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FROM THE DG'S DESK

Greetings from the NAM S&T Centre!

The world is still grappling with the COVID-19 Pandemic but gradually there are some signs of hope of getting back to normal life as seen across the world. However, the NAM S&T Centre is continuing its activities in virtual mode with all its scientific programmes being executed very successfully with commendable support from its Focal Points and scientific community in its Member Countries.

I am pleased to inform you that during the last quarter, the Centre has organized an International Workshop on "*Smart Agriculture for Developing Nations: Broader Perspectives and Special Challenges for Island States*" during August 11-12, 2021 jointly with the Ministry of Education, Tertiary Education, Science and Technology, Republic of Mauritius. More than 58 scientists and professionals from 13 NAM Member Countries participated, making the event a great success.

Further, the First Meeting of the Bureau of the 15th Governing Council (GC) of the NAM S&T Centre was hosted by Egypt in virtual mode on 20 September 2021 under the Chairmanship of Mr. Jayantha De Silva, President of the 15th GC of the NAM S&T Centre and Secretary, Ministry of Technology, Government of Sri Lanka. During the meeting, many important scientific and administrative decisions were taken and performance of the Centre during the last six months was reviewed.

I take pride to inform our Member Countries and other stakeholders that the Centre's first Scientific Monograph titled "*Lightning - Science, Engineering and Economic Implications for Developing Countries*" edited by Prof. Chandima Gomes from the University of Witwatersrand, South Africa has been recently published by Springer Nature, Singapore.

As a part of our activities in the next quarter, the Centre has announced the organization of two important scientific events through online platforms – an International Workshop on "*Application of Ocean Science and Technology for the Practice of Sustainable 'Blue Economy' in Developing Countries*" in partnership with the Scientific Committee on Oceanic Research (SCOR), Delaware, USA during 8-9 November 2021; and another International Workshop on "*Technology Transfer and Commercialization*" in association with the National Research and Innovation Agency of the Republic of Indonesia, Jakarta during 7-8 December 2021.

Various scientific programmes on a wide range of topics have also been planned by the Centre for the near future and we look forward to receive nominations for participation from our Member Countries and the global scientific community.

I would like to thank you all for extending your strong support in our successes and encouraging us to take new initiatives.

Stay Safe and Happy Reading!!

Amitava Bandopadhyay

(Amitava Bandopadhyay)
Director General

First Meeting of the Bureau of the 15th Governing Council of the NAM S&T Centre

20 September 2021
(Hosted by Egypt in Virtual Mode)

The 1st Meeting of the Bureau of the 15th Governing Council (GC) of the Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre) was held on 20th September 2021 in Virtual Mode which was hosted by the Academy of Scientific Research and Technology (ASRT), Government of the Arab Republic of Egypt. 43 delegates from 20 countries including Focal Points of NAM S&T Centre in Member Countries; representatives from the Diplomatic Missions of Argentina, Cambodia, Cyprus, Malawi, Mauritius, Sri Lanka, Venezuela and Zambia; senior officials of ASRT; and representatives of the NAM S&T Centre Secretariat attended the meeting.

At the outset, Mrs. Abeer Mohamed Attia, Acting General Director, International Scientific Relations, ASRT, Egypt

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Centre Organised

International Workshop on Smart Agriculture for Developing Nations: Broader Perspectives and Special Challenges for Island States

11-12 August 2021
(Virtual Mode)

Smart Agriculture is a management concept using modern technology to increase the quantity and quality of agricultural products. It has seen many revolutions, it is suggested that agriculture is now in another revolution triggered by the exponentially increasing use of information and communication technology (ICT) in agriculture. With the help of tools such as Sensors, Software solutions, long range connectivity and robotics etc., it will be easier for farmers to monitor field conditions in an efficient way.

Smart Farming and IoT-driven agriculture are paving the way for what can be called a *Third Green Revolution*. That revolution draws upon the combined application of data-driven analytics technologies, such as precision farming equipment, IoT, "big data" analytics, Unmanned Aerial Vehicles (UAVs or drones), robotics, etc. In the future, the smart farming revolution will ensure that pesticide and

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welcomed the Members of the Bureau, delegates from other Member Countries and the distinguished representatives from the diplomatic missions of various countries.

Mr. Jayantha De Silva, Secretary, Ministry of Technology, Government of Sri Lanka and President of the 15th GC of the NAM S&T Centre welcomed the Excellencies and distinguished delegates, and said that the last six months since the 15th GC Meeting had been quite challenging for the whole world and all the stakeholders in the Member Countries had been trying their best to support the good work being done by the NAM S&T Centre.

He advocated that being a part of the NAM S&T Centre, all the Member Countries should try their best to share knowledge and solutions amongst themselves. He said that over half of the population in the world is within the Centre's Member Countries, which is their main asset and therefore, the talents available in these countries should be properly utilised for the benefit of their own people. He concluded by stating that the members of the Centre should work together to attain a better world through cooperation in science and technology and expressed hope that the Bureau/GC would be able to meet soon physically for the benefit of the NAM S&T Centre and for the people of its Member Countries.

Prof. Dr. Gina Elfeky, Supervisor, Scientific & Cultural Relations Sector, ASRT, Egypt attended the meeting on behalf of Prof. Dr. Mahmoud Sakr, President, ASRT and Vice President of the 15th GC of the NAM S&T Centre who could not be present due to some unavoidable circumstances.

Prof. Elfeky welcomed the delegates on behalf of ASRT, and appreciated the NAM S&T Centre for the crucial role it has been playing over the years to tackle various economic, scientific and developmental ties to shape the S&T strategies of developing countries. She mentioned that all the Member Countries of the NAM S&T Centre share a common mission to improve their contribution to global scientific advancement, developing scientific and technological intellectual capital, and facilitating their own progress via a knowledge based economy, creating as well an enabling and stimulating scientific environment, and most importantly, maximizing the outcomes through the promotion, coordination, assessment, encouragement and appreciation of excellence in science, technology and innovation.

She added that ASRT has carried out a huge strategic study to chalk out future course of action to tackle the Covid-19 Pandemic by a group of experts working for the ASRT through the Council and the National Committees. She said that ASRT would be happy to share the outcome of the study with the members of the NAM S&T Centre.

She assured that ASRT would continue to work in partnership with the Centre for various activities on different aspects and disciplines for the welfare of the Member Countries of the Centre. She concluded by thanking all the delegates for attending the meeting and also thanked her colleagues at the ASRT, especially Mrs. Abeer Mohamed Attia for her great efforts to make this meeting a success.

Mr. Vedanand Bhurosah, Acting Director, Tertiary Education and Scientific Research Division, Ministry of Education, Tertiary Education, Science and Technology, Mauritius attended the meeting on behalf of Mrs. Shabina Lotun, Permanent Secretary of the Ministry, and Vice President of the 15th GC of the NAM S&T Centre.

In his remarks, he pointed out that due to the Pandemic, the Bureau Meeting was being organised in Virtual mode, and added that Mauritius too had hosted an international workshop virtually in collaboration with the NAM S&T Centre on the theme *'Smart Agriculture for Developing Nations: Broader Perspectives and Special Challenges for Island States"* during 11-12 August 2021 and thanked the NAM S&T Centre for co-organising the event and also thanked all the participants from various countries for having actively contributed during the event. He also expressed his happiness that the Centre has organised and funded a large number of international workshops, conferences, training courses and fellowship schemes, and published several books - from which scientists from Mauritius and from other Member Countries have immensely benefited. He recognised the contributions made by the NAM S&T Centre and appreciated the good work accomplished by the Centre aligned with its vision.

He pointed out that Covid-19 crisis has affected economies around the globe and would permanently reshape the world as it continues to unfold and therefore, the Centre should focus more on Open Science and Open Access and sharing of Research among Member Countries. He further suggested that the NAM S&T Centre should organize workshops on topics related to Green Innovation, Collaboration and Digitalization in the future. He concluded that the Republic of Mauritius as one of the Vice-Presidents of the NAM S&T Centre reiterates its gratitude to other Member States for their continued support.

Dr. Hussein A. Al-A'raj, Vice-President, Higher Council for Innovation and Excellence (HCIE), Government of the State of Palestine and Vice President of the 15th GC of the NAM S&T Centre in his remarks thanked the NAM S&T Centre for continuous support to Palestine in general and to HCIE in particular.

He said that the Higher Council of Innovation & Excellence (HCIE), Palestine has been playing a very important role by investing and supporting innovative projects, opening international and regional horizons for innovators, and taking up

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membership of international and regional institutions working in the areas of innovation. He informed the delegates that HCIE supports prototypes, startups, links (entrepreneurs, private sector), and nomination (International Conferences, Exhibitions, and Forums) and Palestine has been part of many scientific training activities that were organized by the NAM S&T Centre in recent years including the training workshop on STI Diplomacy. He also mentioned that HCIE has established a "National Innovation and Leadership System" to facilitate tasks for innovators in various fields to develop a mechanism that creates synergy between all relevant entities. He informed that HCIE has launched a network of institutions working in the field of Innovation in Cooperation with the Union of Engineers and Leadership and also has created a Data Bank for Innovators. Finally, he informed the delegates about the establishment of the Palestinian Innovation Complex with Centers on various sectors including Energy, Water and Advanced Technology, and a Science Park, for which HCIE has obtained land and grants for underground infrastructure, which will start very soon.

He further added that HCIE is keen to establish collaboration with the Member Countries, and invited the delegates to participate in the Sixth National Forum - A Transition to Innovation that would be organized by HCIE during 7th-8th December 2021.

Dr. Amitava Bandopadhyay, Director General (DG), NAM S&T Centre expressed his gratitude to the Government of Egypt and other dignitaries, and more specifically to Prof. Dr. Mahmoud M. Sakr, President, ASRT; Prof. Dr. Gina Elfeky, Supervisor, Scientific & Cultural Relations Sector; Mrs. Abeer Mohamed Attia, Acting General Director, International Scientific Relations; and other colleagues within ASRT for the admirable job of shouldering the responsibility of the coordination and day-to-day work in organising the Bureau Meeting on behalf of the Government of Egypt.

Dr. Amitava Bandopadhyay also welcomed all the Focal Points of NAM S&T Centre in Member Countries, all other dignitaries and delegates and made a presentation on the objectives and functions of the NAM S&T Centre and its role in developing partnerships and promoting South-South and North-South cooperation in Science & Technology.

Thereafter, two books published by the NAM S&T Centre since the 15th Governing Council Meeting in February 2021 were released: a) Monograph titled *'Lightning: Science, Engineering and Economic Implications for Developing Countries'*: Edited by Prof. Chandima Gomes (South Africa) and published by Springer Nature, Singapore in August 2021 [Released by Mr. Jayantha De Silva (Sri Lanka)] and b) *Air Pollution and Public Health: Challenges, Interventions and Sustainable Solutions*: Edited by Dr. Nour Shafik El-Gendy (Egypt) and Dr. Vartika Mathur (India) and published by Allied Publishers, New Delhi in June 2021 [Released by Prof. Dr. Gina Elfeky (Egypt)].

At the end of the Opening Session, Prof. Dr. Gina Elfeky, ASRT, Egypt proposed a vote of thanks to all the esteemed delegates and participants.

The Working Level Discussion of the Bureau Meeting was chaired by Mr. Jayantha De Silva, President of the 15th GC of the NAM S&T Centre and Secretary, Ministry of Technology, Government of Sri Lanka.

The Bureau then took up various items of Agenda for discussion. The Bureau expressed satisfaction that in spite of severe problems due to the COVID – 19 Pandemic, the Centre has been able to start many important initiatives and implement a few scientific activities during the short period of about six months since the last GC Meeting, including organization of two international events (Workshop and Roundtable) and publication of two books, and congratulated the Director General and his team for diligent and efficient working towards successful planning and execution of the same. The delegates congratulated the DG, NAM S&T Centre for achieving an impressive output in spite of very limited financial resources, even during the Pandemic.

The Bureau accorded in-principle approval for undertaking several international workshops and training programmes by the NAM S&T Centre in partnership with various organisations. The Bureau urged other Member Countries and agencies to come forward with relevant proposals for implementation by the Centre in near future.

The Bureau expressed concern that the Centre had been facing financial constraints due to non-payment of the membership subscription by a number of Member Countries. The Bureau made a strong appeal to the non-paying Member Countries to expedite payment of their membership subscription dues to the Centre.

The President, Mr. Jayantha De Silva thanked all the participants/delegates for their guidance to the Centre and taking part in fruitful and successful deliberations in the Bureau Meeting. The Director General thanked the President, Mr. Jayantha De Silva and other Bureau Members and GC Members participating in the Bureau Meeting and offering their support and guidance to the Centre. The Director General also thanked the Government of Egypt, and in particular, Prof. Dr. Mahmoud Sakr, President, ASRT; Prof. Dr. Gina Elfeky, Supervisor, Scientific & Cultural Relations Sector; Mrs. Abeer Mohamed Attia, Acting General Director, International Scientific Relations; and other officials of the ASRT for making excellent arrangements for hosting the meeting in Virtual Mode.

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fertilizer use will drop while overall efficiency will rise. Thus, smart farming has a real potential to deliver a more productive and sustainable form of agricultural production.

Considering the importance of the subject, the Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), New Delhi, India jointly with the Ministry of Education, Tertiary Education, Science and Technology (METEST), Republic of Mauritius organized an International Workshop on **'Smart Agriculture for Developing Nations: Broader Perspectives and Special Challenges for Island States'** during **August 11-12, 2021.** The Workshop was hosted by METEST, Mauritius in **Virtual-Mode**.

The two-day workshop aimed to bring together scientists, researchers, and policy makers from the developing countries in the areas of agriculture management and other representatives from government, academia and industry to: (i) Highlight the Smart Farming Technologies – *Drones, Sensors, Internet of Things, Multi-spectral Imaging, Robotics, Big Data, Artificial Intelligence etc.* (ii) Discuss IoT solutions to agricultural problems and farming automation/robotization; (iii) Investment in R&D; (iv) Showcase new business models; and (v) Any other areas relevant to "Smart Agriculture".

The Workshop was attended by **58** scientists, researchers, academicians, policy makers and other professionals from **13** countries namely; **Bangladesh, Egypt, India, Indonesia, Iraq, Malaysia, Myanmar, Nigeria, Pakistan, Palestine, South Africa and Sri Lanka** and the host country **Mauritius.**

The Workshop started with **Introduction and Welcome** by the Master of Ceremony, Ms. Carole Ricco in the **Inaugural Session**. Then Dr. Amitava Bandopadhyay, Director General, Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), in his address, welcomed the Guest of Honour - Her Excellency Leela Devi Dookun-Luchoomun, Vice Prime Minister and Minister of Education, Tertiary Education, Science and Technology, Republic of Mauritius; Mrs. Shabina Lotun, Permanent Secretary, METEST, Mauritius; Mr. Vedanand Bhurosah, Acting Director, METEST; Keynote Speakers and all other participants and expressed his pleasure that in spite of the complexities caused due to the COVID-19 pandemic, the Workshop could still be organised with the help and cooperation from all stakeholders, most importantly, METEST, Mauritius. He highlighted the importance of Smart Agriculture for sustainable agricultural production, and then briefed the participants about the NAM S&T Centre which aims at promoting South-South Cooperation in Science and Technology for collective self-reliance of developing countries, with a special focus on Sustainable Development Goals-2030. He expressed his concern about reducing the gap between developed and developing countries, and the role of governments, academia, industry and civil society of various NAM and other developing countries for effective and efficient management of activities and programmes in order to achieve the same.

The inaugural address was delivered by the Guest of Honour- Her Excellency Leela Devi Dookun-Luchoomun, Vice Prime Minister and Minister of Education, Tertiary Education, Science and Technology, Republic of Mauritius. In her address, she stated that smart farming has become necessary, as nearly 120 million populations are undernourished. She emphasized that application of smart farming technologies is required to address the issues of population growth, climate change and labour shortage and that due to the population growth; we need to produce in high quantity as well as improve the quality of food. She highlighted how smart agriculture can benefit the entire community, and advised the scientists, researchers, academicians, policy makers and other professionals to share the ideas, since the future lies in networking and cooperation.

A Vote of Thanks was given by Ms. Carole Ricco, Assistant Permanent Secretary, Ministry of Education, Tertiary Education, Science and Technology, Republic of Mauritius.

The Workshop was conducted with **4 Technical Sessions** under which 5 Keynote Lectures and 23 paper presentations were made, all deliberating on the critical issues on "Smart Agriculture for Developing Nations: Broader Perspectives and Special Challenges for Island States".

Technical Session I - 'Smart Information and Communication Technology (ICT) Solutions for Agriculture' was chaired by Dr. G.V.T.V Weerasooriya (Sri Lanka).

Keynote Lecture I titled 'Sensing and Data analytics for Smart Agriculture' was delivered by **Dr. Rabi N Sahoo,** Principal Scientist, ICAR– Indian Agricultural Research Institute, New Delhi, India. It highlighted the shrinking natural resource base (per capita availability of land and water devoted to agriculture), and expressed that declining quality of resources and environmental degradation issues would imply increasing threat to the ability to meet the basic needs of the growing population unless modern technologies are practiced for improving productivity. He concluded that Precision Agriculture (PA) needs to go from a technology-push to application-driven approach. .

Keynote Lecture II titled 'Smart Agriculture Research and Development Initiatives: Case study of the University of

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Mauritius' was delivered by **Dr. Kavi Kumar Khedo,** Associate Professor, University of Mauritius. Dr. Khedo highlighted the challenges for Small Island Developing States (SIDS): (1) Agriculture and agricultural trade (2) Linkage between tourism and agriculture (3) Natural disaster preparedness and agriculture (4) Environmental protection and sustainable development and (5) Impacts of climate change on food security.

This was followed by a paper presentation titled 'Modernization and Enhancement of Agriculture through Advanced Technologies' by **Dr. Ten Seng Teik,** Senior Research Officer, MARDI, Malaysia. He explained the possibility to enhance the existing practices in agricultural sector from mechanization, automation towards the advanced technologies especially the research works in the MARDI into new era of *Agriculture 4.0* to reduce the dependency on the labour force, the period of production and increase in productivity and food quality.

In the paper titled 'Mau Crop: An AI-Driven Interactive Mobile Application to Advise on Crop Selection and Cultivation for Small-Scale Crop Farmers in Mauritius' by **Dr. Sandhya Armoogum**, Senior Lecturer, University of Technology, Mauritius, discussed about selecting crops, monitoring and managing the cultivation land, and records the yield by using a “Mobile Application”. The gathered data about the cultivation by the application could be used for training and developing a ML model that can efficiently predict the yield.

A paper titled 'Agronomic Applications Using Drone Technology & Remote Sensing for Improving Sugarcane Production in Mauritius' was presented by **Dr. Sumantlall Seeruttun**, MSIRI / MCIA, Mauritius in which he explained his R&D project on how by using a drone system equipped with multispectral sensors, together with associated software for image interpretation and analysis, applications are developed for improving sugarcane production.

Afterwards, **Dr. Amit Kumar**, CSIR-Institute of Himalayan Bioresource Technology (IHBT), Palampur, India, presented paper titled 'High Resolution Remote Sensing and Ecological Niche Modelling for Smart Agriculture of Medicinal, Aromatic and Commercially Important Crops in Himalayas'. He mentioned that the first of its kind facility for nextGen remote sensing application has been established at CSIR-IHBT, Palampur which has taken a lead role in drone and ground based multispectral, hyperspectral and LiDAR remote sensing for SMART agriculture of medicinal, aromatic and commercially important crops over Indian Himalayas. He concluded that with the help of data and information gathered, mathematical models and algorithms are being generated using artificial intelligence based techniques for efficient and SMART cultivations of medicinal, aromatic and commercially important crops to boost the farmers' income.

Subsequently a paper titled 'Image Processing - a Smart Technology for Early Detection of Crop Pests and Diseases' presented by **Dr. Kandiah Pakeerathan**, Dept. of Agricultural Biology, Faculty of Agriculture, University of Jaffna, Sri Lanka discussed the advanced technological knowledge of image processing, and its success in the detection of economically important crop pests and diseases around the world.

The next paper titled 'Exploitation of Big Data Earth Observation to Support Smallholder Farms' was presented by **Dr. Cilence Munghemezulu**, Pretoria, South Africa who explained development of tools to monitor crops using open source software and geospatial libraries to support smallholder crop farms and local governments with critical information.

This was followed by discussion and exchange of viewpoints among the participants in response to questions raised to the presenters.

Technical Session II - 'Internet of Things (IoT) Driven Smart Farming' was chaired by Dr. Rabi N. Sahoo (India) and Dr. Ten Seng Teik (Malaysia).

Under this technical session, a paper titled 'Spirulina Production and Potential Upscaling by Precision Farming IoT Solutions in Pakistan' was presented by **Dr. Sofia Qaisar**, PCSIR Laboratories Complex, Pakistan. She discussed the importance of Spirulina production, an alkaline algae known for its nutrition and health benefits.

Thereafter, in the paper titled 'Aquaculture Water Quality Monitoring Using Fuzzy Interface System and IoT' was presented by **Dr. Abu Hassan Abdullah**, Director, Institute of Sustainable Agrotechnology (*INSAT*), Universiti Malaysia Perlis (*UniMAP)*, Malaysia, who explained the water quality monitoring system using a sensor for fish aquaculture. He discussed the system development, both hardware and software, as well as the fuzzy logic system.

Dr. Abeer Ahmed Mohamed Hedia, Researcher of Irrigation Systems, Agricultural Engineering Institute, Irrigation and Drainage Department, Agricultural Research Center, Cairo, Egypt presented her paper titled 'Verification of Hedia Computer Model'. She explained about a comprehensive computer model 'HEDIA' created by her to simulate sprinklers water overlapping patterns theoretically by one sprinkler superimposition technique under selected layout design.

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The paper titled 'Removal of Nitrates from Water through Chia Seeds' presented by **Mr. Salah Abdal Rahman El Sadi**, Ministry of Economy, Palestine described the 'Green Process' in which Chia seeds are used and treated and converted into new material.

The presentation titled 'Smart Fertilizer: Encapsulation of Bacillus Salmalaya for Sustainable Agriculture' by **Dr. Rosazlin Abdullah**, Institute of Biological Sciences, University of Malaya, Malaysia discussed that as an alternative, the use of plant growth promoter based bacteria plays a role in supporting the plant growth under various stress conditions. Unfortunately, bacteria activities decrease due to temperature and environmental factors.

The Session was concluded with a comprehensive discussion to enhance learning and get diverse perspectives on the above presentations**.**

Technical Session III - 'Sustainable and Smart Agricultural Practices for Developing Countries and Island States' was Chaired by **Dr. Sumantlall Seeruttun** (Mauritius) and Dr. Uvasara Dissanayeke (Sri Lanka).

Keynote Lecture III titled 'Smart Affordable Technologies for Transforming Agriculture Industry in Developing Countries' was presented by **Prof. S. Rohan Munasinghe,** Commission Member, National Science & Technology Commission (NASTEC), Sri Lanka and Professor, Department of Electronics and Telecommunication Engineering, Faculty of Engineering, University of Moratuwa, Sri Lanka. He explained that high throughput phenotyping is made possible by the combined deployment of these technologies where accurate details of huge crop fields are brought onto the computer screen of the planter to help him/her take accurate and timely decisions.

Keynote Lecture IV titled 'Constraints and Challenges for the Non-Sugar Sector in Mauritius' was presented by **Dr. Ganeshan**, Chief Executive Officer, Food and Agricultural Research and Extension Institute, Mauritius. In his lecture, he highlighted the major constraints to crop production and emphasized that combining artificial intelligence and agriculture can be beneficial in several ways, such as in analyzing market demand, managing risks by forecasting and predictive analysis, managing soil health, efficient use of resources and automated harvesting systems.

This was followed by the paper titled 'A Plant Needs Organic Fertilizer to Grow in a Balanced Way' which was presented by **Mr. Durlave Roy**, Northern Agro Services Ltd., Dhaka, Bangladesh. Mr. Roy suggested that the combined use of organic and inorganic fertilizers can improve crop production and maintain soil health. Many important soil properties depend on, to some degree, on the quantity of organic matter.

A paper titled, 'A Proposed Machine Learning Framework for the Prioritization of Genes and SNPs Associated with Abiotic and Biotic Stress-Resistant Traits in Rice' presented by **Dr. Arpah Abu,** University Malaya, Malaysia discussed the recent advances in high throughput *Omics Platform* which have generated a tremendous amount of rice omics data. She added that the Machine Learning Framework could lead to the development of a decision support system (DSS) in the rice gene and SNP validation, as well as genome editing.

Dr. Abhinav Kumar, Department of Biotechnology, Integrated Institute of Higher Learning and Management – College of Engineering & Technology (IILM-CET), India presented his paper titled 'Begomovirus (Family Geminiviridae) as a Gene Silencing Tool and an Analysis of Machine Learning Approach to Classify Genes and Genera in Family Geminiviridae'. He highlighted an advance gene-silencing tool called Virus-induced Gene Silencing (VIGS) which follows an RNA-mediated antiviral defense mechanism. VIGS technology is entirely based upon the backbone of the infectious virus clones.

Afterwards, **Dr. Ashish Warghat**, CSIR- Institute of Himalayan Bioresource Technology (IHBT), Palampur, India in his paper titled 'Increasing Nutrient Electrical Conductivity Promote Growth, Flowering, and Quality of Lilium Cultivated under a Hydroponic System' explained that Hydroponics is an eco-friendly and modern agriculture system for commercial-scale production of high-value flower crops. The study provides a simple yet robust hydroponic protocol by reducing the cultivation cycle for flower production with good shelf life in Lilium varities .

Thereafter, a paper titled 'Assessing the Sustainability Performance for Pepper Cultivation in Sarawak via Agriculture Sustainability Index' was presented by **Dr. Shanti Salleh**, University Malaysia Sarawak, Malaysia. Dr. Shanti reported about the challenges in pepper production in Sarawak related to environmental, social, and economic constraints resulting in insignificant productivity, depletion of soil nutrients, and thus rises in production cost. Her study is to mitigate pepper cultivation problems.

In the paper titled 'Seaweed Harvesting Machine - A Novel Device for Harvesting the Grown Biomass through Tube-Net Methods' presented by **Dr. V. Veeragurunathan**, CSIR-Central Salt & Marine Chemicals Research Institute

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(CSMCRI), India explained that utilization of seaweeds for plant growth stimulants production is helpful in agricultural applications and also for bio-fuel purpose He added that, apical portions have more sap content than middle and basal portion and in order to get apical parts from fully grown plant without trimming or pruning, his team developed a device for simultaneous harvesting and segregating quality material for seeding as well as processing in inexpensive manner while the remaining parts in tube net can be used for reseeding purpose.

Dr. Yasar Saleem, Senior Scientific Officer, Pakistan Council of Scientific and Industrial Research (PCSIR), Pakistan presented a paper titled 'Use of Nano-Fertilizers and Soil Conditioners for Managing Future Agriculture Needs'. He said that a nano-fertilizer with slow release has been developed and tested for sustaining the soil fertility levels and at the same time preventing the nutrient loss.

The subsequent paper titled 'Development of Smart Sprayer for Small Holder Farmers in Conservation Agriculture' prsented by **Dr. Tingmin Yu**, Agricultural Research Council, Pretoria, South Africa discussed the project to develop a cost-effective small-scale smart spraying system for smallholder farming in Conservation Agriculture to implement weed control.

The Session concluded with a discussion to get diverse perspectives on the above presentations**.**

Technical Session IV - 'Climate Smart Agriculture' was Chaired by Dr. Tingmin Yu (South Africa) and Dr. Amit Kumar (India).

Keynote Lecture V titled 'Halophytic Cultivation in Coastal Site in Semi-Arid Areas as a Bio-Saline Agriculture' by **Dr. D.R. Gangapur,** CSIR-Central Salt & Marine Chemicals Research Institute (CSMCRI), Bhavnagar, India highlighted how improper utilization of water resources for agriculture purposes as an irrigation source results in the deterioration of soil health which leads to decline in the growth and development of conventional crops. In order to address this issue, he said, the study of salt adaptation mechanisms of halophytes will give some base line information for the development of salt tolerant crops using gene resources of halophytes.

A paper titled 'Smart Greenhouse Development: A Case Study in West Java, Indonesia' was presented by **Dr. Sulastri,** Researcher, Agency for the Assessment and Application of Technology (BPPT) and she talked about the project to assesses the potential and constraints of smart greenhouse development in West Java, Indonesia.

Dr. G.V.T.V. Weerasooriya, Department of Agricultural Engineering and Soil Science , Rajarata University of Sri Lanka, presented a paper titled 'Adoption of Climate Smart Agriculture (CSA) Technologies in Sri Lanka: Scope, Present Status, Problems, Prospects, Policy Issues and Strategies'. He highlighted about his study with the focus on the scope, present status, problems, prospects, policy issues and strategies related to the adoption behaviour of Climate Smart Agriculture Technologies in Sri Lanka.

Afterwards, in the paper titled 'Agro-Meteorology Advisory Systems to Reduce Climate Change Risks among Dry Zone Farmers in Sri Lanka' presented by **Dr. U. I. Dissanayeke** discussed a study to establish an efficient integrated weather information system for farmers and local decision makers in the rain-fed dry zone.

The paper titled 'Sustainable Development: Retrofitted CNC Machine with IR4.0 Project' was presented by **Dr. Yusri Yusof,** Professor, Advance Manufacturing and Material Centre (AMMC), Universiti Tun Hussein Onn Malaysia (UTHM). He discussed about Industry 4.0, and said that the digital transformation of the industry is enabled and forced by rapid technology development. He added that Industry 4.0 readiness assessments, and maturity models can support the management at benchmarking, and setting up a roadmap for the digital transformation of their organization.

The above Session was concluded after some discussions on the presentations**.**

The **Concluding Session** was chaired by Dr. Preeaduth Sookar, Senior Scientific Officer at Ministry of Agro Industry and Food Security, Mauritius and Dr. Amitava Bandopadhyay, Director General, NAM S&T Centre. Extensive discussions were held, and views were exchanged for understanding the key learnings, experiences and takeaways from the Workshop. Further, after a comprehensive deliberation, a **'Resolution on Smart Agriculture for Developing Nations: Broader Perspectives and Special Challenges for Island States'** was resolved and unanimously adopted by the participants – with several important recommendations made for the governments, institutions, policy makers, end users and other key stakeholders.

Closing Remarks were made by Mr. Vedanand Bhurosah, Acting Director, Tertiary Education and Scientific Research, Ministry of Education, Tertiary Education, Science and Technology, Republic of Mauritius.

Resolution

on

"Smart Agriculture for Developing Nations: Broader Perspectives and Special Challenges for Island States"

Pont Fer, Phoenix, Mauritius
(11-12 August 2021)

Resolution adopted by the participants of the International Workshop on **"Smart Agriculture for Developing Nations: Broader Perspectives and Special Challenges for Island States"** organised jointly by the Ministry of Education, Tertiary Education, Science and Technology, Republic of Mauritius; and the Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), New Delhi; held virtually from 11 to 12 August 2021.

We, the participants of the International Workshop on "**Smart Agriculture for Developing Nations: Broader Perspectives and Special Challenges for Island States**" representing the governments, academic and research institutions and S&T agencies from Bangladesh, Egypt, India, Indonesia, Iraq, Malaysia, Mauritius, Myanmar, Nigeria, Pakistan, Palestine, South Africa, and Sri Lanka; as well as other relevant stakeholders;

RECOGNIZING that smart farming is an emerging concept that refers to managing farms using technologies like Internet of Things (IoT), robotics, unmanned aerial vehicles and artificial intelligence to increase the quantity and improve the quality of products while optimizing the human labour required for production;

REALIZING that the new technologies have not only provided a better way to measure and control growth factors like irrigation, plant treatment and fertilizer on a farm, but has also changed how we view agriculture entirely;

RECALLING the aims of the workshop: (a) to bring together the experts, professionals and the policy makers from the developing countries in the areas of agriculture, IoT, AI, big data analytics and smart applications domain (b) to develop synergy, exchange knowledge and share ideas on smart agriculture, and (c) to provide solutions with a broader perspective while keeping a special focus to Island States;

REAFFIRMING that capacity-building in Smart Agriculture should remain as one of the items on top of the agenda of an economy amid the pandemic in view of its potential to boost crop productivity;

ALSO BEING ATTENTIVE of the necessity for Island States to encourage smart farming as well as realizing the need for appropriate mechanisms to increase the productivity;

UNANIMOUSLY RESOLVE AND RECOMMEND the following:

- Governments and all other stakeholders should encourage a ***Third Green Revolution (TGR)*** in the NAM and other developing countries through the application of smart agricultural technologies such as, precision farming, Internet of Things (IoT), big data analytics, remote sensing and low cost sensors, Unmanned Aerial Vehicles (UAVs or drones), robotics, etc.
- In this context, Governments should adopt innovative policies that support opportunities in Smart Agriculture, thus ensuring that the smart farming takes its rightful role in increasing quality and quantity of food products.
- Strategic and systematic plans and supportive government schemes are required to adopt smart farming technologies and endorse its implementation.
- Call upon the Governments of the NAM and other developing countries and the international financial institutions for providing funds for the execution of projects in the priority areas as well as capacity building of scientific research, innovation and technology development and transfer on Smart Agriculture. For this purpose, more importance should be accorded to cooperation and collaboration in the field of smart agriculture with (a) SADC, AU, UN, African Development Bank etc. and (b) Other inter-governmental and non-governmental technological organizations including FAO, UNESCO, UNDP, WHO, Afro-Asia Rural Development Organisation, Asian Development Bank, etc.

(Contd. on page 9)

(Contd. from Page 8 - Resolution)

- Adequate incentives should be provided by the Governments of NAM and other developing countries to farmers for adopting smart farming technologies. Tax incentives should be provided for import and local manufacturing of drones and other equipment used in smart agriculture practices.
- A robust cyber security mechanism should be made available to protect the farmers from breach of privacy, data theft and fraud, which are commonly faced in any internet based system.
- A dedicated reliable high speed Internet connectivity and communication network infrastructure should be made available especially in rural areas as an enabler for development of smart agriculture.
- Uninterrupted power supply should be provided to farmers for adopting smart farming technologies for which renewable energy sources such as solar and wind energy should be extensively used.
- Developing nations are focusing on advanced manufacturing capabilities by investing in high-tech infrastructure and quality education. Similar initiatives like big data collection and AI applications in agriculture based industry are required to increase agro-food production and economy.
- IR4.0 should be implemented in agriculture based industry of NAM and other developing countries to increase productivity and improve quality, and for better monitoring and cost effectiveness. Right ecosystem of IR4.0 should be adopted and aligned into the existing and future development of agriculture based industry for increased food security and food safety.
- IoT driven systems for agriculture should be adopted, such as: smart greenhouses, food grain silos and other storage facilities to intelligently monitor and control the climate, and eliminating the need for manual intervention; and Internet of Food and Farms (IoFF) for food and farming industry for increased food safety and security and sustainable development - through more efficient use of water, and optimization of treatments and inputs.
- A mechanism should be developed for capacity building and technology transfer among scientists, young researchers and academia on advanced technologies on smart agriculture.
- Regular training should be provided to the farmers in learning various aspects of using smart technologies. Effective outreach activities may be devised for more and more use of smart agriculture initiatives.
- Awareness and commercialization of digital/smart farming should be encouraged by implementing cross border mechanisms such as grooming skill levels, arranging collaborative platforms, providing digital infrastructure, enabling funding support, providing data availability and sharing, and innovation capacity.
- In order to avoid the problems of fragmented land holdings, farmers should be encouraged to join cooperatives or other social institutions through policy interventions for applying smart farming technologies in agriculture.
- A professional organization tentatively named: ***"Society for Smart Agriculture (SSA)"***, should be created with flexible Membership, to (a) enhance regional cooperation and integration in Smart Farming; (b) design and implement regional projects; and (c) collaborate and strengthen networking, including a sectoral Working Group on scientific and technological innovations in "Smart Agriculture for Developing Nations". The NAM Member States should participate actively at the highest level of decision-making, in pursuit of the work of the SSA, thus ensuring continuity.
- The NAM S&T Centre Member Countries should join together for establishing a ***"NAM S&T Centre of Excellence on Smart Agriculture"***, and also encourage individual Member States to set up national level centres or similar scientific institutions.
- Young people must be empowered and encouraged because of their immense potential to contribute in Smart Agriculture.

That this resolution be submitted to the Heads of State and Governments of NAM Member States and other Developing Countries for appropriate actions.

THUS, UNANIMOUSLY RESOLVED AND ADOPTED *VIRTUALLY* ON THIS DAY, THE 12th OF AUGUST 2021, AT PONT FER, PHOENIX, MAURITIUS.

Special Feature

THE FORMATION OF ACLENET: NAM S&T CENTRE'S INVOLVEMENT IN PREVENTING LIGHTNING INJURIES AND DEATHS

Mary Ann Cooper
Managing Director and President
African Centres for Lightning and Electromagnetics Network (ACLENet)
River Forest, IL 60305 USA
E-mail: macooper@uic.edu

and

Richard Tushemereirwe
Vice President
African Centres for Lightning and Electromagnetics Network (ACLENet)
E-mail: richadt2002@yahoo.com

Introduction

Lightning often causes death, injury and property damage, most commonly in tropical and subtropical areas where lightning stroke density and populations are high and where 'lightning safe' areas are not readily available.[1-13] The Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre) began addressing these issues over a decade ago and has offered continuing support since then, fostering the formation of an international organization focused on Africa to address the impacts of lightning – the African Centres for Lightning and Electromagnetics Network, Inc. (ACLENet).[1,2]

This paper will outline the involvement of the NAM S&T Centre in international lightning safety and injury prevention, the risks of lightning injury and what ACLENet, with NAM S&T's ongoing assistance, has been doing to decrease deaths, injuries and property damage from lightning across Africa.

The Risk of Lightning Injury

The factors that increase the risk of lightning injury are well known (Table I). People are at higher risk of lightning injury when they are involved in labor intensive work such as animal husbandry and farming, when they do not have access to 'lightning safe buildings for habitation, work or study', and when lightning stroke density (strokes per km^2 per year) where they reside is high.[1,2,13,14] Lightning stroke density is higher in tropical and subtropical areas of the world, precisely where people are less likely to have substantial, developed housing and where work is more often outdoors. [15]

These areas also tend to have no or less medical infrastructure such as medical centres, trained personnel, ambulance services, first aid and first responders.[16] Besides the high exposure and risk of lightning strike, victims also have less chance of recovery because of lack of specialized services to care for those who survive.

While lightning deaths in developed countries rarely involve more than one person and injuries to groups are few, deaths in developing countries often involve more than one person, sometimes with more than ten deaths and injuries per event.[12] Sometimes this is because people, particularly students, are packed together in classrooms, churches or walking with several others.[17] This leads some experts to hypothesize that ground current, responsible for at least 50% of deaths in developed countries, may play an even bigger role in these situations.[18]

Another factor that makes lightning injuries different in the developing world is the combination of Keraunoparalysis (KP) and dry thatch roofs.[1,2,16] Lightning injury often causes a temporary paralysis that lasts for at least several minutes. This is particularly a problem to families sleeping inside their mudbrick homes roofed by generations-old dry thatch. KP can prevent even the most fit young person from escaping a home as the burning thatch starts to fall. ACLENet has collected a number of newspaper reports from developing countries where neighbors have reported hearing their friends inside a building screaming as the burning thatch fell on them but were unable to rescue the inhabitants due to the heat of the fire.

NAM S&T Centre's Support

In 2007, the NAM S&T Centre sponsored the first lightning protection meeting in Colombo, Sri Lanka, organized by Chandima Gomes, PhD. Most of the points in the Colombo Declaration addressed protecting property from lightning damage. An outgrowth of the Colombo meeting was the Kathmandu meeting in 2011, hosted by Shri Ram Sharma, PhD, with assistance by Professor Gomes, where lightning injury mechanisms and lightning safety of individuals and populations were discussed in more detail. As a result of attending this meeting during which he discovered the large number of lightning deaths in his country that year, Richard Tushemereirwe of Uganda vowed to return to Uganda and begin a pan-African organization dedicated to decreasing deaths, injuries and property damage from lightning.[1,2]

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(Contd. from Page 10 - Special Feature)

Table – I: Factors that Affect the Risk of Lightning Injury and Death*

Factors that INCREASE Risk	Factors that DECREASE Risk
High lightning stroke density	Low lightning stroke density
Large rural population; inadequate building construction	Urbanization with high quality building construction involving wiring, plumbing and metal components in the walls and roof that will act as a 'Faraday cage' to safely divert lightning energy around inhabitants.
Labor intensive, outdoor work such as farming, fishing and animal husbandry	Mechanized farming and stricter laws governing work conditions
Lack of lightning safe areas for easy evacuation; lack of proven individual actions that individuals can take to decrease risk	Easy availability of lightning safe buildings and fully enclosed metal vehicles within easy reach. Widespread personal knowledge of lightning injury avoidance behavior.
Lack of reliable and timely weather forecasts or forecasts that are only available to specific sectors, primarily aviation, of the economy	Weather forecasti ng system with high quality forecasts available to the public on a free and real time basis
No or little lightning detection data or non-availability to the public	High quality lightning detection data incorporated into weather forecasts
Delayed or nonexistent access to high quality medical care	Easy access to high quality medical care
Low literacy rate	High literacy rate
Little or no valid public education on lightning safety; strongly held beliefs that injuries are inevitable, regardless of personal behavior, that lightning is called down by witches and other cultural reliance on myths	An active media; news reports of injuries; enthusiastic public education with access to lightning safety information; knowledge of how lightning is formed and where it is more likely to hit

(*) Modified from Cooper, Holle, Tushemereiwe Andrews 2018[2]

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(Contd. from Page 11 - Special Feature)

Table II : NAM S&T Centre's Lightning Meetings and Resolutions(**)

RESOLUTIONS	YEAR	LOCATION
Colombo Declaration	2007	Colombo, Sri Lanka
Kathmandu Resolution	2011	Kathmandu, Nepal
Resolution for Establishing ACLIR (later changed to ACLENet)	2013	Kampala, Uganda
1st ACLENet Scientific Symposium	2014	Entebbe, Uganda
2nd ACLENet Scientific Symposium and Resolution to Establish International Lightning Safety Day	2015	Lusaka, Zambia

(**) All Declarations available at https://aclenet.org/news-publications/publications/declarations.html

Within eighteen months of the Kathmandu meeting and with NAM S&T Centre's help, Mr Tushemereirwe successfully catalyzed a meeting in Uganda that resulted in the resolution to establish ACLIR, later renamed to ACLENet (African Centres for Lightning and Electromagnetics Network, Inc). Makerere University Business School agreed to host ACLENet and provided offices for the organization. With NAMS&T Centre's support again, ACLENet held its first scientific symposium in 2014 in Entebbe, Uganda, and a subsequent meeting in Lusaka, Zambia, where the first National Centre, ACLE-Zambia, was launched under the coordination of Ms Foster Chileshe Lubasi in 2015.[1,2]

The NAM S&T Centre's support allowed ACLENet to invite participants from many other countries, both in Africa and Asia, and provided a disciplined administrative structure. Some of the attendees already had active safety programs in their countries but returned home with fresh ideas and contacts for their programs in Malaysia, Nepal and Bangladesh so that NAM S&TCentre's support helped not only those in Africa but also those in Asia.

ACLENet

The African Centres for Lightning and Electromagnetics Network, Inc, is a pan-African network of national centres dedicated to decreasing deaths, injuries and property damage from lightning. Table III outlines a broad range of objectives and methods to pursue in accomplishing this mission.[1,2,13]

Discussion

The NAM S&T Centre has brought together people from around the world who are interested in lightning safety, which led to the formation of ACLENet. It has continued to catalyze conferences that help establish the sustainability of ACLENet. This support takes the form of financial support in bringing together delegates from countries across Africa and Asia plus tried and tested administrative structure.

It is fair to say that without NAM S&T Centre's support, ACLENet would not have formed. The people behind the formation and continuous running of ACLENet never would have had cause to meet without these NAM S&T Centre sponsored meetings.[1,2,13]

The NAM S&T Centre has continued to extend its support for opening of national centres. For example, the symposia that launched ACLE-Zambia was supported, to a substantial level, by the NAM S&T Centre.

Thoughts for the Future

ACLENet would like to continue its relationship with the NAM S&T Centre as it expands to other countries. As ACLENet moves along, four service products have emerged as distinct offerings in which ACLENet serves the African public to improve lightning safety;

1. **The African Flash** – a monthly online newsletter highlighting fatalities, injuries and property damage due to lightning and advisories on what could be done.[19] Data from these listings can be used by researchers and public health specialists to determine the size of the problem as well as where potential injury hotspots may be.
2. **Graduate Study** – a program that has passed through the approval process of the University of Zambia (UnZa) with help from Prof. Chandima Gomes. This is hoped to be the nucleus for building Africa's own expertise in Lightning Protection.[20]

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(Contd. from Page 12 - Special Feature)

3. **School Protection and Education Program** – ACLENet's program of fundraising worldwide to design and install LP at selected schools as an act of charity and to use as 'model schools' where ongoing educational lightning safety seminars are presented, starting with a celebratory session after installation for teachers, parents, students and district officials.[21]
4. **Symposia** – these were originally planned to be annual, but, for various reasons, we are entering the fourth year without holding one.

Table III : ACLENet's Multi-Faceted Goals

AREAS	PROGRAMS
Education	1. Conduct public education in lightning safety using such methods as: a. Newspaper inserts b. Television and radio specials and public service announcements c. Direct safety education at schools and other public venues 2. Work with teachers, government agencies, and others to promote lightning safety and improved building codes 3. Improve training and Continuous Professional Development courses for engineers, architects and others involved with designing and installing Lightning Protection (LP) and encourage certification in these areas 4. Encourage and mentor both undergraduate and graduate training in electrical and lightning areas at universities across Africa
Protection	1. Work with governments to adopt internationally recognized building and lightning protection (LP) codes and require their use for construction of public buildings and schools 2. Find funding for lightning protection of schools and other important public buildings 3. Work with LP experts to design low cost LP templates that can be applied to structures such as schools 4. Encourage construction supply companies to stock code compliant LP materials to avoid import fees
Research	1. Collect data on lightning deaths, injuries and property damage for each country 2. Investigate effective measures that individuals can use to decrease their chances of lightning injury 3. Use data from lightning detection companies to determine lightning stroke density and risk maps for each country in Africa
Warning	1. Improve forecasting and availability of weather data to all citizens 2. Encourage the development of smartphone apps for weather warnings 3. Develop and test systems for early warning of lightning danger
National Centres	1. Foster national centre development recognizing that each country will have its own challenges and concerns, talents and individual strengths, but will work together, just as pieces of a quilt to make a whole cover. 2. Organize regular symposia across Africa to bring together like-minded individuals and groups who are interested in public health and disaster management issues related specifically to Lightning Safety.

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(Contd. from Page 13 - Special Feature)

It is in the service product of annual symposia that ACLENet can continue to benefit from its partnership with NAM S&T Centre for mutual benefit. Whereas ACLENet has set itself to addressing the lightning hazard in Africa on various fronts, it needs the critical administrative support from NAM S&T Centre that was initially responsible for its formation.

Conclusions

The NAM S&T Centre's activities in developing countries are responsible for the birth of the African Centres for Lightning and Electromagnetics Network (ACLENet) and it has nurtured ACLENet in its infancy. The NAM S&T Centre's meetings have brought together people with similar concerns from many countries. Representatives from these countries have expressed interest in forming ACLE national centres in their countries.

It is hoped that the relationship between the NAM S&T Centre and ACLENet will continue as the Centre has a role to play in supporting ACLENet by organizing annual symposia for improving lightning safety and in bringing together people interested in preventing lightning injury, death and property damage.

Note: *ACLENet retains the copyrights of all Tables, Figures etc. included in this article.*

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Science, Technology & Innovation News

RESEARCH AND DEVELOPMENT

Solar-Powered Microbial Protein Production

Microbes have played a key role in our food and drinks, from cheese to beer, for millennia but their impact on our nutrition may soon become even more important. The world is facing growing food challenges as the human population continues to increase alongside its demand for resource intensive animal products. If these needs are to be met solely by conventional agriculture, the environmental cost will be huge. An international research team led by a Göttingen University alumnus has now shown that using solar-panels to produce microbial protein which is rich not just in proteins but also in other nutrients is more sustainable, efficient and environmentally friendly than growing conventional crops. This method uses solar energy, land, nutrients, and carbon dioxide from the air. Their research was published in *Proceedings of the National Academy of Sciences*. Using computer simulations drawing directly from laboratory results, the researchers modeled large-scale microbial food production facilities, which use solar energy, air, water, and nutrients to grow microbes. The protein-rich biomass is harvested and processed, and the resulting powder can be used as feed for animals, or as food for people. The study carried out an analysis of the energy requirements for each step, from the very start to the end product, taking into account: electricity generation (from solar panels), electrochemical production of energy-rich substrate for the microbes, microbe cultivation, harvesting, and processing the protein-rich biomass. Several types of microbes and growth strategies were compared in order to identify the most efficient. The study found that for each kilo of protein produced, solar-powered microbes require only 10% of the land area compared to even the most efficient plant crop -- soybean. The study calculated that even in northern climates with less sunshine, the yields of solar-powered microbial foods could far out produce staple crops, while minimizing water and fertilizer use. Importantly, this production could also be located in regions not suitable for agriculture, such as deserts. Integrating the cultivation of nutrient-rich microbes with renewable energy systems, such as solar panels, has the potential to produce more food with less resource. This could free up vast amounts of agricultural land, and, in addition, prevent the further destruction of natural ecosystems thereby making a valuable contribution to conservation and sustainability whilst promoting food availability globally.

July 30, 2021; www.sciencedaily.com

ENVIRONMENT AND CLIMATE CHANGE

Tiny Swimming Robots may help clean up a Micro-plastics mess

Micro-plastics are tiny bits of plastic, usually no wider than the top of a pencil eraser, and they're everywhere — from the bottom of the ocean to air blowing onto ice atop mountains. They've turned up in drinking water, both bottled and tap water. Some studies estimate that trillions of pieces of plastic end up in the world's waters. The plastic has many sources, from drinking straws and shopping bags to laundry and cleaning wipes. To tackle a big environmental problem, Chemist Martin Pumera at the Czech University have been working on a new miniature robot that has one purpose: To help clean up tiny bits of plastic polluting waterways across the globe. Each *microrobot* is no bigger than the tip of a sharpened pencil. They are magnetic and shaped like stars. When sunlight hits them, they produce chemical reactions that propel them through water in a specific direction. When they find a piece of plastic, they glom onto it and start to break it down. When the lights go out, they let go and are free to be used again.

The scientists reported that these robots can either break down a piece of micro-plastic or hold onto it to be collected later.

Pumera's ultimate goal is to make cheap and environmentally-friendly robots that can be used anywhere in the world. He suspects that at first they might be most useful in plants that treat wastewater. They can remove plastics before it reaches open water.

September 10, 2021; www.sciencenewsforstudents.org

Intensified Water Cycle Slows Down Global Warming

A new study led by scientists at the University of Miami (UM) Rosenstiel School of Marine and Atmospheric Science, in collaboration with scientists at Princeton University, shows that the intensification of global hydrological cycle drives more ocean heat uptake into the deep ocean and moderates the pace of global warming. As a result of a warming climate, the global water cycle becomes more intensified and as a result wet regions are getting wetter and dry regions are getting drier. The researchers found that this intensification is also reflected in ocean salinity. The increase in ocean surface salinity in salty regions, such as the subtropical oceans, leads to denser seawater and more heat uptake in to the deep ocean. The increase in the rate of ocean heat uptake would reduce the rate of surface warming. "We discovered a new mechanism that influences the rate of global warming through a suite of climate model experiments," said Maofeng Liu, a researcher at the UM Rosenstiel School, Department of Atmospheric Sciences. "The good match between climate model simulations and observations in the past few decades suggest that the salinity changes due to human-induced warming are likely working to enhance the ocean heat uptake."Global warming from emission of greenhouse gas into the atmosphere is increasing sea levels and resulting in more frequent and intense storms, drought, and wildfires. Predicting the rate of global warming is still a challenge," said Liu. This study found a new impact to the rate of global warming.

September 23, 2021; www.sciencedaily.com

Philippines gets its First 'Zero Waste' Island: GAIA

Apo Island became the first of the over 7,000 islands in the Philippines to go 'Zero Waste', according to the Global Alliance for Incinerator Alternatives (GAIA).

A popular tourist destination in the central part of the archipelago, the island village (*barangay*) of about 1,000 people had been struggling with waste management for years.

In 2020, the community, living off the tip of Negros Island, was introduced to effective waste management systems such as:

- Proper waste segregation at source
- Door-to-door segregated waste collection system
- Use of composting methods
- Establishment of a decentralized materials recovery facility (MRF), where organic wastes are composted and recyclables are aggregated for junk shop sale
- Waste assessment and brand audits to identify waste composition and design a suitable waste management system.

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(Contd. from Page 15 - STI News)

Information campaigns conducted under the War On Waste (WOW) Negros Oriental-Zero Waste Cities Project (ZWCP) by GAIA Asia Pacific and 10-member collaborators from India, Indonesia and the Philippines since 2020 enabled households to embrace more efficient waste management solutions. The small island, a famous scuba-diving spot, now has seven waste workers, four MRFs and an ordinance regulating single-use plastics in the island, according to the organisation. Residents of the island now rinse and dry out their plastic bottles, food cans and other recyclables before throwing them away. Local awareness and action is only a part of the solution as the island has to deal with plastics and other toxic waste depositing on its shore from surrounding landmasses. A zero-waste store, and zero-waste elementary and high schools have also been envisioned under the project. A livelihood project by WOW Negros Oriental makes use of discarded clothing to provide local women a means of income.

September 20, 2021; www.downtoearth.org.in

HEALTHCARE

WHO and UN Partners to create Compendium

WHO, UNDP, UNEP and UNICEF have partnered to create a new compendium of 500 actions aimed at reducing death and diseases driven by environmental risk factors, the first such resource to unite this expertise from across the UN system. The *Compendium of WHO and other UN guidance on health & environment* provides easy access to practical actions for practitioners to scale up efforts to create healthy environments that prevent disease. It is designed for policymakers, staff in government ministries, local government, in-country UN personnel and other decision makers. The repository presents actions and recommendations to address a comprehensive range of environmental risk factors to health, such as air pollution, unsafe water, sanitation, and hygiene, climate and ecosystem change, chemicals, radiation and occupational risks, among others. The compendium can also play an important role in achieving health equity, as low- and middle-income countries bear the greatest environmental burden in all types of diseases and injuries.

"Events like record-breaking high temperatures in North America, massive flooding in Europe and China, and devastating wildfire seasons provide increasingly frequent, grim reminders that countries need to step up action to eliminate the health impacts of environmental risk factors," said Dr. Maria Neira, Director, Department of Environment, Climate Change and Health, at WHO. Further, "Implementing the actions in the compendium should be part of a healthy and green recovery from the COVID pandemic and beyond, and is essential to attaining the Sustainable Development Goals. The UN is uniting its health and environment expertise to support countries in this endeavour."

"The Compendium can be used to engage in country dialogue on development priorities in line with the 2030 Agenda, and to direct resources accordingly for resilient, healthy, inclusive and sustainable development," said Dr Mandeep Dhaliwal, Director of the HIV, Health and Development Group at UNDP.

September 3, 2021; www.who.int

New CRISPR-Based Diagnostic Test to Detect COVID-19 Variants from Saliva Samples

With the Delta variant wreaking havoc on unvaccinated populations and COVID-19 cases spiking around the world, the pandemic is far from over. Despite the impressively fast development of SARS-CoV-2 diagnostic tests over the last year and a half, the vast majority of patient samples must still be sent to a lab for processing, which slows down the pace of COVID-19 case tracking. If a sample is to be tested for a specific variant of the virus, it must be genetically sequenced, which takes even more time and resources.

Now, researchers at the Wyss Institute for Biologically Inspired Engineering at Harvard University, the Massachusetts Institute of Technology (MIT), and several Boston-area hospitals have created an inexpensive, CRISPR-based diagnostic test that allows users to test themselves for SARS-CoV-2 and multiple variants of the virus using a sample of their saliva at home, with no extra instrumentation needed.

The diagnostic device, called Minimally Instrumented SHERLOCK (miSHERLOCK), is easy to use and provides results that can be read and verified by an accompanying smartphone app within one hour. It successfully distinguished between three different variants of SARS-CoV-2 in experiments, and can be rapidly reconfigured to detect additional variants like Delta. The device can be assembled using a 3D printer and commonly available components for about $15, and re-using the hardware brings the cost of individual assays down to $6 each.

miSHERLOCK eliminates the need to transport patient samples to a centralized testing location and greatly simplifies the sample preparation steps, giving patients and doctors a faster, more accurate picture of individual and community health, which is critical during an evolving pandemic."

"By combining cutting-edge biotechnology with low-cost materials, this team has created a powerful diagnostic device that can be manufactured and used on a local level by people without advanced medical degrees. It's a perfect example of the Wyss Institute's mission in action: to put life-changing innovations in the hands of people who need them," said Wyss Founding Director Don Ingber, M.D., Ph.D., who is also the *Judah Folkman Professor of Vascular Biology* at Harvard Medical School and Boston Children's Hospital, and Professor of Bioengineering at the Harvard John A. Paulson School of Engineering and Applied Sciences.

August 6, 2021; www.news-medical.net

Genetic Link between Blood Type and the Risk of Infection with SARS-CoV-2

A study of more than 45,000 people with COVID-19 has uncovered 13 genetic variants linked to an increased risk of infection with SARS-CoV-2 or a higher chance of developing severe illness, researchers report July 8 in *Nature*. The team includes more than 3,300 researchers in 25 countries. Researchers again confirmed a genetic link between blood type and the likelihood of getting infected, but don't know why people with type O blood may be slightly protected. The study also verified that a variant that disables the *TYK2* gene raises the risk of critical illness and hospitalization. That variant is known to protect against autoimmune disease, but leaves people more vulnerable to tuberculosis. An unknown association, a variant in a gene called *FOXP4* is associated with more severe COVID-19, the team found. That variant boosts the gene's activity and has been previously linked to lung cancer and interstitial lung disease, a group of diseases that cause scarring and stiffness of the lungs. Yet-to-be-developed drugs that inhibit activity of *FOXP4*'s protein might help people recover from COVID-19 or prevent them from becoming very ill.

July 8, 2021; www.sciencenews.org

FOOD SECURITY AND SUSTAINABLE AGRICULTURE

Global Agri-Food System needs to transform to reach SDGs by 2030

Additional efforts in the agricultural and food sector are urgently needed in order to meet global food security and environmental targets, according to a new report released by the UN Food and Agricultural Organization (FAO) and the Organisation for Economic Co-operation and

(Contd. on Page 17)

(Contd. from Page 16 - STI News)

Development (OECD). Although progress towards the UN Sustainable Development Goals (SDGs) is expected to be made in the coming decade, the past year of disruptions from COVID-19 has moved the world further away from achieving these goals, especially the Zero Hunger goal (SDG2), according to the "OECD-FAO Agricultural Outlook 2021-2030". OECD Secretary-General Mathias Cormann and FAO Director-General QU Dongyu warned "Without additional efforts, the Zero Hunger goal will be missed and greenhouse gas emissions from agriculture will increase further. We must all work together to transform the way the world produces, consumes and thinks about food. An agri-food systems transformation is urgently needed."

The Outlook is published by the two organisations each year and presents production, consumption, trade and price trends for the main farm and fisheries products at regional, national and global levels for the coming decade. The Global Domestic Product (GDP) in 2030 is projected to remain below pre-pandemic projections. The effects of income losses and inflation in consumer food prices have already made access to healthy diets more difficult for many people.

The authors write that "health and environmental concerns, together with animal welfare and ethical considerations regarding eating animals are also leading to an increase in the number of vegetarian, vegan or 'flexitarian' lifestyles in high-income countries, and in particular among young consumers." Fruits and vegetables would continue to provide only 7% of the available calories by 2030. The authors point out that additional efforts are needed to increase this share so that a net intake of 400g of fruits and vegetables per person a day is possible for everyone in line with the World Health Organisation's recommendations. In order to achieve this aim, food loss and waste that is particularly high for these perishable products, also need to be reduced.

The Outlook also highlights the significant contribution of agriculture to climate change. Global greenhouse gas emissions from agriculture are projected to increase by 4% over the next ten years, mostly due to expanding livestock production which accounts for more than 80% of this increase. Thus, additional policy effort will be needed for the agricultural sector to effectively contribute to the global reduction in greenhouse gas emissions as set in the Paris Agreement, the authors find.

July 5, 2021; www.globalagriculture.org

Blue Foods have Potential to Become More Sustainable

Aquatic or blue foods can be made more environmentally sustainable according to a recently released paper titled *Environmental performance of blue foods* which was one of five initial scientific papers published as part of the Blue Food Assessment (BFA). The paper noted that seaweeds and farmed bivalves, such as mussels and oysters, generated the fewest greenhouse gas and nutrient emissions and used the least land and water. The paper added that greenhouse gas emissions in capture fisheries ranged from relatively low, such as for sardines and cod, to relatively high for flatfish and lobsters, compared to farmed fish. These fisheries have the potential to reduce greenhouse gas emissions through improved management and optimising gear type. Many sub-sectors among blue foods such as carp and milkfish also had the potential to improve their environmental performance through improved farm management, reduced feed conversion ratios and innovative technological interventions. The research fills the gap in previous studies on the environmental stresses associated with food production, which often excluded blue foods.

September 24, 2021; www.downtoearth.org

GLOBAL INNOVATION INDEX 2021

Mauritius ranks first in Africa in Global Innovation Index 2021

Mauritius emerged the most innovative African country in a recent ranking. The island nation placed 52nd among 132 countries globally. Mauritius, unlike most African countries, has a high human development score. Its economy has grown robustly in the last half a century, especially on financial services, tourism and information technology. It was followed by South Africa (61), Tunisia (71) and Kenya (85) in terms of innovation, according to the 15th edition of the Global Innovation Index (GII 2021) released September 21, 2021. The GII 2021 was published by World Intellectual Property Organisation (WIPO) in partnership with the Portulans Institute, an independent non-profit, non-partisan research and educational institute based in Washington, DC.

Kenya and Tanzania are among developing economies that have performed above expectations on innovation relative to their economic development, the index showed. They have retained their position in the top 100 and improved their performance over time. Rwanda (102) regained the first position in the low-income group after ranking second in 2020. It ranked 1st in 2015, 2016 and 2019 and has been consistently in the top three of its income group since 2014. As many as nine other economies in Africa moved up the GII ranks since 2020: Kenya (85), Cape Verde (89), Egypt (94), Namibia (100), Malawi (107), Madagascar (110), Zimbabwe (113), Burkina Faso (115) and Algeria (120). Cape Verde improved its rank considerably from 103 in 2013, the authors of the report noted.

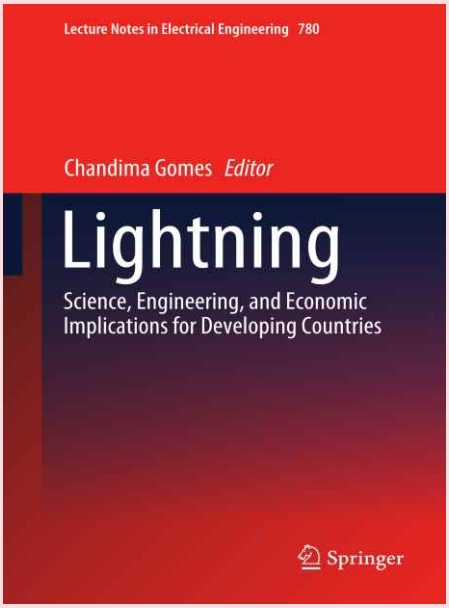
The GII ranking is based on performance across seven pillars:

i. Institutions
ii. Human capital and research
iii. Infrastructure
iv. Market sophistication
v. Business sophistication'
vi. Knowledge and technology outputs
vii. Creative outputs

The sub-Saharan Africa region performed the best in the 'institutions' category. This is based on the political, regulatory and business environment for strengthening institutions. Mauritius ranked the highest in the region in the following categories: Institutions (rank 21), infrastructure (65) and creative outputs (31). Namibia came first in 'human capital and research' (57) and South Africa in 'market sophistication' (23), 'business sophistication' (51) as well as 'knowledge and technology outputs' (61). Mauritius also fared well in various categories globally. It stood 21st in 'institutions' and 31 in 'creative outputs'. It needs to work towards improving its performance under 'business sophistication' (111) and 'knowledge and technology outputs' (93). Angola in Africa ranked lowest in the global ranking.

September 22, 2021; www.downtoearth.org.in

New Publication



Lightning

Science, Engineering, and Economic Implications for Developing Countries

Lightning and thunderstorms are of concern for the human beings for many centuries. Even today, many communities and tribes believe that lightning is a God itself or it is a weapon hurled by the divine powers. As people started analysing lightning as a physical phenomenon around 300 years back, the attention was mainly on understanding the nature of lightning and the ways of avoiding the lightning strikes that damages properties and causes loss of life. With time, this focus was shifted to safeguarding of human beings and livestock, protecting power lines that stretch over hundreds of kilometres over highly exposed land, protection of defence systems and electronics & communication system.

NAM S&T Centre has reached another milestone by publishing its first Scientific Monograph titled Lightning—"Science, Engineering and Economic Implications for Developing Countries". The book comprises a logically organized sequence of 11 chapters that are, at the same time, self-contained and can, therefore, also be read separately. It starts with three fundamental and general chapters describing the physics of lightning, basic approaches for lightning detection and warning systems, and risk assessment, making the book also very accessible to the technical non-expert. The ensuing chapters are focused on the protection of different types of systems and infrastructure, with special attention to the protection of renewable energy systems. The final chapters are concerned with economic, human and technical aspects of lightning protection, with a strong emphasis on developing countries.

This book would be a valuable reference material for the scientists, researchers and other professionals working in the area of "Lightning" and other relevant fields.

Foreword: *Farhad Rachidi (Switzerland)*

Preface: *Chandima Gomes (South Africa)*

Introduction: *Amitava Bandopadhyay (India)*

1. **Lightning, the Science -** Vladimir A. Rakov
2. **Lightning Detection and Warning -** *Anirban Guha, Yakun Liu, Earle Williams, Carina Schumann, and Hugh Hunt*
3. **Risk Assessment for Lightning Protection -** *Alain Rousseau*
4. **Protection of Buildings and Structures -** *Alexis Barwise*
5. **Protection of Low-Voltage Equipment and Systems -** *Hélio Eiji Sueta, Sergio Roberto Santos, and Ruy Alberto C. Altafim*
6. **Lightning Protection of High-Risk Installations: Petrochemical Plants -** *Arturo Galván Diego*
7. **Protection of Selected Cases: PV Systems, Wind Turbines and Railway Systems -** *Michael Rock*
8. **Lightning Injury: Occurrence and Medical Treatment -** *Ronald L. Holle, Mary Ann Cooper, and Norberto Navarrete-Aldana*
9. **Lightning: Public Concepts and Safety Education -** *Chandima Gomes and Ashen Gomes*
10. **Economic, Technical and Human Implications of Lightning Protection -** *Chandima Gomes and Ashen Gomes*
11. **Frontiers in Lightning Research and Opportunities for Scientists from Developing Countries -** *Adonis F. R. Leal*

DISTINGUISHED VISITORS TO THE CENTRE

H.E. Mariana P. Montes, Ambassador (4th From L) and Ms. Angelica Patino, Second Secretary of Consular Affair (3rd From L) of the Embassy of Colombia in India, New Delhi.

Dr. C. S. Azad, General Secretary, Society of Energy Engineers and Managers (SEEM), Ghaziabad, India

Meetings and Visits of Director General, NAM S&T Centre

Visit to JSS Academy of Higher Education & Research (JSS AHER), Mysuru

Dr. Amitava Bandopadhyay, Director General visited the JSS Academy of Higher Education & Research (JSS AHER), Mysuru during August 16-17, 2021 for a meeting with Prof. B. Suresh, Pro-Chancellor; Dr. Surinder Singh, Vice Chancellor; Dr. C. G. Betsurmath, Executive Secretary, JSS Mahavidyapeetha and other senior officials from the JSS Academy.

JSS Group of educational institutions is spearheading the league of private universities in India. NAM S&T Centre highly appreciates the core values of JSS AHER meeting the highest standards of professionalism to achieve excellence in academic and research activities in science, technology and innovation, and supporting health and environment, thus benefiting the society. Fostering a student-centric environment for professional excellence is in legacy and sustaining principles of JSS Academy.

In the past, the NAM S&T Centre had implemented Joint Scientific events with JSS Academy, Mysuru including the organisation of a Joint *International Training Workshop on* ***'Herbal Medicine: Drug Discovery from Herbs - Approaches, Innovations and Applications'***, during 30th March to 3rd April 2015 at Mysore and Ooty. 31 scientists and experts from 24 NAM and other developing countries participated while 83 Indian scientists attended the Workshop. A large number of papers were presented by the foreign and Indian participants including 39 poster presentations made by young scientists and researchers.

A book published by the NAM S&T Centre titled ***"Drug Discovery from Herbs – Approaches and Applications"***, was edited by Prof. Suresh along with Dr. Tijen Talas-Ogras from Turkey, Dr. Shamiem Adam from South Africa and Dr. SubbaRao V. Madhunapantula from JSS Academy. Dr. SubbaRao has also recently edited our second book on a similar subject titled ***"Drug Development from Natural Sources: Scope and Challenges"***.

Further, three researchers, one each from - Côte d'Ivoire, Rwanda and Uganda were hosted by JSS College of Pharmacy, Mysore and Ooty under NAM S&T Centre's *Research Training Fellowship for Developing Country Scientists (RTF-DCS)* Programme. All the three researchers successfully completed their research projects under the guidance of JSS faculty members.

In view of the long past association of the NAM S&T Centre with the JSS Academy, Dr. Bandopadhyay's visit has opened up new possibilities of S&T collaboration between the JSS Academy and the NAM S&T Centre. Based on the discussion, both institutions decided to re-establish and expand their collaborative relationship on the basis of previously built contacts and mutual understanding.

Recognising the common interest and importance of strengthening cooperation between the two institutions with the purpose of scientific and technological collaboration, exchange of expertise, and dissemination of S&T knowledge and information, it has been proposed to sign a *Memorandum of Understanding (MoU)* in the near future. The objective of the MoU is to establish the basis for an organizational arrangement in order to encourage engagement in the broad fields of academic, science and technology, especially to take up joint scientific activities including organization of International Workshops, Training Workshops and Training Programmes in areas of common interest; providing fellowship opportunities to the scientists and researchers from the developing countries for working in the laboratories of JSS AHER or its designated Institutions/Centres in the fields of Science and Technology including Medical Sciences; and bringing out scientific publications from time to time through mutual assistance and cooperation. Accordingly, a draft MoU is under preparation and the same will be shared with JSS Academy for their consideration.

During the visit, Dr. Bandopadhyay had presented a copy of the *30th Anniversary Compendium* of the NAM S&T Centre and a copy of a recent scientific book titled *"Air Pollution and Public Health : Challenges, Interventions and Sustainable Solutions"* to Prof. B. Suresh.

Dr. Bandopadhyay also had the opportunity to pay a visit to His Holiness Swamiji, the Chancellor of the JSS AHER.

Centre Announces

International Workshop on "Technology Transfer and Commercialization"

December 7-8, 2021
[In Virtual-Mode]

In recent years, there is a great emphasis on transferring inventions and technologies originating from non-profit research institutes such as universities and state owned research centers to industry through technology transfer/licensing or commercialization. The main objectives of this technology commercialization include leveraging R&D outcomes and intellectual assets, raise the accessibility of scientific outcomes to a broad range of consumers, development of new services and products ready for commercialization, and last but not the least, to intensify industrial competition.

The transfer literally can originate either due to technology push (through research) or market pull (through industry). However, in order to create socially useful innovation, the collaborative actors - involving academia or researchers, industry and policy makers must formulate and implement coherent and feasible technology transfer/ commercialization strategies. A critical issue addressed to strategy development is how governments, especially from emerging economies, can make effective technological promotion policies, specifically by providing incentives, patent protection and ownership or engaging the profit-oriented private sectors.

In order to discuss the underlined issues regarding technology transfer and commercialization in developing countries, the **National Research and Innovation Agency** of the Republic of Indonesia, Jakarta will host a **two-day International Workshop** on "***Technology Transfer and Commercialization***" during **7-8 December 2021** jointly with the **Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre)**, New Delhi, India in order to enable Scientists & Researchers, Industrialists, Technology Providers, Technology Consultants, Project-planners, Government officials, Policy makers and other stakeholders from industry and non-government organizations from NAM S&T Centre Member Countries and other developing countries to share, learn, collect, analyze and study best practices on how to encourage and reinforce technology transfer/commercialization processes in order to accomplish technological enhancement and upgradation through policy development.

The Workshop will be conducted virtually from Jakarta, Indonesia.

The last date for submission of application is November 23, 2021.

International Training Workshop on "Industry 4.0 and Energy Management"

January 19-20, 2022
[In Virtual-Mode]

The global manufacturing sector has witnessed various industrial revolutions. Currently in the fourth industrial revolution phase, high technological production strategies blended with intelligent decision support system, take the sector to newer heights of productivity.

The principle of Industry 4.0, unlike the traditionally hierarchical and centralized manufacturing system, exhibits a decentralized architecture in which autonomous industrial components connect with one another. These autonomous components interact among themselves with a connected Decision Support System (DSS) to self-diagnose and self-respond in the overall manufacturing scenario. The technologies that are incorporated for the decision-making are the Internet of Things (IoT), Cloud Computing, and Big Data. The overall framework of these technologies is connected under a common platform called Cyber Physical System (CPS). CPS is a backbone of Industry 4.0, where the physical world and virtual space are linked for a live communication environment in the shop floor. CPS provides a live digital copy of industrial assets and processes. The robust analytical decision-making system utilizes the real data captured from the various sensor devices attached to industrial physical environment. In the near future, inequalities between the economic developments of industrialized; emerging economies and developing countries could further deepen, if all countries cannot tap into the benefits of digital development.

Energy availability, reliability and manageability are essential ingredients of energy-critical buildings and manufacturing processes in the scope of Industry 4.0. This is driven by a mix of environmental factors, cost challenges, regulations, proactive energy consumption capabilities and the integration of alternative sources of energy in the energy mix. Industry 4.0 requires innovative technological solutions capable of limiting energy waste and providing real-time control over consumption. In short, without energy management, there is no Industry 4.0.

Keeping in view of the growing significance of Industry 4.0, to deliberate upon the role of energy management in Industry 4.0, and to impart skills and knowledge on the principles and practices of energy management for emerging manufacturing processes in future, the **Centre for Science & Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre)**, jointly with the **Society of Energy Engineers and Managers (SEEM), India** is organizing a two days International Training Workshop on '***Industry 4.0 and Energy Management***' during **January 19-20, 2022**. The Workshop will be held in **Virtual Mode**.

The Training Workshop intends to provide basic knowledge on the subject through interactive lectures about various aspects of the Industry 4.0 framework and explore the disruptive management practices of Industry 4.0 with various opportunities and challenges of the energy management in Industry 4.0 era.

Experts and scientists desirous of participating in the Workshop, **excepting those from INDIA,** may submit their filled-in application form **electronically** directly to the NAM S&T Centre (namstcentre@gmail.com) as early as possible, latest by **Wednesday, 5th January, 2022.**

Applicants from India should, however, submit their requests directly to the SEEM, India.

For further details, please contact the NAM S&T Centre (Email: namstcentre@gmail.com) or visit our Website: www.namstct.org

Editor: Dr. Kavita Mehra ❖ **Editorial Adviser:** Mr. Madhusudan Bandyopadhyay ❖ **Associate Editor:** Ms. Rhaeva Bhargava
Contributors: Ms. Jasmeet Kaur and Ms. Nidhi Utreja ❖ **Compilation & Design:** Mr. Pankaj Buttan
Published By: Dr. Amitava Bandopadhyay, Director General, Centre for Science & Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), Core 6A, 2nd Floor, India Habitat Centre, Lodhi Road, New Delhi-110003 (India)
Phone: +91-11-24645134, 24644974 ❖ **Fax:** +91-11-24644973 ❖ **E-mail:** namstcentre@gmail.com ❖ **Website:** http://www.namstct.org
Lovely Printers, New Delhi, E-mail: lovelyprintersindia@gmail.com; Ph: 9811086866.