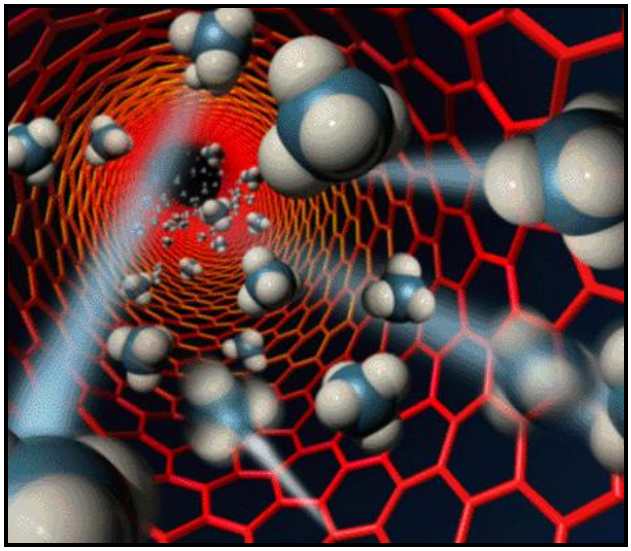

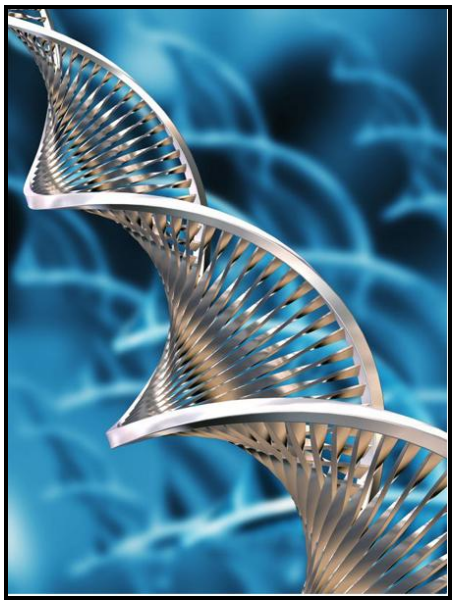

Global Forum of Sri Lankan Scientists:

Empowering Sri Lanka through Networking and Knowledge Sharing

13-15 December, 2011
Colombo
Sri Lanka

GLOBAL FORUM OF SRI LANKAN SCIENTISTS

Empowering Sri Lanka through Networking and Knowledge Sharing

13 -15 December, 2011
Hotel Galadari
Colombo

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ACKNOWLEDGEMENTS

Our sincere thanks and appreciation goes to the Board of Management, the Chairperson and the Director of the National Science Foundation for placing their trust and confidence in us for Coordinating this National Forum. Special thanks are due to Anusha, (Head, ILD), Sujini, Christine, Sumali, Maheshi, Mahesha and Rukshani for their unstinted support in organizing the forum, from the time of planning (9 months ago) to the final day of the Forum. Our sincere thanks also go to all other staff members of the NSF who gave their fullest support and coorporation towards the organization of the forum, both before and during the event.

We appreciate the generous support given to us by both local and expatriate scientists in making this Forum a success. We would like to place on record a special 'THANK YOU' to, the Organizing Committee and the Programme Committee of the Global Forum for their immense help in planning and executing this event, Chairpersons and Rapporteurs of various sessions for their invaluable service in collating and presenting the information, and the Keynote speakers and Panelists for enriching the Forum with their knowledge, experience and expertise.

We also wish to thank the event manager, Global Events Pvt. Ltd. for their fullest cooperation and the Hotel Galadari for all assistance in the organization of the event.

Dr. M.C.N. Jayasuriya and Dr. Anura Senaratne

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Global Forum of Sri Lankan Scientists

13-15 December, 2011

Colombo, Sri Lanka

EXECUTIVE SUMMARY

The National Science Foundation (NSF) in collaboration with UNESCO and under the auspices of Ministry of Technology and Research organized the Global Forum of Sri Lankan Scientists with a view to harnessing the knowledge of expatriate and local scientists for post-conflict socio-economic development of the country. The Forum was expected to complement the National Science, Technology and Innovation Strategy of Sri Lanka, developed by the Ministry of Technology and Research in close collaboration with the National Science Foundation. By bringing relevant stakeholders from several sectors and disciplines under one platform, including the innovators and potential investors both from Sri Lanka and overseas, an attempt was made to bring the benefits of science, technology and innovation to end users and society, with the ultimate objective of national development.

The main themes of the Forum reflected national interests covering sectors such as energy, health care, agriculture and information technology, among others. Over 325 participants, comprising thirty nine (39) Sri Lankan expatriate and foreign scientists, and over 250 local scientists, policy makers, administrators from public and private sector institutions, industrialists, entrepreneurs and businessmen, attended the Forum.

The inauguration attended by Hon. Pavithra Wanniarachchi, Minister of Technology and Research and Hon. Prof. Tissa Vitarana, Senior Minister for Scientific Affairs, was followed by three days of plenary, key note addresses and breakout/panel discussion sessions. The Forum was enriched by key note addresses and panel presentations from outstanding Sri Lankan expatriate and foreign scientists who are engaged in cutting-edge research in fields such as Nanotechnology, Biotechnology, Advance Design and Manufacture, Information and Communication Technology and Green Energy Technologies. The final day of the Forum was dedicated to an 'Innovestor' forum, where innovators and potential investors were brought together on to a common platform along with the public-private sector technologists, entrepreneurs, business community and industrialists, with a view to promoting technology transfer and entrepreneurship.

The Innovestor Forum and the discussion session that followed identified/proposed various activities that could lead to partnerships and collaboration between Sri Lankan expatriate scientists/foreign scientific institutions and local scientists/scientific institutions, entrepreneurs and local industrialists. The proposed activities were of two major categories

- **Proposals for Research collaboration** – For collaborative research between expatriate scientists/foreign scientific institutions and local scientists/scientific institutions. This activity could be in conjunction with NSF Human Resource Development strategies such as IPSAT (International Partnerships for Science and Technology) and OSTP (Overseas Special Training Programme) in priority research areas
- **Partnerships and investment opportunities -** for technology transfer between expatriate scientists/foreign scientific institutions and local scientists/scientific institutions/entrepreneurs/local industrialists

Some general recommendations arising from the Forum:

- Researchers should establish links with local industries, plan and focus research to fulfill the needs of the country
- Establish a '*contact-center* 'or a '*cell*' at NSF, fully dedicated to monitor and facilitate proposed collaborations between expatriate/foreign scientists and local scientists/entrepreneurs for both research collaboration and partnership activities
- Identify and find remedial measures for IP issues related to collaborative research and product development when in partnership with expatriate scientists/foreign scientific institutions
- Establish 'Centers of Excellence' in the area of Biotechnology
- Establish a 'Central Authority' for issue of permits/licenses for using biotech products

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- Establish a Natural Products Focal Point and a Natural Resources Committee to strengthen and promote R&D in natural resources of the country

Some recommendations for investment/partnership opportunities:

- Establishment of a Cord Blood Stem Cell Bank and a Bone Marrow Transplant programme in Sri Lanka
- Introduction of Bioinformatics services and training of Sri Lankan scientists in Bioinformatics
- Establishment of an antibody based Vaccine Production facility in Sri Lanka
- Collaboration in molecular plant breeding utilizing SNP marker techniques
- ISO certification of Sri Lankan Herbal Medicine and Supplements
- Establishment of a collaborative mechanism with Norwegian Institute for Water Research on Water Management and Waste Treatment methods
- Development of social networks to disseminate scientific knowledge to farmers through mobile phones for quick decision making
- Development of a platform for transferring of patented technologies in food related areas from Australia to local industry
- Introduction of innovative methods for examining the use of ground water in Sri Lanka
- Manufacture of Chitosan based Biocomposites for Bio medical applications using local raw materials
- Development of Advance ceramic materials using local raw materials
- Development of advanced metal products for medical implants
- Early detection of dengue, malaria, aids etc. using infrared detector technology
- Utilization of nanotechnology to develop value added rubber products ie. Nano-carbon impregnation to improve the properties of rubber composites
- Investigation of readily exploitable Cashew Nut Shell liquid (CNSL), as a surfactant for atomic control of nano-material
- Application of iron oxide nano particles in industry and bio medical sciences
- Application of nanotechnology in fertilizer utilization
- Encouragement and facilitation of solar energy research in Sri Lanka
- Establishment of 'Solar villages' in rural areas

For detailed description of the proposed projects/activities and personnel involved the reader is referred to the main report.

The Global Forum of Sri Lankan Scientists was a land mark event in the S&T history of Sri Lanka. It was a highly successful event that ended with whole hearted and overwhelming support from the expatriate community. The National Science Foundation, the premier S&T institution in the country has a major role to play in facilitating the necessary support platforms to ensure that recommendations arising from the Forum are implemented.

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REPORT

1. INTRODUCTION

The National Science Foundation (NSF) in collaboration with UNESCO and under the auspices of Ministry of Technology and Research organized the Global Forum of Sri Lankan Scientists with a view to harnessing and blending the knowledge of expatriate and local scientists for post-conflict socio-economic development of the country. The Forum was expected to complement the implementation of the National Science, Technology and Innovation Strategy of Sri Lanka, developed by the Ministry of Technology and Research in close collaboration with the National Science Foundation. By bringing relevant stakeholders from several sectors and disciplines under one platform, including the innovators and potential investors, both from Sri Lanka and overseas, an attempt was made to bring the benefits of science, technology and innovation to the end users and our society, with the ultimate consideration of national development.

The main themes of the Forum namely, Nanotechnology & Nano materials, Biotechnology, Information and Communication Technology, Green Energy Technologies, Advanced Design and Manufacture, Natural Resources and Food and Water Security, reflects national interests that have a major bearing on the economic development through different sectors of energy, health care, agriculture, tourism, consumer goods, exports, etc. Thus, the Forum was expected to accentuate the integrated roles of technologies, applications and market and the eventual commercialization of products of scientific research in the above fields.

It was envisaged that the following would benefit from the Forum.

- The University academics of Sri Lanka through establishment of links and collaborative research
- Local industries by partnering with expatriates for better development and improvement in respective industries
- Agencies of the Government and industries of Sri Lanka that could link up with the expatriate community for direct access to expertise and involvement
- Expatriate scientists with similar interest and expertise through formulation of constructive dialogue

Major Outputs of the Forum were expected to be:

- The establishment of partnerships with foreign institutions/scientists to promote excellence in science and bridge the knowledge gap
- Promoting industry oriented research
- Developing networks to utilize emerging opportunities to train local scientists abroad
- Forming a platform to enhance and integrate intellectual contribution
- Agreement on strategies and mechanisms that would pave the way towards effective collaboration, knowledge sharing and technology transfer
- Formulating a well developed plan for the establishment of a gateway to promote collaborative research and development activities

Thus, the Forum will be a significant contributor to the National Development process enhancing the Science and Technology capability of the country, paving the way for realization of National aspirations.

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2. THE FORUM

2.1. Inauguration

The Forum was ceremonially inaugurated by Hon. Pavithra Wanniarachchi, Minister of Technology and Research, Prof. Tissa Vitarana, Hon. Senior Minister of Scientific Affairs, Mr. Prithi Perera, National Director, UNESCO in Sri Lanka and Chairperson and the Director of the National Science Foundation. While the Chairperson of the National Science Foundation welcomed the participants, the Director of the National Science Foundation, proposed the Vote of Thanks.

Welcoming Hon. Pavithra Wanniarachchi, Minister of Technology and Research

Welcoming Hon. Prof. Tissa Vitarana, Senior Minister of Scientific Affairs

Lighting of the traditional oil lamp

Hon. Pavithra Wanniarachchi, Minister of Technology and Research addressing the gathering

Over 325 participants, comprising thirty nine (39) Sri Lankan expatriate and foreign scientists, and over 250 local scientists, policy makers, administrators from public and private sector institutions, industrialists, entrepreneurs and businessmen, attended the inauguration ceremony.

Over 325 participants attended the inauguration ceremony

The expatriate and foreign scientists who attended the Forum were from United Kingdom, United States of America, Australia, New Zealand, Ireland, Japan, Hong Kong, Singapore, India, Taiwan, Korea, Norway and France.

The inauguration was followed by three days of plenary, key note addresses and breakout/panel discussion sessions. Between 200 to 250 participants were registered for the plenary and breakout/panel discussion sessions on each of the three days of the Forum.

The final day of the Forum was dedicated to the 'Innovestor' forum, where innovators and potential investors were brought together on to a common platform along with the public and private sector technologists, entrepreneurs, business community and industrialists.

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2.2. Plenary sessions

13th December 2011

2.2.1. Plenary Session 1. Harnessing Talents for Sri Lanka

Following presentations were made at the **Plenary 1 on Day 1**. The session was chaired by Prof. P.W. Epasinghe

- An Overview of the Forum *by Dr. Sarath Abayawardana,* Director, NSF,
- From Brain Drain to Brain Circulation *by Prof. Sirimali Fernando,* Chairperson, NSF
- Environment and Natural Resource Management - An opportunity for Sri Lanka to focus research towards economic development *by Prof. Tissa Illangasekera*
- Virtualizing the Global Forum *by Chamindra de Silva,* Virtusa

Prof. Tissa Illangasekera addressing the Global Forum

The breakout/panel discussion session that followed after lunch considered the following themes.

- **Food and Water Security** (Co-Chairs – Dr. Gerry Jayawardene and Prof. Vijay Jayasena and Rapporteurs – Dr. Jaanaki Gooneratne and Dr. Sitara Attapattu)

  The following Panelists made presentations: Dr. Gerry Jayawardene, Dr. Jaanaki Gooneratne, Dr. Shanthi Wilson, Dr. Collin Chartres, Prof. Vijay Jayasena, Prof. Harsha Ratnaweera, Prof. K.B. Palipane and Mr. B.R.L. Fernando.

- **Green Energy Technologies** (Co-Chairs - Prof. Lakshman Dissanayake and Prof. I.M. Dharmadasa and Rapporteurs – Prof. Oliver Ileperuma and Prof. W. Sumathipala).

  The following Panelists made presentations. Prof. I.M. Dharmadasa, Mr. Bimmy Dhanapala, Dr. Lareef Zubair, Prof. S.B. Tennakoon, Prof. S. A. Kulasooriya, Mr. Parakrama Jayasinghe, Prof. Oliver Ileperuma, Mr. . Sena Peiris, Dr Thusitha Sugathapala, Mr. Sudath Chandana and Prof. S. Sivananthan

- **Advanced Design and Manufacture** (Co-Chairs – Prof. R. Attalage and Prof. M.A.R.V. Fernando and Rapporteurs – Prof. N. Munasinghe and Mr. S.B. Samarasiri).

  The following Panelists made presentations. Prof. I.S. Jawahir, Dr. Wasantha Amerakoon, Prof. Unil Perera, Dr Nanditha Hettiarachchi, Dr. S.U. Adikari, Prof. S.D. Pathirana, Prof. Kapila Jayasinghe, Mr. Shantha Jayasinghe and Dr. Karnika de Silva

- **Natural Resources** (Co-Chairs – Prof. Tuley D. de Silva and Dr. Nimal Gamage and Rapporteurs – Dr. A.L. Jayawardene and Prof. Ruchira Cumaranatunge).

  The following Panelists made presentations. Prof. Tuley D. de Silva, Prof. E.D. de Silva, Prof. Nimal Chandrasena, Dr. Nimal Gamage, Prof. Gomika Udugamsooriya, Dr. N. Ishwaran, Dr.

L.M. Tilelkaratne, Dr. A.L. Jayawardene, Dr. Radhika Samarasekera, Prof. Ruchira Cumaranatunga, Prof. Tissa Illangasekera and Prof. Ajith Abeyasekera

The panel presentations and discussions took place in five different locations of the hotel. The presentations were followed by lively discussion and the salient points were recorded by the rapporteurs for subsequent presentation and discussion at the Innovestor Forum on Day 3.

Further details on Sub-themes discussed under each Theme are shown in **Annex 1**, 'Programme at a Glance'

A Fellowship sponsored by Elsevier publishers followed the afternoon session on Day 1

14th December 2011

2.2.2. Plenary Session 2. Advanced Technology

Following presentations were made at the **Plenary 2 on Day 2**. The session was chaired by Prof. Tuley D. de Silva

- Stem Cells: from Bench to Bedside *by Prof. Ariff Bongso*
- Emerging Infectious Diseases: Prevention and Control *by Prof. Malik Peiris*

Key note speakers - Prof. Ariff Bongso and Prof. Malik Peiris

The session after the tea break was chaired by Prof. Kumar Wickremasinghe

- Nanotechnology for Energy Conversion and Storage *by Prof. Gehan Amaratunga*
- Wealth Creation for a Sustainable Future via Nanotechnology *by Prof. Ravi Silva*

Key note speakers - Prof. Gehan Ameratunge and Prof. Ravi Silva

These presentations were followed by a pre-lunch presentation by Ms. Padma Muralidharan of Elsevier Publishers, New Delhi, India

The break out session/panel discussion that followed after lunch considered the following themes for discussion

- **Nanotechnology and Nanomaterials** (Co-Chairs – Prof. Ravi Silva and Prof. Viranja Karunaratne and Rapporteurs – Dr. Rohini de Silva and Dr. Shehan de Silva).

  The following were the panelists at this session. Prof. Veranja Karunaratne, Prof. Ajith de Alwis, Dr. Challar Kumar, Prof. Yoon-Bong Hahn, Prof. Li-Chyong Chen, Dr. Upul Ratnayake, Dr. Rohini de Silva and Dr. Nilwala Kottegoda

- **Biotechnology** (Co-Chairs – Prof. Rohan Jayasekera and Prof. Preethi Gunaratne and Rapporteurs – Prof. Vajira Dissanayake and Dr. Anil Jayasekera).

  The following were the Panelists who made presentations. Prof. Preethi Gunaratne, Prof. Gemunu Gunaratne, Dr. Pawan Gupta, Dr. Aravinda de Silva, Prof. Vajira Dissanayake, Dr. Nimal Dissanayake and Dr. Anil Jayasekera

- **Information and Communication Technology** (Co-Chairs – Prof. Gihan Dias and Mrs. Chitrangani Mubarak and Rapporteurs – Dr. Ruwan Weerasinghe and Mr. Sanath Panawennage).

  The following Panelists made presentations. Prof. Athula Ginige, Dr. Sanjiva Weerawarne, Dr. Ruwan Weerasinghe, Prof. Lalith Gamage and Mr. T.R. de Silva

Further details on sub-themes discussed under each theme are shown in **Annex 1** 'Programme at a Glance'.

Conference Banquet followed the afternoon session on Day 2. The Cultural event during the Banquet was sponsored by Sri Lanka Convention Bureau of Sri Lanka Tourism.

Cultural event - performance by 'Sri Lanka Youth' - sponsored by Sri Lanka Convention Bureau

Participants at the Conference Banquet

15th December 2011

2.2.3. Plenary Session 3. Driving Growth through Innovation and Entrepreneurship

Following presentations were made at the **Plenary 3 on Day 3**. The session was chaired by Prof. Ravi Silva

- Probing the Nanoscale in Biology and Medicine *by Prof. Kumar Wickremasinghe*
- From Chemistry to Medical Diagnostics and Information Processing *by Prof. A.P. de Silva*

Key note speakers - Prof. Kumar Wickremasinghe and Prof. A.P. de Silva

After the Tea break the following presentations were also made. This session was Co-Chaired by Prof. P.W. Epasinghe and Prof. Uma Coomaraswamy

- Innovation Beyond Borders: Creating a sustainable science and technology driven open innovation incubation ecosystem *by Prof. Monte Cassim*
- Strategies for Sustained Collaboration *by Dr. Sarath Abayawardana and Prof. Sirimali Fernando*

Key note speaker Prof. Monte Cassim

Dr. Sarath Abayaratna, Director NSF and Prof. Sirimali Fernando, Chairperson, NSF addressing the gathering on 'Developing Strategies for sustained collaboration'

The afternoon session on Day 3 was devoted to the 'Innovestor' Forum, chaired by Mr. Nawaz Rajabdeen. Presentations were made *by Dr. Nihal Samarppuli* on 'Your next investment destination' on behalf of the Board of Investment and by *Mr. D.M. Karunaratne* on 'Challenges in collaborative work' on behalf of the Intellectual Property Office of Sri Lanka.

The discussions in relation to outputs from breakup sessions on Day 1 and Day 2 were presented by the Rapporteurs of the various sessions. Dr. Anura Senaratne along with Dr. Nimal Gamage chaired this session.

Unexpectedly high participation and the enthusiasm of the participants attested the success of the Forum. The efforts of the NSF were praised by many and wished this was the first of many such forums in the future. The discussions were beneficial highlighting technological needs of the country, many new pathways to initiate turnkey technologies, strengthening collaborations and concerted efforts leading to new ventures.

'Innovestor' Forum - Chaired by Mr. Nawaz Rajabdeen with speakers Dr. Nihal Samarappuli and Mr. D.M. Karunaratne

The Way Forward - Final session Chaired by Dr. Nimal Gamage and Dr. Anura Senaratne

2.3. Special Presentations

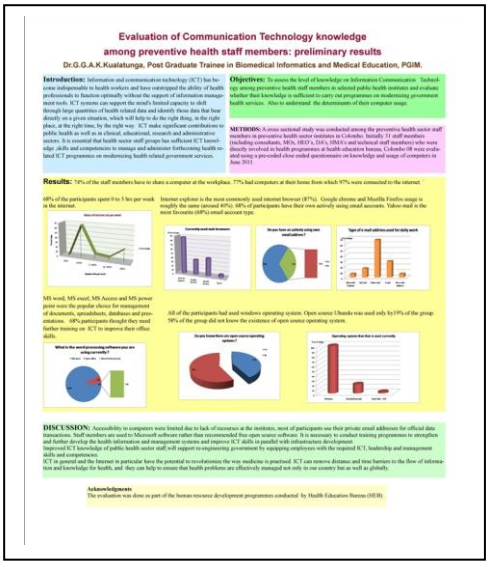
There were three unscheduled presentations during the Forum. They were from Mr. Mahesh Amalean, Chairman, MAS, Mr. Ashroff Omar, CEO, Brandix and Dr. Hans Wijayasuriya, Director, Group CEO, Dialog PLC. These presentations though were unscheduled added much value to the overall programme and highly stimulated and encouraged the participants in their forward thinking. Their ideas were well taken and considered at the various panel discussions.

Mr. Mahesh Amalean, Chairman, MAS

Dr. Hans Wijayasuriya, Director, Group CEO, Dialog, PLC

2.4. Poster Presentations

The Forum also provided an opportunity for Sri Lankan scientists to present their research findings by way of poster presentations. Only those projects that had a bearing on national development efforts were encouraged. Twenty four posters were exhibited on varied themes and subject areas such as Nanotechnology and Nano-materials, Biotechnology and Bioinformatics, Human Genetics, Green Energy Technologies including Bio-fuels, Software Engineering and Medical Education (See Annex II for posters presented at the Forum).



Three of the many posters exhibited at the Forum

An Executive Summary of each Key Note Presentation along with biography of the speaker as well as an introductory note on the Co-Chairpersons and Panelists who took part in the Forum were published and made available to all participants as a pre-Forum publication (See Keynote Summaries and Introduction to Co-Chairpersons and Panelists).

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3. 'INNOVESTOR' FORUM

3.1. PANEL DISCUSSIONS AND 'INNOVESTOR' FORUM

3.1.1. Introduction and Procedure

Seven panel discussions supporting the seven themes were held during the afternoon of each day of the forum. Four panels met on the first day and three on the second. Each panel convened independently and consisted of expatriate and local scientists and other interested participants from research institutes, ministries and private and public sector organizations. Each panelist was given the task of making a 10 minute presentation to introduce the specific area and propose methods to incorporate the technologies involved in that specific area in developing Sri Lanka. Two member chair, one local and one expat scientist, were assigned for each panel to lead and moderate the session. The proceedings of each panel discussion were recorded by two rapporteurs. They were requested to make note of important ideas that came up during discussion for presentation at the 'innovestor' forum, scheduled for the final day. In addition to moderating the sessions the chair persons initiated and kept the dialogue alive between the panelists and the participants.

The Innovestor Forum Chaired by Mr. Nawaz Rajabdeen was the platform for the Board of Investment and the Intellectual Property Office of Sri Lanka to make participants aware of government policies on investment and IP related issues.

This was followed by the final Discussion Session chaired by Dr. Nimal Gamage and Dr. Anura Senaratne, where the rapporteurs from each of the panel discussion sessions presented their reports. These reports included the summary of the discussions that took place at the panel discussions as well as excerpts from keynote speeches and any salient information from the poster presentations that were on display during the Forum. Scientists, potential investors, industrialists, policy makers and other stake holders who participated in this discussion identified/proposed various activities that could lead to partnerships and collaborations between Sri Lankan expatriate scientists/foreign scientific institutions and local scientists/scientific institutions, entrepreneurs, local industrialists etc. The participants strongly recommended that National Science Foundation should coordinate and facilitate the proposed collaborative activities.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. General comments, concerns and suggestions

General consensus among all presenters was that the researchers should establish links with local industries to promote high-tech based industries and to win the trust of the local industrial community. They stressed the importance of starting applied research programs complementing basic research and collaborating with industry at all levels.

All modern technologies are not subject specific but evolving on multidisciplinary platforms. Thus, Sri Lanka needs more of cross-disciplinary research to get the benefits of modern technologies.

All participants agreed with identifying the IP issues related to collaborative product development work, especially protection of IPR on indigenous knowledge, if Sri Lanka is to establish collaborations with expatriates. Proper training of the local research community on IP protection laws and methodologies is essential.

A '*contact-center* 'or a '*cell*' is needed to continue, monitor and facilitate the collaborations with the expatriates (possibly NSF should establish a dedicated unit for this!). The center will be completely

dedicated to coordinating the functions of the networks between the expatriates and local scientists/institutions. Thus, any interested expatriate or local scientist could contact the 'centre' to link himself with appropriate parties engaged in similar research.

Following are the specific recommendations arising from the Panel discussions and the Innovestor Forum.

4.2. Biotechnology

Co-Chair : Prof. Rohan Jayasekara and Prof. Preethie Gunaratne
Rapporteurs : Prof. Vajira Dissanayake and Dr. Anil Jayasekara

Biotechnology panel discussions were centered mainly on Medical and Agricultural biotechnology. In spite of some dairy and brewing industries in Sri Lanka have been using traditional biotechnology (fermentation) for some time, modern biotechnology is still at an infant stage. There was no National Biotechnology policy for Sri Lanka until 2010. The National Biotechnology policy was approved by the cabinet in 2010 and the act for implementation is in the draft stage. Biotechnology industry is now emerging from the laboratories to the factories. Few biotech companies are now in business to serve forensic and medical purposes. There is no dedicated research institute in the country engaged in industrial biotechnology. However, Industrial Technology Institute of Sri Lanka recently started a biotechnology research center mainly to concentrate on industrial biotechnology research.

4.2.1. Agricultural Biotechnology

- Dr. Anil Jayasekara of University of Colombo proposed the establishment of Centers of Excellence as a key component in the strategy for enhancement of biotechnology in Sri Lanka. This in turn will upgrade the existing strengths in the Universities and public/private institutions. The activities of the centers should be coordinated and linked via a dedicated office. The approved National Biotechnology Policy recommends the establishment of a National Biotechnology Council (NBC) which will be responsible for advancement of Biotechnology in the country.
- Dr. Nimal Dissanayake of the Rice Research Institute, Batalagoda highlighted the contribution of Biotechnology in improving rice varieties in Sri Lanka to resist disease, insects and pests, and drought, to increase efficient utilization of nitrogen and phosphorous and to improve yield and quality. Conventional breeding coupled with DNA marker technology or transgenic technology is employed to assemble/to combine these favorable traits to improve the rice crop.
- Mr. Kumar Devanayagam of Bio Power Lanka Pvt. Ltd. highlighted the importance of a "*central authority*" to issue permits or licenses for usage of biotech products such as locally developed effective micro-organisms (eg. *Bacillus thuringiensis)* or Rock Phosphate solubilizing bacteria and imported effective micro-organisms.
- Dr. Cholani Weebadde, of Michigan State University proposed to adopt recent revolutionary innovations in biological sciences, especially in platforms for 'omics' based research and applications providing crucial tools to improve crop productivity and offered to collaborate with Sri Lankan scientists in this area.

4.2.2. Medical Biotechnology

- Prof. Vajira Dissanayake of the University of Colombo stressed the importance of establishing a Cord Blood Stem Cell bank and Bone Marrow Transplant program in the country. Bone marrow transplantation, the standard of care for treating hematological disorders, which have no other hope of a permanent cure, is not available in Sri Lanka. As a result chronic care of patients affected with these conditions take up a large chunk of the health care budget of the country (Sri Lanka's health care system spends 5% of its annual recurrent budget on providing chronic care to around 2000 patients with Thalassemia). In addition many children with Leukemia die needlessly because they cannot receive bone marrow transplantation. The cord

blood stem cell bank can cater to the demands not only of Sri Lanka, but also to the demands of populations of Sri Lankan and South Asian origin living all over the world who find it difficult to find matching donors.

- Prof. Preethie Gunaratne of University of Houston, informed that the completion of the Human Genome Project in 2001 laid the foundation for an explosion of activities in biomedical research. This research has now been accelerated by the development of next generation high throughput technologies. The cost of genome wide analysis is coming down, and a $1000 genome is a reality, but it comes with a much higher price tag for analysis as bioinformatics services are a scarce commodity and there is high demand for such services. Prof. Gemunu Gunaratne volunteered to undertake training of Sri Lankan scientists in bioinformatics. In addition to the biomedical benefits the high throughput technology could be used in sequencing of organisms and plants endemic to Sri Lanka, for example rice varieties.

- Currently Sri Lanka does not produce the vaccines needed in the country. Hence, it is very important to establish vaccine production facility in the country considering the large amounts of money spent on importing vaccines into the country. Prof. Aravinda De Silva of University of North Carolina, USA offered his support and expertise for establishment of an antibody based vaccine development facility in Sri Lanka. Local partners have to be found to take this proposal forward.

4.3. Natural Products

Co-Chair : Prof. Tuley D de Silva and Dr. Nimal Gamage
Rapporteurs : Dr. A L Jayawardena and Prof. Ruchira Cumaranatunga

- Prof. Tuley de Silva summed up the progress of the natural product research in Sri Lanka. Over the years, Sri Lanka has accumulated a vast wealth of knowledge in natural product research. Many undergraduates completed their basic training in this area and majority left the country to pursue their carriers in many parts of the world. Many of these expatriate scientists are willing to collaborate with local scientists and have offered their help to the mother land. Thus, he proposed to establish a Natural Products **FOCAL POINT** in the country to collect and collate the available information and also to coordinate the collaborative efforts of the scientists. It was generally agreed that lack of funds for research & development and lack of advanced facilities to confirm preliminary findings of bioactivity studies are two major limiting factors for the progress in natural product research. Since Sri Lanka is a very small market for analytical instruments the suppliers are not willing to spend money on keeping in-house maintenance crews. Because of this sustainable maintenance of analytical instruments to identify the bio-medically active ingredients in plant extracts is a major problem.

  He emphasized the following key points to consider when planning research in this area.

  1. Sri Lanka possesses a vast number of marine natural resources that could be used in health care (for prevention and protection). However, more research is need in this area.
  2. Interdisciplinary & multidisciplinary approach is necessary when designing research projects
  3. There is a lack of planning and focus in research
  4. Not to imitate research done in developed countries since such research may not be useful to Sri Lanka
  5. Scarcity of trained human resources for research (need for training of young scientists through collaborative projects with expatriates)
  6. Technology transfer is necessary from successful projects handled by expatriates at institutions in developed countries
  7. Inadequate commitment of the Government to promote research

8. Promote and nurture innovations, inventions and technology development
9. Problems faced with respect to medicinal plant extracts
    a. Unavailability of plant varieties of high quality, high yielding and with resistance to pests
    b. Plants produce a complex mixture of extracts; because of this it is difficult to decide the quality & dosage for treatment

- Prof. Gomike Udugamsooriya of University of Texas highlighted the problems faced, during the development of purified drugs from natural resources such as high cost and after effects. In contrast he emphasized the advantages of traditional medicines extracted from indigenous plants, ie. less expensive and minimal side effects due to synergistic effects. However, analyses of the natural extracts for active ingredients are necessary for quality assurance and standardization purposes. The concepts/ideologies of the indigenous system of treatment ought to be studied scientifically. The active principle of the extracts has to be screened in order to explore the indigenous knowledge with respect to diagnostic and analytical system because according to the traditional treatment not only the illness but the patients are also being treated.

- Prof. Ajith Abeysekera reiterated that the indigenous medicines target curing and nutrition of the patient taking the immune system into consideration. He also mentioned the importance of preserving the genome of local medicinal plants. He said that Sri Lanka needs active collaborative programs for a) To access to modern analytical laboratories b) to carry out clinical studies and c) for biological assays.

- Rules and protocols should be laid down to resolve the proprietary problems faced by the local scientists (eg. bio-piracy) during collaborations with foreign institutions/scientists. As a solution to this adoption of the policy document prepared by a group of experts on a request made by Hon. Tissa Vitarana, the Senior Minister for Science & Technology was recommended by the panel. The suggestion came from Mr. Samantha Gunesekera who was a member of the expert group involved in the preparation of the above document.

- Prof. Dulip De Silva of University of Colombo stressed the importance of research involving marine organisms due to their high diversity. He elaborated the differences in the research methodologies between terrestrial & marine organisms. He pointed out that the 680 km^2 coral reefs extending around Sri Lanka have not been explored sufficiently to harness the possibilities of extracting biomedical compounds from the invertebrates housed in the reefs. Nevertheless, he cautioned the scientists to be extremely environmentally conscious in planning research on marine invertebrates living on coral reefs.

- The importance of establishing herbal centers in Sri Lanka for mass production and sustainability of producing natural product industry was discussed at length. This is a very crucial step to develop traditional drug industry maintaining the quality requirements. At present only a very few local industries are engaged in this industry, yet the global demand is rising steeply for natural drugs.

- Dr. Radhika Samarasekera of ITI stressed the importance of collaborative research and urged the expatriate scientists to help Sri Lanka in developing drugs based on traditional treatment system. Sri Lanka should capture the current wave of global interest in natural drugs and nutraceuticals. The global markets are seeking more and more natural treatments for many age old ailments. Sri Lanka boasts to have 500 native species of plants important for herbal medicines used for indigenous & Ayurvedic medical practice. At present we do not have scientific screening and/or clinical trials (efficacy and purity) programs for traditional medicines. Development of traditional medical treatment centers could be used as an attraction for tourist industry in the country. Cultivation of medicinally important plants in commercial scale should be encouraged by giving incentives, such as tax rebates to the farmers. The export

potential of these medicines should be explored. She requested help from the expatriates in analyzing the plant materials but cautioned about the regulatory road blocks in the process.

- Dr. Nimal Chandrasena, Principal Ecologist, ALS Global, Australia explained in detail how to harness the natural resources sustaining the ecological harmony. He emphasized the importance of establishing frameworks to monitor and keep track of opportunities to share our resources with collaborators, the extent of wealth of natural resources, value of our biodiversity and other knowledgeable sources. Valuing environmental resources is a key to ecologically sustained development. It is important to apply ecological principles to natural resource management, ie. monitor, evaluate and report on annual basis for improvement. Identify descriptive and measurable ecological indicators for scientific record keeping and to reach the relevant goals and objectives. Ecologists should study the related structure and functions affected by anthropogenic activities to manage natural ecosystems efficiently and to resolve environmental conflicts.

  With respect to aquatic ecosystems he highlighted the following

  a. Monitoring physicochemical parameters with reference to biological parameters and human health. eg. Fish (composition, reproductive success, etc.), birds, invertebrates, exotic species, Algal cyanobacteria, etc.
  b. In streams, submerged and riparian vegetation could be used as indicator species
  c. With reference to health Coliform bacteria, (*Enterococci, Cryptosproridium, Giardia* & Cyanobacteria) could be used as indicator species for pollution

  He also highlighted the importance of setting goals and identification of key issues with respect to agriculture and natural systems, mitigation, invasive species, etc. Also, active political commitment and consensus is a plus point. Educating the public on natural resource management issues and getting their participation is a necessity.

  In response to a query made by Prof. Mala Amarasinghe Dr. Chandrasena agreed to help her to identify the indicators of aquatic pollution with respect to chemical pollutants.

- Prof. Ruchira Cumaranatunga of Ruhuna University enlightened the audience about the possible research involving the marine bio-species and alerted about the impacts of climate change to coastal and marine natural living resources.

  1. Bleaching of corals (in thermo-sensitive corals)
  2. Reduction of sea grass & algal beds with low temperature tolerance
  3. Loss of feeding and breeding grounds for fish & other economically important coastal and marine organisms
  4. Alteration of migratory circuits of highly migratory & economically important fish species (e.g. Tuna, bill fish, etc.)
  5. Reduction of coastal land area available for aquaculture and beaches & sand dune ecosystems due to coastal inundation

  With reference to the above following actions were proposed (provided ample funding & training being available)

  a. Identify the most vulnerable & easily adaptable species to climate change and promote temperature and salinity tolerant species for aquaculture purposes.
  b. Identify the changes in migratory circuits of tuna, bill fish, etc. through biotechnological & satellite remote sensing techniques.
  c. Introduction of coastal & offshore Mari culture in floating cages for temperature tolerant species of tuna, garouper, ornamental fish & other temperature tolerant species. (Using short video clips on experiments conducted at University of Ruhuna, transplanting corals on cement tiles & on mesh and culture of sea weeds in mesh enclosures were demonstrated). For this technology transfer & training is necessary from countries like China.

d. Soft natural barriers should be promoted as solutions for coastal inundation and strong wave action (ie. establishment of artificial reefs, restoration of sand dune vegetation, etc.
e. Allocate funds for monitoring ecosystem changes and for research programs related to above areas.

She indicated the use of similar Mari-culture techniques to grow marine plants and sedentary animals that could be used for extraction of bio medically active compounds (related to Dr. Dulip De Silva's research programs).

- Dr. N. Ishwaran of UNESCO stressed the importance of sustainable development of natural resources and its need as an adaptation to climate change. He elaborated emerging funding framework for modern farmland with biodiversity credit, CO_2 offset credit, renewable electricity, etc. Funding can be established through Athelia climate, Athelia Ecosphere, Terra Bella fund etc. He urged to work with cluster villages and to educate the farmers on low carbon emissions, green life styles and proposed reward schemes for green life styles. He also emphasized the importance of establishing green belts around cities. e.g. SAOPAULO City.

- Dr. Nimal Gamage of Computer Associates/Nimsoft Developing Cloud, USA discussed the importance of nutraceutical industry as a stepping stone to the international health care markets in the developed nations. He emphasized the following key points to consider in competing in the global markets.
    1. Product life cycle management strategies for nutraceuticles and natural products
    2. Development of quality assurance protocols (Software-based quality assurance) for manufacture of natural products, packages, laboratories, holds (stores nutraceutical), etc.
    3. Management of the problems faced by industry due to regulation procedures
    4. Construction of physical plants with the help of qualified scientists (expatriate help)
    5. Establishment and use of western manufacturing and batch production records
    6. Establishment of procedures for quality control operations (adopt from international protocols and standards)
    7. Establish good manufacturing practices
    8. Establish a sponsor, a body to conduct compliance test

4.4. Food & Water Security

Co-Chair : Dr. S. S. B. D. G. Jayawardena and Prof. Vijay Jayasena
Rapporteurs : Dr. Jaanaki Gooneratne and Dr. Sithara Atapattu

- Currently Norway uses many innovative solutions for detection of water pollution, water measurements, waste water treatment and detection of bacterial contamination in less than 6 hours. Prof. Harsha Rantaweera, Professor in Environmental Engineering of Norwegian Institute for Water Research suggested that Sri Lanka should develop a national competence center at a University/Research Organization on water and waste water management and engineering in collaboration with Norwegian Institute for Water Research. Support can be provided for specialist knowledge for infrastructure and financial sustainability. Knowledge can also be imparted for curriculum development, postgraduate training etc.

  Prof. Harsha Ratnaweera, pointed out that the data available (source: Water Board) on local water access and availability for populations and treatment plants, and upgrading programmes, are poor and outdated. One reason may be the inadequacy of local resources to design upgrade, operate and maintain services. In terms of sustainability, the need to introduce water management techniques at University level was discussed.

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- Prof. Athula Ginige, Professor in Information Technology, University of Western Sydney, Australia emphasized developing social networks to disseminate scientific knowledge to farmers for quick decision making through mobile phones. Currently, such a programme which operates in Australia collaborates with the University of Colombo to establish a similar programme. This can be expanded to scientists, to participate as a knowledge source. There was a response from Dean, Faculty of Agriculture, University of Peradeniya regarding the possibility of linking their on-going programmes.

- Prof. Vijay Jayasena, Professor in Food Science, Curtin University, Australia addressed the possibilities of transferring patented technologies on food related areas to local industry.

- Prof. Monte Cassim, of Ritsumeikan University of Japan described an on-going programme in Japan on monitoring of adaptation of plants to climate change. Data obtained in the laboratory is distributed to school children who match this data with intrinsic data obtained from their farms, with help from their parents at different locations – A similar programme can be initiated in Sri Lanka and Prof. Cassim volunteered to support such a programme.

- Dr. Shanthi Wilson of ITI described measures to minimize the post-harvest losses of agricultural produce. This could be successfully achieved by developing tools for detecting maturity index ie. electronic 'nose' for maintaining quality before and after harvesting and proper storage and transport methods (currently this is a major issue in Sri Lanka and subjected to political debate). Minimizing losses could bring the consumer price of the produce down. The market price of rice is linked to the cost of bran removal and milling. Energy efficient novel methods could reduce the consumer price of rice and energy efficient methods of "cool chain" for prolonging shelf life will bring down the consumer prices of fresh fruits and vegetables.

- Dr. Jaanaki Gooneratne of ITI highlighted the importance of Food composition tables of local raw materials, food intake and nutritional surveys at national level for providing dietary advice on micronutrient deficiencies and non-communicable diseases. Identification of plant materials that can provide ingredients for enhancing nutritional composition in other foods (eg. *Moringa* and *Lupin*) is very important from the nutritional point. Soil depletion of micronutrients affects crops. eg. Low iron and zinc content in grass fed to cattle resulting in low zinc in milk.

- Land limiting factor has to be taken into consideration in agricultural crop planning. One must examine the use of ground water by innovative methods. Fresh water for agriculture is a diminishing resource and hence the need for a unified water policy that would specify the equitable allocation is crucial. Practice of multiple uses of reservoirs for inland fisheries and water productivity for high value agriculture is recommended. A Systems approach is essential in water management for solving high degree of disrepair of agri-water infrastructure.

- Mr. B R L Fernando of Colombo CIC stressed the need to focus on high value agricultural crops. He also stressed the need to invest in technologies to reduce water uptake by rice plants from the present 4 to 1.7 per kg. of rice. CIC has already started research in this area and has worked out the possibility of using water at 2 ½ times per kg. of rice.

- Many scientists agreed that there is a communication gap between the scientists and the general public. Research findings need to be conveyed to journalists as a means for dissemination of scientific know-how to the public.

- Dr. Tissa Illangasekera cautioned that by 2033 the water availability will drop by 30% and stressed the importance of developing sensors to monitor the water flow (these sensors could also be used to monitor landslides!)

4.5. Advanced Design and Manufacture

Co-Chair : Prof. R Attalage, Prof. M A R V Fernando
Rapporteurs : Prof. N Munasinghe, Mr. B S Samarasiri

- Prof. Attalage of the University of Moratuwa said that the contribution from design and manufacturing to the national GDP is significantly poor and only amounts to 18%. Prof. Fernando of Moratuwa University added that Sri Lanka needs to build the infrastructure for design and manufacture not only for new products but also for machinery that makes them. He said that during the early parts of the past century we had the confidence and ability to build even the machinery for tea and rubber processing, but today the trend is to import everything.

- Dr. Nanditha Hettiarachchi of Ruhuna University emphasized in changing the research culture to think in making value added products and processes. He gave an example of using novel research finding to improve making of dies and moulds required in the country at a lower cost and higher speed. We import 80% of the country's requirement.

- Prof. Wasantha Amarakoon of Alfred University, USA said that Sri Lanka already has the technology to make quality ceramic material and now it is time to step up a facility for making advanced ceramic materials especially for electronic applications. These are value added materials for global niche markets. Prof. Amarakoon also mentioned that one of his colleagues, Prof. Carti is volunteering to help the ceramic industry in Sri Lanka to develop advanced value added ceramic materials. During the past few years he visited Sri Lanka several times and is already assisting the ceramic research center in the country to make 'once fired porcelain'.

- Issues in Sri Lankan manufacturing industries such as poor quality infrastructure, lack of R&D coupled with incorrect selection of academic streams by University graduates have made them to leave the profession early creating a vicious cycle. This requires innovative approach to HR capacity building both at graduate level and vocational level and effective policy changes to modernize the manufacturing industry. Not many manufacturing industries in Sri Lanka could afford local in-house R&D programmes, hence very few new manufacturing technologies or advancements emerge from local industries.

- Dr. Adhikari of University of Moratuwa made a presentation on making advanced materials used for medical purposes from locally available raw material, chitosan. Chitosan is available as a byproduct of the local shrimp industry. The global chitin base material market is around 6 billion and Chitin base materials are used in water purification, biodegradable packaging, cosmetics, food industry, and medical applications. Laboratory scale development work has been completed and awaiting for a potential investor to collaborate in commercialization.

- Prof. Jawahir of University Kentucky, USA discussed the importance of converging conventional manufacturing to 'sustainable manufacturing' in line with the emerging 'green manufacturing' processes. He proposed to train students to embrace the sustainable manufacturing concept very early in their educational curriculum in manufacturing high end products such as medical implants, tools etc. Mr. A. A. S. P. Jayasinghe from NERD Center corroborated this idea of making high end products for higher return and to train young graduates in more challenging areas to keep them interested in the subject.

- At present there are no industrial incubation facilities for small and medium scale manufacturing industries to test pilot scale manufacturing ideas without spending large sums of money for equipment and infrastructure. It was suggested that institutions (government supported institutes) such as ITI and NERD center should establish flexible incubation facilities for this purpose. Due to lack of business incubation facilities, many technology

projects are shelved after the initial laboratory investigation stage (majority of scientists are poor businessmen !!!!)

- Several rubber/polymer based product development opportunities in areas such as Thermo Plastic Elastomers (TPE), wood plastic composites (WPC), light weight composites (for aviation industry), are worth investigating. The products should meet the international quality and standards requirements. Dr. Karnika De Silva of University of Auckland offered collaborative research programs with New Zealand in this area. She is currently working with a Sri Lankan rubber manufacturer in rubber based PVC pylon manufacturing for global markets.

- Prof. Jayasinghe of Moratuwa University mentioned that it is the responsibility of the Universities to train and make scientists who are ready to take up design and manufacture in the country. He is not sure whether Sri Lanka has the required number of trained design and multidisciplinary engineers who can operate incubator systems even if the facilities are established. The main goal of many students entering the university is to leave the country for better living (because of poor remuneration packages for scientists) and offer their services to other countries. He also said that the local scientists and engineers are not trained properly in product development, because the teachers do not understand the real meaning of product development (*bringing the product into the market!!!*!)

4.6. Information and Communication Technology

Co-Cahirs : Prof. Gihan Dias, Mrs. Chitranganie Mubarak
Rapporteurs : Dr. Ruwan Weerasinghe, Mr. Sanath Panawennage

Many private companies participated in this session than any other thematic panel discussion. In Sri Lanka many private companies are into ICT business and provide employment opportunities for many young graduates. The present trend among the young graduates is to seek employment in the private companies for an attractive remuneration package. In spite of this a number of students from the top tier are leaving the country.

- IT industry is one of the fastest growing industries in Sri Lanka amounting to 25% /yr and the 5th largest export earner with Rs.400mn worth products and services being exported every year. Mrs. Mubarak from ICTA said IT industry in Sri Lanka is growing relatively faster than many other countries in the region. Sri Lanka has already established a National IT policy. The 'Nanasala' network under the government sponsorship has established 629 centers connecting many parts of the country. Currently the computer literacy rate is at 38% and the target is to reach 75% by 2016. Government is encouraging many departments and offices to do business online. Making things available on the internet, paying bills, vehicle registration, e-banking etc. would prompt the public to learn IT on their own to attend to these daily activities. Peradeniya University has developed software to warn the Electricity Board service crews of damages to the power lines due to falling trees/branches. IT is a very versatile support system which could be utilized in developing many other areas as well ie. biotechnology , nanotechnology, design engineering etc. and thus focus more on cross disciplinary research.

- Prof. Athula Ginige of University of Sydney Australia said that the mobile phone penetration has reached 75% of the country. A huge market is evolving for the mobile telephone industry and in India mobile phones are used by fishermen and farmers to study the market position before deploying their produce to get a better price. Also, the mobile phones could be used as sensors to monitor weather effects, ground water flows and pending natural disasters including earth slips. We must educate the rural community about the power of IT technology through e-learning programs. There is a need to establish social networks linking communities, employers, potential employees' market places etc. and information gathering and

dissemination. Furthermore there must be an effort to establish post graduate training programs involving visiting expatriates as instructors on a regular basis to increase the value to human resource.

- There is a need to establish a conducive research environment in the universities to enhance the creativity and innovation of the students to benefit the industry. A high speed internet connectivity throughout the entire country should be established to facilitate communication and research. Lack of incubator facilities in the country is a major road block; however the Universities which could be potential incubator facilities, being public institutions have strict regulations when catering to private sector. To overcome this problem more private-public partnerships and the necessary protocols to develop together have to be developed.

- Annually a good number of new graduates are coming out of the local Universities and the employees are expecting more quality and skills from the graduates which are needed to compete in the international markets. Since the country cannot afford to risk capital funds country should focus more on developing software which involve minimum capital and target to play a leading role in the software industry within the region. Like our neighbour India, Sri Lanka could provide software services to the world.

4.7. Nanotechnology and Nanomaterials

Co-chair : Prof. Ravi Silva, Prof. Veranja Karunaratne
Rapporteurs : Dr. Rohini De Silva, Dr. Shehan De Silva

- Sri Lanka is blessed with very high quality nano raw materials. Up until recently we were exporting these at a very nominal price. Prof. Veranja Karunaratne of SLINTEC explained recent value addition programs initiated at SLINTEC to nano raw materials, increasing their value substantially. The nano materials area is growing exponentially and SLINTEC is now at the forefront of value addition to local nano raw materials. Sri Lanka is the only country to produce high quality vein Graphite which exist in crystalline form in contrast to flake graphite found in other countries. SLINTEC now has a patented process to make carbon nano tubes from the crystalline graphite which sells at USD 50,000/kg (vein graphite is selling at USD 2 /kg). In addition, Magnetite, vein quartz and illmanite are also being processed for value addition. Presence of montmorillonite in Mannar, Sri Lanka was discovered and exploited to make Bentonite at 70% purity which sells at USD 100-200/MT.

- Prof. Ajith De Alwis of University of Moratuwa stressed the need of Chemical and Process development engineers to support this nanomaterial development effort. Although SLINTEC is starting in-house pilot plants for specific uses, lack of flexible pilot plants that anyone can use hampers the research efforts in the country. Many collaborators are interested in joining SLINTEC in its efforts; SLINTEC actively solicits potential investors to start up commercial ventures.

- Combine nano technology with the strength/expertise unique to Sri Lanka (ie. natural product chemistry), to generate novel technology and products where we can claim IP rights. Thereafter, use this technology/product to address the world challenges (in areas such as energy, food, environment, water and diseases) creating an international market potential. Dr Challa Kumar of Louisiana State University, USA assured that with this strategy Sri Lanka could be on the global nanotechnology map. We must blend advanced technology with naturally available raw materials to develop unique products/technologies for international markets.

- Prof. Yoon-Bong Hahn, WCU Professor of Chonbuk National University, said Sri Lanka should learn from the Korean model in developing the nation with advanced technology.

Korean government spend large sums of money to, a) breed high quality research manpower cultivating 'brain culture', b) establish world class Universities to invite international scholars who possess advanced research capabilities to collaborate with local scientists. Korea has very little natural resources but very high level of educated human resources.

- Prof. Li-Chyong Chen of National Taiwan University compared Sri Lanka to Taiwan and said starting fresh Sri Lanka could avoid the mistakes that Taiwan made during her path towards development in advanced technology. To empower Sri Lanka with nano-technology it is important to develop specialized educational programs aimed at developing technology. Taiwan organized a very similar fora 30-40 years ago at the onset of their road to development and received support from expatriate scientists.

- Rubber is one of the most unique engineering raw materials and Sri Lanka has more than 100 years of working experience with rubber and rubber products. Local industries consumed 60-65% of rubber produced in the country. Nano-materials can be incorporated into the rubber making non-conventional rubber composites with enhanced beneficial properties. Rubber Research Institute of Sri Lanka is currently collaborating with SLINTEC in developing this novel high value added products ie. Montmorillini tiered graphite etc. and Carbon nano tubes to increase the strength of rubber composites.

- University of Colombo has developed a new nano-iron oxide impregnated activated carbon as water purifiers to remove arsenic in water. These nano-composites have the power of removing thousand times of its weight of arsenic. Dr. Rohini De Silva disclosed a novel technology discovered by her group to convert illmenite to nano TiO2 and nano FeO2. Although still at laboratory scale with proper investment this could be developed into a profit making commercial venture. Arsenic in water is a major problem in many countries in the region (eg. Bangladesh).

- Dr. Niwala Kottegoda of SLINTEC described the application of nanotechnology in agriculture. Minimizing the environmental pollution and saving money the fertilizers could be incorporated into nano-composites to reduce waste improving the availability of fertilizers for the plants to use properly. Encapsulating/Impregnating the fertilizer into glyricidia wood chips is another new method of slow release of fertilizer into the soils; potential investors are needed for commercialization of this process.

4.8. Green Energy Technologies

Co-Chair : Prof. Lakshaman Dissanayake, Prof. I M Dharmadasa
Rapporteurs : Prof. O Illeperuma, Prof. W L Sumathipala

- Dr. Ananda Kulasooriya**,** of IFS Kandy emphasized that Sri Lanka should move away from the dependency on the fossil fuel as an energy requirement. The solution is to have a combination of several renewable energy sources and methods in order to replace/supplement fossil fuels ie, solar, wind, biomass, bio-fuel, geothermal, ocean wave and tidal energy. Key factor is to avoid competition between food and fuel resources because the land is limited in Sri Lanka. Alternatively, explore the possibility of utilizing algae, cyanobacteria and other microbes as energy sources. Another area gaining interest is development of photo-bio reactors. It is important to consider green agricultural methods such as biological nitrogen fixation and bio-fertilizers.

- Prof. I. O. Illeperuma of University of Peradeniya said that his group has already designed and fabricated polymer based solar cells with a quantum efficiency of 7.5%. This type of solar cells can be made into arrays and are simple to fabricate large commercial scale solar cells. These

have an added advantage since there is no leaking electrolyte. His group is now soliciting potential entrepreneurs to commercialize this technology.

- Building human resource capacity aimed at manufacturing Solar Panels locally is important. There must be a programme to train students and young scientists in R&D to develop the necessary know how in the shortest possible time (one year). Attempts must be made to link up several Universities/institutes with institutes overseas with the required expertise in partnership in order to set up a solar panel manufacturing company in Sri Lanka with our own resources and trained personnel. A local partner is invited to invest in this venture.
  NSF is expected to facilitate this by providing logistics and sponsor ship of research funding. Intense research on solar thermal applications and their uses at domestic and industrial level is necessary. This is supposed to be a low cost, high tech route for utilizing solar energy.

- Dr Thusitha Sugathapala of University of Moratuwa_presented multitudes of applications of thermal energy which plays a vital role in energy services in all the sectors including domestic, commercial and industry. Thermal energy is used widely in drying or dehydration of agricultural and food products, especially in small scale in domestic and rural industrial sectors. Appropriate selection and dissemination of technologies based on the locally available renewable energy resources, such as solar and biomass including wastes could improve the situation significantly with positive socio-economic and environmental impacts. The concept of Sustainable Assessment of Technology (SAT) could be used for the selection of the best resource-technology-application combination/s. SAT methodology uses stage-wise evaluation process of different options: Screening, Scoping and Detailed Assessments, with grading in relation to technical, environmental, social and financial aspects and final ranking with weighted averages.

- Prof. Sanath Tennakoon of Stafforshire University UK, emphasized using Power Electronic Techniques for harnessing wind energy. Sri Lanka will benefit by establishing a HVDC link with India to harness wind power.

- Prof. I. M. Dharmadasa of Sheffield Hallam University, United Kingdom presented three proposals contributing towards development of Sri Lanka. This initiative will have immediate impact on rapid development of Sri Lanka by using "Green Energy Technologies" for social development and poverty reduction. Sri Lanka needs to establish a low-cost thin film solar cell production line in the near future. This needs trained personal at postgraduate level, with good understanding of the subject.

- APSL is now in the process of designing second stage of APSL-Awards to identify best green energy ideas. Through an island-wide competitive selection process, 4 or 5 bright ideas will be selected, and awards (a cash prize, Trophy and Certificate) will be presented for recognition. These bright ideas will then be introduced to the national funding bodies, local industry and the Government in order to fund, further develop the ideas with relevant professional guidance & nurture, incubate, scale-up, manufacture and market the final products.

- Solar village is the final product of HE-Link programme funded by DFID-UK, managed by the British Council and coordinated by Prof. Dharmadasa in the 1990s over a period of 8 years. The Link activities supported local solar energy research, and renewable energy applications. Solar village was designed to empower needy communities, successfully piloted in 2008 close to Anuradhapura, and monitored for 3 yrs. This project is now ready to replicate for immediate social development. Support is needed from the Government and Industry to install the required critical number in order to establish sustainable expansion. These villages will contribute to a common pool in order to install more systems round the country. What is necessary is to plant the "Seed" of the "Solar Village" concept and guide the community by a group of scholars from a close school or a University. The business plan for this will be ready in 2-3 months.

5. 'INNOVESTOR' FORUM – PROPOSALS FOR CONSIDERATION

5.1. BIOTECHNOLOGY

Proposal	Responsible persons	
	Expatriate	**Local**
1. Establishment of a cord blood stem cell bank and bone marrow transplantation programme	**Prof. Ariff Bongso** – National University of Singapore – to provide expertise in setting up the facility **Prof. Amittha Wickrama** – University of Chicago – to provide expertise in setting up the facility including setting up a HLA typing facility **Prof. Malik Peiris** – Hongkong University – to provide expertise in setting up molecular infectious diagnostic services **Dr. Pavan Gupta** – Manipal Institute of Regenerative Medicine – to provide training in stem cell biology as a collaborative MSc course. (Agreement for this was signed today (15/12/2011) with University of Colombo)	**Prof. Vajira Dissanayaka,** Faculty of Medicine, University of Colombo
2. Establishment of a Bioinformatics service that caters to the global need for sequence analysis. 3. Establishment of a high throughput genomics facility.	**Prof. Gemunu Gunarathne** Bioinformatics **Prof. Preethi Gunarathne** Bioinformatics and High throughput genomics	**Prof. Vajira Dissanayaka,** Faculty of Medicine, University of Colombo
4. Establishment of an antibody based vaccine development facility.	**Prof. Aravinda Silva** of North Carolina State University, USA	**Medical Research Institute/the Health Dept**. and/or any interested private parties.
5. Expand collaboration in molecular plant breeding and utilize the SNP marker and knowledge generated via Coordinated Agricultural Projects (CAP) in USA and develop research capacity in local institutes.	**Prof. Cholani Weebadage** offered to expand the collaboration with the University of Colombo	**University of Colombo**

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6. Setting up facilities for initiating regulatory capacity in agriculture with the view to co-evolving scientific research innovations and regulatory mechanisms. Importance of regulators to make science based informed decisions on innovations in agricultural crops were highlighted.		

5.2. NATURAL PRODUCTS

Proposal	Responsible persons	
	Expatriate	**Local**
Establish a Natural Product Focal Point Restart stalled legislative process on 'Policy for exploitation/export/research cooperation of natural Resources	**Proposed members:** **Exapatriates: Dr. Nimal Gamage, Dr. L M V Tillekaratne, Dr. Gomika Udugamasooriya, Dr. Nimal Chandrasena, Dr. Gamini Jayatileka,**	Establish a committee of natural scientists including expatriates to sphere head these activities. To be named as **Natural Resources Committee (NRC)** **Proposed members:** **Local: Dr. AJith Abeysekara, Dr. Dulip De Silva, Dr. Anura Senaratne, Dr. A L Jayawardena, Dr. Ruchra Cumaranatunga, Dr. A M Mubarak, Dr. A Nugawela, Prof. Tuley De Siva**
Participate/influence ISO TC 249 to include indigenous Sri Lankan Herbal Medicine and Supplements	**Dr. Nimal Gamage** of Computer Associates/Nimsoft Developing Cloud, USA	The above committee could delegate this assignment to a sub-committee
Create a single realistic MOU template for IP/Risk-reward management for all Natural Product based Foreign partnerships Be a single point negotiator.		**Natural Resources Committee**
CREATE and HOST Cloud Based Solution for Product Lifecycle Management (PLM) for Natural products adhering US FDA 21 CFR 111/210/211, ISO 13485 and other emerging world standards	**Dr. Nimal Gamage** of Computer Associates/Nimsoft Developing Cloud, USA	
Establish central information base for Natural Product activity (from 1970		**NSF**- Set up a Research Project, and provide funds

onwards) – Include research as well as traditional knowledge		
Establish a Technical and Technological transfer clearing house	**Dr. Nimal Gamage (USA), Dr. Gomika Udugamsuriya (University of Texas, USA) and Dr. L M V Tilekaratne (University of Toledo, USA)**	Function of a sub-committee of **Natural Resource Committee**
Intra-governmental clearing house for the facilitation of Natural Resource Management, Exploration, and Exploitation. Tightly couple local industry with NGO/GO in activities, Form Leadership Team (local/expat) to ensure continued coordination		
Extended training for the young scientists	**Dr. Gomika Udugamsuriya** agreed to provide assistance in training local scientists/students Agreed to provide tissue cultures/cell cultures for research purposes [but local scientists highlighted the possible contamination of such samples under local conditions]	
Effective management of natural eco-systems	**Dr. Nimal Chandrasena (ALS Global, Australia)** agreed to provide training to any person on effective management of ecosystems and to identify ecological indicators **Dr Ishwaran (UNESCO)** is willing to train scientists in Green technologies	
Develop Sea weed farming as an export industry		Develop Sea weed farming as an export industry. **Prof. Ruchira Cumaranatunga of Ruhuna University**

5.3. FOOD AND WATER SECURITY

Proposal	Responsible persons	
	Expatriate	**Local**
Collaborate with Norwegian Institute for Water Research, on Water Management and Water Treatment methods. Currently Norway uses many innovative solutions for detection of water pollution, water measurements, waste water treatment and detection of bacterial contamination in less than 6 hours. Sri Lanka should develop a national competence center at a University/ Research Organization on water and waste water management and engineering in collaboration with Norwegian Institute for water research.	**Prof. Harsha Rantaweera**, Support can be provided for specialist knowledge for infrastructure and financial sustainability.Knowledge can be also imparted for curriculum development, postgraduate training etc. **Prof. Harsha Ratnaweera**, emphasized that data available on local water access and availability for populations and treatment plants, and upgrading programs, are poor and outdated. One reason may be the inadequacy of local resources to design upgrade, operate and maintain services. In terms of sustainability there is the need to introduce water management techniques at university level.	
Develop social networks to disseminate scientific knowledge to farmers for quick decision making through mobile phones. *Currently, such a program is in operation in Australia with University of Colombo.* This can be expanded to scientists, to participate as a knowledge source.	**Prof. Athula Ginige**, Professor in Information Technology) of University of Western Australia	**Dean, Faculty of Agriculture, University of Peradeniya** - possibility of linking with their on-going program
Platforms for transferring patented technologies on food related areas to local industry.	**Prof. Vijay Jayasena**, Professor in Food Science, of Curtin University of Technology, Perth, Western Australia	**Dr. Jaanaki Gooneratne** of ITI
Establish a program to monitor	**Prof. Monte Cassim** of Ritsumeikan University, Japan	**NSF**

adaptation of plants to climate change. Data obtained in the laboratory will be distributed to school children who match this data with intrinsic data obtained from their farms.	could provide modes and techniques to implement.	
Examine the use of ground water by innovative methods.	**Prof. Tissa Illangasekera** is willing to help Sri Lanka in this venture	

5.4. ADVANCE DESIGN AND MANUFACTURE

Proposal	Responsible persons	
	Expatriate	**Local**
Novel Ideas for Enterprise Creation. Manufacture of Chitosan Based Bio composites for Bio-Medical applications using local raw materials. Major part of the research work is completed and an investor can immediately join for further development leading to technology transfer		**Dr. S.U. Adikari**, Dept. of Materials Engineering, University of Moratuwa. Major part of the development work is completed and potential investor can join in for commercial venture.
Development of Advanced ceramic materials using local raw materials	**Prof. Wasantha Amarakoon** of Alfred University, USA is willing to train/consult relevant local institutes in startup programs	**Ceramic Centre at ITI**
Advanced Metal Products development for medical implants and human resource development in sustainable manufacturing	**Prof. I S Jawahir** of University of Kentucky, USA is willing to train/consult relevant local institutes in startup programs. Also he is willing to help training local students either through research assistantships and/or short term training	
Infra-Red detectors and their applications in early detection of Dengue, Malaria, Aids etc.	**Prof. Unil Perera** of Georgia State University, USA is willing to collaborate with Local institutes	
Several Rubber/Polymer based product Development opportunities available	**Dr. Karnika de Silva**, of University of Auckland, New Zealand is willing to collaborate or help local entrepreneurs and provide technical support	**Rubber Research Institute**
Conduct a survey on the current status of the manufacturing Industries in the country		**NSF** could provide funds as a grant for a research student to carry out the survey.

5.5. INFORMATION AND COMMUNICATION TECHNOLOGY

Proposal	Responsible persons	
	Expatriate	**Local**
Need for an eco-system to harness the creativity and innovation in undergraduate projects to benefit industry State or PPP incubator/facility to mature research to technology and then to disseminate to industry	**Dr. Nimal Chandrasena,** ALS Global**,** Australia will train scientists	**Ministry of Higher Education/Grants Commission** to Coordinate this activity within the University system Funding mechanisms (Angel, Venture Capital) Universities and PP companies (ie. SLINTEC)
Areas such as Financial/Accounting, Mobile etc. for the "top of pyramid" customers e-Society applications to reach the "middle of pyramid" majority Panel identified low-end mobile access to the majority as a strategic 'market' to focus on Agriculture, Health, Education		**SLASSCOM** has already identified these areas **ICTA** piloted several of these programs. Publish the results to motivate the public.
Possibility of transnational research groups using Sri Lankan expat contacts	**Prof. Athula Ginige** of University of Western Australia, Sydney, is willing to support this program.	Prof. Ginige is already supervising PhD students in **University of Colombo**. Programme can be extended to other Universities
Accessibility to recent journals		Requested the expat community to help in this endeavor
Start training programs to build capacity where expatriates can train the local graduates on a regular basis		**NSF** provides funding for this type of programs

5.6. NANOTECHNOLOGY

Proposal	Responsible persons	
	Expatriate	**Local**
Investigate the readily exploitable Cashew Nut Shell liquid (CNSL), based surfactants. Unique surfactants provide a unique opportunity for atomic control of nano-material	**Dr. Challa Kumar, Louisiana State University, USA** proposed to identify unique technologies/products to Sri Lanka to establish IP rights	
Government to facilitate ways to invite international scholars who posses advanced research capabilities to collaborate with Sri Lankan academics(Brain Cultivation program). Concurrently provide incentives to local scientists for innovation	**Prof. Yoon-Bong Hahn, Chonbuk National University, Korea** quoted Korean examples. He invited local academics to join Korean Universities as Post-doctoral fellows for purposes of human resource development. Post doctoral opportunities are available for HR development	**Open to Universities and research Institutions in Sri Lanka**
Proposed to initiate programs to make nano-rubber composites, using local graphite base, nTiO2, nSiO2.		**Dr. Upul Ratnayake,** Industrialist from the audience was interested in making cups for rubber collection.
Proposed application of iron oxide nano-particles in industries and biomedical sciences. Granular activated carbon iron oxide nanoparticle composites (absoption capacity of 103 L/g) in removing arsenic from drinking water.		**Dr. Rohini de Silva,** University of Colombo

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Simplifyed DNA extraction using hydroxyapatite coated nano-particles is of a potential commercial venture. Methods have been developed on lab scale to convert Ilmenite to TiO2 Nps and iron oxide Nps.		
Requested the scientists to look into a nano-solution to increase the utilization of urea as a plant nutrient. She proposed to use sustainable release of urea through nano-technology. Also increase the solubility of rock phosphate through nano-sizing.		**Dr. Nilwala Kottegoda, SLINTEC** (SLINTEC already has developed methodologies for these)
Since SLINTEC has discovered a process for purifying Magnetite look into making nano-magnets for auto industry		**SLINTEC** to follow up with potential investor.

5.7. GREEN ENERGY TECHNOLOGIES

Proposal	Responsible persons	
	Expatriate	**Local**
1. Establish vibrant solar energy research in local institutes to build human capacity and knowledge in the country as preparation for manufacturing our own solar panels. Sri Lanka needs to establish a low-cost thin film solar cell production line in the near future. This needs trained personal at postgraduate level, with good understanding of the subject.	Establishment of the production line should be supported by an established Company in Sri Lanka and the Government. **Prof. I M Dharmadasa** of Hallam University, UK	Research need to be supported through **NSF** or any other research funding mechanism.
2. Convert new GEIs (Green Energy Ideas) into new GEPs (Green Energy Products) by careful selection process through second stage of APSL-Awards Scheme. APSL is now in the process of designing second stage of APSL-Awards to identify best green energy ideas. Through an island-wide competitive selection process, 4 or 5 bright ideas will be selected, and awards (A cash prize, Trophy and certificate) will be presented for recognition. These bright ideas will	**Prof. I M Dharnadasa,** of Hallam University, UK	

then be introduced to the national funding bodies, local industry and the Government in order to fund, further develop the ideas with relevant professional guidance & nurture, incubate, scale-up, manufacture and market the final products.		
3. Replicate "Solar Villages" attached to each university and established schools, as "Social Science Laboratories". This is a non-profit making social engineering venture for rapid development of rural communities.	Solar village is the final product of HE-Link program funded by DFID-UK, managed by the British Council and coordinated by **Prof. Dharmadasa** in the 1990s over a period of 8 years. The Link activities supported local solar energy research, and Renewable energy applications. Solar village was designed to empower needy communities, successfully piloted in 2008 close to Anuradhapura, and monitored for 3 yrs. This project is now ready to replicate for immediate social development. Support is needed from the Government and Industry to install the required critical number in order to establish sustainable expansion. These villages will contribute to a common pool in order to install more systems round the country. What is necessary is to plant the "Seed" of the "Solar Village" and guide the community by a group of scholars from a closest school or a university. The business plan for this will be ready in 2-3 months. **Prof. I M Dharmadasa** of Hallam University, UK	
Solar village program for utilization of commercially purchased solar panels should be expanded		Government should support until SL manufacture its own panels.
Program of joint research and development between the University	**Prof. Sivalingam Sivanathan,** University of Illinois, Chicago, USA	

of Peradeniya, Jaffna, Ruhuna, and the University of Illinois at Chicago and Sivananthan Laboratories, Inc., exchange of students, faculty and senior scientists. Focusing on solar energy.		

6. ANNEXES

Annex 1. Programme at a Glance
Annex II. Posters presented at the Forum

7. OUR SPONSORS

We are thankful to the following for providing sponsorships and financial support towards the success of the Forum

- MAS Holdings for the generous financial support
- Elsevier Publishers for hosting the Fellowship on Day 1 and publishing the 'Keynote Summaries and Introduction to Chairpersons and Panelists'
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- Mr. Dasa for printing all 20 posters for exhibition

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