National Science Foundation (NSF), 21st Aug 2014.
- Workshop on Experimental Designs, organized by Young scientists Forum (YSF)/National Science and Technology Commission (NASTEC), held at postgraduate Institute of Agriculture (PGIA), University of Peradeniya, 11th Sept 2014.
- Workshop on Scientific Writing organized by Sri Lanka Association for the Advancement of Science (SLAAS) section D/University of Sri Jayawardhanapura held at University of Colombo, 15th Oct 2014.
- Workshop on Scientific writings organized by the Postgraduate Institute of Science (PGIS), University of Peradeniya/National Science Foundation, November 2014

- Young Researchers Camp-Research Frontiers, organized by Young Researchers Forum (YRF), 1314 Dec 2014
- Training programme- Hands-on training on advanced scientific instruments for material characterization, organized by the Industrial Technology Institute (ITI), 13th-14th March 2014
- 3rdInternational symposium on water quality and human health: Challenges ahead, organized by Postgraduate Institute of Science (PGIS),University of Peradeniya 27th -28th June 2014
- International Peradeniya University Research Session (IPURSE), organized by University of Peradeniya, 4th-5th July 2014
- PGIS research Congress, organized by Postgraduate Institute of Science (PGIS),University of Peradeniya, 11th Oct 2014.
- Driving Research toward Economy, organized by National Institute of Fundamental Studies (PGIS) and Sri Lanka Academy of Young Scientists (SLAYS), 30th Nov 2014.

W.W.M.B.A. Medawatte
- Training workshop on tree algometric equations held at the Distance Learning Centre Ltd., SLIDA Building 28/10, Malalasekera Mawatha, Colombo 7, held from 20th to 24th May 2014.
- Training Workshop on "Use of 'R' for Building Algometric Equations"held at the Distance Learning Centre Ltd., SLIDA Building 28/10, Malalasekera Mawatha, Colombo 7, held 29th September to 02nd October, 2014.

Mrs. R.M.A.S. Ratnayake
International Workshop on 'Promoting the Sharing of Expertise and Infrastructure for Dengue Vector Surveillance towards Integration of the Sterile Insect Technique with Conventional Control Methods among South East Asian Countries' organized by the Industrial Technology Institute (ITI) from 5th – 9th May, 2014 held at ITI, Colombo 07, Sri Lanka.

Dr. C.T.K Tilakaratne, Mr. S.H. Wanigasekara and Mr. V. Ekanayake participated in "Smart Society Congress 2014"organized by ICTA held on 4th November 2014 at BMICH Colombo

Ms. T.C.P.K. Thilakaratne
- Workshop on DSpace Software, National Science Foundation on 18-19th March 2014.
- Seminar on Open Access to Research Publications, University of Peradeniya on 4th December 2014.

Mr. G.C.K.S. Bandara and Mr. V. Ekanayake participated in Deruwa; New typing method in Sinhala for computers and mobile devices, 27th January 2014 at National Science Foundation Colombo.

Ms. D.S. Thalakiriyawe presented a paper on "Open Science circle in Electronic Media at "Smart Society congress 2014"organized by ICTA held on 4th November 2014 at BMICH Colombo.

Mr. S. Opatha participated in Instrumentation Training for Technical Staff of the Open University of Sri Lanka. 19 May – 25 May 2014, and Training Program for Technical Officers and Experimental Officers of Coconut Research Institute. 10-15 March, 2014.

13.5 ORGANIZATION OF SYMPOSIA/CONFERENCE/WORKSHOPS/TRAINING PROGRAMME

Prof. M.A.K.L. Dissanayake, Member Organizing Committee, Solar PV Workshop, University of Jaffna, 16-17 April 2014. Number of Participants: 75

Dr. M. Vithanage (Chair), Dr. Viduranga Waisundara (Coordinator)
Second International Symposium of the Sri Lanka Academy of Young Scientists – 'Driving Research Towards Economy: Opportunities and Challenges', 13 – 14November 2014, 75 participants, copartners of the event / major sources of funding: Coordinating Secretariat of Science, Technology and Innovation (COSTI), National Science Foundation (NSF).

Prof. U.L.B. Jayasinghe (Chair), Prof. N.S. Kumar (Co-Chair)
Title of Program: National workshop on Investigating bioactive metabolites fromNatural sources: Enzyme inhibition, NMR and LC-MSinterpretation.

Date: 13.10.2014 – 17.10. 2014
Number of Participants: 65

Prof. G. Seneviratne
Molecular Biology Methods for Quality Control of Microbial Biofertilisers for an Improved Economy and Environment in Sri Lanka.AusAID (Australia) funded Workshop, National Institute of Fundamental Studies, Kandy, April 21 - 25, 2014. Number of participants- 27.

13.6 VISITS BY IFS SCIENTISTS

Dr. Viduranga Waisundara

- Department of Chemistry, McGill University, Montreal, Canada.
- Department of Chemistry, University of Toronto, Toronto, Canada

13.7 RESEARCH GRANTS RECEIVED DURING 2014

Research Grants (continued in 2014)

- Research Grant (2012-2014) received by Prof. M.A.K.L. Dissanayake and Dr. G.K.R. Senadeerafrom National Science Foundation, Sri Lanka;

  Title: "*Optimization of the growth process of cadmium sulfide (CdS) semiconductor thin films for efficiency enhancement in CdS/CdTe solar cells"*

- Research Grant (2011-2014) received by Prof. C.B. Dissanayake and Prof. M.A.K.L.Dissanayakefrom National Research Council, Sri Lanka;
  Title: "*Synthesis, characterization and study of physico-chemical properties of some polymeric materials in the form of nanofibres and their applications in antimicrobial polymer nanofibre water filters and dye-sensitized solar cells.*"

Research Grants received in 2014

Prof. M.A.K.L. Dissanayakewas a team member of a international research collaboration involving the NIFS, Rajarata University, University of Malaya, Malaysia and Chalmers University, Sweden. The group was successful in receiving a three year research grant from the Swedish Research Council for 2014-2017.

Dr. M.C.M. Iqbal
National Research Council Grant no. NRC TO 14-04 (Co-investigator). *Target oriented multidisciplinaryResearch Grant*: Comprehensive research proposal on an operational model to control dengue in Sri Lanka using multiple vector control intervention, new product development and community engagement.

Dr. M. Vithanage
Research Grant of the Quantitative assessment of potential human and ecosystem health risks imposed by atmospheric particulates in Kandy, Sri Lanka, Rs. 3,900,000/-, National Science Foundation (20142016)

Dr. N.D. Subasinghe

- National Science Foundation Grant No: RG/2012/NRB/03 Continued. Total Amount: Rs. 2,060,063.00
- Travel grant RGB/GEN/06/2014/02/20 received from the National Science Foundation to attend a conference in Beijing, China, June, 2014.
- Travel Grant received from the NAM S&T Centre (India) to attend a workshop in Kish Island, Iran, November 2014.
- National Inst. Radiological Sc., Japan, donated 3rdbatch of passive radon detectors (Amount: 50 detectors) for the Radon Monitoring programme.
- International Atomic Energy Authority, Austria provided 2nd batch of50 track detectors for Indoor radon measurements.

Dr. Suresh P. Benjamin received an equipment grant from Alexander von Humboldt Fellows (SLAVH).

Dr. Crisenthiya I. Claytonreceived a National Research Council Post-doctoral Fellowship
Project title "The effect of six pesticides on development, behaviour and immune response in the Asian hive bee *Apiscerana*."

Prof. U.L.B. Jayasinghe and Prof. N.S. Kumar
NSF – (RG/2012/AG/01), Chemistry and Bioactivity of some edible fruits: Studies on possible applications in health and agriculture" – (2012-2014)

Prof. N.S. Kumar and Prof. U.L.B. Jayasinghe
NSF – (RG/2012/BS/06), Bioactive molecules from endophytic microorganisms associatedwith medicinal and allelopathic plants from Sri Lanka. – (2012-2014)

Prof. U.L.B. Jayasinghe and Prof. N.S. Kumar
NRC – (12-032) "Bioactive metabolites from some selected Sri Lankan fruits and theirassociated fungi: possible uses in agricultural, pharmaceuticals and functional food products" (2013-2016)

Prof. U.L.B. Jayasinghe and Prof. N.S. Kumar
NSF – (RG/2014/BS/02), Chemistry and bioactivity of endophytic fungi from six plants used in indigenous medicine in Sri Lanka: Possible applications in health and agriculture". – (2015-2017)

Dr. Viduranga Waisundara
- National Research Council of Sri Lanka Grant no. 14-13: *In vitro* Assay-Guided Identification of Functional Food and Nutraceuticals from Sri Lankan Plant Products (co-supervisor Prof. U.L.B. Jayasinghe).
- Travel Grant awarded by the National Science Foundation of Sri Lanka to attend the 17th International Union of Food Science & Technology World Congress in Montreal, Canada.

Dr. C.T.K. Tilakaratne
- United Nations Educational, Scientific and Cultural Organization (UNESCO), project No. 6651137004SRL"Inculcate Scientific Methodology and Novel teaching techniques for the level of Junior Secondary Education in Sri Lanka". Rs. 2,589,515.40
- National Foundation Sri Lanka, for Science You-tube Channel-"ViduNenaDasuna". Rs. 896,000.00

Dr. D.N. Magana-Arachchi
- National Research Council ; NRC/11/059
- Co-investigator of National Science foundation grant; RG/2014/EB/03

Dr. H.W.M.A.C. Wijayasinghe
Innovative Research Grant – 2013 from University Grants Commission of Sri Lanka (2014-2016).

14. RESEARCH PUBLICATIONS OF IFS MEMBERS – 2014

1. Ahmad, M.;Moon, D.H.; **Vithanage, M**.; Koutsospyros, A.; Lee, S.S.; Yang, J.E.;and Ok, Y.S. Production and use of biochar from buffalo weed (Ambrosia trifida L.) for trichloroethylene removal from water. *Journal of Chemical Technology and Biotechnology*, **2014**,*89(1),* 150-157.

2. Ahmad, M.; Rajapaksha, A.U.; Lim, J.E.; Zhang, M.; Bolan, N.; Mohan, D.; **Vithanage,M.;** Lee, S.S.; Ok, Y. S. Biochar as a sorbent for contaminant management in soil and water: a review. *Chemosphere.* **2014**, *99*, 19-33.

3. Ahmad, M.; **Vithanage, M.;** Kim, K.; Cho, J.S., Lee; Y.H., Joo; Y.K.; Ok, Y.S. Inhibitory Effect of Veterinary Antibiotics on Denitrification in Groundwater: A Microcosm Approach. *The Scientific World Journal*, Article ID 879831, **2014**,7 pages.

4. Ajith De Silva.; Bandara, T.M.W.J.; Fernado, H.D.N.S.; Fernando, P.S.L.; **Dissanayake, M.A.K.L**.; Jayasundara, W.J.M.J.S.R.; Furlani, M.; Mellander B-E.Higher Efficiency for Quasi-Solid State Dye Sensitized Solar Cells Under Low Light Irradiance. Publication date: 2014/3/4, *Bulletin of the American Physical Society.*

5. Akilavasan, J.; Wijeratne, K.; Gannoruwa, A.; Alamoud, A.R.M.; **BandaraJ**. Significance of TiCl4 post-treatment on the performance of hydrothermally synthesized titania nanotubes-based dyesensitized solar cells. *AppliedNanoscience. 4 (2),* 185-188.

6. Alakolanga, A.G.A.W.; Siriwardane, A.M.D.A.; **Kumar, N.S**.; **Jayasinghe, L**.; Jaiswal, R; Kuhnert, N. LC-MS^nidentification and characterization of the phenolic compounds from the fruits of *Flacourtiaindica* (Burn.F.) Merr.And *Flacourtiainermis*Roxb.*Food Research International*, **2014**, *62*, 388-396.

7. Almaroai, Y.A.; **Vithanage, M**.; Rajapaksha, A.U.; Lee, S.S., Dou, X.; Lee, Y.H.; and Ok, Y.S. Natural and synthesised iron-rich amendments for As and Pb immobilisation in agricultural soil. *Chemistry and Ecology*. **2014,***30(3),* 267-279.

8. Arof, A.K.; Aziz, M.F.; Noor, M.M.;Careem, M.A.;Bandara, L.R.A.K.;Thotawatthage, C.A.; Rupasinghe, W.N.S.; **Dissanayake M.A.K.L.**Efficiency enhancement by mixed cation effect in dyesensitized solar cells with a PVdF based gel polymer electrolyte. *Int. J Hydrogen Energy***, 2014**, 39, 2929 -2935.

9. Bandara, T.M.W.J.; Jayasundara, W.J.M.J.S.R.; **Dissanayake, M.A.K.L**.; Fernando, H.D.N.S.; Furlani, M.; Albinsson, I.; MellanderB.-E. Quasi solid state polymer electrolyte with binary iodide salts for photo-electrochemical solar cells. *Int.J Hydrogen Energy***.2014**, *39,*2997 -3004.

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Director's Office



Prof. C.B. Dissanayake
Director
National Institute of Fundamental Studies



From left: *Ms. Abesingha A.M.N.U, Ms. Senevirathne O.W.K, Ms. Jeewa Kasthuri M.D., Mr.Malwewa M.P.D.K, Ms.Kapilarathne S.M.A.K*

All the activities related to administrative work of the National Institute of Fundamental Studies is facilitated by the Director's Office. The Director of the institute is the Chief Excutive Officer of the Institute. Prof. C.B. Dissanayake is the present Director of the NIFS. Personal Assistant to the Director is Ms. Jeewa Kasthuri and Ms. OWK Seneviratne is the Stenographer. Mr. MGDK Malwewa is the Office Aid. Two trainees, Ms. AMNU Abeysinghe and Ms. SMAK Kapilaratne are also working in the Director's Office.

Administration Division

Secretary



Dr. P.S.B. Wanduragala
Secretary to the Board
Secretary / National Institute of Fundamental Studies

Division



From left, front: *Mr. Kumara AVAP, Mr. Dorakumbura DGK, Mr. Gunathilake AGST, Ms.Hettiarachchi TP, Ms. Weerasooriya RPM, Ms. Ilangakoon CLS, Ms. Ruwangalla NP, Ms. Ranasinghe C, Mr. Jayasinghe HADN, Mr. Somananda MAG.*

From left, back: *Mr. Gunasekara KBTB, Mr. Jayasekara DJMWP, Mr. Dissanayake DMDB, Mr. Gunawardene RSK, Mr. Gunathilaka DG, Mr. Dharmasena DG, Mr. Ariyawansha KM, Mr. Lal MA, Mr. Jayaweera ABGW, Mr. Aluthgedara AGJS*

Administration Division consists of the following sections:•Maintenance•Reception•Transport•Workshop**Duties and responsibilities entitled for the Administration Division**

- Maintaining office procedures in Administration division
- Work related to recruitments
- Work related to contractual services
- Arranging Tender Board and Supplies Committee meetings and keeping minutes of them
- Calling Tenders and quotations for goods and services – local purchases
- Preparing Administrative report annually
- Supervision of NIFS visitor's rooms
- Maintaining Leave records of NIFS Staff
- Call for registration of suppliers annually
- Work related to construction and renovations
- Checking Overtime, fuel orders and contractual payments
- Man the reception desk and preparation of reports when necessary
- Directing visitors to appropriate contacts
- Maintenance of the Building (Electrical, water, Sanitary etc.)
- Insurance coverage of NIFS staff
- Maintain NIFS vehicles
- Providing transport facilities for the NIFS staff

Internal Audit

The Internal Audit Division is functioning under the direct supervision and guidance of the Director.



From Left to Right: Ms. Jayasooriya SN, Gunasena, CO

The Division is responsible for independent and objective reviews and assessment of the Institute's activities, operations, financial systems and internal controls adhering to Laws, Circulars, Financial Regulations and provisions of the Establishments Code and to make observations and recommendations to the Senior Management.

When dealing with internal audit functions of the institution, special attention is paid for the below functions as mentioned in F.R. 133,

- Examine whether the internal inspection and administrative system implemented within institution to prevent frauds and malpractices are successful in its planning and implementation.
- Ascertain the accuracy of the accounting and other records and ensure that the accounting methods used are effective for the preparation of financial statement.
- Evaluating the quality of performance demonstrated by the staff in the performance of their duties and responsibilities.
- Verifying how far the assets belonging to institute have been protected from any kind of damages.
- Examine whether the provisions of the circulars issued from time to time by the Ministry in charge of the subject of public administration and the General Treasury, establishments code, financial regulations of the government and other supplementary instructions are properly followed
- Conducting special investigation wherever necessary.
- Following the guide lines and directions given from time to time by the Department of Management Audit, conducting the meetings of audit & management committee quarterly and taking follow up actions to verify the progress in the implementation of decisions taken at those meetings.

Accounts Division



From Left to Right: Mr. Weerasooriya BJ, Ms. Nissanka MK, Ms. Gamlath TP, Ms. Nishshanka LNMDSK, Ms. Samarakkody PSS, Ms. Rathnayake RMVP, Ms. PalliyaGuruge MP, Mr. Ariyaratne, MP, Mr. Perera MAP, Mr. Keshan MKD

This division consists of the Deputy Accountant (supervisor-in-charge), an Accounts Officer, three Senior Staff Assistants (Clerks, Book-Keeper), a Staff Assistant (Stores Keeper), three Management Assistants and an Office Machine Operator. The division provides support for finance and accounting services at the institute in the following areas:

- **Funding Sources:** Recording of cash received from the General Treasury and other external local and foreign sources.
- **Payroll:** Preparation of salaries based on personal information, taxes and other deductions and allowances.
- **Personal Provident Fund:** Maintenance of the contribution of Employees Provident Fund by keeping cards and records separately for individual employees, investing & monitoring fixed deposits and withholding tax.
- **Staff Loan:** Management of the EPF and concessionary loan schemes, and maintenance of relevant records.
- **Cash payments:** Payment of a wide variety of purchases, taxes;upkeep all supporting documents and files to assure the amount to be paid is correct and in compliance with relevant government rulesand regulations.
- **Budgeting:** Estimating the sources and expenditure for the period; this also serves a number of important purposes such as monitoring and controlling the finances of the institute.
- **Procurement & Inventory:** Keeping track of all purchases such as stationery, hardware & general items, and local inventory items.
- **Final Accounts Statement:** Preparation of comprehensive final accounts and statements in compliance with Sri Lanka public accounting Standard and accepted accounting principles.
- **Maintenance of Financial Records:** Ensure proper maintenance and updating of accounting records and preparation of financial reports upon request

Procurement &Laboratory Stores

Our Objectives

The Procurement and Laboratory Stores is committed to providing the necessary resources to achieve the goals of the National Institute of Fundamental Studies.

Our Team



From Left to Right: Ms. J. P. G. H. T. Jayalath (Trainee), Ms. E. M. G. W. D. Edirisooriya (Trainee), Ms. H. M. M. H. K. Herath (Trainee), Eng Ms. W. D. S. P. Perera (Laboratory Manager), Ms. D. M. K. L. Kumari (Senior Staff Technical Officer), Ms. G. W. R. P. Chandrakanthi (Senior Staff Assistant/Stenographer)

Our Services

- Foreign and local purchasing for all items including Laboratory Equipment, Chemical, Glassware and Consumables
- Handling Chemical and Glassware Stores and implementing and monitoring the Bin card system
- Handling Customs procedures for all import and export items
- Maintains a record of assets owned by Institute. The system includes a complete description of the asset; Its acquisition date and cost, location, condition and other information

Technical Staff



The mission of the Technical staff of the National Institute of Fundamental Studies is to support the research activities when analytical and technical expertise are needed.

The expertise of the Technical Staff is useful for the scientists to carry out the research. They guide the undergraduates and post graduates to operate the instruments for research.



The technical staff also support computer and system administration of the institute, and also handle orders and manage supplies of chemicals and glassware. Thus, they are key to achieving the objectives of the institute.

Further, they conduct sample analysis for other institutes. Some have research publications in referred journals and received several presidential awards.





The role of the Technical officer at IFS

programming, operation and maintenance of servers, computers and network system of the entire institute

The maintenance and operation of the PABX system and telephone network of the institute

The maintenance and supervision of the electrical installation, switchgears, generator and the Central

UPS system in the institute

Maintaining the chemical, glassware store and inventory of the institute

Instrument, sample preparation and analysis

Maintenance, calibration and operation of analytical equipment.

Maintenance and operation of the automated attendance system for the whole staff

Web designing, providing technical support to school science programs, conferences, seminars and workshops

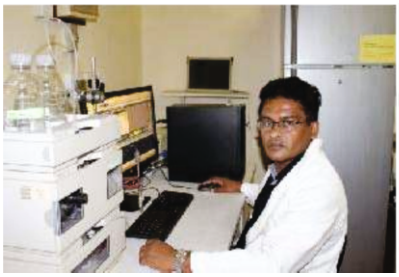
General maintenance of the analytical instrument range in the institute

Field sample collection, preservation

Ethics of laboratory discipline in line with GLP

Other miscellaneous services provided include participation in committees like Tender Board, supplies Committee, Instrument Committee, Salaries committee, Technical Evaluation Committees, Computer committee, Web committee, Interview panels and also has represented the Institute in various occasions.















The technical personnel have contributed in setting the specifications by evaluating the analytical requirement from various basic to high - end instrumentation by maintaining and living up to the standards of the institute.











N.P.Athukorala
D. Aluthpatabendhi
A.K. Pathirana
S.S.K.Skalasooriya
A.B. Herath
R.C.K. Karunarathna
R.S.M. Perera
M.D.K. Lakshmi
Kumari D.S. Jayaweera
S. Opatha
I .Thmpala
W.G. Jayasekara Banda
G.C.K.S. Bandara
V. M. Ekanayeke
R.B. Weerakoon
M.N.B. Kulathunga

Library

The NIFS library was established in 1985 with a small collection of books and journals donated by Prof. Cyril Ponnamperuma, well-wishers and the Asia Foundation. Since then it now has a modest collection of over 6669 books and about 120 Journal titles covering the life, physical and mathematical sciences as well as the philosophy and history of science the fundamental text books, monographs and edited volumes.

Objective

The Main objective of the library is to collect, compile, retrieve and disseminate information related to our research for the benefit of NIFS Research staff and other interested parties.



During the last year, 84 new books were added to the collection, consisting of 58 purchased books, and 26 books received on complimentary basis. A large number of periodicals, newsletters, annual reports from local and foreign institutions were also received on a complimentary or an exchange basis, and the library subscribed to 14 journals related to our research

Library Services

NIFS Library provided services on reference and lending, document delivery, resource sharing, inter-library loan facility, photocopying facility, information alert services and sourcing web based electronic journals and articles. The Library also provides access to the OARE data base through subscriptions. This provides online access to scientific journals. Currently 40 such journals are available online through this scheme.

Digitization of institute publications

National Science Foundation undertook digitization of our institute's publications starting from 2013-12-21. The aim of the project was to establish an institutional e-repository and provide quick enhanced online access to institute publications. About 60,000 pages were electronically scanned to upload to server (http://ifs.nsf.ac.lk/).



Conferences and Seminar

- Institutional Repository of the NIFS: A Seminar with demonstration on the National Digitization was organized by the NIFS Library. Lectures were conducted by Mrs. Sunethra Perera, Head NSF Library and Resource Centre, on 03rd August ,2015.
- A workshop on Dewey Decimal Classification System was organized by the National Library and Documentation Center on 11th August 2015
- Progress review meeting of "National Digitization Project", National Science Foundation, was held on 22 September 2015

Other Activities

- A series of lectures on Improving reading habits in children and intorducton of library system was conducted at the following places
- Palath Paalana Sathiya, A special lecture was delivered on education and library development day organized by Kandy Municipal Council, on 10th September, 2015
- Janaraja Maha Vidyalaya, Katugastota, Kandy, on 15th October, 2015
- Hillwood College, Kandy, 29th October, 2015



From Left to Right: Ms.Tilakarathne TCPK, Ms.Witharana RM, Ms. Sumanarathne HMTL

NIFS Colombo Office

With the Parliamentary Act No. 55 of 1981, the Institute of Fundamental Studies was established as the only research Institute engaged in fundamental research in Sri Lanka.

In 1985 on December 5th the main laboratories were installed at Hantana, Kandy and the objectives of the institute are being fulfilled by the following activities by the Colombo office.

- Co-ordination of all administration and research work was done through the Colombo office with the ministry.
- Organizing of seminars, lectures & conferences
- The Colombo office has been providing accommodation for the scientists who attend for various matters in Colombo.
- Some of the laboratory items, chemicals and other equipment which are ordered are being kept at the Colombo office until they are transported to the Kandy main branch. Also any samples to be sent abroad or which has been imported and customs related formalities are arranged by the Colombo office.

NIFS- Sam Popham Arboretum

When you travel from Dambula towards Anuradhapura on the A9 road and proceed about two and half kilometers along the Kandalama road you will encounter the NIFS- Sam Popham Arboretum (NIFS-SPA) on the right hand side. This unique site was owned by an Englishman, Mr. F. H. (Sam) Popham, who gifted it to NIFS (then IFS) in 1989 to carry out research and educational activities.

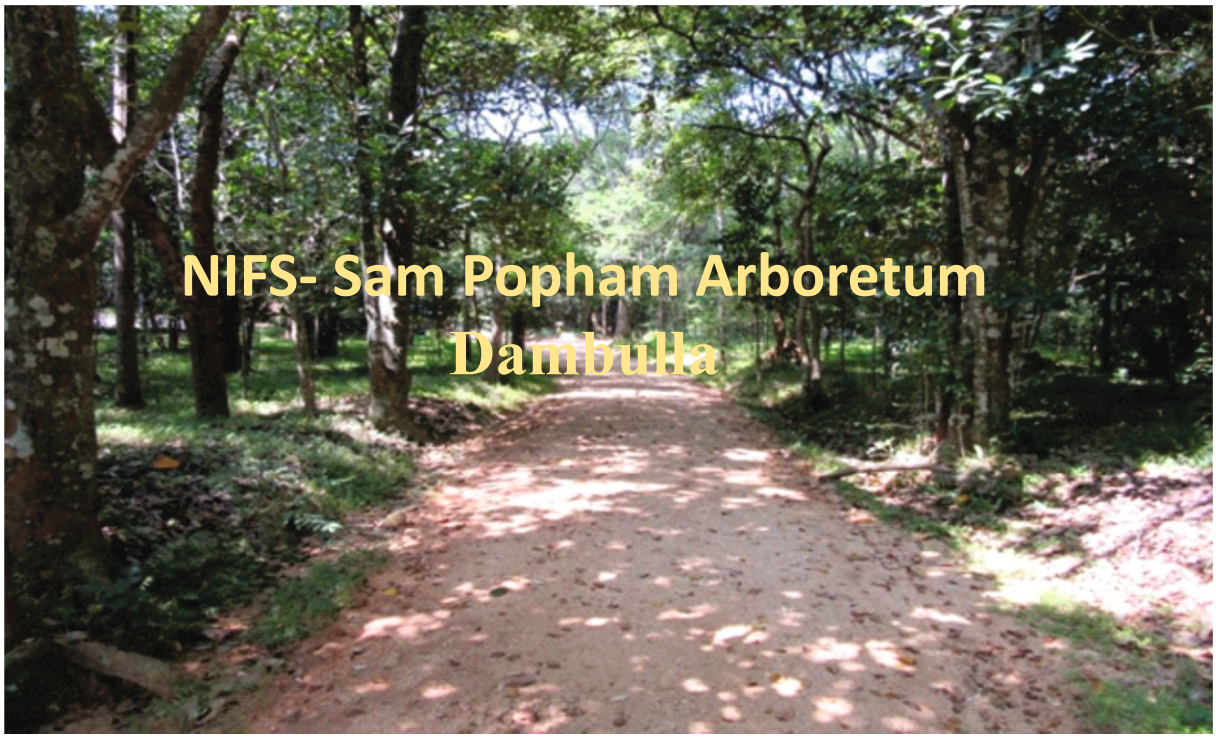
Mr. Popham was originally a Naval Officer who later became a Tea Planter. His last occupation was the administrator of the Revision of the Flora of Ceylon project funded by the Smithsonian Institution of Washington, DC. That project was based at the National Herbarium of Royal Botanic Gardens, Peradeniya.

Original site bought by Popham in 1963 was a seven and half acre-scrub jungle. Popham allowed the indigenous tree saplings in the site to emerge and establish by removing the 'weedy' shrubs around them. Consequently, the scrub jungle was turned into a dry zone woodland with a closed canopy.

After taking over the land in 1989, NIFS bought another 27 acres of adjoining scrubland to expand the arboretum. Popham's method of 'assisted regeneration' was practiced to convert that land also into a dense woodland.

Currently, NIFS-SPA is visited by many local and overseas researchers for educational purposes and ecological research. It is also a popular tourist destination owing to the presence of unique fauna such as Slender Loris, Pangolin and a rich vegetation consisting of over 200 species of trees.

Since 2005 the management of NIFS-SPA is carried out by Ruk Rakaganno (the Tree Society).



15. IFS STAFF 2014

Director : Prof. C.B. Dissanayake
Secretary : Dr. P.S.B. Wanduragala

Research Staff

Research Professors
Prof. J.M.S. Bandara
Prof. C.B. Dissanayake
Prof. M.A.K.L. Dissanayake
Prof. U.L.B. Jayasinghe
Prof. N.S. Kumar
Prof. A. Nanayakkara
Prof. P.R.G. Seneviratne

Associate Research Professor Prof.
S.P. Benjamin

Senior Research Fellows
Dr. M.C.M. Iqbal
Dr. N.D. Subasinghe
Dr. D.N. Magana Arachchi

Research Fellows Dr. R.
Liyanage
Dr. R.R. Ratnayake
Dr. M. Vithanage
Dr. V.Y. Waisundara
Dr. H.W.M.A.C. Wijayasinghe

Visiting Research Professors
Prof. S.A. Kulasooriya

Visiting Associate Research Professor
Prof. G.K.R. Senadeera

Visiting Senior Scientist
Dr. W.P.J. Dittus

Research Assistants - Grade I
Dr. C.I. Clayton
Mr. W.W.M.A.B. Medawatte
Mr. C.A. Thotawatthage
Ms. R.P. Wanigatunge
Mr. A. Manjceevan
Ms. S.M.M.P.K. Seneviratne

Research Assistants Grade II

Awanthi W.T
Bandara D.M.V.Y.S.
Bandara D.M.T.U..
De Silva E.H.
De Silva K.N.L.
Dissanayake D.M.D.M.
Ekanayake E.M.H.G.S.
Herath H.M.P.S.
Herath P.H.M.I.D.K.
Jayathilake R.M.G.C.S.K.
Jayawardena N.N.
Jayathilake H.A.P.P.B.
Karunaratne R.I.C.N.
Karunawansha I.S.
Kathirgamanathan M.
Kehelpannala C.L.
Keerthirathne T.P.
Kobbekaduwa K.P.V.B.
Kumari J.M.K.W.
Kumarathilake S.M.P.R.
Kulatunga K.M.S.D.B.
Nimalsiri T.B.
Priyadharshika E.G.C.K.
Perera O.S.
Perera M.B.U.
Qader M.M.
Rajapaksha R.T.N.
Rajapaksha R.P.S.K.
Ranasinghe U.G.S.L.
Ratnayake G.R.N.
Rathnayake R.M.N.M.
Ratnayake R.M.A.S.
Samaranayake S.A.
Suriyaarachchi N.B.
Thanabalasingham D.
Vishvanathan R.
Wasana H.M.S.
Watawana M.I.
Weerasekera D.K
Weerasinghe A.M.J.S.
Wijepala P.C.
Wijesekara S.S.R.M.D.H.R.

Technical Staff

Chief Technical Officers

Kulathunga M.N.B.
Weerakoon W.M.R.B.

Senior Staff Technical Officers

Aluthpatabendi D.
Athukorale N.P.
Herath H.M.A.B.
Jayasekara Banda W.
Jayaweera D.S
Karunaratne R.K.C.
Opatha S.
Pathirana A.K.
Perera R.S.M.
Sakalasooriya S.S.K.
Tumpale I.

Director?s Office

Jeewa Kasthuri M.D.	Personal Secretary to the Chief Ex. Officer
Seneviratne O.W.K.	Stenographer Gr.II
Malwewa M.P.D.K.	Office Aide
Saranga R.H.G.	Internal Auditor
Gunasena C.O.	Management Assistant Grade III

Library

Tilakaratne T.C.P.K. - Asst.Librarian
Witharana R.M. - Lib. Asst. Gr. III

Colombo Office

Rajapakse M.C.	Coordinator cum Scientific Officer
Gunawardena A.D.	Karyala Karya Sahayake/Driver

Accounts Division

Samarakkody P.S.S.	Deputy Accountant
Nishshanka L.N.M.D.S.K.	Accounts Officer
Nissanka M.K.	Senior Staff Assistant – Book Keeper
Palliya Guruge M.P.	Senior Staff Assistant - Clerical
Gamalath T.P.	Management Assistant Grade III
Rathnayake R.M.V.P.	Staff Assistant – Clerical
Keshan M.K.D.	Management Assistant Grade III
Ranasinghe C.	Staff Assistant – Receptionist
Gunathilake D.G.	Record Keeper Gr. I
Jayasekara D.J.M.W.P.	Machinist – Special Grade
Lal M.A.	Laboratory Attendant – Special Grade
Hapukotuwa R.B.	Laboratory Attendant – Special Grade
Kumara A.V.A.P	Machinist Gr. I
Dharmasena G.D.	Electrician Gr. II
Dorakumbura D.G.K.	Mason Gr. II

Science Dissemination Unit

Dr. Tilakaratne C.T.K .- Coordinator
Samarakoon K.I.K . - Stenographer Gr.II
Ekanayake V.M. - Tech. Officer Gr. III
Bandara G.C.K. - Tech. Officer Gr. III

Procument & Lab Stores Division

Perera W.D.S.P. - Laboratory Manager
Lakshmi Kumari D.M.K.- Senior Staff Technical Officer
Chandrakanthi G.W.R.P.- Senior Staff
Basnayake G.A.R. Driver – Special Grade
Dayasiri M.G. Driver – Special Grade
Gunawardena R.S.K. Driver - Gr..I
Gunasekara K.G.T.B. Driver - Gr. I
Jayasinghe H.A.D.N. Driver – Gr..III

NATIONAL INSTITUTE OF FUNDAMENTAL STUDIES - SRI LANKA

SIGNIFICANT ACCOUNTING POLICIES - YEAR ENDED 31ST DECEMBER 2014

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1.1 The financial statements have been prepared on the basis of historical costs in accordance with the Srilanka Public Sector Accounting Standards for the accrual basis accounting and no adjustments have been made for inflatory factors affecting these accounts, instead of Motor Vehicle re-valuation according to the special Re-valuation committee.

1.2 Similarly Laboratory Equipment, Machinery Tools & Implements, Refrigerators, Air Conditioners, Communication Equipment, Office & Miscellaneous Equipment, Sports Items are re- valued by the Special Re-valuation Committee and there is no inflator factors affecting to the accounts.

1.3 The value of Revaluation of Fixed Asset in 2011 has been shown as Revaluation Reserve being adjusted by Institute Fund Account.

1.4 Previous year figures and phrases have been re-arranged wherever necessary to conform to the current presentation.

1.5 CONVERSION OF FOREIGN CURRENCIES

All foreign exchange transactions are converted of the rate of exchange prevailing at the time the transactions were effected. Non-resident foreign currency account balance has been translated at the rate of exchange prevailing at the date of Statement of Financial Position.

1.6 TAXATION

Under the provision of sections 8(a) (xxxix) and 42 (ff) of the Inland Revenue Act No. 28 of 1979 (as amended) the Institute is exempted from income tax in Sri Lanka.

(2) ASSETS AND BASES OF THEIR VALUATION

2.1 STOCKS:

Stocks have been valued at historical cost basis and all issues are valued at FIFO Basis.

2.2 FIXED ASSETS:

2.2.1 The cost of fixed assets is the cost of purchase or construction together with any incidental expenses thereon. The fixed assets are recorded at cost and accumulated depreciation which is provided in the depreciation on the basis specified in 2.2.2

2.2.2 DEPRECIATION OF FIXED ASSETS

The provision for depreciation has been calculated on the cost of fixed assets in order to write-off such costs over the estimated useful lives as follows:

Motor vehicles	20%
Library books	33.33%
Building	10%
Lab Equipment	10%
Sports goods	33.33%
Computers	25%
Furniture & fittings	10%
Communication	10%
Air - Conditioners	10%
Refrigerators	10%
Machinery Tools & Implements	10%
Office & Miscellaneous	
Room Linen	33.33%
Crockery Cutlery & Canteen Equipment	33.33%
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Office Equipment	20%
Sundry Assets	10%
Expandable Assets	10%

* Safety Equipment - Rate of depreciation had been changed from 33.33% to 10% with effect from 1999.

The depreciation of Fixed Assets are provided from the date of purchased to the date of disposal.

2.2.3 The Accumulated depreciation has been corrected due on 31st December 2014 to meet the Fixed Assets of the Institution by that date.

2.3 INVESTMENT

Employer's and employees' contributions made towards the NIFS provident fund has been invested in fixed deposits at the National Savings Bank.

2.4 Contribution made towards Consumption Loan Fund has been deposited in Savings Account at the National Savings Bank.

(3) LIABILITIES AND PROVISIONS

3.1 All known liabilities and provisions as the date of the Statement of Financial Position have been provided for in the accounts.

3.2 RETIREMENT GRATUITY

Provision is made in these Accounts for retirement gratuity payable under the payment of Gratuity Act No.12 of 1983 in respect of employees with 5 or more years of continued service in the Institute. This item is grouped under deferred liabilities in the Statement of Financial Position.

3.3 I.F.S. PROVIDENT FUND

Members' fund as at 31st December 2014 are shown under specified funds in the Statement of Financial

4.1 GOVERNMENT GRANT

Government grant received during the year under review towards the recurrent expenditure has beer charged to the Statement of Financial Performance for the year. Total revenue and capital fund of the Institute accumulated from the previous years have been shown as Institute funds in the Statement of Financial Position.

4.2 FOREIGN AND OTHER GRANTS

All foreign and other monetary grants received during the year, are dealt with by charging to the State of Financial Performance to the extent of such grants recognized in the Financial Statements do ma with the associated cost incurred during the year. Unspent grants during the year are shown unde specified funds and grants in the Statement of Financial Position.

4.3 RESEARCH GRANT FUND

The un-utilized specified grant balances have been shown as in the Research Grant Fund under specified fund in the Statement of Financial Position.

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Deputy Accountant

NATIONAL INSTITUTE OF FUNDAMENTAL STUDIES

SRI LANKA

STATEMENT OF FINANCIAL POSITION AS AT 31.12.2014

	NOTE	| \ x 2014	SLRs 2013
ASSETS			
CURRENT ASSETS			
CASH AND BANK BALANCES	1	63,088,740.95	48,504,610
DEPOSITS PREPAYMENTS & ADVANCES	2	6,569,005.35	8,245,472
DISPOSABLE OF FIXED ASSETS		24,915,351.37	24,915,351
FESTIVAL ADVANCE FUND INVESTMENT		256,000.00	255,000
CONSUMPTION LOAN FUND INVESTMENT		289,668.41	192,962
INTEREST RECEIVABLE FOR FIXED DEPOSITS		2,840,451.54	4,452,482
STAFF CONSUMPTION LOAN	3	4,029,005.00	3,948,038
DEBTORS AND OTHER RECEIVABLE	4	112,398.46	186,926
STOCKS	5	2,287,129.16	2,042,253
		104,387,750.24	**92,743,095**
NON-CURRENT ASSETS			
WORK IN PROGRESS (NEW BUILDING)		142,920,000.00	62,920,000
PROVIDENT FUND INVESTMENT	6	50,694,277.44	40,150,002
TRAINING CAPACITY		837,697.40	823,697
PROPERTY, PLANT AND EQUIPMENT	7	260,800,703.21	255,539,911
MAPPING REPORT		1,097,477.65	1,097,478
MODEL OF LAND		37,500.00	37,500
		456,387,655.70	**360,568,588**
TOTAL ASSTES		**560,775,405.94**	**453,311,683**
LIABILITIES			
CURRENT LIABILITIES			
ACCOUNTS PAYABLE	8	1,073,499.89	1,822,906
ACCRUED EXPENSES	9	1,861,438.80	1,471,490
		2,934,938.69	**3,294,396**
NON CURRENT LIABILITIES			
SPECIFIED FUNDS & GRANTS	10	76,949,754.14	69,261,002
DIFFERED LIABILITIES	11	18,970,557.50	15,640,909
		95,920,311.64	**84,901,911**
TOTAL LIABILITIES		**98,855,250.33**	**88,196,307**
NET ASSETS		**461,920,155.61**	**365,115,376**
NET ASSETS/EQUITY			
CAPITAL FUND - SPENT	12	374,327,139.94	262,427,056
- UNSPENT		21,494,277.43	13,594,362
PRESIDENT'S FUND - SPENT		7,078,501.15	7,078,501
ASSET REVALUATION RESERVE		122,463,619.32	122,463,619
INSTITUTE FUND		(63,443,382.23)	(40,448,162)
TOTAL NET ASSETS/EQUITY		**461,920,155.61**	**365,115,376**
		-	-

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Director Secretary Deputy Accountant

NATIONAL INSTITUTE OF FUNDAMENTAL STUDIES

SRI LANKA

STATEMENT OF FINANCIAL PERFORMANCE FOR THE YEAR ENDED 31.12.2014

	NOTE	| \ x 2014	SLRs 2013
OPERATING REVENUE			
RECURRENT GRANT		144,441,000.00	117,068,000
OTHER INCOME	13	14,035,419.97	10,821,016
		158,476,419.97	**127,889,016**
EXPENDITURE			
PERSONAL EMOLUMENTS	14	87,426,420.77	79,703,841
TRAVELLING	15	1,071,394.04	777,472
SUPPLIERS & CONSUMABLE	16	16,358,699.59	9,792,684
MAINTENANCE	17	7,622,018.32	2,927,575
CONTRACTUAL SERVICES	18	16,648,909.86	14,366,458
DEPRECIATION		29,441,926.07	27,759,754
OTHER EXPENSES	19	21,040,842.53	16,758,979
TOTAL OPERATING EXPENSES		**179,610,211.18**	**152,086,763**
DEFICIT FROM OPERATING ACTIVITIES		(21,133,791.21)	(24,197,747)
FINANCE COST			
KNRR NE CDONR@K NE EHWDC @RRDSR		-	(1,570,623)
OFU!EFGJDJU!GP S !UI F!ZFBS		**(21,133,791.21)**	**(25,768,370)**

NATIONAL INSTITUTE OF FUNDAMENTAL STUDIES
SRI LANKA

STATEMENT OF CHANGES IN NET ASSETS/EQUITY FOR THE YEAR ENDED 31.12.2014

ATTRIBUTABLE TO OWNERS OF THE CONTROLLING ENTITY					
	CONTRIBUTED CAPITAL	PRESIDENT FUND	REVALUVATION SURPLUS	INSTITUTE FUND	TOTAL NET ASSEST/EQUITY
BALANCEAS AT 01 JANUARY 2014	276,021,417.37	7,078,501.15	122,463,619.32	(40,448,161.76)	365,115,376.08
FIXED ASSET PURCHASE FROM GRANT	-	-	-	2,535,979.04	2,535,979.04
ADDITION DURING THE YEAR TO INSTITUTE FUND	-	-	-	(1,665,577.95)	(1,665,577.95)
DEFICIT FROM OPERATING ACTIVITIES	-	-	-	(21,133,791.21)	(21,133,791.21)
LOSS OF DESPOSAL LOSS OF FIXED ASSETS	-	-	-	-	-
PRIOR YEAR YEAR ADJUSTMENT - **NOTE 20**	-	-	-	(2,731,830.35)	(2,731,830.35)
CAPITAL FUNDS RECEIVED FROM GOVERNMENT & OTHER SOURCES	119,800,000.00	-	-	-	119,800,000.00
BALANCE AS AT 31 DECEMBER 2014	**395,821,417.37**	**7,078,501.15**	**122,463,619.32**	**(63,443,382.23)**	**461,920,155.61**

NATIONAL INSTITUTE OF FUNDAMENTAL STUDIES
SRI LANKA
STATEMENT OF CASH FLOW FOR THE YEAR ENDED 31.12.2014

	SLRs. 2014		| \ x 2013
Cash-Flow from Operating Activities			
Deficit for ordinary activities	(21,133,791)		(28,164,597)
Add/Less : Net adjustment to the fund	(1,665,578)		50,085,567
Prior Year Adjustments	(2,731,830)		
		(25,531,200)	21,920,970
Not involving movement of cash			
Depreciation	29,441,926		27,759,754
Provision for Gratuity	3,721,449		2,085,929
Adjustments in respect of Capital Expenditure			-
incurred by Projects	2,535,979		2,558,295
Adjustments to Provision for Depreciation	4,000,361		1,574,968
(Increase)/Decrease Disposable of Fixed Assets	-		1,709,040
(Increase)/Decrease Staff Consumption Loan	(80,967)		(130,775)
(Increase)/Decrease Stocks	(244,876)		448,932
(Increase)/Decrease Debtors and other			
Receivable	74,528		50,745
(Increase)/DecreaseWorking in			
progress (New Building)	(80,000,000)		(62,920,000)
(Increase)/Decrease Festival Advance Inv.Fund	(1,000)		(5,000)
(Increase)/Decrease Consumption Loan Inv.Fund	(96,706)		(41,187)
(Increase)/Decrease Int.rec.for Fixed Deposits	1,612,030		(1,685,165)
(Increase)/Decrease Deposits, prepayment			
and Advances	1,676,467		29,287,541
Disposable of Fixed Assets			
Cash in Hand for Festival Advance			
Increase/(Decrease) Accounts Payable	(749,407)		913,245
Increase/(Decrease) Accrued Expenses	389,949		419,936
Gratuity Paid	(391,800)		(586,425)
Adjustment of Fixed Assets	211		(1,709,040)
Profit on Disposal of Fixed Assets	(581)	(38,112,438)	1,570,623
Net Cash flow from Operating Activities		**(63,643,637)**	23,222,386
Cash Flow from Investing Activities			
Purchase of Fixed Assets	(38,703,729)		(71,188,961)
Training & Capacity	(14,000)		(8,000)
Mapping Report	-		(1,097,478)
Adjustments to Fixed Assets	1,020		-
Investments made- Provident Fund	(10,544,276)		(3,339,213)
- Consumption Loan Fund			-
Write off Over Spent Grant for Reimbursement			
		(49,260,984)	
Net Cash Flow from Investing Activities		**(112,904,621)**	(52,411,266)

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Government Capital Contribution	119,800,000		56,605,555
Specific Funds and Grants	7,688,752		12,265,084
Over-Spent Grant Reimbursement			-
Proceed on Sales of fixed Assets		127,488,752	138,416
Net increase/ (Decrease) in cash and cash equivalent		14,584,130	16,597,789
Cash and cash equivalent at beginning of period		48,504,610	31,906,821
Cash and cash equivalent at the end of the period		**63,088,741**	**48,504,610**

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

		SLRs
	2014	2013
NOTE 1		
CASH AND BANK BALANCES		
National Savings Bank, Kandy - EPF Account A/C No 1-0015-01-02989	5,765,450.50	9,416,248
National Savings Bank, Kandy - Research Fund A/C No 1-0015-01-03152	63,830.99	60,724
National Savings Bank, Kandy -Consumption Loan Fund A/C No 1-0015-109-1808	289,668.41	192,962
Bank of Ceylon, Kandy, -A/C NO RFC/162747	5,357,148.12	5,773,439
Bank of Ceylon, Kandy, A/C No 32794	2,000,380.62	2,414,938
Bank of Ceylon, Kandy, A/C No 32795	18,390,669.50	16,627,197
Bank of Ceylon, Kandy, A/C No 32779	31,221,592.81	14,019,102
	63,088,740.95	**48,504,610**
NOTE 2		
DEPOSITS PREPAYMENTS & ADVANCES		
Refundable Deposit (Note 2A)	417,100.00	417,100
Prepayment (Note 2B)	1,369,257.24	959,913
Prepayments & Advance Foreign (Note 2C)	1,420,136.90	2,948,841
Prepayments & Advance Letter of Credit (Note 2D)	1,507,624.48	1,998,158
Advance to Suppliers & Others (Note 2E)	63,095.60	-
Advance of Stand - Structural Geology	4,960.00	4,960
Advance of Director, Building Dep.	1,782,831.13	1,782,831
Advance of Hydraulic Jack	4,000.00	4,000
Contribution from Welfare	-	129,669
	6,569,005.35	**8,245,472**

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

	| \ x 2014	**SLRs 2013**
NOTE 2A		
REFUNDABLE DEPOSIT		
Ceylon Electricity Board	275,000.00	275,000
Sri Lanka Telecom	5,000.00	5,000
Kandy Municipal Council	20,000.00	20,000
Ceylon Oxygen Ltd.	32,100.00	32,100
Colombo Gas Company	2,000.00	2,000
Lanka Internet Service	1,000.00	1,000
Kandy Tyre Rebuilding Co.	50,000.00	50,000
D.A. Epa & Sons (Pvt) Ltd	3,750.00	3,750
C.I.S.I.L.	15,000.00	15,000
Shell Gas Lanka Limited	3,750.00	3,750
MTN Network Pvt. Ltd.	2,500.00	2,500
Dialog Telecom Package	4,000.00	4,000
America Preime Water Systems	3,000.00	3,000
	417,100.00	**417,100**
NOTE 2B		
PREPAYMENT		
American Chemical Society	116,496.85	97,277
American Physical Society	26,175.83	25,407
American Society For Microbiology	61,117.50	-
American Association	-	15,072
The American Archeological Society	13,152.00	-
Chief Post Master Kandy	5,000.00	2,500
Defence Levy - Director General Custom	-	250,182
Staff Insurance	-	427,109
Metropolitan Office Pvt Ltd	4,895.66	-
Macmillan Subscriptions Ltd	10,587.64	9,255
National Geographic Society	8,172.96	7,882
New Scientist	17,193.01	20,191
Portland Customer Service	17,564.95	-
S.B. Freight Services	630.57	47,680
Scientific America	6,480.00	-
JohnKeells Office Automation (Pvt.) Ltd.	19,119.18	43,958
Oxford Journal	9,629.95	-
Sri lanka insurance	581,109.98	-
Society for Conservation Biology	15,280.00	-
Director General Government Information	576.00	448
Peoples Bank / Economic Review	-	135
Perdium for Indo- SL Grant	-	12,593
Wijjaya Newspapers	-	225
ACS Member Service	41,079.45	-
American Association for Advance of Science	20,776.73	-
Material Research Society	16,957.85	-
World Health Organization	205,060.71	-

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

	| \ x 2014	SLRs 2013
Elsevier Ltd Journal	63,426.00	-
John Willey & Sons Ltd	9,629.95	-
British Ecology Society	17,234.16	-
New York Acedemy of Science	21,265.00	-
Acoustical Society of America	15,945.00	-
The Union	21,380.20	-
Society for Free Radical Biology	3,975.00	-
Society for Ecology Restoration	14,615.00	-
	1,369,257.24	**959,913**

NOTE 2C

ADVANCES (FOREIGN PURCHASE)

A J Cope & Sons Ltd.	-	590,603
Amersham Life Science Ltd	1,546.27	1,546
Bacheman California	11,873.65	11,874
Biomatter Ltd	-	28,869
Cardolite Ltd	-	569,541
Cole Promer International	-	73,448
Elsevier Science	61,008.50	61,009
Fisher Scientific UK	-	425,015
Forestry Suppliers	-	104,034
Fluka Chemical	34,771.47	34,771
Phatpocket Ltd	126,070.70	-
John matty Chemicals India (pvt) Ltd	-	157,150
Kluwer Academic	47,733.25	47,733
Memmert GMBH	-	198,154
M.J. Patterson (Scientific) Ltd	20,447.53	20,448
Sigma Aldrich	32,616.72	32,617
Milestone Sri	285,255.36	-
U.S. Speaker	-	13,160
Ven India Imports & Export	1,167.50	1,168
VWR International Ltd	68,562.20	567,974
Wageningen Agricultural University Netherlands	9,727.20	9,727
Macrogen Inc	165,320.31	-
Intragrated DNA Technologies	40,946.70	-
ILE Co.	114,071.58	-
Electron Microscopy Sciences	88,649.25	-
Brookfield Engineering	310,368.71	-
	1,420,136.90	**2,948,841**

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

		| \ x 2014	SLRs 2013
NOTE 2D			
PREPAYMENTS & ADVANCES (LETTER OF CREDIT)			
New Port Corporation FP/14/41 - BTD/M064468		1,507,624.48	1,998,158.00
		1,507,624.48	**1,998,158**
NOTE 2E			
ADVANCES TO SUPPLIERS & OTHERS			
Genetech		7,800.00	-
Sri Lanka Telecome PLC		3,020.00	-
Ceylon Oxygen Ltd		38,565.60	-
Konsolidated Multi Trading (Pvt) Ltd		13,710.00	-
		63,095.60	**-**

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	| \ x 2014	SLRs 2013
NOTE 3		
STAFF CONSUMPTION LOAN	3+/ 18+/ / 4-/ /	3,948,038.00
	4,029,005.00	3,948,038.00

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

		| \ x 2014	**SLRs 2013**
NOTE 4			
DEBTORS & OTHER RECEIVABLES			
Staff Debtors - Festival Advance	(Note 4A)	9,000.00	9,000.00
Advances & Other Receivables	(Note 4B)	68,398.46	141,926
		77,398.46	**150,926**

NOTE 4A

STAFF DEBTORS - FESTIVAL ADVANCES

	44,000.00	45,000
	44,000.00	45,000

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

	|\ x	SLRs
	2014	**2013**
NOTE 5		
STOCKS		
Chemical Glassware & Labware	1,215,991.29	1,373,078
Stationery and Sundry Stores	606,698.39	263,561
Publications	151,880.44	154,117
Consignee Stock - Publications	17,405.84	17,406
Building Maintenance	277,678.20	234,090
Goods in Transit	17,475.00	-
	2,287,129.16	**2,042,253**

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

		| \ x 2014	**SLRs 2013**
NOTE 6			
PROVIDENT FUND INVESTMENT			
CERTIFICATE NO.			
1	2-0015-03-19546	4,450,994.13	3,911,242.60
2	2-0015-03-19538	4,439,260.40	3,911,242.60
3	2-0015-03-19511	4,439,260.40	3,911,242.60
4	2-0015-03-19520	4,439,260.40	3,911,242.60
5	200-15-03-20153	2,664,630.31	2,385,524.00
6	2-0015-03-18809	4,328,274.35	3,813,457.52
7	2-0015-03-19988	2,778,495.78	2,487,462.66
8	2-0015-17-56516	2,089,892.93	1,870,987.45
9	2-0015-03-20005	2,089,892.93	1,870,987.45
10	2-0015-17-56486	2,089,892.93	1,870,987.45
11	2-0015-17-56508	3,981,239.32	3,564,225.00
12	2-0015-03-21192	3,760,258.56	3,386,400.00
13	2-0015-03-18752	3,694,425.00	3,255,000.00
14	2-0015-03-21737	2,179,400.00	-
15	2-0015-03-21745	3,269,100.00	-
		50,694,277.44	**40,150,002**

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

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NOTE 7

FIXED ASSETS

COST

(SL Rs)

DEACRIPTION	TOTAL AS AT 01.01.2014	ADDITIONS	ADJUSTMENT/ DISPOSABLE	TOTAL AS AT 31.12.2014
Land	28,622,151.00	-	-	28,622,151.00
Buildings	29,728,586.91	1,396,010.00		31,124,596.91
Laboratory Equipment	219,027,204.63	31,685,101.63	-	250,712,306.26
Machinery Tools & Implements	764,994.28	234,930.00	-	999,924.28
Motor Vehicles	20,574,263.55	-	-	20,574,263.55
Library Books	12,722,628.01	796,117.62	-	13,518,745.63
Refrigerators	1,682,480.38	74,775.00	-	1,757,255.38
Air Conditioners	4,796,607.80	454,160.00	-	5,250,767.80
Communication Equipment	871,185.42	11,130.00	-	882,315.42
Computers & Printers	17,764,705.47	2,659,777.50	-	20,424,482.97
Furniture & fittings	3,308,486.74	619,963.20	-	3,928,449.94
Sport Items	13,480.00	-	-	13,480.00
Office & Miscellaneou Equipment	18,943,869.06	771,763.60	(650.00)	19,714,982.66
	358,820,643.25	**38,703,728.55**	**(650.00)**	**397,523,721.80**

DEPRECIATION

DESCRIPTION	TOTAL AS AT 01.01.2014	CHARGE FOR THE		TOTAL AS AT 31.12.2014
		YEAR	ADJUSTMENT/ DISPOSABLE	
Buildings	20,011,671.05	1,442,048.96	303,247.07	21,756,967.08
Laboratory Equipment	46,962,096.01	15,144,717.49	48.44	62,106,861.94
Machinery Tools & Implements	263,144.44	88,640.96	-	351,785.40
Motor Vehicles	6,546,565.05	3,317,041.80	3,375,371.30	13,238,978.15
Library Books	11,732,390.35	763,913.06	(32,575.67)	12,463,727.74
Refrigerators	331,174.94	169,711.00	-	500,885.94
Air Conditioners	1,388,167.01	493,285.49	(4,342.50)	1,877,110.00
Communication Equipment	183,813.77	83,310.07	12,936.44	280,060.28
Computers / Printers	10,423,337.62	3,941,214.94	-	14,364,552.56
Furniture & fittings	694,041.31	363,309.19	605.82	1,057,956.32
Sport Items	12,870.00	610.00	-	13,480.00
Office & Miscellaneou Equipment	4,731,460.26	3,634,123.11	345,069.81	8,710,653.18
	103,280,731.81	**29,441,926.07**	**4,000,360.71**	**136,723,018.59**
Written down value	**255,539,911.44**			**260,800,703.21**

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

	| \ x	**SLRs**
	2014	**2013**
NOTE 8		
ACCOUNTS PAYABLE		
Creditors - Suppliers & Services (Note 8A)	940,631.07	1,690,038
Other Creditors and Payable (Note 8B)	132,868.82	132,869
	1,073,499.89	**1,822,906**

NOTE 8A

CREDITORS-SUPPLIERS & SERVICES

General Upkeep - Janitorial	65,460.00	59,964
General Upkeep - Garden Maintenance	39,000.00	39,292
General Upkeep - Catering	25,000.00	25,000
Department of Inland Revenue (stamp)	13,455.00	12,180
Department of Inland Revenue (PAYE tax)	12,516.00	106
Dr. R. Rathnayaka	-	11,519
Kandy Tyre Rebuilding Co. Ltd	115,869.50	75,552
Mr.P.G.Chamila Sanka Wickrama	115,530.00	93,934
Mr.T. Gamini Silva	46,200.00	100,500
Security Services	174,081.60	163,586
New Central Hardware	30,400.00	-
Haji M.K.M. Hasson & Sons	-	4,930
Hemsons International (Pte) Ltd	-	95,738
EWIS Peripheral (Pvt) Ltd	14,500.00	-
Organic Trading (Pvt) Ltd.	-	42,885
Exodus Labtech 9pvt0 LTD	4,000.00	-
ACE International Express (Pvt) Ltd	5,152.00	-
W.G. Jayasekara	-	3,491
R.D.W.C. Rajapakshe	-	230
R.G.K. Kumara	-	5,000
Dr. M. Vithanage	-	3,735
Dr. Benjamin	-	800
K.I.K. Samarakoon	-	920
Namal Athukorala	-	2,340
D.G. Gunathilake	-	545
S.B. Fright Service	-	40,582
R.K.C. Karunaratne	-	1,582
C.A. Thotawattage	-	26,983
Prof. L. Dissanayake	-	19,347
S.L. Jayarathne	-	19,347
O.S. Perera	-	38,827
Dr. R. Liyanage	-	41,173
kundasale Auto Service	-	19,838
ACE Internatinal Care	-	23,097
Dr. M.C.M. Iqbal	-	56,154
Prof. U.L.B.Jayasinghe	-	24,338

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

		| \ x	SLRs
		2014	**2013**
Indra Motors Spare (Pvt) Ltd		39,900.00	-
Dr. A. Wijesinghe		-	4,547
Jeewa Kasthuri		-	3,500
M.A.G. Somananda		-	400
Mr.L. Wenkdasamy		1,140.00	2,487
Saman Priyadeva		-	1,600
Dinapaala (pvt) Ltd		-	36,250
R.S.KJ.Gunawardena		-	400
Green Park Holding		-	22,700
Royal Garden Hotel		-	86,285
Sri Ramya Hotel & Bakers		-	30,000
Solvem Trading Company		-	5,100
Ampitiya Auto Care		-	16,860
Narah Stationers		17,475.00	-
IFS Welfare Association		-	129,669
Analytical Instruments (Pvt) Ltd		112,985.16	296,725
Refco Engineering Center		750.00	-
Qualitron (Pvt) Ltd		70,280.00	-
R.B.Hapukotuwa		3,800.00	-
R.S.M.Perera		5,200.00	-
E.M.G.S.Ekanayake		2,014.00	-
Mohan Perera		1,500.00	-
Danushka Malwewa		200.00	-
B.J.Weerasooriya		340.00	-
S.B.Freight		15,882.81	-
		940,631.07	**1,690,038**

NOTE 8B

OTHER CREDITORS & PAYABLE

NRC Rent (Refundable Deposit)	90,000.00	90,000
Disposable Item (Refundable Deposit)	900.00	900
Malwatte Contractors	27,000.00	27,000
Sooner Scientific	14,968.82	14,969

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

	| \ x 2014	**SLRs 2013**
NOTE 9		
ACCRUED EXPENSES		
Traveling & Subsistence	7,375.00	5,400
Government Audit Fees	422,592.00	302,592
Temporary Staff Allowance - NIFS	68,000.00	85,930
Temporary Staff Allowance - Grant	360,912.74	374,045
Communication	45,602.42	46,271
Overtime - NIFS	91,006.86	90,478
Overtime - Grant	6,830.55	11,312
Water Charges	83,394.79	141,685
Internet	467,361.50	101,272
Miscellaneous	2,000.00	-
Visiting Salary-Prof. S.A. Kulasooriya - NIFS	44,199.03	36,445
Electricity	250,387.78	276,061
Paper Bill	1,760.00	-
Visiting Research Allowance - Prof.S.A.Kulasooriya - Grant	10,016.13	-
	1,861,438.80	**1,471,490**

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

		| x 2014	SLRs 2013
NOTE 10			
SPECIFIED FUNDS & GRANTS			
I. F. S. Provident Fund		59,571,238.36	54,289,791
Retired Members Fund		1,738,712.43	2,153,270
Festival Advance Fund		256,000.00	255,000
Consumption Loan Fund		289,668.41	192,962
Specified Grants (NOTE-10A)		13,038,434.01	10,706,795
Research Grants Fund		2,055,700.93	1,663,184
		76,949,754.14	**69,261,002**
NOTE 10A			
SPECIFIED GRANT BALANCES			
School Science Programme		4,750.33	12,257
BES Grant		62,412.22	62,412
RG/2006/AASR/04 - Dr. G. Seneviratne		54,505.83	54,506
RG/2006/EB/08		35,522.39	35,522
Sample Analysis		-	59,117
Scientia Magazine		174,705.75	174,706
Dayata kirula		13,825.28	13,825
Sample Analysis - Outside Funds		482,491.44	19,859
Bioassaya		43,442.83	49,443
Vidu Kirana		159,306.97	144,992
Annual Review		236,670.00	10,000
Sola- Asia		306,562.75	310,913
Tube Chanel		-	300,000
Symposium		282,740.07	306,195
University Of Sydney		2,398.11	475,742
RG/2011/BS/01		116,117.98	116,118
HETC Project		168,892.82	126,690
Anuradapura District Tank		-	2,400,000
RG/2011/AG/09 - Dr. R. Liyanage		78,285.02	91,557
IFS Sweeden Grant		380,013.05	391,436
Rhizobium Grant		1,247,082.08	1,721,986
PV Workshop - Prof. L. Dissanayake		9,831.78	40,032
RG/2012/BS/06 - NSF - Prof. N.S. Kumar		9,361.29	364,483
NSF/SCH/2012/02 - Postgraduate Research		416,773.01	263,682
RG/2012/NRB/03 - Dr. N.D. Subasinghe		255,925.26	24,997
RG/2012/BS/04 - Prof. L.Dissanayake		524,822.98	194,290
Water Quality - Mr. Padmasiri		31,542.51	39,356
Tokyo Cement - Dr. Iqbal		92,400.00	520,245
NSF - RG/2012/AG/01 - Dr. Jayasinghe		18,486.10	323,849
NSF-RG/2012/ESA/01		823,518.01	977,440
Spectra Industries		290,000.00	290,000
MTR Indian Grant		2,717,719.42	791,147
NSF-Vidu Nena Dasuna		415,340.35	-
President Sri Lanka Society		22,000.00	-
Sample Analyzed - Dr.Meththika		62,000.00	-

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

		| \ x 2014	SLRs 2013
NOTE 10			
SPECIFIED FUNDS & GRANTS			
I. F. S. Provident Fund		59,571,238.36	54,289,791
Retired Members Fund		1,738,712.43	2,153,270
Festival Advance Fund		256,000.00	255,000
Consumption Loan Fund		289,668.41	192,962
Specified Grants (NOTE-10A)		13,038,434.01	10,706,795
Research Grants Fund		2,055,700.93	1,663,184
		76,949,754.14	**69,261,002**
NOTE 10A			
SPECIFIED GRANT BALANCES			
School Science Programme		4,750.33	12,257
BES Grant		62,412.22	62,412
RG/2006/AASR/04 - Dr. G. Seneviratne		54,505.83	54,506
RG/2006/EB/08		35,522.39	35,522
Sample Analysis		-	59,117
Scientia Magazine		174,705.75	174,706
Dayata kirula		13,825.28	13,825
Sample Analysis - Outside Funds		482,491.44	19,859
Bioassaya		43,442.83	49,443
Vidu Kirana		159,306.97	144,992
Annual Review		236,670.00	10,000
Sola- Asia		306,562.75	310,913
Tube Chanel		-	300,000
Symposium		282,740.07	306,195
University Of Sydney		2,398.11	475,742
RG/2011/BS/01		116,117.98	116,118
HETC Project		168,892.82	126,690
Anuradapura District Tank		-	2,400,000
RG/2011/AG/09 - Dr. R. Liyanage		78,285.02	91,557
IFS Sweeden Grant		380,013.05	391,436
Rhizobium Grant		1,247,082.08	1,721,986
PV Workshop - Prof. L. Dissanayake		9,831.78	40,032
RG/2012/BS/06 - NSF - Prof. N.S. Kumar		9,361.29	364,483
NSF/SCH/2012/02 - Postgraduate Research		416,773.01	263,682
RG/2012/NRB/03 - Dr. N.D. Subasinghe		255,925.26	24,997
RG/2012/BS/04 - Prof. L.Dissanayake		524,822.98	194,290
Water Quality - Mr. Padmasiri		31,542.51	39,356
Tokyo Cement - Dr. Iqbal		92,400.00	520,245
NSF - RG/2012/AG/01 - Dr. Jayasinghe		18,486.10	323,849
NSF-RG/2012/ESA/01		823,518.01	977,440
Spectra Industries		290,000.00	290,000
MTR Indian Grant		2,717,719.42	791,147
NSF-Vidu Nena Dasuna		415,340.35	-
President Sri Lanka Society		22,000.00	-
Sample Analyzed - Dr.Meththika		62,000.00	-

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

		| \ x 2014	SLRs 2013
NSF-RG/2014/EB/03		1,540,000.00	-
BIO Film		208.80	-
N.W.I.B.M.N.S(Enzyme Inhibitory Studies)		13,352.24	-
Plant Nursary in Dambulla ARB		355,265.00	-
Tissue Culture - Kantale		963,125.77	-
NSF-RG/2014/BS/02		452,828.00	-
South East University - Oluvil		163,098.44	-
Young Scientists Symposium		11,110.13	-
		13,038,434.01	**10,706,795**

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DIFFERED LIABILITIES

Provision for Retirement Gratuity	18,970,557.50	15,640,909
	18,970,557.50	**15,640,909**

NOTE 12

CAPITAL FUND SPEND AND UNSPENT

Capital Fund Spent

Capital Fund Spent	274,135,895.58	217,491,299
Government Grant Capital Spent(Current Year)	100,191,244.36	44,935,756
	374,327,139.94	**262,427,056**

Capital Fund Unspent

Capital Fund Unspent	1,885,521.79	1,924,563
Government Grant Capital Unspent(Current Year)	19,608,755.64	11,669,799
	21,494,277.43	**13,594,362**

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

	| \ x 2014	**SLRs 2013**
NOTE 13		
OTHER INCOME		
Foreign & Local Grants (NOTE 13A)	10,771,766.56	9,271,537.82
Donation	1,935,645.00	-
Sale of Books	1,054.44	103,871
Sundry Income	189,981.51	221,531
Interest Received	300,295.62	308,680
Foreign Currency Exchange Gaining	72,812.47	184,187
Income - Hiring Auditorium	76,000.00	50,000
Income - Accomadation	687,283.17	681,210
Sale of Disposable Items	581.20	-
	14,035,419.97	**10,821,016**
NOTE 13A		
FOREIGN & LOCAL GRANTS INCOME		
School Science Programme	253,506.71	377,067
NSF- RG/SCH/2012/02	146,908.72	36,318
RG/2012/NRB/03	788,853.20	743,811
Bioassays	6,000.00	-
Science Magazine	-	55,300
CCD Murunga	-	7,345
Copenhagen University	-	48,903
Water Quality	15,013.81	9,334
Saitma University	-	3,400
Vidukirana	21,940.18	600,699
Annual Review	63,330.00	262,500
IFS Sweeden Grant	-	33,500
Sola - Asia	4,350.00	-
Symposium	5,500.00	3,750
University of Sydney	473,344.09	1,452,590
C.K.D. Wiyaba	-	108,269
RG/2011/BS/01	-	205,415
HETC Project	72,796.97	348,610
Rhizobium - Prof. Kulasooriya	1,231,714.24	1,138,782
Manaweli Irrigation- Prof. Kulasooriya	-	83,022
PV Workshop - Prof. L.Dissanayake	30,200.00	2,400
RG/2011/AG/09	13,272.00	252,335
RG/2012/BS/06 NSF - Prof. Kumar	721,171.28	587,080
Rhizobium Master Class - Prof. Kulasooriya	-	89,822
Tokyo Cement - Dr. Iqbal	53,100.00	82,754
NSF- RG/2012/AG/01 - Dr. Jayasinghe	544,606.71	745,532
RG/2011/BS/04	-	650,710
Dayata Kirula	-	68,895
Science Camp	-	11,600
Sample Analysis	-	112,883
NSF/ESA/01	623,395.99	374,060

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

b £x !M̊L€g̊ !E ġ̊	557,079.50	208,853
Short Course	-	11,540
Specified Research Grant Fund	3,536.00	124,316
RG/2012/BS/04	486,799.99	-
Sample Analysis - Prof.Gamini	107,611.54	-
Vidu Nena Dasuna	214,439.65	-
UNESCO	1,244,259.26	-
CEY Water	364,470.51	-
RG/2014/EB/03	122,500.00	-
BIO Film	148,139.20	-
N.W.I.B.M.N.S	1,294,170.34	-
Plant Nursary in Dambulla ARB	38,735.00	-
Tissue Culture - Kantale	36,874.23	-
RG/2014/BS/02	70,000.00	-
C.I.R. Equipment	39,676.08	-
South East University - Oluvil	6,901.56	-
Young Scientists Symposium	38,889.87	-
	10,771,766.56	**9,271,538**

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EXPENDITURE FOR PERSONAL EMOLUMENTS

		SLRs 2014	SLRs 2013
Salaries	(Appendix 01)	73,575,518.54	67,553,005
EPF	(Appendix 01)	9,763,718.01	8,533,001
ETF	(Appendix 01)	1,952,743.71	1,714,947
Temporary Staff Allowances		962,075.00	919,695
Overtime		1,172,365.51	983,194
		87,426,420.77	**79,703,841**

NOTE 15

TRAVELLING

Local	(Appendix 01)	289,044.50	231,561
Foreign	(Appendix 01)	782,349.54	545,911
		1,071,394.04	**777,472**

NOTE 16

EXPENDITURE FOR SUPPLIERS & CONSUMABLES

Stationery & Office Requisites	(Appendix 01)	471,216.81	530,818
Fuel and Lubricants		2,398,095.51	2,084,472
Chemical & Glassware	(Appendix 01)	6,447,407.48	2,161,265
Consumable	(Appendix 01)	7,041,979.79	5,016,129
		16,358,699.59	**9,792,684**

NOTE 17

EXPENDITURE FOR MAINTENANCE

Building	(Appendix 01)	1,389,743.58	483,556
Equipment	(Appendix 01)	3,615,361.72	1,569,240
Vehicle		2,616,913.02	874,779
		7,622,018.32	**2,927,575**

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

		| \ x 2014	SLRs 2013
NOTE 18			
EXPENDITURE FOR CONTRACTUAL SERVICES			
Transport		545,372.41	540,976
Telecommunication		753,575.63	710,616
Postage		118,255.00	116,740
Electricity		7,280,247.54	6,873,744
Water		1,638,251.81	1,432,207
Garden Maintenance		468,000.00	446,497
Janitorial Services		785,520.00	674,932
Security Services		2,078,483.57	1,963,032
Catering Services		300,000.00	300,000
Internet Service		2,681,203.90	1,307,713
		16,648,909.86	**14,366,458**
NOTE 19			
OTHER EXPENDITURE			
Advertisement		300,748.00	441,056
Arboretum Expenses		180,000.00	180,000
Audit Fees		250,000.00	200,000
Auditorium And Room Maintenance		73,152.40	94,777
Bank Charges		56,080.00	28,555
Entertainment		5,845.00	6,000
Grant Expenses (Note 19A)		10,771,766.56	9,271,537.82
Gratuity		3,721,448.51	2,085,929
Staff Insurance		438,419.05	420,026
Insurance - Building		383,160.27	344,057
Insurance Motor Vehicle & License Fee		509,904.24	594,375
Journal Periodicals & Subscription		479,419.33	327,317
Membership Fees		518,295.73	588,268
Miscellaneous		768,921.88	461,703
Printing / Photocopy		52,428.00	82,601
Publication - Donation		291.20	710
Research Council Meeting Expenses		38,354.00	33,462
Welfare		1,571,949.91	1,190,004
Legal Expenses		-	408,600
Annual Review - IFS		232,402.00	-
Room Expenditure		573,580.00	-
IFS Science Week		114,676.45	-
		21,040,842.53	**16,758,979**

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

	| \ x 2014	SLRs 2013
NOTE 19A		
GRANT EXPENSES		
School Science Programme	253,506.71	377,067
NSF- RG/SCH/2012/02	146,908.72	36,318
RG/2012/NRB/03	788,853.20	743,811
Science Magazine	-	55,300
CCD Murunga	-	7,345
Copenhagen University	-	48,903
Water Quality	15,013.81	9,334
Saitma University	-	3,400
Vidu Kirana	21,940.18	600,699
Annual Review	63,330.00	262,500
IFS Sweeden Grant	-	33,500
Sola - Asia	4,350.00	-
Symposium	5,500.00	3,750
University of Sydney	473,344.09	1,452,590
C.K.D. Wiyaba	-	108,269
RG/2011/BS/01	-	205,415
HETC Project	72,796.97	348,610
Rhizobium - Prof. Kulasooriya	1,231,714.24	1,138,782
Manaweli Irrigation- Prof. Kulasooriya	-	83,022
PV Workshop - Prof. L.Dissanayake	30,200.00	2,400
RG/2011/AG/09	13,272.00	252,335
RG/2012/BS/06 NSF - Prof. Kumar	721,171.28	587,080
Rhizobium Master Class - Prof. Kulasooriya	-	89,822
Tokyo Cement - Dr. Iqbal	53,100.00	82,754
NSF- RG/2012/AG/01 - Dr. Jayasinghe	544,606.71	745,532
RG/2011/BS/04	-	650,710
Dayata Kirula	-	68,895
Science Camp	-	11,600
Sample Analysis	-	112,883
NSF/ESA/01	623,395.99	374,060
Traning Programme	928,679.93	430,142
MTR Indian Grant	557,079.50	208,853
Short Course	-	11,540
Specified Research Grant Fund	3,536.00	124,316
Bioassays	6,000.00	-
RG/2012/BS/04	486,799.99	-
Sample Analysis - Prof.Gamini	107,611.54	-
Vidu Nana Dasuna	214,439.65	-
UNESCO	1,244,259.26	-
CEY Water	364,470.51	-
RG/2014/EB/03	122,500.00	-
BIO Film	148,139.20	-
N.W.I.B.M.N.S	1,294,170.34	-
Plant Nursary in Dambulla ARB	38,735.00	-
Tissue Cultrue - Kantale	36,874.23	-
NSF - RG/2014/BS/02	70,000.00	-

NOTES TO THE ACCOUNTS FOR THE YEAR ENDED 31.12.2014

		| x 2014	SLRs 2013
Young Scientists Symposium		38,889.87	-
		10,771,766.56	**9,271,538**

NOTE 20

PRIOR YEAR ADJUSTMENT

Credit		
Chemical & Glassware Stock Difference	3,500.00	-
Reimbursement Fuel Expense-NSF	-	4,560
Accommodation	2,500.00	-
Foreign Travell	39,086.24	-
Over Payment - Research Allowance	5,222.90	-
Salary - Nopay Deductions	23,359.33	47,880
Membership	-	27,913
1% Administration Expenses	-	36,325
Major Vehicle Repair	-	150,250
	73,668.47	266,927
Debit		
Vehicle Maintenance	17,915.00	-
Under Provision Audit Fees	80,336.00	-
Foreign Travel	30,717.60	-
Subscription	8,585.00	-
Dialog Bill	-	810
Depreciation	2,438,018.82	1,577,004
Chemical & Glassware	-	7,670
Membership	41,926.75	6,661
Salary	187,999.65	610,878
EPF & ETF	-	460,131
	2,805,498.82	2,663,154
	(2,731,830.35)	**(2,396,227)**

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PROJECT RECURRANT EXPENDITURE

CODES	CHEMICAL & GLASSWARE, CONSUMABLE	EQUIPMENT MAINTANANCE	BUILDING MAINTANANCE	FOREIGN TRAVELLING	STATIONARY	TRANSPORT	LOCAL TRAVELLING	COMMUNICATION	ADVERTISING	SALARIES, EPF,ETF
PLANT BIOTECHNOLOGY	299-689	231,733	65,479	81,269	12,020	12,600	45,455	-	-	4,755,631
SGDNQDSHE@K%EN LOTS@SNM@K SCIENCE	2-144-482	32,930	1,977	-	2,855	-	3,090	18,581	32,760	3,251,127
M@STQ@K CONCTBS BGDLRSQX	: 29-267	547,135	103,200	46,529	10,691	-	10,957	11,737	13,104	8,296,905
EDK ANKNFX	2-134-423	202,054	13,629	75,900	10,438	-	7,100	3,337	13,104	3,406,360
RNKHDRS@DBGDLRSQX	1,192,719	44,802	1,889	105,700	11,533	-	10,800	-	-	3-621-425
ENMCDMBDL@SHDQCKRHR										2-685-84:
CKNSNBGDLRSQX	2-249-622	211,879	91,321	-	11,638	-	1,000	-	-	4,902,378
DENKNFX%DMUKNNLDMS@K BIOLOGY	578-881	323,164	43,193	42,400	4,391	5,150	25,700	4,058	8,736	3,585,994
LHBQNA@KANSEDBGNKNFX UNT										
BIOFILMED BIOFERTILIZER	796-: 94	8,740	12,164	113,792	11,321	-	14,950	5,305	-	7,719,449
ANETDKK	2-545-993	35,912	7,001	158,950	11,970		41,010	8,547	-	
FDNSGDQ@K QDRNTGED MAPPING	23: -578	25,836	1,162	77,810	10,486	1,550	17,050	-	-	4,576,328
BGDLHE@K%DMUNQNLDMS@K MODELLING	2-39: -231	37,516	86,601	-	7,883	-	7,000	10,631	8,736	3,253,658
DKDBSQNBGDLHE@KL@SDQHR	2-321-323	29,320	50,600	-	11,081	-	4,700	-	-	2,754,173
ENNCRBHMEDM@STQ@K, H	998-284	9,936	864	-	2,580	550	1,400	-	-	2,954,302
ENNCRBHMEDM@STQ@K, IHI	2-672-965	15,804	3,788	80,000	8,590	-	4,750	-	-	2,108,344
@DLNRSQ@SNM	439-38:	1,858,601	906,876		343,740	537,689	94,483	691,380	224,308	29,642,279
SNS@K	**24-59: -498**	**3,615,362**	**1,389,744**	**782,350**	**471,217**	**557,539**	**289,445**	**753,576**	**300,748**	**85,291,980**

AGE ANALYSIS OF DEBTORS & OTHER RECEIVABLES AS AT 31.12.2014

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	0 - 12 MONTHS Rs	1 - 2 YEARS Rs	2 - 3 YEARS Rs	3-4 YEARS Rs	4 - 5 YEARS Rs	OVER 5 YEARS Rs
I.F.S. E.P.F.1%	46,481.51	-	-	-	-	-
Transport - Dr.M.C.M.Iqbal	77.00	-	-	-	-	-
Accomadation	-	-	-	-	-	-
Accomadation - T.C.P.Thilakarathne	1,311.99	-	-	-	-	-
Accomadation - Ms.S.S.Weerakkody	2,500.00	-	-	-	-	-
Accomadation - Miss.Y.Nijanthini	1,250.00	-	-	-	-	-
Accomadation - Miss.S.Logini	1,250.00	-	-	-	-	-
Ministry of science & Technology	7,027.96	-	-	-	-	-
	59,898.46	**-**	**-**	**-**	**-**	**-**

FESTIVAL ADVANCE Rs. 44,000.00:

0 - 12 MONTHS Rs	1 - 2 YEARS Rs	2 - 3 YEARS Rs	3-4 YEARS Rs	4 - 5 YEARS Rs	OVER 5 YEARS Rs
44,000.00	-	-	-	-	-
44,000.00	**-**	**-**	**-**	**-**	**-**

AGE ANALYSIS OF ACCRUED EXPENSES & ACCOUNTS PAYABLE AS AT 31.12.2014

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	0 - 12 MONTHS Rs	1 - 2 YEARS Rs	2 - 3 YEARS Rs	3-4 YEARS Rs	4 - 5 YEARS Rs	OVER 5 YEARS Rs
Traveling & Subsistence	7,375.00	-	-	-	-	-
Government Audit Fees	422,592.00	-	-	-	-	-
Temporary Staff Allowance - NIFS	68,000.00	-	-	-	-	-
Temporary Staff Allowance - Grant	360,912.74	-	-	-	-	-
Communication	45,602.42	-	-	-	-	-
Overtime - NIFS	91,006.86	-	-	-	-	-
Overtime - Grant	6,830.55	-	-	-	-	-
Water Charges	83,394.79	-	-	-	-	-
Internet	467,361.50	-	-	-	-	-
Miscellaneous	2,000.00	-	-	-	-	-
Visiting Salary-Prof. S.A. Kulasooriya - NIFS	44,199.03	-	-	-	-	-
Electricity	250,387.78	-	-	-	-	-
Paper Bill	1,760.00	-	-	-	-	-
Visiting Research Allowance - Prof.S.A.Kulasooriya - Grant	10,016.13	-	-	-	-	-
	1,861,438.80	**-**	**-**	**-**	**-**	**-**

OTHER CREDITORS AND PAYABLE BALANCE Rs.132,868.82 :

	0 - 12 MONTHS Rs	1 - 2 YEARS Rs	2 - 3 YEARS Rs	3-4 YEARS Rs	4 - 5 YEARS Rs	OVER 5 YEARS Rs
NRC Rent (Refundable Deposit)	-	-	-	-	-	90,000.00
Disposable Item (Refundable Deposit)	/	: 11/11	-	-	-	-
Malwatte Contractors	-	-	-	-	-	27,000.00
Sooner Scientific	-	-	-	-	14,968.82	-
	-	**900.00**	**-**	**-**	**14,968.82**	**117,000.00**

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	0 - 12 MONTHS Rs	1 - 2 YEARS Rs	2 - 3 YEARS Rs	3-4 YEARS Rs	4 - 5 YEARS Rs	OVER 5 YEARS Rs
Kandy Tyre Rebuilding Co. Ltd	115,869.50	,	-	-	-	-
Hvmg!Tijof!Dnfbojoh!Tfswjdft	104,460.00	,	-	-	-	.
Mr.P.G.Chamila Sanka Wickrama	140,530.00	,	-	-	-	.
Mr.T. Gamini Silva	46,200.00	,	-	-	-	.
Aroma Guard And Security (Pvt) Ltd	174,081.60	,	-	-	-	.
New Central Hardware	30,400.00	,	-	-	-	.
EWIS Peripheral (Pvt) Ltd	14,500.00	,	-	-	-	.
Exodus Labtech 9pvt0 LTD	4,000.00	,	-	-	-	.
ACE International Express (Pvt) Ltd	5,152.00	,	-	-	-	.
Gatambe Motors	8,000.00	,	-	-	-	.
Indra Motors Spare (Pvt) Ltd	39,900.00	,	-	-	-	.
Mr.L. Wenkdasamy	1,140.00	,	-	-	-	.
Narah Stationers	17,475.00	,	-	-	-	.
Analytical Instruments (Pvt) Ltd	112,985.16	,	-	-	-	.
Refco Engineering Center	750.00	,	-	-	-	.
Qualitron (Pvt) Ltd	70,280.00	,	-	-	-	.
	885,723.26	-	-	-	-	-

\	ACCRUED EXPENSES	-	1,861,438.80
L/2	CREDITORS	-	940,631.07
L/3	CAPITAL FUND SPENT	-	274,135,895.58
L/4	CAPITAL FUND UNSPENT	-	1,885,521.79
L/5	E.P.F. PAYABLE	-	-
L/6	E.T.F. PAYABLE	-	-
L/8	I.F.S.PROVIDENT FUND	-	59,571,238.36
L/10	INSTITUTE FUND	42,113,739.71	-
L/12	PROVISION FOR GRATUITY	-	18,970,557.50
L/13	PROVISION FOR DEPRECIATION	-	136,723,018.59
L/14	PRESIDENT FUND CAPITAL SPENT-SUPPLEMENTARY	-	7,078,501.15
L15	RENT PAYBLE	-	-
L/19	OTHER PAYABLE ACCOUNTS	-	-
L/20	RETENTION MONEY PAYABLE	-	-
L/21	RETIRED MEMBERS FUND ACCOUNT	-	1,738,712.43
L/22	CAPITAL EXPENDITURE SPECIFIED FUNDS & DONATION	-	2,535,979.04
L/23	SCHOOL SCIENCE PROGRAMME	-	4,750.33
L/24	PAYABLE OF 10% to WELFARE ASSOCIATION	-	-
L/25	BUILDING CONTRACTORS	-	27,000.00
L/26	FESTIVAL ADVANCE - FUND ACCOUNT	-	256,000.00
L/28	CONSUMPTION FUND	-	289,668.41
L/36	SPECIFIED RESEARCH GRAND FUND	-	2,055,700.93
L/42	BES GRANT	-	62,412.22
L/44	GOV. TAX	-	-
L/45	DEP OF INLAND REVENUE	-	-
L/46	RG/2006/AASR/04 DR GAMINI	-	54,505.83
L/48	RG/2006/EB/08	-	35,522.39
L/55	BIOASSAYS	-	43,442.83
L/56	SCIENCE MAGAZINE	-	174,705.75
L/65	VIDU KIRANA	-	159,306.97
L/66	ANNUAL REVIEW	-	236,670.00
L/70	SOLA ASIA	-	306,562.75
L/72	SYMPOSIUM	-	282,740.07
L/73	UNIVERSITY OF SYDNEY	-	2,398.11
L/76	RG/2011BS/01 DR NADEESHANI	-	116,117.98
L/78	HETC PROJECT	-	168,892.82
L/79	ANURADAPURA DISTRIC TANK	-	-
L/81	RG/2011/AG/09	-	78,285.02
L/82	IFS SWEEDEN	-	380,013.05
L/83	RHIZOBIUM	-	1,247,082.08
L/84	RG/2012/AG/01	-	18,486.10
L/86	PV WORK SHOP	-	9,831.78
L/89	RG/2012/BS/06	-	9,361.29
L/91	NSF/SCH/2012/02	-	416,773.01
L/92	RG/2012/NRB/03	-	255,925.26
L/93	RG/2012/BS/04	-	524,822.98
L/94	WATER QUALITY	-	31,542.51
L/95	TOKYO CEMENT COMPANY	-	92,400.00
L/96	REVALUVATION RESERVE	-	122,463,619.32
L/97	MTR DAYATA KIRULA	-	13,825.28
L/99	SAMPLE ANALIZED PROF - OUTSIDE FUNDS	-	482,491.44
L/100	NSF/ESA/01	-	823,518.01
L/101	RG/2012/EQ/07	-	-
L/102	SPECTRA INDUSTRIES	-	290,000.00
l/104	MTR (INDIAN)	-	2,717,719.42
L/103	TRANNING PROGRAM	-	-
L/106	TOKYO CEMENT - COTTAGE	-	-
L/107	NSF - VIDU NANA DASUNA(VND)	-	415,340.35

TRIAL BALANCE AS AT31.12.2014

c i		DEBIT	CREDIT
F/A/1	AIR CONDITIONER	5,250,767.80	-
F/A/2	BUILDING	31,124,596.91	-
F/A/3	COMPUTER & PRINTERS	20,424,482.97	-
F/A/4	COMMUNICATION EQUIPMENT	882,315.42	-
F/A/5	FURNITURE & FITTINGS	3,928,449.94	-
F/A/6	IMPROVEMENTS TO BUILDING	-	-
F/A/7	LAND	28,622,151.00	-
F/A/8	LABORATORY EQUIPMENT	250,712,306.26	-
F/A/9	LIBRARY BOOKS	13,518,745.63	-
F/A/10	MOTOR VEHICLE	20,574,263.55	-
F/A/11	MACHINERY TOOLS & IMPLEMENTS	999,924.28	-
F/A/12	OFFICE & MISCELLANEOUS EQUIPMENT	19,714,982.66	-
F/A/13	REFRIGERATORS	1,757,255.38	-
F/A/14	SPORT ITEMS	13,480.00	-
F/A/15	MOTOR VEHICLE OVERHALL	-	-
F/A/16	KITCHEN EQUIPMENT	-	-
F/A/17	TRAINING CAPACITY	837,697.40	-
O/F/A/1	EMPLOYEE PROVIDENT FUND INVESTMENT	50,694,277.44	-
O/F/A/2	DISPOSAL OF FIXED ASSETS	24,915,351.37	-
O/F/A/3	MODEL OF LAND	37,500.00	-
O/F/A/4	INVESTMENT OF CONSUMPTION LOAN	289,668.41	-
O/F/A/5	GEOTERMAL MAPPING REPORT	1,097,477.65	-
O/F/A/6	NEW BUILDING - WORKING PROGRES	142,920,000.00	-
C/A/1	BUILDING MAINTENANCE STOCK	277,678.20	-
C/A/2	CHEMICAL GLASSWARE AND LAB WARE STOCK	1,215,991.29	-
C/A/3	CONSIGNED STOCK	17,405.84	-
C/A/4	STATIONERY STOCK	239,628.64	-
C/A/5	SUNDRY STOCK	367,069.75	-
C/A/6	PUBLICATION STOCK	151,880.44	-
C/A/10	INSURANCE CLAIM RECEIVABLE(JANASHAKTHI)	-	-
C/A/11	ADVANCE TO SUPPLIES & OTHERS	63,095.60	-
C/A/12	FOREIGN PAYMENTS ON ADVANCE	1,420,136.90	-
C/A/13	LETTER OF CREDIT MARGIN	1,507,624.48	-
C/A/14	FESTIVAL ADVANCE	44,000.00	-
C/A/15	SPECIAL ADVANCE	-	-
C/A/16	SALARY ADVANCE	-	-
C/A/17	SCIENCE WEEK PROJECT	-	-
C/A/18	REFUNDABLE DEPOSIT	417,100.00	-
C/A/19	PREPAYMENT	1,368,626.67	-
C/A/20	OTHER RECEIVABLE ACCOUNT	59,898.46	-
C/A/21	INTEREST RECEIVABLE FOR FIXED DEPOSIT	2,840,451.54	-
C/A/22	NRC BUILDING DEPOSIT	-	90,000.00
C/A/23	REFUNDABLE DEPOSIT FOR DISPOSABLE ITEMS	-	900.00
C/A/24	REFUNDABLE BENCH FEES	-	-
C/A/26	SOONER SCIENTIFIC	-	14,968.82
C/A/36	HYDRAULIC JACK	4,000.00	-
C/A/38	BOOK RACK NATU . PRODUCT	-	-
C/A/39	STAND ST, GEOLOGY	4,960.00	-
C/A/40	FESTIVAL ADVANCE INVESTMENT ACCOUNT	256,000.00	-
C/A/41	DIRECTOR BUILDING DEPARTMENT - ADVANCE	1,782,831.13	-
C/A/42	YOUNG SCIENTISTS SYMPOSIUM	-	11,110.13
C/A/43	CONTRIBUTION FORM WELFARE	-	-
C/A/45	NEW SCIENCE BUILDING	-	-
C/A/46	GOODS IN TRANSIT	17,475.00	-

\	PRESIDENT SRI LANKA SOCITY	-	22,000.00
L/111	SAMPLE ANALIZED PROF: BANDARA	-	-
L/112	SAMPLE ANALIZED DR: METHIKA	-	62,000.00
L/113	UNESCO	-	-
L/115	RG/2014/EB/03	-	1,540,000.00
L/116	BIO FILM	-	208.80
L/117	N.W.I.B.M.N.S	-	13,352.24
L/118	PLANT NURSERY IN DAMBULLA ARB.	-	355,265.00
L/119	TISSUE CULTURE KANTHALE	-	963,125.77
L/120	NSF RG/2014/BS/02	-	452,828.00
L/122	SOUTH EASTERN UNIVERSITY	-	163,098.44
I/1	FOREIGN CURRENCY EXCHANGE GAINING	-	72,812.47
I/2	GOVERNMENT GRANT RECURRENT	-	144,441,000.00
I/3	GOVERNMENT GRANT CAPITAL -SPENT -RS. 100,191,244.36 -UN SPENT RS. 19,608,755.64		119,800,000.00
I/4	ACCOMADATION INCOME	-	687,283.17
I/5	HIRING AUDITORIUM	-	76,000.00
I/6	INTEREST RECEIVED	-	300,295.62
I/7	SALE OF BOOKS	-	1,054.44
I/8	SUNDRY INCOME	-	189,981.51
I/10	DONATION	-	1,935,645.00
I/13	SALE OF DISPOSABLE ITEM	-	581.20
I/16	FOREIGN & LOCAL GRAND FUND INCOME	-	10,771,766.56
E/1	ADVERTISEMENT	300,748.00	-
E/2	AUDIT FEES	250,000.00	-
E/3	AUDITORIUM AND ROOMS MAINTENANCE EXPENSES	73,152.40	-
E/4	BUILDING INSURANCE	383,160.27	-
E/5	BANK CHARGES	56,080.00	-
E/6	COMMUNICATION	753,575.63	-
E/7	CLEARANCE	630.57	-
E/8	DEFENSE LEVY AND GST	-	-
E/9	DAMBULLA ARBORETUM	180,000.00	-
E/10	ELECTRICITY	7,280,247.54	-
E/11	FUEL	2,398,095.51	-
E/12	GENERAL UP KEEP-JANITORIAL SERVICE	785,520.00	-
E/13	GENERAL UPKEEP-GARDEN MAINTENANCE	468,000.00	-
E/14	GENERAL UPKEEP-CATERING SERVICE	300,000.00	-
E/15	GRATUITY	3,721,448.51	-
E/16	MAINTENANCE OF MOTOR VEHICLES	2,616,913.02	-
E/17	MOTOR VEHICLE INSURANCE	447,287.91	-
E/18	MOTOR VEHICLE LICENSE	62,616.33	-
E/19	MAINTENANCE OF BUILDING	1,389,743.58	-
E/20	MAINTENANCE OF EQUIPMENT	3,615,361.72	-
E/21	OVERTIME	1,172,365.51	-
E/22	POSTAGE	118,255.00	-
E/23	PRIOR YEAR ADJUSTMENT	2,731,830.35	-
E/24	RESEARCH COUNCIL MEETING EXPENSES	38,354.00	-
E/25	SECURITY	2,078,483.57	-
E/26	STAFF TRANSPORT	545,372.41	-
E/27	ANNUAL REVIEW IFS	232,402.00	-
E/28	SUBSCRIPTION PERIODICALS & JOURNALS	479,419.33	-
E/29	MEMBERSHIP FEES	518,295.73	-
E/30	STAFF INSURANCE	438,419.05	-
E/31	TRAVELLING & SUBSISTENCE	289,044.50	-
E/32	WELFARE	1,571,949.91	-
E/33	WATER	1,638,251.81	-
E/34	SALARY	73,575,518.54	-
E/35	E.P.F. 15%	9,763,718.01	-

:	E.T.F. 3%	1,952,743.71	-
E/37	STATIONARY USED	471,216.81	-
E/38	CHEMICAL GLASSWARE AND LABWARE USED	6,447,407.48	-
E/39	CONSUMABLE	7,041,979.79	-
E/40	PRINTING	52,428.00	-
E/41	LEGAL EXPENSES	-	-
E/43	ENTERTAINMENT ALLOWANCE	5,845.00	-
E/45	DEPRECIATION	29,441,926.07	-
E/47	TEMPORARY STAFF ALLOWANCE	962,075.00	-
E/49	MISCELLANEOUS	768,921.88	-
E/50	INTERNET	2,681,203.90	-
E/53	FOREIGN &LOCAL GRAND EXPENDITURE	10,771,766.56	-
E/54	PUBLICATION DONATION	291.20	-
E/56	TRAVELLING FOREIGN	782,349.54	-
E/57	ROOM EXPENDITURE	573,580.00	-
E/58	DESPOSAL YEAR 2013	-	-
E/59	IFS SCIENCE WEEK	114,676.45	-
O/C/B/1	NATIONAL SAVINGS BANK. A/C NO1-0015-01-02989	5,765,450.50	-
O/C/B/2	RESEARCH FUND N.S.B.1-0015-01-03152	63,830.99	-
O/C/B/3	PETTY CASH CONTROL ACCOUNT	-	-
O/C/B/4	PETTY CASH IMPREST	8,000.00	-
O/C/B/5	STAMP IMPREST	500.00	-
O/C/B/6	PROVIDENT FUND CURRENT ACCOUNT B.O.C.32794	2,000,380.62	-
O/C/B/8	COLOMBO OFFICE	-	-
	N.S.B A/C NO.100151091808	289,668.41	-
O/C/B/11	STAFF CONSUMPTION LOAN RECEIVABLE A/C	4,029,005.00	-
	BANK OF CEYLON 32779	31,221,592.81	-
	BANK OF CEYLON 32795	18,390,669.50	-
	CASH	-	-
	SFCA/KN/USD/01	5,357,148.12	-
		921,954,205.77	**921,954,205.77**

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கணக்காய்வாளர் தலைமை அதிபதி திணைக்களம்
AUDITOR GENERAL'S DEPARTMENT

මගේ අංකය / எனது இல. / My No. CL1/KD/J/IFS/1/13/12 ඔබේ අංකය / உமது இல. / Your No.

දිනය / திகதி / Date 26 January 2015

Director
Institute of Fundamental Studies of Sri Lanka

Report of the Auditor General on the Financial Statements of the Institute of Fundamental Studies of Sri Lanka for the year ended 31 December 2013 in terms of Section 14(2)(c) of the Finance Act, No. 38 of 1971

The audit of financial statements of the Institute of Fundamental Studies of Sri Lanka for the year ended 31 December 2013 comprising the statement of financial position as at 31 December 2013 and the statement of financial performance, statement of changes in equity and cash flow statement for the year then ended and a summary of significant accounting policies and other explanatory information, was carried out under my direction in pursuance of provisions in Article 154 (1) of the Constitution of the Democratic Socialist Republic of Sri Lanka read in conjunction with Section 13(1) of the Finance Act, No. 38 of 1971 and Section 36(4) of the Institute of Fundamental Studies of Sri Lanka Act, No. 55 of 1981. My comments and observations which I consider should be published with the Annual Report of the Institute in terms of Section 14(2)(c) of the Finance Act appear in this report. A detailed report in terms of Section 13(7)(a) of the Finance Act was furnished to the Chairman of the Institute on 17 June 2014.

1.2 Management's Responsibility for The Financial Statements

Management is responsible for the preparation and fair presentation of these financial statements in accordance with Sri Lanka Public Sector Accounting Standards and for such internal control as the management determines is necessary to enable the preparation of financial statements that are free from material misstatements whether due to fraud or error.

1:3 Auditor's Responsibility

My responsibility is to express an opinion on these financial statements based on my audit. I conducted my audit in accordance with Sri Lanka Auditing Standards consistent with International Standards of Supreme Audit Institutions (ISSAI 1000 – 1810). Those Standards require that I comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatements.

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An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatements of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the Institute's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the Institute's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by management, as well as evaluating the overall presentation of financial statements. Sub-sections (3) and (4) of Section 13 of the Finance Act, No. 38 of 1971 give discretionary powers to the Auditor General to determine the scope and extent of the audit.

I believe that the audit evidence I have obtained is sufficient and appropriate to provide a basis for my audit opinion.

1.4 Basis for Qualified Opinion

My opinion is qualified based on the matters described in paragraph 2.2 of this report.

	iii. Financial Regulation 1646	Daily Running Charts and originals of the Monthly Summaries had not been furnished to the Auditor General before the 15th of the following month.
	iv. Financial Regulation 1647(c)	In case of availability of three or more motor vehicles in one place, a register should be maintained in respect of all purchases and issue of goods not entered in the Log Book. Nevertheless, such register had not been maintained despite the availability of 10 motor vehicles belonging to the Institute.
	v. Financial Regulation 1647(e)	Even though 10 motor vehicles existed in the Institute, a register including all details of the motor vehicles had not been maintained.
(d)	Treasury Circular No. 842 of 19 December 1978	A register in respect of fixed assets valued at Rs.328,333,310 belonging to the institute had not been maintained in terms of the Circular.
(e)	Public Administration Circular No.41/90 of 10 October 1990	Fuel consumption of four motor vehicles belonging to the Institute had not been tested once in six months while a sum of Rs.1,080,837 had been spent on fuel during the year.
(f)	Public Administration Circular No.25/2014 of 12 November 2014 Section 7	Seven officers had been recruited temporarily to the Institute contrary to the circular, and salaries amounting to Rs.962,075 had been paid from the Institute's funds during the year.
(g)	Treasury Circular No.IAI/2002/02 of 28 November 2002	Even though a Register of Fixed Assets for Computers, Accessories and Software should be maintained in respect of computers and printers valued at Rs.20,424,482, it had not been so done.

3. Financial Review

3.1 Financial Results

According to the financial statements presented, the financial result for the year ended 31 December 2014 was a deficit of Rs.21,133,791 as compared with the corresponding deficit of Rs.25,768,370 for the preceding year. As such, the financial results for the year under review indicated an improvement of Rs.4,634,579 as compared with the preceding year. Even though the personal emoluments and wages, expenditure on supplies and services, maintenance, and other expenses had increased by Rs. 7,722,580, Rs.6,566,015, Rs.4,694,443 and Rs.4,281,863 respectively , increase in recurrent grants and other income by Rs.27,373,000 and Rs.3,214,404 respectively had mainly attributed to the above improvement.

4. Operating Review

4.1 Management Inefficiencies

The following observations are made.

(a) Even though all advertisements should be published in all three languages in accordance with the implementation of the Official Language Policy, advertisements with regard to the recruitment of Research Assistants had been published only in English language in 6 instances.

(b) Six Government quarters at Nilagama, Digana belonging to the Sri Lanka Mahaweli Authority had been obtained for the accommodation of officers employed in the National Institute of Fundamental Studies since the year 1986. Nevertheless, an agreement between the two parties had not been entered into even by 31 March 2015.

(c) According to the Public Finance Circular No.438 of 13 November 2009, Heads of the Departments are authorized in terms of Section 3 to take action with regard to disposable goods already identified in terms of Section 2(a). Nevertheless, action had not been taken to dispose the assets valued at Rs. 1,389,076 not used as identified by the Board of Survey Report of the year 2014.

(d) In terms of Section 28 of the Provident Fund Minute of the National Institute of Fundamental Studies, the accounts of the Fund should be prepared for each calendar year and subject to a check . Nevertheless, the accounts of the Fund of the year under review had not been prepared even by 01 April 2015, the date of audit.

(e) Even though a decision had been taken during the year 2012 to dispose the assets belonging to the Institute including laboratory equipment, tools and furniture valued at Rs.24,915,351 , action had not been taken to dispose even by the end of the year under review.

4.2 Operating Inefficiencies

Nine advances totalling Rs.220,892 had been paid for the purchase of library books, chemicals and equipment from foreign institutions during years from 1996 up to 2000. Nevertheless, action had not been taken to obtain those equipment or books even by the end of the year under review while it had been shown as advances brought forward in the accounts. Further, the difficulty in obtaining those books and equipment had been a loss occurred to the Fund , whereas no action had been taken to recover that loss from the relevant officers responsible.

4.3 Transactions of Contentious Nature

The following matters were observed in the examination of the Project relating to the liquid fertilizer called Rhizobium Inoculaint product for soya beans under the Rhizobium Project assigned to the National Institute of Fundamental Studies on 31 August 2011 by the Postgraduate Institute of Science.

(a) The income received from this Project being implemented as a self-Fund is maintained under the name of Rhizobium Project Fund in which the two officers employed as the Head of the Project and the Research Assistant had been paid salaries amounting to Rs. 884,847 from the provision of the Institute in the year under review.

(b) Action had not been taken by the officers responsible even as at 31 March 2015, the date of audit to obtain the patent to the Institute for the discovery of coir refuse planting medium used for the production of the liquid fertilizer called Rhizobium

Inoculaint product, discovered as a result of the experiments done with a view to using the inventions of the National Institute of Fundamental Studies efficiently for the betterment of general public in the country. Instead of the sale of products of the Institute directly to the market , sale had been made through 3 institutions due to the lack of a patent. Thus, an estimated income of Rs.390,814 had been deprived of to the Institute during the year under review.

4.4 Underutilization of Funds

Provisions amounting to Rs.747,089 received in respect of 7 special proposals of the Institute had remained idle without being used.

4.5 Idle and Underutilized Assets

The following observations are made.

(a) Books and publications valued at Rs.151,880 printed by the National Institute of Fundamental Studies had remained unsold for over a long period of time.

(b) Action had not been taken even by March 2015 to use the Greenhouse constructed at a cost of Rs.2,360,000 in the year 2010 with optimum efficiency, effectiveness and economy.

(c) An examination of the stores of chemical stocks and the stock verification reports as at 31 December 2014 revealed that 77 items of stocks valued at Rs.472,376 had been non-moving stocks over a long period while 53 items of slow moving chemical stocks valued at Rs.273,954 had been kept in the stores. Even though attention of the Management of the Institute had been drawn thereto by audit queries of the preceding year, no action whatsoever had been taken by the end of the year under review.

(d) Even though 28 items of fixed assets valued at Rs.3,773,821 had been idling without being used, no course of action had been taken by the Management to repair and use those or to take any other action for disposal .

4.6 Personnel Administration

Vacancies in the academic and non-academic staff as at 31 December 2014 stood at 23 and out of that, approval for the recruitment to the post of Deputy Director (Research) on contract basis for a period of 3 years had been granted by the letter No.DMS/1608 of 29 May 2014 of the Director General of the Department of Management Services. Nevertheless, action had not been taken to recruit by preparing a Scheme of Recruitment and obtaining the approval of the Department of Management Services.

5. Accountability and Good Governance

5.1 Action Plan

Even though an annual Action Plan had been prepared with a view to achieving the objectives included in the Corporate Plan, a methodology for the periodical review of the progress of achieving the objectives in the Plan had not been formulated by the Institute.

5.2 Internal Audit

In terms of Financial Regulation 134(2), internal audit work should be carried out by preparing an Internal Audit programme for each accounting year covering all the financial aspects of accounts and financial control in order to enable an adequate and efficient check on financial activities. Nevertheless, such internal audit programme had not been prepared and an internal audit had also not been carried out during the year 2014.

5.3 Submission of Reports to the Management

The reports which should be submitted to the Board of Management monthly in terms of Section 4.2.2 of the Public Enterprises Circular No. PED/12 of 02 June 2003 had not been submitted.

5.4 Audit Committees

In terms of Section 7.4.1 of the Public Enterprises Circular No. PED/12 of 02 June 2003, the Audit Committee had not furnished its observations to the Board of Directors and the following matters of the Audit Committee had not been brought to the scope.

i. Determination of the responsibilities of the Internal Audit Unit and the review of the annual audit plan.

ii. Review and evaluate internal control system pertaining to all activities of the Institute.

iii. Review of the proposals/guidance made to the Committee on Public Enterprises.

iv. Statements on identified old slow moving and idle stocks and other items.

5.5 Procurement Plan

Even though a Procurement Plan in respect of Rs.120,000,000 had been prepared for the year under review in terms of provisions of the Procurement Guidelines, the following weaknesses therein were observed.

(a) Procurement activities expected at least for a period of three years had not been included.
(b) Procurement activities for the ensuing year should be included in detail and the Master Procurement Plan should be regularly updated within not less than a period of six months. Nevertheless, action had not been taken accordingly.

5.6 Budgetary Control

In terms of Section 5.2 of the Public Enterprises Circular No. PED/12 of 02 June 2003, the annual budget should be made use of as an instrument for the achievement of the long term goals according to the Corporate Plan. Nevertheless, it was observed that the budget had not been made use of as an effective instrument of financial control due to the following differences.

(a) A variance ranging from 2 to 97 per cent amounting to Rs.7,377,000 existed between the estimated expenditure and actual expenditure pertaining to 23 Objects.
(b) Out of the provision amounting to Rs.600,000 made for 3 Objects , 100 per cent had been saved.
(c) Income totalling Rs.764,500 pertaining to 4 Revenue Heads not included in the estimated sources of income had earned during the year under review.
(d) A comparison between the estimated income and actual income under the source of various income revealed an underestimation of income amounting to Rs.90,000.

6. Systems and Controls

Weaknesses in systems and controls observed during the course of audit were brought to the notice of the Director from time to time. Special attention is needed in respect of the following areas of control.

(a) Accounting
(b) Administration of Staff Loans
(c) Research Grants
(d) Stock Control

W.P.C.Wickramaratne
Acting Auditor General