7TH ANNUAL SOUTH ASIA BIOSAFETY CONFERENCE

September 14 – 16, 2019 | The Westin, Dhaka, Bangladesh

SOUTH ASIA
BIOSAFETY PROGRAM

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ORGANIZED BY

The South Asia Biosafety Program

ILSI Research Foundation

Biotech Consortium India Limited

WITH SUPPORT FROM

Bangladesh Academy of Sciences (BAS)

Bangladesh Agricultural Research Council (BARC)

Bhutan Agriculture and Food Regulatory Authority (BAFRA)

Institute for International Crop Improvement - Donald Danforth Plant Science Center

International Maize and Wheat Improvement Center (CIMMYT)

International Society for Biosafety Research (ISBR)

National Academy of Agricultural Sciences (NAAS), India

United States Agency for International Development (USAID)

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Supported by the United States Agency for International Development and managed by the ILSI Research Foundation, the South Asia Biosafety Program works to assist South Asian countries to further strengthen institutional governance of biotechnology by providing technical assistance to the biosafety risk assessment and research communities.

For more information about the South Asia Biosafety Program or about this publication, please contact:

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acknowledge USAID for its continued support.

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AGENDA OF THE PLENARY SESSIONS

Saturday, 14 September 2019

Time	*Session/Actvity*
08:00-09:00	Registration
09:00-10:30	**Inaugural Session**
09:00-09:05	**Welcome Address** *Dr. Vibha Ahuja* Chief General Manager, Biotech Consortium India Limited and Senior Advisor, South Asia Biosafety Program, India
09:05-09:15	**14 Years of the South Asia Biosafety Program** *Dr. Aparna Islam* Country Manager, South Asia Biosafety Program, Bangladesh
09:15-09:30	**Remarks by Guest of Honor** *Dr. Rob Bertram* Chief Scientist, Bureau for Food Security, United States Agency for International Development (USAID), United States
09:30-09:45	**Remarks by Special Guest** *Mr. Md. Nasiruzzaman* Respected Secretary, Ministry of Agriculture, Government of the People's Republic of Bangladesh
09:45-10:00	**Remarks by Special Guest** *Mr. Abdullah Al Mohsin Chowdhury* Respected Secretary, Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh
10:00-10:25	**Remarks by the Chief Guest** *Dr. Muhammad Abdur Razzaque MP* Honorable Minister, Ministry of Agriculture, Government of the People's Republic of Bangladesh

Time	*Session/Actvity*
10:25-10:30	**Vote of Thanks** *Dr. Andrew Roberts* Deputy Executive Director, ILSI Research Foundation, United States
10:30-11:00	Tea Break
11:00-13:30	**Plenary Session I: Biosafety Regulation in South Asia** *Chair: Dr. A.K.M. Rafique Ahammed, Department of Environment, Bangladesh* *Co-chair: Mr. Alex Owusu-Biney, United Nations Environment Programme, Kenya*
11:00-11:05	**Introduction**
11:05-11:25	**Update on Biosafety Regulation in Bangladesh** *Mr. Mohammed Solaiman Haider* Department of Environment, Bangladesh
11:25-11:45	**Biosafety Regulation in Bhutan** *Mr. Namgyal* Bhutan Agriculture and Food Regulatory Authority, Bhutan
11:45-12:05	**Current Status of GE Plant Risk Assessment and Regulation in India** *Mr. Tarun Kathula* Ministry of Environment, Forest and Climate Change, India
12:05-12:25	**Pakistan Biosafety Regulatory System** *Ms. Parveen Ejaz* Ministry of Climate Change, Pakistan
12:25-12:45	**Present Status of Biosafety Regulations in Sri Lanka** *Dr. D.M.J.B. Senanayake* Ministry of Mahaweli Development and Environment, Sri Lanka
12:45-13:15	**Guest Country: Nigerian Biosafety Regulatory System and Its Approach to Risk Assessment and Decision Making** *Dr. Rufus Ebegba Eseoghene* National Biosafety Management Agency, Nigeria
13:15-13:30	**Session Q&A**
13:30-14:30	Lunch
14:30-16:00	**Plenary Session II: Building a Community of Biosafety Practitioners** *Chair: Dr. Md. Kabir Ikramul Haque, Bangladesh Agricultural Research Council, Bangladesh* *Co-Chair: Prof. Dr. Yearul Kabir, Bangladesh Academy of Sciences, Bangladesh*
14:30-14:35	**Introduction**
14:35-15:00	**Keynote Presentation: Fostering Agricultural Innovation in Bangladesh** *Dr. Rob Bertram* United States Agency for International Development, United States

Time	*Session/Actvity*
15:00-15:15	**Introduction to SABP's Biosafety Research in Bangladesh Grants Program** *Dr. Andrew Roberts* ILSI Research Foundation, United States
15:15-15:25	**Vegetable Pest Management Practices in Bangladesh and Their Impacts on the Environment** *Prof. Dr. Md. Shahidul Haque* Bangladesh Agricultural University, Bangladesh
15:25-15:35	**Assessment of Weed Management Practices in Rice Cultivation in Bangladesh** *Dr. Abdun Noor Muhammad Iftekhar Alam* National Institute of Biotechnology, Bangladesh
15:35-15:45	**Use and Handling Practices of Agrochemicals Used in the Cultivation of High Yielding Potato Varieties in Bangladesh** *Dr. Mohammad Zabed Hossain* University of Dhaka, Bangladesh
15:45-16:00	**Session Q&A**
16:00-16:30	Tea Break
16:30-17:30	**Lightning Round for Students and Early Career Researchers** *Chair: Dr. Andrew Roberts, ILSI Research Foundation, United States*
16:30-16:35	**Introduction**
16:35-16:40	**A Preliminary Survey on Sri Lankans' Knowledge and Understanding of Biosafety and GMOs** *Ms. Mihiri Kandanaarachchi* Food and Agriculture Organization of the United Nations, Sri Lanka
16:40-16:45	**DNA Barcoding and Characterization of Non-Edible Oil Feedstock with Potential for Biodiesel Production in Bangladesh** *Ms. Farhana Haque Nimme* University of Sciences and Technology, Bangladesh
16:45-16:50	**Strigolactones Positively Regulate Defense Mechanisms to Enhance Resistance Against Sheath Blight of Rice (*Oryza sativa*)** *Dr. Mohammad Mostofa* Bangabandhu Sheikh Mujibur Rahman Agricultural University, Banlgadesh
16:50-16:55	**Metagenomics and Phylogenetic Studies for Identification of *Enterococcus spp.* Causing Streptococcosis in Tilapia (*Oreochromis niloticus*)** *Ms. Tasmina Akter* Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh
16:55-17:00	***In vitro* Regeneration and *Agrobacterium*-mediated Genetic Transformation of Local Varieties of Mungbean (*Vigna radiata* (L). Wilczek)** *Mr. Sujay Bhajan* University of Dhaka, Bangladesh

Time	*Session/Actvity*
17:00-17:05	**Genetic Transformation Aimed at Overexpressing Glyoxalase III has Enhanced Salinity Stress Tolerance in Sugarcane** *Mr. V.M. Manoj* ICAR-Sugarcane Breeding Institute, India
17:05-17:10	**Are Root Characteristics/Architectural Traits of Rice Plants a Better Indicator of Salt Tolerance?** *Mr. Mohammad Umer Sharif Shohan* University of Dhaka, Bangladesh
17:10-17:15	**Towards Development of β-ODAP-free Grasspea (*Lathyrus sativus* L.)** *Dr. Neetu Singh* ICAR-Indian Institute of Pulses Research, India
17:15-17:20	**Spatio-temporal Expression of Cry1Ac Protein in Bt Eggplant Varieties and Susceptibility of Brinjal Fruit and Shoot Borer to Cry1Ac Protein** *Mr. Saiful Islam* Bangladesh Agricultural Research Institute, Bangladesh
17:20-17:25	**Success of Wide Hybridization on the Genetic Improvement of Indica Rice** *Dr. Md. Nashir Uddin* North South University, Bangladesh
17:25-17:30	**Morphological and Molecular Diversity Among the *Pyricularia oryzae* Cavara Isolates Causing Wheat Blast in Bangladesh** *Mr. Abdullah Al Noman* University of Dhaka, Bangladesh
17:30-18:30	**Poster Session**

Sunday, 15 September 2019

09:00-11:00	**Plenary Session III: Rationalizing Risk Assessment and Regulation of Low Risk Activities** *Chair: Dr. Janet Gorst, Food Standards Australia New Zealand, Australia (retired)* *Co-chair: Dr. Lalitha Gowda, Central Food Technological Research Institute, India (retired)*
09:00-09:05	**Introduction**
09:05-09:35	**Keynote Presentation: Understanding the Concept of Proportionality – Low Risk Activities and the Future of Biosafety Regulation** *Dr. Andrew Roberts* ILSI Research Foundation, United States
09:35-09:55	**Gene-edited Crops – Need for Rationalized and Proportionate Risk Assessment and Regulation** *Dr. Ramaiah Valasubramanian* Corteva Agriscience, India
09:55-10:15	**Efficient Resistance to BmNPV Infection by Transgenic Silkworm (*Bombyx mori*), as Demonstrated by Multilocational Contained Trials** *Dr. P.J. Raju* Andhra Pradesh State Sericulture Research and Development Institute, India

Time	*Session/Actvity*
10:15-10:35	**Biosafety Analysis of GE Crops – Our Experience with Mustard** *Prof. Deepak Pental* University of Delhi South Campus, India
10:35-11:00	**Session Q&A**
11:00-11:30	Tea Break
11:30-13:30	**Plenary Session IV: Biotechnology Research and Development in South Asia** *Chair: Dr. Zeba Seraj, University of Dhaka, Bangladesh* *Co-chair: Prof. Ranil Dassanayake, University of Colombo, Sri Lanka*
11:30-11:35	**Introduction**
11:35-11:55	**Development of a Novel Salt-Tolerant Transgenic Indica Rice Plant Through Manipulation of the Inositol Metabolic Pathway** *Prof. Arunendra Nath Lahiri Mazumder* Bose Institute, India
11:55-12:15	**Transforming a Local Rice Variety Using HVA-1 Promoter to Demonstrate Over-Expression of *OsDREB2A* Gene Under Drought and Salinity Stress: A Laboratory Experience in Accommodating Transgenic Research in Sri Lanka** *Ms. Vajirapani De Silva* GENETECH Molecular Diagnostics, Sri Lanka
12:15-12:35	**Improvement of Grain Legumes through Biotechnology** *Dr. Rakha Hari Sarker* University of Dhaka, Bangladesh
12:35-12:55	***Colocasia esculenta* Tuber Agglutinin, a Newly Characterised Non-allergenic Protein Provides Resistance to Indian Mustard Against Most Devastating Sucking Insect, Mustard Aphid** *Prof. Sampa Das* Bose Institute, India
12:55-13:15	**Okra Cultivation in Bangladesh: Major Challenges and Opportunities** *Dr. Md. Anowar Hossain* University of Rajshahi, Bangladesh
13:15-13:30	**Session Q&A**
13:30-14:30	Lunch
14:30-18:00	**Parallel Workshops**

Monday, 16 September 2019

09:00-11:10	**Plenary Session V: Planning and Permitting Field Trials for Novel Organisms** *Chair: Dr. Abul Kalam Azad, Bangladesh Agricultural Research Institute, Bangladesh* *Co-chair: Dr. Donald MacKenzie, Donald Danforth Plant Science Center, United States*
09:00-09:05	**Introduction**

Time	*Session/Actvity*
09:05-09:35	**Target Malaria's Field Entomology Preparedness for the First Releases of GM Malaria Mosquitoes in Africa** *Dr. Frederic Tripet* Keele University, United Kingdom
09:35-09:55	**Comparative Fitness Assessment of RNA Interference-Based Transgenic *Aedes aegypti* Resistant to Dengue Virus Transmission in a Contained Facility in Sri Lanka** *Prof. Ranil Dassanayake* University of Colombo, Sri Lanka
09:55-10:15	**Achievements in Genetic Transformation of a Tree Crop and Obstacles for Field Trial: The Case of Natural Rubber (*Hevea brasiliensis*) from India** *Dr. James Jacob* Rubber Board - Ministry of Commerce & Industry, India
10:15-10:35	**Planning Field Trial of Transgenic *Artemisia annua* L.: A Source of a Novel Antimalarial Drug** *Prof. Malik Zainul Abdin* Jamia Hamdard University, India
10:35-10:55	**Social Mobilization Strategy Towards Positive Regulatory Outcome of the Golden Rice Field Trial Application in the Philippines** *Dr. Ronan Zagado* Philippine Rice Research Institute, Philippines
10:55-11:15	**Session Q&A**
11:15-11:45	Tea Break
11:45-13:10	**Plenary Session VI: Sharing Outcomes from Workshops** *Chair: Dr. Vibha Ahuja, Biotech Consortium India Limited, India* *Co-chair: Dr. Aparna Islam, South Asia Biosafety Program, Bangladesh*
11:45-11:50	**Introduction**
11:50-12:05	**Workshop I: Managing Fall Army Worm in South Asia** *Dr. Timothy J. Krupnik* International Maize and Wheat Improvement Center, Bangladesh
12:05-12:20	**Workshop II: Gene Editing and Regulation** *Dr. Md. Tofazzal Islam* Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh
12:20-12:35	**Workshop III: GE Food Safety Assessment - Mutual Acceptance of Data** *Dr. Lalitha Gowda* Central Food Technological Research Institute, India (retired)
12:35-12:55	**Special Presentation: Outcomes from the SAARC Regional Expert Consultation Meeting on the Progress and Prospects of Agricultural Biotechnology and Biosafety in South Asia** *Dr. Md. Abdullah Yousuf Akhond* Bangladesh Agricultural Research Institute, Bangladesh
12:55-13:10	**Session Q&A**

Time	*Session/Actvity*
13:10-14:00	Lunch
14:00-16:10	**Plenary Session VII: Public Sector GE Crop Development and Deployment** *Chair: Prof. Deepak Pental, University of Delhi South Campus, New Delhi, India* *Co-chair: Dr. Karen Hokansan, University of Minnesota, United States*
14:00-14:05	**Introduction**
14:05-14:35	**Keynote Presentation: Impacts of Bt Brinjal (Eggplant) Technology in Bangladesh** *Dr. Akhter Ahmed* International Food Policy Research Institute, Bangladesh
14:35-14:55	**Genetically Engineered Crop Development and Deployment in Africa: The Case of Pod Borer Resistant (PBR) Cowpea** *Mr. Francis Nwankwo Onyekachi* African Agricultural Technology Foundation, Nigeria
14:55-15:15	**Role of the Public Sector in Transgenic Research** *Dr. K.B.R.S. Visarada* Indian Institute of Millets Research, India
15:15-15:35	**Development of Cassava Brown Streak Disease Resistant Cassava Event 4046** *Dr. Donald MacKenzie* Donald Danforth Plant Science Center, United States
15:35-15:50	**Bringing Bt Eggplant to Resource-Poor Vegetable Farmers in Bangladesh and the Philippines** *Dr. Tony Shelton* Cornell University, United States
15:50-16:10	**Session Q&A**
16:10-16:30	**Closing Session** **Poster Awards** **Lightning Round Awards** **Summary Remarks**

AGENDA

PARALLEL WORKSHOP I:
MANAGING FALL ARMY WORM IN SOUTH ASIA

Organizers

Timothy J. Krupnik, Ph.D. and Dan McGrath, Ph.D.
International Maize and Wheat Improvement Center (CIMMYT), Email: t.krupnik@cgiar.org

Overview

This interactive portion of the workshop will familiarize participants with Fall Armyworm (FAW), an invasive Lepidopteran pest that was introduced to India in 2018 and that has since rapidly spread across the Asian continent. FAW feeds on over 80 species of plants but prefers maize as a host. There remains considerable debate on the most appropriate ways to manage FAW in Asia, with proponents suggesting a wide array of potential solutions depending on their country and context. This interactive workshop will highlight these issues and discuss opportunities for improving regional coordination in FAW management.

Agenda

Time	*Presentation/Activity*
14:45-15:00	**Welcome and Introduction** *Dr. Timothy J. Krupnik, CIMMYT, Bangladesh*
15:00-15:30	**Introduction to FAW** *Dr. Dan McGrath, CIMMYT, Bangladesh*
15:30-16:00	**Agroecological Management of FAW** *Dr. Timothy J. Krupnik, CIMMYT, Bangladesh*
16:00-16:30	**Case Study 1: Bangladesh Experiences of FAW** *Dr. Syed Nurul Alam, Bangladesh Agricultural Research Institute, Bangladesh*
16:30-17:00	**Case Study 2: Lessons from Africa in FAW Biosafety** *Dr. Dan McGrath, CIMMYT, Bangladesh*
17:00-18:00	**Discussion/Q&A**

AGENDA

PARALLEL WORKSHOP II:
GENE EDITING AND REGULATION

Organizers

Andrew Roberts, Ph.D. and Bhavneet Bajaj, Ph.D.
ILSI Research Foundation, Emails: aroberts@ilsi.org, bbajaj@ilsi.org

Overview

Gene editing is a very popular topic and has been the subject of interest and discussion around the world in biosafety conferences and other fora. It is important to understand various technologies encompassed by gene editing and their context in the safety assessment. This workshop will provide an opportunity to review various gene editing techniques and understand the global landscape of regulation of products derived using these technologies. Participants will be provided with a resource document containing two case studies, followed by an exercise involving applicability of current risk assessment elements to gene edited products under study. This will be followed by a discussion about appropriate risk assessment for gene edited plants relative to other plant breeding techniques. During the discussion session, consensus points will be noted down and preferably put into a ppt slide. The group will identify a speaker who will present the consensus points/ key messages the following day to the audience.

Agenda

Time	*Presentation/Activity*
14:45-15:00	**Welcome and Introduction** *Dr. Andrew Roberts, ILSI Research Foundation, USA*
15:00-15:30	**Innovative Breeding Technologies and Applications in Rice** *Dr. Inez H Slamet-Loedin, International Rice Research Institute, Philippines*
15:30-16:00	**Overview of Global Status of Regulation of Gene Edited Products** *Dr. Bhavneet Bajaj, ILSI Research Foundation, USA*
16:00-16:15	**Introduction to Case Studies: Elements of Risk Assessment and Their Applicability to Gene Edited Products** *Dr. Bhavneet Bajaj, ILSI Research Foundation, USA*
16:15-17:15	**Case Study 1: Non-Browning Mushroom** *Breakout Groups* **Case Study 2: High Oleic Soybeans (Calyxt)** *Breakout Groups*
17:15-18:00	**Discussion/ Q&A**

AGENDA

PARALLEL WORKSHOP III:

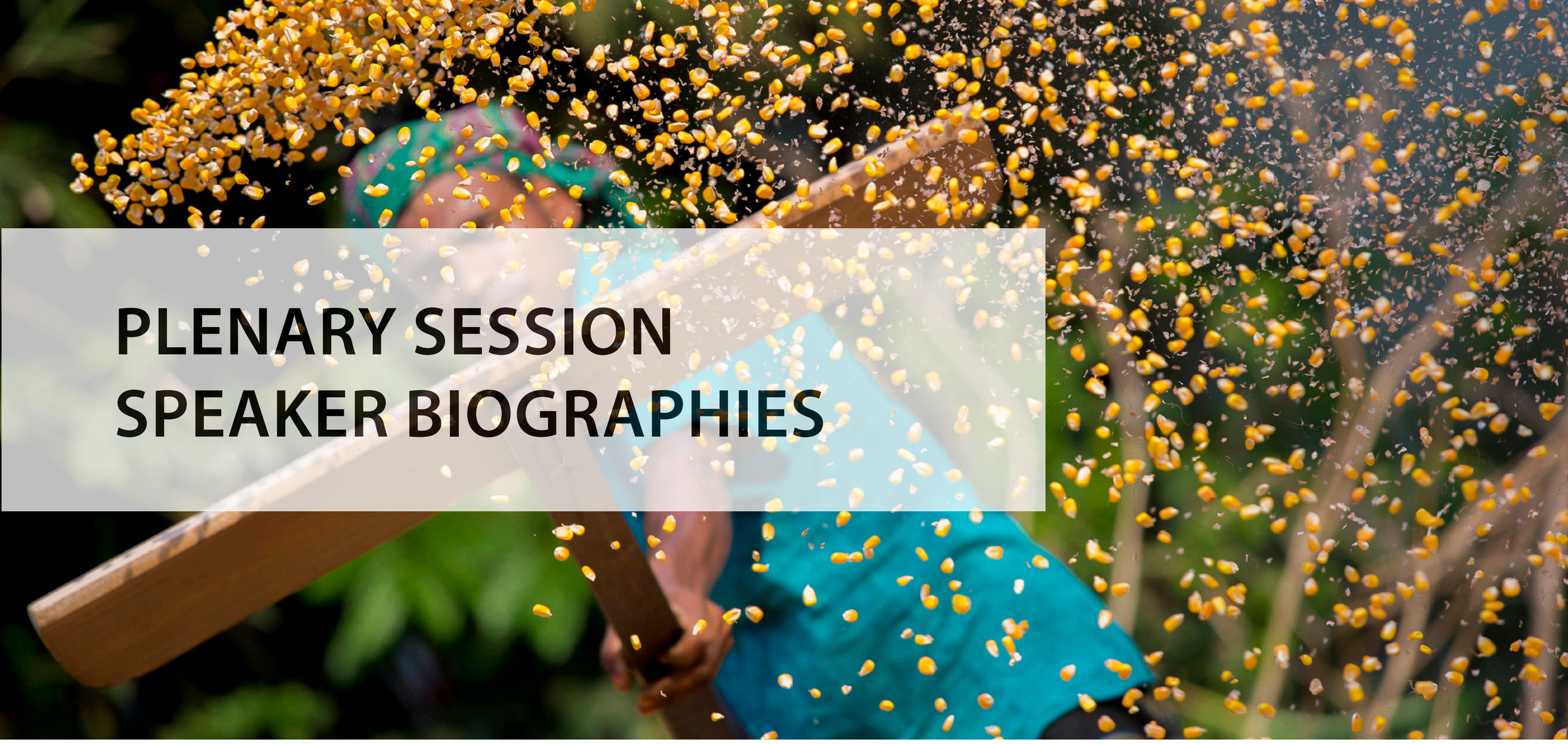
GE FOOD SAFETY ASSESSMENT— MUTUAL ACCEPTANCE OF DATA

Organizers

Vibha Ahuja, Ph.D. and Lalitha Gowda, Ph.D.
Biotech Consortium India Limited, India, Email: vibhaahuja.bcil@nic.in
CSIR-Central Food Technological Research Institute, India (retired), Email: lrgowda2k11@gmail.com

Agenda

Time	*Presentation/Activity*
14:45-15:00	**Welcome and Introduction** *Dr. Vibha Ahuja, Biotech Consortium India Limited, India*
15:00-15:30	**GE Food Safety Assessment: Information Requirements as per Codex Guidelines** *Dr. Lalitha Gowda, Former Scientist, Central Food Technological Research Institute, India*
15:30-16:00	**Mutual Acceptance of Data (MAD) of OECD** *Dr. Ekta Kapoor, Department of Science & Technology, India*
16:00-16:30	**Review of Data Generated in Different Regulatory Systems: Experience by FSANZ** *Dr. Janet Gorst, Food Standards Australia New Zealand, Australia (retired)*
16:30-17:00	**Food Safety of Bt Brinjal in India and Bangladesh: A Case Study** *Dr. Vibha Ahuja, Biotech Consortium India Limited, India*
17:00-17:30	**Discussion/ Q&A**



PLENARY SESSION SPEAKER BIOGRAPHIES

Malik Zainul Abdin, Ph.D.

Jamia Hamdard, India
Email: mzabdin@jamiahamdard.ac.in

Professor M. Z. Abdin has been a professor in the Department of Biotechnology at Jamia Hamdard, New Delhi, India since 2004. He is currently serving as Head of the Department of Biotechnology in Jamia Hamdard. He has published around 194 research papers with H-index 25, citation index 2190, and i10 62. He has also published 18 review articles, 39 book chapters, and edited 4 books. Professor Abdin has supervised 44 Ph.D. students and attended 22 international and 31 national conferences. He has organised 2 international and 23 national conferences/workshops. He has visited several national and international universities and institutes to deliver lectures in the area of plant physiology and biotechnology. He is also a member of various professional societies, such as the Indian Society for Plant Physiology, Society for Plant Biochemistry and Biotechnology, The Indian Society of Genetics and Plant Breeding, Indian Science Congress Association, Biotechnology Society of India, National Environmental Science Academy, and National Academy of Sciences (Allahabad).He is a recipient of many awards like the Vigyan Ratan Award for the year 2011-2012 for significant scientific achievements in the field of biotechnology by UPCST, Government of Uttar Pradesh, India, Biospectrum Public Private Partnership Excellence Award by Biospectrum, Banglore, India in 2011, Senior Award for the year 2004 by the Academy for Advancement of Agricultural Sciences, New Delhi, India and Distinguished Scientist of the Year 2004 Award by the National Environmental Science Academy,New Delhi, India.

Professor Abdin is actively working in the area of plant physiology and plant biotechnology. His current research interests include metabolic engineering of medicinal and industrial crops to increase their secondary plant metabolite contents. Using overexpression and downregulation of genes encoding enzymes catalyzing key steps in artemisnin and steviolglycoside biosynthetic pathways, he is able to increase artemisnin and steviolglycoside contents in *Artemisia annua* and *Stevia rebaudiana* plants, respectively.

Akhter Ahmed, Ph.D.

International Food Policy Research Institute (IFPRI), Bangladesh
Email: a.ahmed@cgiar.org @IFPRI

Dr. Akhter Ahmed is a senior research fellow in the Poverty, Health, and Nutrition Division and Country Representative of IFPRI-Bangladesh. He joined IFPRI in 1990. He works on strategies for agricultural and rural development, social protection, and women's empowerment to reduce poverty, food insecurity, and undernutrition of the poor in developing countries. Dr. Ahmed was posted in Bangladesh from 1990 to 1994, where he worked on targeted interventions and participated in designing the innovative Food for Education program. From 1996 to 1999, he led IFPRI's collaborative project on food security research in Egypt. During 2000-2009, he worked on poverty and human development issues in Bangladesh, China, India, Malawi, the Philippines, and Turkey. Since 2010, Dr. Ahmed has been posted in Bangladesh where he is leading the Policy Research and Strategy Support Program. Before coming to IFPRI, Dr. Ahmed worked with the World Bank and was an agricultural economist for the U.S. Agency for International Development. He received a Ph.D. in agricultural economics from Colorado State University, and an M.S. in agricultural economics from Cornell University.

Abdun Noor Muhammad Iftekhar Alam, Ph.D.

National Institute of Biotechnology, Bangladesh

Email: ifte.alam@gmail.com

Dr. Iftekhar Alam is a Senior Scientific Officer in the National Institute of Biotechnology, Dhaka, Bangladesh, where he has worked since 2013. He received his Ph.D. in molecular plant physiology from Gyeongsang National University, South Korea in 2010. He worked as a postdoctoral researcher in the same university and in the Université Catholique de Louvain, Louvain-la-Neuve, Belgium. He has been actively involved in transgenic research during his entire Ph.D. and postdoctoral period. He has received research grants from a number of local and international agencies, such as the Ministry of Science and Technology, Bangladesh and The World Academy of Science (TWAS). He is a Principal Investigator in a collaborative research project with the International Center for Genetic Engineering and Biotechnology (ICGEB), New Delhi, India. His current research focuses on micropropagation and genetic engineering for crop improvement. He has published more than 40 scientific articles in internationally reputed journals, including Science.

Rob Bertram, Ph.D.

United States Agency for International Development (USAID), United States

Rob Bertram is the Chief Scientist in USAID's Bureau for Food Security, where he serves as a key adviser on a range of technical and program issues to advance global food security and nutrition. In this role, he leads USAID's evidence-based efforts to advance research, technology and implementation in support of the U.S. Government's global hunger and food security initiative, Feed the Future. He previously served as Director of the Office of Agricultural Research and Policy in the Bureau for Food Security, which leads implementation of the Feed the Future research strategy and related efforts to scale innovations in global food security efforts, working with a range of partners. Prior to that, he guided USAID investments in agriculture and natural resources research for many years. Dr. Bertram's academic background in plant breeding and genetics includes degrees from University of California, Davis, the University of Minnesota and the University of Maryland. He also studied international affairs at Georgetown University and was a visiting scientist at Washington University in St. Louis. He has been especially active in plant genetic resources policy as it relates to research for development, including applications of biotechnology in food security-related research. Before coming to USAID, he served with USDA's international programs as well as overseas with the Consultative Group on International Agricultural Research (CGIAR) system.

Sampa Das, Ph.D.

Bose Institute, India

Email: sampa@jcbose.ac.in

Dr. Sampa Das, INSA Senior Scientist, formerly Head, Division of Plant Biology, Bose Institute did her M.Sc. from the University of Burdwan. She started her research career at Bose Institute in the area of yeast genetics and got her Ph.D. degree from the University of Calcutta. After a couple of years of post doctoral research at Bose Institute and Friedrich Miescher Institute in Switzerland, she joined Bose Institute as an independent faculty member in 1991. Since then, she has been actively involved in identifying insecticidal and pathogen resistant genes from indigenous sources and expressing them in different plants like rice, mustard and chickpea. She also worked on elucidating the possible mechanism of action of those insect/pathogen resistant genes on target pests and pathogens.

In her long research career, she published more than 75 articles in reputed international journals, guided 25 Ph.D. students, and trained a good number of post doctoral research fellows. She has two granted patents. One of her patented technologies had been licensed to industries. For the first time at Bose Institute, she introduced an integrated M.Sc.-Ph.D. course in Plant Molecular Biology and Biotechnology in 2007, which has been extended later as M.Sc. in Life Science.

As a recognition of a successful researcher, she has been awarded by different academic bodies as: Fellow of the National Academy of Sciences India (2009), Fellow of Indian National Science Academy (2009), Fellow of West Bengal Academy of Sciences and Technology (2011).

Ranil Dassanayake, Ph.D.

University of Colombo, Sri Lanka
Email: rsdassanayake@chem.cmb.ac.lk

Ranil S. Dassanayake is a Senior Professor in Biochemistry and Molecular Biology, University of Colombo and Scientific Co-Founder of CeyGen Biotech (pvt) Ltd., the first registered Biotech company in Sri Lanka, and has been involved in research and development work related to molecular-based technology and services since 1995. He has published more than hundred research articles in both international and local journals and has been instrumental in developing a transgenic mosquito for the first time in Sri Lanka.

Vajirapani De Silva, M.Sc.

GENETECH, Sri Lanka
Email: kdespani@gmail.com

Born in a small village in the suburbs of Colombo as the only girl with two big brothers, to a father attached to the Ministry of Education and a mother who was a courageous home maker, Ms. De Silva grew up in a house surrounded by paddy fields and farms. The use of animals for the rice production process was one of the best experiences she had as a child. Although born after two boys and about 10 years their junior, she was not treated as a weak and soft girl in the family. Hence, she grew up into an independent woman and to have faith in her own strength.

She had her early education at a small primary school near her home town and gained entrance to Visakha Vidyalaya, Colombo—one of the leading ladies schools in the country, through fifth grade scholarship exams. After sitting for the advanced level examination, she entered the Faculty of Science, University of Colombo, where she met the late Dr. Maya Gunasekera—the pioneering lady of the Sri Lankan DNA fingerprinting technology and molecular diagnostics. Dr. Gunasekera selected Ms. De Silva as a volunteer in her laboratory when she was an undergraduate, to be a supporting hand for a fascinating project on DNA finger printing of the Sri Lankan elephant. Part of her post graduate research was on molecular detection of banana viral diseases. She was awarded a short term scholarship by IAEA to learn molecular diagnostics and application of biotechnology in Belgium, University of Gembleux, as Sri Lanka did not have the facilities to apply these techniques at the time. She also worked on a pioneering effort by Dr. Kshanika Himburegama, on training rural school leavers to work in tissue culture laboratories.

Just three days after giving birth to her first baby, she was invited to be a part of the pioneering team establishing the country's very first genetechnology company—GENETECH Molecular Diagnostics and School of Gene technology. She joined as a scientific officer. Today she serves as the Head of Infectious Disease Diagnostics, Technical Manager of the establishment, and Head of School. Mother to two teenage daughters, she has been married for 21 years to a husband who supports and encourages her to be the best she can be.

Rufus Ebegba Eseoghene, Ph.D.

National Biosafety Management Agency, Nigeria
Email: rebegba@hotmail.com @RufusEbegba

Rufus Eseoghene Ebegba, Ph.D. is a Nigerian. He has been the Pioneer Chairman of the Steering Committee of the West African Biosafety Regulators Forum (WABRF) since 2018 and was recently adopted as the Chair of the newly established African Union Biosafety Regulators Forum. He has been the Pioneer Director General/Chief Executive Officer of the National Biosafety Management Agency (NBMA) since April 18, 2015 to date. As the DG/CEO of NBMA, he is responsible for the provision of regulatory framework, institutional and administrative mechanisms for safety measures in the application of modern biotechnology in Nigeria, with the view to preventing any adverse effect on human health, animals, plants and environment. His activities in this regard have elevated him and indeed Nigeria to leadership positions internationally in the areas of biosafety and biodiversity conservation. He led the development of various biosafety policies and guidelines. He was also involved in the development of the National Biosafety Bill and National Biotechnology Policy.

He has 29 years of working experience in the areas of administration, biosafety management, biodiversity conservation, biotechnology and sustainable utilization of renewable natural resourses, and strategic planning in biosafety and biodiversity. Currently, he is the National Project Coordinator, UNEP-GEF National Biosafety Framework Implementation Project in Nigeria; the Cartagena Protocol on Biosafety National Focal Point for Nigeria; and a member of the Expert Committee of West African Biosafety Regulation. He is a former member of the UN, CBD *Ad-hoc* Technical Expert Group on Biosafety Risk Assessment and Risk Management of the Convention on Biological Diversity of the United Nations. He has represented Nigeria and Africa at various international levels. He has presented over fifty papers.

He has a Ph.D. (Biodiversity – 2016), M.Sc. (Environmental Biology – 2002), and B.Sc. (Agriculture – 1988). Dr. Ebegba has received numerous awards for hard work and service to humanity.

Parveen Ejaz, M.Phil.

Ministry of Climate Change, Pakistan
Email: parveenejaz1@gmail.com

Mrs. Parveen Ejaz has been working as Biochemist/Deputy Director (Biodiversity) in the Biodiversity Directorate, Ministry of Climate Change (MoCC), Islamabad since February 2014. In this capacity, she provides support to the Director of Biodiversity in MoCC as a member of the Consultation Committee of Marine Protected Areas and looks at the implementation status of the National Biodiversity Strategic Action Plan (NBSAP). She is also part of the team that monitors the compliance to decisions of various regional forums related to biodiversity, such as ASIAN, SAARC, ECO, etc. Mrs. Ejaz is also responsible for the evaluation of biodiversity-related projects and programs in the country. Before assuming this position, she worked as a biochemist in the Zoological Survey of Pakistan, Ministry of Climate Change, Islamabad from November 2007 to February 2014 and in the Marine Biological Research Laboratory, Zoological Survey Department, Ministry of Environment based at Karachi from September 1994 to Oct. 2007. Mrs. Parveen Ejaz holds an M.Phil. degree in Biochemistry from the University of Karachi, Pakistan. She has participated and represented Pakistan in various national and international workshops, meetings, and conferences on Biodiversity Strategy and Action Plan and its implementation in Pakistan, Biosafety Clearing House, use and exchange of crop genetic resources, and related topics. She is author/co-author of number of publications.

Muhammad Shahidul Haque, Ph.D.

Bangladesh Agricultural University, Bangladesh
Email: haquems@yahoo.com

Prof. Dr. Muhammad Shahidul Haque is a Professor at the Department of Biotechnology, Bangladesh Agricultural University (BAU). He obtained B.Sc.Ag.(Hons) and M.Sc. degrees from BAU. Then he did an M.S. and Ph.D. with a specialization in Plant Tissue Culture and Micropropagation from Nagoya University, Japan. Later, he joined as a JSPS Postdoctoral Fellow during 2002-04 in Nagoya University, where he worked on genetic engineering and gained experience in virus detection and elimination, and on genetic transformation techniques in plants. He has experience in pursuing research on molecular breeding as a visiting professor at Nagoya University for one year. Since 2004, he has been teaching biotechnology and genetic engineering. He has published 120 articles in national and international journals. Over the past 30 years, his research efforts have been dedicated to multidisciplinary, integrated approaches to understanding how morphogenesis of plants can be manipulated, how viruses can be detected and eliminated through culturing root meristem, and the biosafety of GMOs. His research achievements include virus detection, elimination, cyclic micropropagation through in vitro bulblet formation, gene transfer, and molecular breeding. He has operated eight research projects funded by national and international (USDA, BAS-USDA, MoE, NST) funding agencies. He is interested in biotic and abiotic stress tolerance in crops and is currently working on morpho-molecular screening of wheat for heat, drought, and salinity tolerance; country bean for pod borer and aphid resistance; and chilli for anthracnose resistance. He has supervised 8 Ph.D. scholars and 60 M.S. students. He has attended, organized, chaired, and given lectures in at least 70 workshops, seminars, trainings, and international conferences related to modern biotechnology, genetic engineering biosafety, and the promotion of GM crops at home and abroad. He has worked as a resource person, discussant, participant, and consultant for formulating guidelines, frameworks, and policy for the safe use of biotech products protecting human health and environment.

Md. Solaiman Haider, M.Sc.

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Mr. Mohammed Solaiman Haider is the Director (Planning) of the Department of Environment (DoE) under the Ministry of Environment and Forests of the Government of the People's Republic of Bangladesh. He received a B.Sc. (Hons.) and an M.Sc. in Botany. He completed his Professional Masters in Natural Resources Management at the International Institute for Geo-Information Science, the Netherlands. He also received a Postgraduate Diploma in Biosafety from the University of Malaya, Kuala Lumpur, Malaysia. He joined the Department of Environment in 1996 and since then has served in various capacities in the areas of pollution management, environmental impact assessment, climate change, biodiversity conservation and biosafety issues. He has served as the Member Secretary of the National Committee on Biosafety (NCB) and Biosafety Core Committee (BCC), simultaneously, during 2008 to 2014. Since 2014, he has been serving as the Member Secretary of the Biosafety Core Committee (BCC). He attained wider experiences of participation and presenting papers to the international training, seminars, workshops, negotiation meetings on environment, biodiversity and biosafety issues in the countries like USA, Canada, Mexico, Germany, France, Switzerland, the Netherlands, Egypt, Jordan, South Korea, Tanzania, Kenya, India, Sri Lanka, Nepal, Bhutan, Thailand, Cambodia, China, Hong Kong, Indonesia, Vietnam, Philippines, Malaysia and Japan. As an environmental expert, he possesses vast experiences of presenting papers as a resource person in various topics on environment, biodiversity and biosafety issues home and abroad. As a focal person on Biosafety issues in DoE he has been very keenly associated with the development of the Updated Biosafety Guidelines of Bangladesh, National Biosafety Framework, Biosafety Rules of Bangladesh, Food Safety Assessment Guidelines, SOPs for confined field trials of GE plant and Data Recording Formats. He is also serving as the Project Director of UNEP funded Implementation of Biosafety Framework of Bangladesh.

Md. Anowar Hossain, Ph.D.

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Dr. Md. Anowar Hossain was born in the Sirajganj district in Bangladesh in 1974. He obtained his B.Sc.(Hon) and M.Sc. degrees in Biochemistry from Rajshahi University. He earned excellent results in all his academic and public examinations all through the first classes. He was awarded a gold medal for the excellent results in his B.Sc. (Hon) examination from Rajshahi University. He started his career as a lecturer in the department of Biochemistry and Biotechnology, University of Science and Technology Chittagong (USTC) in 2000. He moved from USTC to the Rajshahi University Department of Biochemistry and Molecular Biology in the early 2005. He was promoted to Assistant Professor in 2006. Dr Hossain was awarded TIGP (Taiwan International Graduate Program) Scholarship for Ph.D. studies in 2006 and stayed one year in Academia Sinica, Taiwan. Later, he got a Japanese Government Monbusho scholarship for his Ph.D. studies in 2007. He obtained his Ph.D. degree in the late 2010 from Okayama University, Japan. He did a post-doctoral fellowship at Georgia Institute of Technology, USA in 2011 and University Malaysia Sarawak in 2013-2015. He also received various awards for his academic and research activities. His research field is plant molecular biotechnology. He has published research articles in 25 national and international peer reviewed journals. In early 2012, he was promoted to Associate Professor in the Department of Biochemistry and Molecular biology, RU. Recently, in 2018, he was promoted to Professor in the Department of Biochemistry and Molecular biology, RU.

Mohammad Zabed Hossain, Ph.D.

University of Dhaka, Bangladesh
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Mohammad Zabed Hossain, Ph.D. has been serving as a Professor at the Department of Botany, University of Dhaka. His area of research and teaching is Plant Ecology, Molecular Ecology and Environmental Biology. His current research topics include plant-microbe interactions, abiotic stresses (e.g., arsenic, salinity, and drought) on plants and adaptation mechanisms of plants. At present, he has been supervising six Ph.D., three M.Phil. and two M.S. students. He has a total of 42 papers in different peer reviewed journals from reputed publishers, including Elsevier, Springer, Wiley, Nova science publishers, and SAGE. Over the years, he received several research grants from various agencies such as the International Foundation for Science, Ministry of Education and Ministry of Science and Technology of the Government of the People's Republic of Bangladesh, and the Bangladesh University Grant Commissions.

Dr. Hossain received his Ph.D. from the United Graduate School of Agricultural Science (UGAS), Iwate University, Japan in 2007, having received a scholarship from the Government of Japan with the research topic "Ecological relationships between plant and soil microbial communities in grasslands: Structural and functional linkages." Then, he pursued postdoctoral research at the Department of Plant Biology and Forest Genetics, Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden between 2009-2011, havign obtained a fellowship from the Swedish Institute with the topic "Microbial ecology of the bacteria associated with the root nodules of blue lupin (*Lupinus angustifolius* L. in Swedish soils." He completed his B.Sc. (Honors) and M.Sc. with thesis from the Department of Botany, University of Dhaka in 1993 (held in 1995) and 1994 (held in 1997), securing 1st class 2nd and 1st class 1st position of merit, respectively. Dr. Hossain was born in 1973 in a town named Munshiganj, located about 25 km away from the capital city of Dhaka, Bangladesh. He has visited India, Nepal, Japan, Sweden, Finland, Spain, Canada and China for study and scientific meeting purposes.

James Jacob, Ph.D.

Rubber Research Institute of India, India
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Dr. James Jacob, Director of the Rubber Research Institute of India (RRII) under the Rubber Board, Ministry of Commerce and Industry, Government of India, is a double-doctorate, Commonwealth Fellow, and a university rank medalist. He is an alumnus of the University of Agricultural Science, Bengaluru, Imperial College, London, and Rothamsted International, Hertfordshire, England. After completing his doctoral degree from England, he worked as a scientist at the Smithsonian Environmental Research Centre, Maryland, USA researching the impact of climate change and rising concentration of CO_2 in the atmosphere on natural vegetation. Quitting a lucrative scientific career in America, he returned to India in 1995 to take up the position of Deputy Director (Physiology) at RRII, and in 2006, he became its Director.

Dr. Jacob is the current Chairman of the Sectional Committee on Rubber and Rubber Products (PCD 13) under the Bureau of Indian Standards. He is a member of the Environment Committee of the Association of Natural Rubber Producing Countries, and a member of the Governing Council of Indian Rubber Manufacturers' Research Association, Mumbai. Dr. Jacob is a former Chairman of the International Rubber Research and Development Board (IRRRDB) and President of the Indian Society for Plantation Crops. He was also Head of the IRRDB Specialist Group on Physiology and Convener of its Task Force on Climate Change for several years.

Dr. Jacob's areas of research include photosynthesis and crop productivity, climate change, and sustainable development. He has more than 130 research publications and three edited books to his credit. Dr. Jacob is also the Editor-in-Chief of *Rubber Science*, a peer-reviewed international scientific journal published from RRII.

Tarun Kathula, M.S.

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Mr. Tarun Kathula is Scientist-F in the Ministry of Environment, Forest and Climate Change, Government of India. He works on biodiversity and biosafety, and he has vast experience in the implementation of multilateral environment agreements (MEA) in India, such as CITES, CBD, UNESCO Natural Heritage, Convention on Conservation of Migratory Species, Global Snow Leopard Ecosystem Protection Programme, and International Whaling Commission. He works closely with the focal points in the Ministry of Environment, Forests and Climate Change, Government of India and has represented focal points in various meetings and workshops. He holds a master's degree in environmental sciences from prestigious Kakatiya University, Warangal, Telangana, India, with a dissertation on industrial water pollution monitoring at National Power Thermal Corporation. He has more than 17 years of experience in the fields of biodiversity, wildlife, climate change, wildlife advocacy, ecological research, related policies, and protected areas management, has published reports to his credit in national and international arenas, and has authored few books.

Arunendra Nath Lahiri Majumder, Ph.D., D.Sc.

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Prof. A. N. Lahiri Majumder works in the Division of Plant Biology, Bose Institute, Kolkata , India. He holds an M.Sc. (Botany-1968), Ph.D. (Botany-1973), and D.Sc. (Biochemistry-1985) from Calcutta University. Between 1977 to 1991, he served as lecturer, reader, Professor, and Head in the Department of Botany ,Visva Bharati University. Between May 1991 to February 2011, he served as Professor, Senior Professor, and Head in the Division of Plant Biology, Bose Institute, Kolkata. He was a Raja Ramanna Fellow (DAE), Division of Plant Biology, Bose Institute, Kolkata (2011-2016) and is currently INSA Senior Scientist, Division of Plant Biology, Bose Institute, Kolkata.

Prof. Majumder was a Visiting Fellow/Associate at the National Institutes of Health, Bethesda, USA from 1973-1976. He was a Visiting Associate at the Department of Genetics, Albert Einstein College of Medicine, NewYork, USA in 1979, 1980, and 1982 (3 months each). He was a Visiting Professor at the Department of Molecular Genetics, Ohio State University, Columbus, USA from 1986-1988 and DBT Overseas Associate/Rockefeller Biotechnology Career Fellow at the Department of Biochemistry, University of Arizona, Tucson, USA in 1994, 1995, 1998, and 1999. He was a Visiting Scientist (DST-USDA) at the Plant Molecular Biology Lab, USDA, Beltesville, USA in 2002 (April to June) and Visiting Scientist (DST-NSF) at the Plant Molecular Biology Lab, University of Illinois, USA from July-August, 2003, September-October 2004, and September-October 2005.

Prof. Majumder has received the following awards: Elected Fellow—Indian National Science Academy, Delhi (FNA), Indian Academy of Science, Bangalore (FASc), National Academy of Sciences, Allahabad (FNASc), National Academy for Agricultural Sciences (FNAAS), West Bengal Academy of Science & Technology(FAScT); SB Saksena Award from the Indian National Science Academy (2008); Sadakharaswamy Endowment Lecture Award, SBC(I) (1994-1995); Parija Memorial Lecture Award, Utkal University (2001); SPatnaik Memorial lecture, Utkal University (2018); Career Development Award, UGC (1980-83); Foundation Day Award, Bose Institute (1998); Fogarty International Center Visiting Fellowship/Associateship, NIH, USA (1973 -1976); Rockefeller Biotechnology Career Fellowship (1998-2003); Sir Rashbehari Ghosh Travelling Fellowship, Calcutta University (1982).

Donald MacKenzie, Ph.D.

Donald Danforth Plant Science Center, United States
Email: dmackenzie@danforthcenter.org @DrDonMacKenzie

Donald MacKenzie is the Executive Director of the Institute for International Crop Improvement (IICI) at the Danforth Plant Science Center. He manages the IICI's programs and partnerships dedicated to translating key discoveries in plant health, disease and pest management, genomics, advanced breeding, and nutrition to staple crops that impact food security around the globe. Don also provides guidance on navigating through the practical, safety, and regulatory processes necessary to demonstrate that new crop varieties are proven safe and effective for the farmers who will benefit from them.

Don is an international expert in regulatory systems for agriculture, including environmental risk assessment, biosafety, and food safety assessments. His extensive experience in plant product development and global regulatory processes aligns with the Institute's commitment to collaborate with international and local partner organizations to deliver crops with improved nutritional content and disease resistance to places where people are in most need. In addition to feeding the hungry, these efforts have the potential to contribute to environmental health and empower farmers to become more self-sufficient.

Under Don's leadership, the IICI is establishing a public-private collaboratory to address cross-cutting issues related to environmental and food safety assessment, quality standards, consensus-building, regulatory policy advocacy, and the practical implementation of stewardship best practices for new technologies.

Namgyal, B.S.

Bhutan Agriculture and Food Regulatory Authority, Bhutan
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Mr. Namgyal is serving as the Sr. Regulatory and Quarantine Inspector/Base In-Charge at Bhutan Agriculture and Food Regulatory Authority, Ministry of Agriculture and Forest, Phuentshopelri (Gomtu), Samtse, Bhutan. He has a background of Bachelor Science in Agriculture from the College of Natural Resources (CNR), Royal University of Bhutan (RUB), Lobesa, Punakha, Bhutan.

Francis Nwankwo Onyekachi, M.S.

African Agricultural Technology Foundation, Nigeria
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Onyekachi Francis Nwankwo is the Programme Officer, West Africa at African Agricultural Technology Foundation (AATF) and a strong advocate of the critical role of technology and innovation in agricultural systems in Africa. Francis has been committed to the complex process of developing two genetically modified products—the Nitrogen-use efficient, water-use efficient and salt tolerant (NEWEST) rice and Pod borer resistant (PBR) or Bt cowpea in Africa. As a key member of the AATF team, Francis has played crucial role at developing the pod borer resistant (Bt) cowpea in West Africa, taking the potential product from laboratory, through field trials to successful deregulation in Nigeria. He is passionate to see the product in farmers' fields across Africa. Francis is a Nigerian national.

Deepak Pental, Ph.D.

University of Delhi South Campus, India
Email: dpental@gmail.com

Dr. Deepak Pental, with colleagues and doctoral students, has worked on the breeding of oilseed mustard and cotton for the last thirty years. His group's work has led to major breakthroughs in mustard breeding for higher yield, better oil and meal quality, and disease resistance. Deepak Pental studied at Panjab University for his B.Sc. and M.Sc. degrees, earned his doctoral degree from Rutgers University, and did post-doctoral work at the University of Nottingham. Since 1993, he has been associated with the University of Delhi. After his superannuation as Professor of Genetics from the University, he continues to work at the Centre for Genetic Manipulation of Crop Plants as CSIR-Distinguished Scientist. He is an elected member of all the major science academies of India and has received many prestigious awards. His group has published around 100 papers, which have received 3000 citations. He has argued for the use of GE technologies to provide small-holder farmers a better deal and written extensively on the subject. From 2005 to 2010, he served as the Vice-Chancellor of the University of Delhi.

P. J. Raju, Ph.D.

Andhra Pradesh State Sericulture Research and Development Institute, India
Email: directorresearch.seri@gmail.com

Dr. P. J. Raju, started his research career in the year 1983 at University of Mysore and objtained his Ph.D. in Silkworm Breeding and Genetics. He joined KSSRDI during the year 1992 and has conducted research especially for rainfed sericulture. He was also instrumental in bringing nearly 75 tribals to mainstream sericulture through the project: *Socio-Economic Empowerment of Tribals through State-of-Art Technologies in Sericulture*. Presently, Dr. P. J. Raju is working as the Director of Andhra Pradesh State Sericulture Research and Development Institute and is involved in research and development in sericulture, especially in the development of new silkworm breeds/hybrids with reference to disease resistance, including abiotic stress. He is associated with the Centre of Excellence for Genetics and Genomics of Silkmoths and in collaboration with the Centre for DNA Fingerprinting and Diagnostics, Hyderabad, India in developing transgenic silkworm stocks. In addition, the Biotechnology Industry Research Assistance Council (BIRAC), New Delhi has funded the project: *To Conduct Multilocational Field Trials on Transgenic BmNPV Resistant Silkworm Hybrids to Establish Their Efficacy and Generate Data for Their Regulatory Approval*, wherein the efficacy studies have proved the worthiness of transgenic hybrids at various test centres across India. Additionally, he has to his credit several silkworm hybrids developed by him, which have been authorized by the Central Silk Board, Ministry of Textiles, Government of India, and some of these hybrids are under commercial exploitation. Currently, Dr. Raju is Coordinator/Principal Investigator for several of the projects on development of thermotolerant silkworm breeds, sex limited breeds, including that of extension and training related projects sanctioned by the Department of Science and Technology, Department of Bio-technology, Government of India, NABARD, RKVY, ICAR, New Delhi and Central Silk Board, Bangalore, India. The Department of Sericulture, Government of Andhra Pradesh assigned Silkworm Seed Production activity to Dr. P. J. Raju to streamline and strengthen the silkworm seed sector.

Andrew Roberts, Ph.D.

ILSI Research Foundation, United States
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Dr. Andrew F. Roberts is the Deputy Executive Director of the ILSI Research Foundation, where he is responsible for programs addressing environmental risk assessment and food safety assessment for biotechnology. Dr. Roberts joined the ILSI Research Foundation in December 2009 as the Deputy Director of the Center for Environmental Risk Assessment (CERA), where his first tasks included developing tools and materials for use in training and capacity building related to the problem formulation approach to environmental risk assessment published by the Research Foundation (Wolt et al 2009). He has served as the coordinator for CERA's capacity building projects under the USAID funded South Asia Biosafety Program (SABP) and the World Bank funded Partnership for Biosafety Risk Assessment and Regulation, in Bangladesh, Pakistan, and Vietnam as well as providing technical support for capacity building work in Brazil, India, Japan, Chile, and South Africa. In January of 2015 he became the director of CERA as well as the Center for Safety Assessment of Food and Feed (CSAFF), which works on food and feed safety assessment for foods derived from genetically engineered plants. In January 2017, he became the Deputy Executive Director of the ILSI Research Foundation.

Prior to joining the ILSI Research Foundation, Dr. Roberts worked at the U.S. Department of Agriculture in several different capacities, all related to the regulation of agricultural biotechnology. He began his career at USDA as an AAAS Risk Policy Fellow in the Office of Science of Biotechnology Regulatory Services (BRS), the group responsible for regulating genetically engineered plants at USDA. After spending a year in the New Technologies office of the Foreign Agricultural Service serving as the lead for USDA's efforts related to the Cartagena Protocol on Biosafety, he returned to BRS to serve in the International Affairs branch where he remained until joining the ILSI Research Foundation.

Dr. Roberts received his Ph.D. in Cell and Developmental Biology from Rutgers University where he worked on signal transduction in the model nematode *C. elegans*.

Rakha Hari Sarker, Ph.D.

University of Dhaka, Bangladesh
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Prof. Dr. Rakha Hari Sarker is curently the Chairman of the Department of Botany, University of Dhaka and has been involved in teaching and research at the Department of Botany since 1982. He obtained his M.Sc. from the Department of Botany, University of Rajshahi and Ph.D. from the University of Reading, UK through the Commonwealth Scholarship. He has received various international trainings in plant biotechnology and biosafety from Germany, USA, CIMMYT (Mexico), and the International Centre for Genetic Engineering and Biotechnology (ICGEB), New Delhi, India. He has received research grants from USDA, Bangladesh Academy of Sciences, and Ministry of Education, Government of Bangladesh.

His field of specialization is plant breeding and biotechnology. He has a variety of research interests for the improvement of crop plants and is interested in propagation and characterization of medicinal plants. He has published more than 100 research articles in several journals including *Proceedings of the National Academy Science* (PNAS), USA; *New Phytologists*; *Euphytica*; *Cytologia*; *SABRAO Journal*; *Phytomorphology*; *Plant Cell, Tissue and Organ Culture*; *Journal of Phytopathology*; *Indian Journal of Agricultural Science*; In vitro *Cellular & Developmental Biology-Plant*; *Academic Press*; *Bangladesh Journal of Botany*; and *Plant Tissue Culture and Biotechnology (PTC&B) Journal*.

Professor Sarker is serving as one of the editors of the *Bangladesh Journal of Botany* and the Executive Editor of *Plant Tissue Culture and Biotechnology (PTC&B) Journal*. He is a member of the National Executive Committee on Biotechnology (NECB) of the Government of Bangladesh and a member of the core committee of the National Technical Committee on Crop Biotechnology (NTCCB). He is presently the Chairperson of the Institutional Biosafety Committee (IBC), University of Dhaka and also was a member of the team responsible for developing *Biosafety*

Guideline and Biosafety Framework for Bangladesh. He is the Director of Dhaka University Center for Advanced Study and Research in Biological Sciences.

Professor Sarker has received the Bangabandhu Jatiya Krishi Puroshkar-1423 (Bangabandhu National Agriculture Award-1423, Gold Medal)—the highest state recognition in the agriculture sector in 2018.

D.M.J.B. Senanayake, Ph.D.

Rice Research & Development Institute, Sri Lanka
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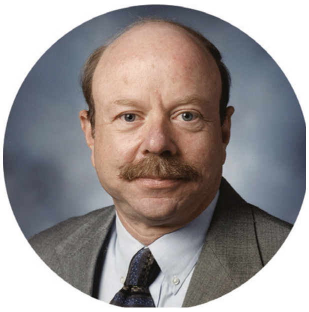
D.M.J.B. Senanayake obtained a B.Sc. (Agriculture) Hons. from the University of Peradeniya and an M.Sc. (Plant Pathology/Molecular Biology & Biotechnology) and Ph.D. (Plant Virology/Molecular Biology & Biotechnology and Genetics) from the Indian Agriculture Research Institute, New Delhi, India. He possesses over 26 years of research experience on plant pathology and biotechnology in field crops and rice in the Department of Agriculture. He was instrumental in establishing a fully equipped international level biotechnology laboratory at the Field Crops Research & Development Institute, Mahailuppallama and initiated biotechnology research at the institute in collaboration with other research officers at the institute. He posseses around 40 publications on biotechnology, virology, and plant breeding aspects in international and national journals, including high impact factor journals. he worked as the Chairperson of the National Biotechnology Committee, taking decisions regarding proposal evaluation for funding, project monitoring, and policy development for national agriculture biotechnology. He is a member of the Faculty Board of the Faculty of Agriculture, Rajarata University, Sri Lanka and a Committee Member of the Research Committee of the Faculty of Agriculture, University of Peradeniya.

He is also a member of the Technical Working Group for the National Biosafety Committee of the Ministry of Environment, which develops national biosafety regulations in the country. He also worked on many other committees related to biotechnology and biosafety in the country. He works as a member of the subcommittee of the Ministry of Health that develops biosafety and biosecurity policy in the country. He was selected as the Best Scientist of the Department of Agriculture, Sri Lanka in 2018. He is a member of the Editorial Board of the Annual Symposium of the Department of Agriculture and *Tropical Agriculture* and has been working as a reviewer for national and international research journals. HIs present research involves the development of quality protein maize, gene discovery for anthracnose resistance, and development of pathogen derived resistance for chilli leaf curl virus and molecular identification of pests and diseases in rice and field crops. Presently, he works as the Principal Agriculture Scientist (Biotechnology) and Director (acting) of the Rice Research & Development Institute, Sri Lanka

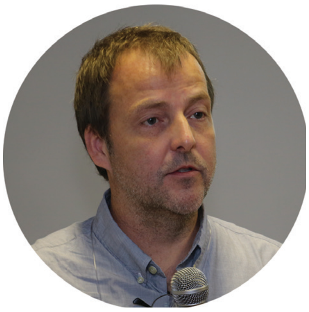


Anthony Shelton, Ph.D.

Cornell University, United States
Email: ams5@cornell.edu @IPMguy

Professor Anthony (Tony) Shelton is an International Professor of Entomology and Associate Director of International Programs for Cornell's College of Agriculture and Life Sciences (CALS). His research program is responsible for developing sound integrated pest management (IPM) strategies for vegetables with spin-offs for other crops. Components of his program stress insect population ecology, biological control, plant resistance, agricultural biotechnology and risk assessment, insecticide resistance, insect movement, trap cropping, and plant productivity and marketability as a function of insect infestations. Tony is also Director of the USAID-funded project on using insect-resistant Bt eggplant in Bangladesh and the Philippines. More than 27,000 farmers are growing Bt eggplant in Bangladesh, and it is dramatically reducing insecticide use while increasing farm income and improving the environment.

Among the awards he has received are the Entomology Society of America's (ESA) National Award for IPM (1995), the NYS Award for Excellent in IPM (2007), the ESA National Recognition Award for Research (2005), Cornell (CALS) Award for Applied Research (2007), the ESA L.O. Howard Award (2011) and the ESA National IPM Team Award (2013). In 2010 he was elected an ESA Fellow. His program has a strong commitment to outreach education for the agricultural community and the general public.



Frederic Tripet, Ph.D.

Keele University, United Kingdom
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Professor Frederic Tripet is Director of the Centre for Applied Entomology and Parasitology at the University of Keele in the UK. He holds a doctorate in Behavioural Ecology and Evolutionary Biology from the University of Bern, Switzerland, complemented by postdoctoral training in Molecular Biology and Population Genetics from the University of California Los Angeles, University of Texas Medical Branch and University of California Davis. His collaborative research partnerships with major vector endemic countries span five continents and focus on the applied integrative biology of mosquitoes that transmit human pathogens, such as Malaria, Dengue, Chikungunya, and Zika, with a view on developing novel tools for their control.

Prof. Frederic Tripet is a partner and field entomology technical coordinator on the Target Malaria consortium, a not-for-profit research consortium sponsored by the National Institutes for Health and the Bill and Melinda Gates Foundation that aims to develop new approaches to sterile male mosquito releases to reduce the population of malaria-transmitting mosquitoes in sub-Saharan Africa.

Ramaiah Valasubramanian, Ph.D.

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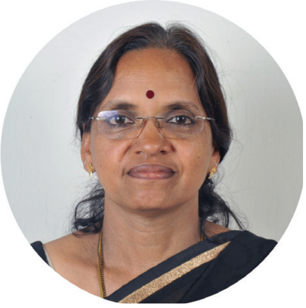
Dr. Ramaiah Valasubramanian is an agriculture biotechnology professional with 20 years of demonstrated experience in the seed and agribiotech industry. He joined Corteva Agriscience™, Agriculture Division of DowDuPont™, in November 2006, when the company started its agbiotech research and development in Hyderabad, India. After leading several discovery and trait development research programs for 10 years, he is currently leading the Seed & Traits - Regulatory And Stewardship group and provides functional and operational direction for seed and biotech regulatory approvals, product registrations, scientific and regulatory policy outreach, and acceptance with stakeholders. Before joining Corteva Agriscience™, Valasubramanian worked as a Principal Scientist with Maharashtra Hybrid Seeds Company Ltd. from 1999- 2006. He also served as a Visiting Scientist at CAMBIA, Australia. Valasubramanian earned his Ph.D. from the University of Madras, India and has done post-doctoral programs at the University of Missouri and Kansas State University. Passionate about sustainable agriculture, his interests are to develop and successfully commercialize technology-based solutions and agricultural products that improve agricultural productivity and public acceptance for new technology and traits.



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Dr. K.B.R.S. Visarada is serving crop improvement through biotechnological and conventional methods under the Indian Council of Agricultural Research (ICAR), India. Her major contributions are reflected in sorghum as the development of pre-breeding material for crop improvement programs through application of tissue culture, transgenic technology, and wide hybridization. She pioneered the biotechnology tools in sorghum with a dedicated lab that has blossomed into a complete establishment at present. In sorghum, a difficult crop to transform genetically, she led successful development of stem borer lines in popular genotypes among the dryland farmers of India. Dr. Visarada could overcome inter-specific barriers in sorghum through modified pollination methods and accomplish novel trait specific breeding lines that have been found promising in all Indian field trials of sorghum that are in the pipeline for registration. In addition to sorghum, her research in rice genetic transformation has pointed out the difficulties and the solutions to overcome them for successful transformation of *indica* rice, the most important food crop in India. It has culminated into a series of four international research papers, which are still cited.

Dr. Visarada is Institute Biosafety Officer (IBO) under ICAR, and she is working on biosafety concerns and guidelines of transgenic crops at different levels of the society. She worked on spreading awareness of intellectual property rights in agriculture through lectures, teaching credit courses, and interactions. She is the elected life member of Plant Tissue Culture Association of India. She has many international fellowships to her credit, has led many competitive projects, and has products, patents, and publications to her credit.

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Dr. Ronan Zagado is the head of the Development Communication Division at the Philippine Rice Research Institute (PhilRice). He earned his Ph.D. degree in Media Studies from the University of Adelaide, South Australia; M.S. in Development Communication (with cognate in Community Development) from the University of the Philippines Los Banos; and BS in Development Communication from Central Mindanao University, Philippines. His areas of specialization include: information campaign, risk communication, agricultural extension, science communication, and media studies.

ABSTRACTS

PLENARY SESSION I:
BIOSAFETY REGULATION IN SOUTH ASIA

Biosafety Regulation in Bhutan

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Bhutan has a pristine environment with rich and varied biodiversity. Bhutan became party to the International Convention on Biological Diversity (CBD) in 1995. In 2002, Bhutan ratified the Cartagena Protocol on Biosafety and in fulfillment of the protocol, Bhutan started the National Biosafety Framework in 2006, followed by the drafting of biosafety legislation, with financial and technical support from UNEP-GEF.

The *Biosafety Act* was endorsed and passed by parliament in July 2015, which addresses the regulation and safety management of GM organisms and GM products in Bhutan. It addresses the safe introduction, handling, and use of modern biotechnology through regulations, guidelines, manuals, and procedures.

The *Biosafety Act of Bhutan 2015* designates the Bhutan Agriculture and Food Regulatory Authority (BAFRA) of the Ministry of Agriculture and Forests (MoAF) as the national competent authority to regulate and co-ordinate all biosafety related activities in Bhutan.

So far, BAFRA has created awareness on GM organisms through posters and animations and has surveyed the food and feed product imported into the country. It has also developed laboratory infrastructure that has the capacity to carry out basic testing targeted at GM elements. Further, for the purpose of screening at the field level, field inspectors are also issued with the rapid test kits.

The presentation provides an update/status on the GMO regulatory systems in Bhutan, current biosafety scenario, and analytical aspects.

Current Status of GE Plant Risk Assessment and Regulation in India

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Currently, all genetically modified organisms (GMOs) are regulated under *the Rules for the Manufacture, Use/Import/Export and Storage of Hazardous Micro Organisms (HMOs)/Genetically Engineered Organisms (GMOs) or Cells, 1989*, notified under the provisions of the *Environmental (Protection) Act, 1986*. These rules and regulations are commonly referred to as Rules, 1989 and cover areas of research, as well as large scale applications of GMOs and their products.

The Rules 1989 also define the competent authorities and composition of such authorities for handling of various aspects of the Rules. Presently there are six competent authorities. The mandate of the six Committees are notified under Rules 1989. These include the Recombinant DNA Advisory Committee (RDAC); the Institutional Biosafety Committee (IBSC); the Review Committee on Genetic Manipulation (RCGM); the Genetic Engineering Appraisal Committee (GEAC); the State Biotechnology Coordination Committee (SBCC); and the District Level Committee (DLC). While RDAC has an advisory role, the IBSC, RCGM, and GEAC are involved in the approval process. The SBCC and DLC have monitoring functions.

Rules 1989 is supported by biosafety guidelines, which are regularly updated, keeping in tune with the international practices and developments in biotechnology. The guidelines are in place for risk assessment and regulation at all stages of development of a genetically engineered (GE) plant. These include laboratory research, confined field trials, food safety assessment, and environmental safety assessment. This presentation will cover the key features of these guidelines and steps for risk assessment and regulation of GE plants in India.

Pakistan Biosafety Regulatory System

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Pakistan became party to the Cartagena Protocol on Biosafety (CP) on 31 May 2009. The Ministry of Climate Change is responsible for implementing the CP. The regulatory framework includes *Pakistan Biosafety Rules 2005* and *Biosafety Guidelines 2015* and is implememted through the National Biosafety Centre, which was established to cater to the obligation of the Protocol at the Pakistan EPA, which acts as the Secretariat of the National Biosafety Committee and Technical Advisory Committee. The National Biosafety Centre provides the necessary management and regulatory framework for the GMOs. It also facilitates Institutional Biosafety Committee in their activities.

i. National Biosafety Committee (NBC): comprised of 12 members, including representatives from provincial and national organizations; the main objective of the NBC is to establish standards and procedures for risk assessment and labeling of living modified organisms, substances or cells and products thereof, to consider application(s) for import, export or commercial release of living modified organisms, and on the recommendations of Technical Advisory Committee, allow release or reject applications after reviewing the risk assessment carried out in accordance with the Biosafety guidelines.

ii. Technical Advisory Committee (TAC): comprised of 14 members; the main objective of the TAC is to examine applications and make recommendation to National Biosafety Committee on permitting or otherwise, laboratory work, field work, or release of living modified organism, substances, cells, and products thereof; to review and control of safety measures adopted while handling large scale use of genetically engineered organisms/classified organisms in research, developmental, and industrial production activities

iii. Institutional Biosafety Committee (IBC): includes the Head of institutions with Subject Experts and Biosafety Officer, Social Scientist/Economist, and representative of Civil Society; the functions of the IBC are to assist in the activities of the NBC and TAC, and to assist researchers in undertaking risk assessment, organizing training programs, and harmonizing experimental conditions with biosafety guidelines.

The designated laboratories for GMO detection are:

- National Institute for Biotechnology & Genetic Engineering, Faisalabad
- National Institute for Genomics and Advanced Biotechnology, NARC, Islamabad
- Ayub Agricultural Research Institute, Faisalabad
- Centre of Excellence in Molecular Biology, Punjab University, Lahore

Present Status of Biosafety Regulations in Sri Lanka

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Sri Lanka is located in the Indian Ocean southwest of the Bay of Bengal, between latitudes 5° and 10°N, and longitudes 79° and 82°E. The total land area is 65,610 km^2 and the population is around 21,670,000. Sri Lanka is one of the important biological hotspots in the world. Sri Lanka does not produce genetically engineered (GE) crops or animals at commercial scale, though some GE-related research is carried out at the laboratory level. Importation, distribution, or marketing of genetically modified (GM) foods and genetically modified organisms (GMOs) or related products have not been banned in Sri Lanka. Sri Lankan trade regulations require mandatory labeling of GE ingredients, GE-free certification for imported goods, and prior approval of imports for food products containing more than 0.5% (by volume) of GE-derived ingredients. Foods, which have a GE content of less than 0.5%, are exempted from these regulations if they have undergone scientific risk assessment. Sri Lanka signed the Cartagena Protocol on 24 May 2000 and ratified it on 28 April 2004. The National Biosafety Policy of Sri Lanka was developed by the Ministry of Environment in 2005. Based on this policy and in accordance with the Cartagena Protocol on Biosafety, a National Biosafety Framework (NBF) was established by the Ministry of Mahaweli Development and Environment (MoMDE), Sri Lanka, including relevant stakeholders in 2005. The project on implementation of the NBF in accordance with the Cartagena Protocol on Biosafety, funded by Global Environment Facility (GEF) is being implemented by the Ministry of Mahaweli Development and Environment of Sri Lanka through the Food and Agriculture Organization of the United Nations. The main objective of this project is strengthening policy, institutional, and regulatory frameworks for biosafety in the country. The Biosafety Act of the country has been drafted and it is to be enacted in the parliament of Sri Lanka. Under this project, a biosafety master plan has been developed and is presently under operation. The master plan addresses strengthening the technical capacity of the relevant institutions to conduct risk assessments, risk management, and risk communication. Under the Master Plan, infrastructure of key laboratories in the country will be upgraded so that they can effectively carry out biosafety-related activities required for the reliable identification and detection of LMOs. The Master Plan also focuses on supporting targeted education and outreach campaigns to raise awareness about biosafety and enhance public participation in decision-making. Completion of the drafted regulations under the Biosafety Act is necessary. It is essential to establish and operate national competent authorities and sectoral committees on GMOs in the country. Insufficient technical capacities and functional administrative and operational systems in the country delay the proper establishment of biosafety regulations in Sri Lanka.

Nigerian Biosafety Regulatory System and Its Approach to Risk Assessment and Decision Making

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The development of the Nigerian national biosafety system followed an eclectic process in which the public and private sectors contributed to the formulation of its components.

The adoption of national biosafety laws in Nigeria has provided a biosafety regulatory regime that ensures a safe and secure environment, taking into account risks to human health in the use, handling, and transport of gentically modified organisms (GMOs). Four general principles of risk assessment are considered, leading to the taking of a final biosafety decision:

- "Risk assessment should be carried out in a scientifically sound and transparent manner, and can take into account expert advice of, and guidelines developed by, relevant international organizations."
- "Lack of scientific knowledge or scientific consensus should not necessarily be interpreted as indicating a particular level of risk, an absence of risk, or an acceptable risk."
- "Risks associated with living modified organisms or products thereof should be considered in the context of the risks posed by the non-modified recipients or parental organisms in the likely potential receiving environment."
- "Risk assessment should be carried out on a case-by-case basis. The required information may vary in nature and level of detail from case to case, depending on the GMO concerned, its intended use and the likely potential receiving environment."

The final decision is taken, putting into consideration socio-economic issues surrounding the LMOs.

ABSTRACTS

PLENARY SESSION II:

BUILDING A COMMUNITY OF BIOSAFETY PRACTITIONERS

Vegetable Pest Management Practices in Bangladesh and Their Impacts on the Environment

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Agriculture plays a vital role in the economic growth and development of Bangladesh. The usage of pesticides has increased manifold since the 1960s worldwide. The use of pesticides has helped to considerably reduce crop losses and to get better yield. Agro-chemicals have become an integral part of crop production and knowledge on their use is considered to be an essential factor in gaining an optimum yield under any set of climatic conditions and production practices. Pesticide abuse is increasing in many Asian countries, with negative effects on the environment. The pesticides have been used indiscriminately in vegetable cultivation and have adverse effects on the ecosystem as well, but the actual figures are not available in Bangladesh. The farming communities are less aware of the recommended dosage and methods of insecticidal application and consequently, natural fertility of the soil is being adversely affected, soil structure is disturbed, and the water holding capacity of the soil is reduced, along with increased susceptibility to soil erosion. The farmers of Bangladesh do not have sufficient knowledge regarding the biological and economic implications associated with indiscriminate use of synthetic pesticides. Pesticides have substantially contributed to the controlling of pests and increasing crop yields, as well as in meeting the food demand of ever-increasing population and control of vector-borne diseases. Cultivation of GE crops worldwide offers enormous benefits to the environment, health of humans and animals, and contributes to the improvement of socioeconomic conditions of farmers and the public. Our recent survey indicated the economic, health, and environmental benefits of Bt-brinjal cultivation in Bangladesh. The information related to indiscriminate use of pesticides in vegetable crops and the effects of pesticides on the environment might help in finding alternative ways, through research on modern biotechnology in Bangladesh, and pave the way for developing and using more genetically engineered crops in the future. However, no systematic study has thus far been carried out to determine the pesticide residue level in vegetables to delve into the effects of pesticides on the environment and on the public health of both farmers and consumers of contaminated vegetables. Though a few studies have been conducted in Bangladesh, either based on analyzing residues or survey questionnaires, none of them applied both the methods together. In view of the adverse environmental effects from unsafe pesticide use, it therefore becomes imperative to identify farmers' pest management practices in vegetable cultivation by investigating farmers' awareness and perceptions about the effects of pesticide use in Bangladesh and to measure the residues of the pesticides.

Assessment of Weed Management Practices in Rice Cultivation in Bangladesh

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Due to climatic conditions, weeds have highly vigorous growth in rice fields in Bangladesh. Weed management here includes manual weeding and herbicide application. The traditional methods of weed control by smallholders include hand weeding by hoe and hand pulling. Usually, two or three hand weedings are done for growing a rice crop. However, especially at the time of peak period of labor demand, weeding often is done late, causing drastic losses in rice yield. Small farm families are typically unable to do all their own weeding and need to hire labor. Getting labor on time and their financing is an issue. On average, the gap in rice yields in farmers' fields due to poor weed control in Bangladesh was determined to be 43-51%. However, the lack of nationwide data on the relative contribution of weed management practices is lacking. Therefore, the goal of the project is to determine the relative contribution of weeding methods and any their drawbacks in order to identify the scope of intervention. Specific objectives include: (1) to assess the current importance of herbicides in weed management strategies of rice farmers in Bangladesh, (2) to find out whether herbicide could contribute to productivity enhancement, (3) to assess the availability and prices of rice herbicides on rural markets to understanding of any drawbacks/ weaknesses of herbicides perceived by farmers, (4) assessment of farmers' knowledge on herbicide usage list of weeds resistant to presently used herbicides (identified by farmers) under current rice farming practices. The data generated in this project will be helpful in deciding which methods to be promoted or a new approach needs to be undertaken to sustain rice production. These may reveal the possible suitability of herbicide-tolerant transgenic rice.

Use and Handling Practices of Agrochemicals Used in the Cultivation of High Yielding Potato Varieties in Bangladesh

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Adoption of "Green Technology" to increase crop productivity in agriculture is gaining popularity. However, diffusing HYV and GM crops has created enormous concerns due to intensive chemical inputs that render potential risks of genetic erosion and environmental degradation endangering the sustainability of crop-based agricultural production systems. Therefore, feasibility assessments for introducing GM crops is relevant to combat food shortages sustainably. Nevertheless, data on use, compositions and handling practices of pesticides used in the non-transgenic crop is important to assess the future potential environmental impacts of the same transgenic crops. Potato (*Solanum tuberosum* L.) is one of the most important vegetable crops in Bangladesh, ranking among the top four food crops. Considering the trend of population growth and consequently, the increased demand for food and dwindling cultivable land area in the country, the introduction of genetically engineered potato resistant to diseases may play an important role in achieving food security in the future. However, before adopting GM potato, it is important to have baseline information on use, composition, and handling practices of agrochemicals (fertilizers and pesticides) for cultivating high yielding potato varieties in Bangladesh in order to inform future assessments of the likely use of the GM potato and their potential impact. A cross-sectional study will be conducted to collect data from farm level surveys among the high yielding potato growers. A multi-stage stratified random sampling design will be followed to select farmers from the districts—those are sub-divided into 3 strata: high, medium and low productivity districts. A total of 600 farmers, including 200 from each of the stratum, will be selected for data collection.

ABSTRACTS

PLENARY SESSION III:
RATIONALIZING RISK ASSESSMENT AND REGULATION OF LOW RISK ACTIVITIES

Understanding the Concept of Proportionality – Low Risk Activities and the Future of Biosafety Regulation

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The use of formal risk assessment processes to inform decision making is a relatively new development, taking shape in the latter half of the 20th century. As the field has matured, it has become clear that a "one size fits all" approach is not only scientifically unjustified but can also be an impediment to achieving management goals. But how do we predict which activities are inherently low risk and which activities deserve more scrutiny? This presentation will explore the basic toolkit available to risk assessors and policy makers, in the context of the last three decades of biosafety experience to provide insight into what we know about the interactions between organisms and the environment and how this can inform our risk assessments and regulatory processes.

Gene-Edited Crops – Need for Rationalized and Proportionate Risk Assessment and Regulation

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Gene editing enables targeted, precise, and efficient improvement of commercially important agricultural crops without introducing transgenic DNA (from different, sexually incompatible species) into the final product and unquestionably is a breakthrough plant breeding innovation. Globally, the discussions on how to regulate gene-edited crops are anchored in evaluation of applicability of the existing biotechnology/GMO regulatory frameworks and risk assessment procedures. Process-based regulatory approach focuses on the biotechnological processes that are used to alter crop DNA and is based on the precautionary principle of anticipating hazards rather than actual risks associated with the given category of products. Conversely, the product-based approach assesses the resulting crop plant and introduced traits, not the process used to create it, and is risk-based and aimed to minimize harm whenever existence of such harm is demonstrated scientifically. Several North and South American countries are paving the way for clarifying or adopting science-based and risk-proportionate regulatory policies for gene edited crops and removing regulatory uncertainty. Their approaches define no novel combination of genetic material under applicable laws if the same genetic change is also capable of being obtained through older breeding methods and hence, carries a similar risk profile. The EU Supreme Court of Justice decision that products of new mutagenesis techniques are not exempted from the GMO regulatory oversight and the risk assessment procedure exemplifies a precautionary principle and puts identical products into different regulatory categories solely based on the production method. In India, the definition of genetic engineering as in Rules, 1989 of EPA 1986 is very broad based and include technologies resulting in "modification, deletion or removal of parts of heritable material". This implies that products of all new biotechnologies, including gene editing, could be subject to regulation under provision of Rules, 1989, even if they could not be distinguished from their conventionally bred counterparts. In our view, crops developed through gene editing should not be subject to different or additional regulatory oversight than conventional varieties if they could also be obtained through earlier breeding methods or found in nature. In this talk, we focus on the need for scientific and risk-proportionate regulatory system, consistent with risk considerations for products of conventional breeding, to enable the broad application of gene editing technology to successfully bring the gene-edited products to market.

Efficient Resistance to BmNPV Infection by Transgenic Silkworm (*Bombyx mori*), as Demonstrated by Multilocational Contained Trials

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The development of transgenic organisms, in order to have sustainable applications in sericulture, turned out to be an emerging technology. The three fundamental requirements of sustainability *viz.,* economical, environmental, and social benefits are carefully considered during the development of silkworm *Bombyx mori*, which is resistant to Bombyx mori Nuclear Polyhedrosis Virus (BmNPV). BmNPV infection causes around 40-60% of the total cocoon crop loss in India, resulting in economic set back to the farmers. The transgenic silkworms were developed using RNA interference technology and have exhibited effective resistance to induced infection, viral genes *viz.*, *ie1*, *lef1*, *lef3*, and *P74* were targeted to achieve resistance. Further, commercially viable transgenic strains CSR2 and Nistari were developed by recurrent back crossing. With close vigilance on environmental impacts under contained conditions, the identified hybrids [PM x CSR2 Tg; CSR2 Tg x CSR4 and Nistari Tg x (SK6 x SK7)] were tested for efficacy of resistance and various silk parameters. Results have shown a 20-30% increase in pupation rate in the transgenic hybrids as compared to controls, leading to economic advantage. The major positive outcome predicted from the study are the social benefit and exposure to the transgenic silkworm had no health effects on the facility personnel and is not expected to do so at the level of farmers as well. The substantial increase in silk production helps the farmers to take up silk farming as an option and which will have a significant social impact on sericulturists. Our expanded studies are now being carried out to address, environmental, economic, and social benefits on a larger scale, with greater farmer participation. This study ensures complete risk analysis for a sustainable future with respect to silkworm rearing farmers and will further substantiate the advantages of transgenic silkworms in sustainable applications.

Biosafety Analysis of GE Crops - Our Experience with Mustard

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The South Asia region has a very high population density. While in the developed world, only 2-4 percent of the population is based on agriculture, this percentage is very high—around 50 percent—in South Asia. Countries of this region require low input–high output agriculture, with low input both in terms of monetary inputs and natural resource inputs. The challenge of higher yields and resistance to pest and pathogens can only be met with effective use of new developments in science and technology. I will present some examples from our work on oilseed mustard (*Brassica juncea*), where we have combined conventional phenotype-based selection, marker-assisted breeding, and genetic engineering technologies to achieve major breeding goals of higher yield, disease resistance, and quality improvement. We have used GE methods specifically for hybrid seed production and improving oil and meal quality. I will discuss our experience of conducting biosafety studies on GE events and will argue that in some cases, like RNAi and antisense RNA based transgenics, elaborate biosafety tests are not required. Most of the CRISPR/Cas based genetic engineering is also safe and does not require any biosafety tests. Many have called for hypothesis-driven biosafety analysis—prudence lies in following this approach. Senseless data collection is not going to placate anti-GM ideologues.

ABSTRACTS

PLENARY SESSION IV:
BIOTECHNOLOGY RESEARCH AND DEVELOPMENT IN SOUTH ASIA

Development of a Novel Salt-Tolerant Transgenic Indica Rice Plant Through Manipulation of the Inositol Metabolic Pathway

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Halophytes are rich sources of salt stress tolerance genes which have often been utilized for introduction of salt-tolerance character in salt-sensitive plants. In the present study, we overexpressed a novel salt-tolerant myo-inositol synthase (MIPS) coding *PcINO1* and inositol methyl transferase (IMT) coding *PcIMT1* gene(s), earlier isolated and characterized in this laboratory from wild halophytic rice *Porteresia coarctata*, into IR64 *indica* rice either singly or in combination and assessed their role in conferring salt-tolerance. Homozygous T3/T4 transgenic plants revealed that PcINO1 transformed transgenic rice lines exhibit significantly higher tolerance, upto 200 mM or higher salt concentration, with negligible or no compromise in their growth or other physiological parameters compared to the untransformed system grown without stress. The PcIMT1-lines or the double transgenic lines (DC1) having *PcINO1* and *PcIMT1* introgressed together, were less efficient in such respect. Comparison of inositol and/or pinitol pool in three types of transgenic plants suggests that plants whose inositol production remains uninterrupted under stress by the functional salt-tolerant PcINO1 protein, showed normal growth as in the wild-type plants without stress. It is conceivable that inositol itself acts as a stress-ameliorator and/or as a switch for a number of other pathways important for imparting salt-tolerance. Such selective manipulation of the inositol metabolic pathway may be one of the ways to combat salt stress in plants.

Transforming a Local Rice Variety Using HVA-1 Promoter to Demonstrate Over Expression of *OsDREB2A* Gene Under Drought and Salinity Stress—A Laboratory Experience in Accommodating Transgenic Research in Sri Lanka

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This presentation will be done in three segments. The first part will be on the project in brief to show how the gene transfer and the *in vitro* production of the new genetically modified rice plant was produced. The second part will be on the professionals' and institute's contribution to supporting the project in a situation where very little facilities were available at the time of the initiation of the work. The third part will be about the barriers that exist to going forward to the next level of this project with concerns and understanding towards genetically modified organisms of different sectors of people in the country.

Rice has been the staple food of all Sri Lankans as long as the existence of the nation is known. Rice and rice products are the most consumed food among Sri Lankans. Hence, the cultivation of rice is the main agricultural activity of Sri Lankan farmers. Their paddy productions suffer huge damages, often due to drought and salinity. These two abiotic stress factors act as environmental stimuli to induce expression of abiotic stress responsive genes via the action of transcription factors that are sensitive to the environmental conditions. In this project, the *OsDREB2A* gene was isolated from an *indica* rice variety and a HVA-1 like promoter was isolated from another source. A third local rice variety was transformed using a new gene construct to exhibit phenotypic expressions towards drought conditions and high salt conditions. The institute that supported this work is Sri Lanka's very first gene technology company- GENETECH. Experts from the University of Colombo were involved in the project along with the GENETECH staff. This work was funded by ICGEB Trieste through the CRP program.

Improvement of Grain Legumes through Biotechnology

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Grain legumes or pulses have been considered as an important source of dietary proteins for many developing countries of the world. Legumes have been cultivated as a major food crop since the early days of agriculture. These crops are important as they all produce grains with high protein content useful for human and animal nutrition. Apart from this nutritional quality, they have the unique symbiotic ability in utilizing atmospheric nitrogen for plant growth, making them preferable crops for sustainable agriculture. In many developing nations of the world, grain legumes have gained much importance in view of the acute shortage in production of animal proteins and due to the wide prevalence of protein malnutrition.

Several grain legumes, including lentil, chickpea, mungbean and peanut are being grown and consumed in Bangladesh and in other South Asian countries. However, these crops are usually characterized by low yield potential due to susceptibility to various diseases and pests. The production of these crops also suffered due to abiotic stresses like drought and salinity. Due to narrow genetic base and non-availability of resistant source among the existing germplam of the above-mentioned grain legumes, the application of conventional breeding techniques did not yield desired results in the past towards the development of biotic and abiotic stress resistance in these crops. Under these circumstances biotechnological approaches have been considered for the improvement of these important grain legume crops.

Biotechnological research, particularly plant genetic transformation, has been carried out for the improvement of lentil, chickpea, peanut, and mungbean at the Department of Botany, University of Dhaka. Research has been conducted for *Agrobacterium*-mediated genetic transformation to integrate a fungal disease-resistant gene into microsperma varieties of lentil and peanut. Earlier complete protocols for *Agrobacterium*-mediated genetic transformation was established by utilizing *GUS* and *nptII* genes. Moreover, research have been carried out for the development of yellow mosaic virus (MYMV) resistance in mungbean and abiotic stress tolerance in chickpea. The results obtained through these investigations will be very useful in developing future genetic modification towards the development of stress tolerance in these crops.

Colocasia esculenta Tuber Agglutinin, a Newly Characterised Non-Allergenic Protein Provides Resistance to Indian Mustard Against Most Devastating Sucking Insect, Mustard Aphid

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Purpose: *Lipaphis erysimi*, commonly known as mustard aphid, is the most devastating sucking insect pest of Indian mustard (*Brassica juncea* L.). Due to its unique feeding habit, it is difficult to control by presently available control measures. However, our group identified that *Colocasia esculenta* tuber agglutinin (CEA), a *Galanthus nivalis* agglutinin related mannose binding lectin, is effective against above mentioned sucking insect. Hence, the present study has been conducted to monitor the efficacy of CEA in controlling the target insect.

Methods: CEA coding sequences were cloned in plant transformation vector followed by establishment of transgenic *B. juncea* plants. After determining the stable integration of the gene through molecular techniques, expression of CEA in T2 transgenic plants was confirmed through western blot.

Results: Expression of CEA in the T2 transgenic *B. juncea* was detected at the level of 0.2 to 0.47% of total soluble protein. In the *in planta* insect bioassays, CEA expressing *B. juncea* lines exhibited insect mortality as high as 70–81.67% and fecundity of *L. erysimi* was reduced by 49.35–62.11% compared to the vector control transformed plants. Biosafety assessment of the transgenic *B. juncea* protein containing CEA was carried out by weight of evidence approach according to the recommendations of Food and Agricultural Organisation, Codex Alimentarius. Bioinformatic analyses, pepsin digestibility, thermal stability assay, immuno-screening and allergenicity assessment in BALB/c mice demonstrated that the expressed CEA from transgenic *B. juncea* does not incite any allergenic response.

Conclusion: Present study clearly establishes CEA as an effective insecticidal and non-allergenic protein that may be utilized for controlling not only mustard aphid but other such hemipteran insects through development of genetically modified plants.

Okra Cultivation in Bangladesh: Major Challenges and Opportunities

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Okra is a popular vegetable and rich source of vitamins and minerals, as well as phytochemicals, consumed throughout the world. However, the production rate of okra per square area in Bangladesh was lower than that of other countries due the heavy infection (50-94%) with Yellow vein Mosaic Virus (YVMV) and Enation Leaf Curl Virus (ELCV). Both viruses belong to the *Begomovirus* genus of the family *Geminiviridae* transmitted by white fly *Bemesia tabaci*. Farmers are using various pesticides two-three times per week in the okra fields to control the vectors. It is difficult to control viral vectors with the foliar application of pesticides that could be harmful for human health and ecosystems. Experimental results showed that among the 23 varieties cultivated, no varieties were found to be resistant to viral diseases. In the farmers' fields, about 2~85% of okra plants were found to be infected in the Rajshahi region. In field performance evaluation, *Shamol bangla* (local) was the high yielding (520 gm/plant) variety with virus incidence of 45% followed by BARI-1 and *Orka anamika* (India). Based on the nutritional, phytochemicals, and medicinal values of the 10 cultivated okra, *Shamol bangla* was found to the nutrient rich variety. It showed the strongest antioxidant, antibacterial, antifungal, and anti-diabetic activity. RAPD and SSR profiling revealed the phylogenetic relationship of 23 cultivated varieties that had three clades with local, hybrid, and wild varieties. The YVMV was successfully characterized at the molecular level, which will be useful for genome editing technology for developing virus resistant okra in the future. Using mutation-breeding technology, we have already developed seven lines of okra that were resistant against YVMV & ELCV in open field condition. We also identified few unique bands on the RAPD profiles of mutant lines that could be responsible genes for resistant okra lines against both viruses. In the future, SCAR and SSR markers will be developed for identifying the YVMV resistant loci of the mutant okra lines, which will be used for MAS selection for breeding program in Bangladesh.

ABSTRACTS

PLENARY SESSION V:
PLANNING AND PERMITTING FIELD TRIALS FOR NOVEL ORGANISMS

Target Malaria's Field Entomology Preparedness for the First Releases of GM Malaria Mosquitoes in Africa

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Every year, Malaria affects approximately 200 million and kills approximately 435 thousand people worldwide, most of them African children under the age of five years (WHO, 2017). In many countries, progress in malaria control has been threatened by the rapid spread of resistance to antimalarial drugs and insecticides. Target Malaria is a not-for-profit research consortium that aims to develop and share new genetic vector control tools for integrated malaria control strategies. The consortium brings together researchers from 14 institutions worldwide to develop high impact, well-organised, and large-scale malaria control campaigns involving genetic modification of mosquitoes.

This presentation will focus on Target Malaria's field entomology preparedness in 3 African partner countries endemic for malaria, namely, Burkina Faso, Mali, and Uganda. These include the establishment of extensive longitudinal baseline entomological surveys; technical and analytical improvements on mark release recapture studies; the development of medium-throughput assays for post-release GM mosquitoes monitoring, all of which inform regulatory dossier release protocols.

Alongside extensive stakeholder engagement activities, field entomology activities play a crucial role in the stepwise preparedness approach advocated by regulators that paved the way to the first release of GM *Anopheles gambiae* s.l., conducted in Burkina Faso in 2019.

Comparative Fitness Assessment of RNA Interference-Based Transgenic *Aedes aegypti* Resistant to Dengue Virus Transmission in a Contained Facility in Sri Lanka

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Germ-line transformation has become a powerful tool for the development of transgenic organisms to combat genetic diseases, viruses, pathogens, etc., and similary, insect genetic technologies have been used to combat the spread of insect-borne diseases. To set up insect transgenic technologies in Sri Lanka, we developed an Arthropod Containment Level-2 (ACL2) facility with a microinjection system guided by biosafety protocols to minimize the risks and environmental release of such insects. This facility was then used to maintain the dengue virus resistant transgenic *Aedes aegypti* strain developed by us using RNA interference (RNAi) technique. This mosquito expresses four different synthetic multiple miR-shRNAs (microRNA based shRNA) under the control of *Ae. aegypti* Carboxypeptidase A (Ae.CPA) promoter and simian virus 40 terminator (SV40), following the blood-meal induction of Ae.CPA in the midgut and salivary glands. The development of this transgenic mosquito (TM) was achived by transfecting *Ae. aegypti* mosquito eggs with synhesized Ae.CPA/multiple miR-shRNAs/SV40 cloned into a plasmid containing DsRed florescent reporter gene and PiggyBac transposase expression plasmid using microinjection. First generation of TM was identified by the expression of DsRed florescent protein in ommatidium units of eyes and nested PCR that detects genomic integration of the transgene. The expression of blood meal induced miR-shRNAs in TM and wild mosquitoes (WM) was then analyzed using extracted siRNA and sequence specific qPCR assay. TMs were maintained under ACL2 condition at 28°C temperature, 72-80% relative humidity, under a 14-15 hr light and 9-10 hr dark cycle while feeding larvae until it became pupae with WHO recommended larval food and adults with 10% glucose solution. Dengue challenging assays were carried out with dengue virus (serotype 1, 2, 3, and 4) infected blood in the ACL-2 facility and under biosafety conditions. Viral RNA expression-based qPCR and dengue virus NS1 antigen expression based on immunohistochemistry indicated remarkable reduction of virus infection rates and NS1 antigen expression in serotype 2 and 4 in TM compared to wild mosquitoes (WM). Laboratory fitness assessments were conducted in the ACL2 facility and semi-field trials were conducted in a closed environment with large semi-field cages. The measurement of laboratory fitness of TM in comparision to WM indicated the slight reduction in fecundity, larval and adult mortality, and larval and adult development rates. Semi-field trials and laboratory trials based on the assessment of mating competitiveness of TM in comparision to WM indicated reduced competitiveness in TM than WM. Finally, TM having integrated exogeneous multiple miRshRNA produced in this study could exert RNAi to resist the transmission of dengue serotype 2 and 4 in spite of slight reduction of fitness as in the case of all known TM.

We acknowledge the National Research Council of Sri Lanka (TO 14-04) for funding and International Atomic Energy Agency (IAEA SRL5/047) for technical co-operation.

Achievements in Genetic Transformation of a Tree Crop and Obstacles for Field Trial: The Case of Natural Rubber (*Hevea brasiliensis*) from India

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Transgenic research in *Hevea brasiliensis* started in the Rubber Research Institute of India (RRII) in the late 1990s, originally in collaboration with the University of California. Binary vector constructs of superoxide dismutase, Sorbitol-6-phosphate dehydrogenase and Iso pentenyl transferase genes were made and *Agrobacterium* mediated transformation was initiated in *Hevea*. The protocol was optimized at RRII and GM rubber plants incorporated with the MnSOD gene, sourced from natural rubber itself, were developed at RRII. GM rubber plants incorporating genes such as, Osmotin, hmgr 1, Sorbitol-6-phosphate dehydrogenase, Iso pentenyl transferase, and Hsp31, etc. were subsequently developed at RRII. The Osmotin gene was sourced from tobacco and the Sorbitol-6-phosphate dehydrogenase gene was sourced from apple. Iso pentenyl transferase is a bacterial gene cloned from *Agrobacterium tumefaciens* and Hsp31 was sourced from *Saccharomyces cerevisiae.*

Gene integration and expression in rubber plants was confirmed by PCR analysis, Southern and Northern hybridizations, as well as by assessing expressed proteins. Laboratory studies using transformed plants indicated desired phenotypic performances as expected from the genes used in transformation.

With a view to develop antibiotic marker-free transgenic rubber plants, a transformation vector with heat inducible Cre-loxP system was synthesized in collaboration with the University of Arkansas during 2012. Functional validation of the transformation vector was carried out in tobacco before producing marker-free transgenic rubber plants.

The high levels of phenols and other secondary metabolites, as well as the recalcitrant nature of the explants posed major challenges to both genetic transformation and the subsequent regeneration. We could successfully perfect the protocol by modifying the tissue culture regime, using the target tissue at the right physiological stage and identifying efficient *Agrobacterium* strains. The main challenge with genetic transformation of this tree species was achievement of high transformation efficiency in desired cultivars and efficient plant regeneration after transformation. A critical step in *Agrobacterium* mediated transformation and transgenic tissue regeneration in *H. brasiliensis* was the establishment of optimal conditions for T-DNA delivery into the infected tissue and tissue recovery without bacterial overgrowth.

Transgenic plant development from materials of clonal origin (budded plants) was cumbersome due to low frequency of transformation and low regeneration potential compared to seedlings. The long time lag in the conversion of transgenic cell lines to embryogenic callus, developmental abnormalities (abnormal embryos and plantlets) and plant hardening were also major hurdles. The total time required to regenerate a plantlet from transformed cells is about two years. The further hardening process requires six months. While the efficiency of transformation varies from 0-30%, the success rate of hardening is only 0-2%.

When RRII developed GM rubber in 2003, it was the first ever genetically modified rubber plant produced anywhere in the world and GM tree species in India. The Genetic Engineering Appraisal Committee of Government of India gave approval for taking up a field trial with MnSOD GM rubber plants in two Indian states, but no NoC was obtained from these states. Later, NoC for GM trial in Assam was obtained from the Assam state Government and permission for taking up the field trial is now pending before GEAC.

There have been several technical constraints in developing GM plants in a tree species like *Hevea*, which we have successfully overcome. However, there are still some policy issues, which are coming in the way of taking GM rubber plants into the field.

Planning Field Trial of Transgenic *Artemisia annua* L. - A Source of Novel Antimalarial Drug

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Artemisia annua L., is an aromatic annual herb. It belongs to the family *Asteraceae*. Its stem is erect,ridged and green, yellow green, or violet green, but becomes brown or violet brown in the late growth stage. In the wild, it attains 30 to 150 cm height but can reach up to 300 cm under cultivation. The leaves are green or yellow green. They have short petioles, are oval in shape, and tripinnately divided into small, elliptical, lanceolate leaflets. The flowers are yellow, with globe like flower heads. The leaf, stem, and floral appendages are covered with glandular and non-glandular trichomes. The former trichomes are the the sites for the synthesis and storage of artemisnin, a sesquiterpenoid lactone with strong antimalarial activity. The plant is native to Asia, most probably China. However, it grows wild in many countries such as USA, Argentina, Bulgaria,France, Hungry, Romania, Italy, Spain, and Yugoslavia. It has now been cultivated in India, Vietnam, and China as an industrial crop.The plant has high adaptability to different agro-climatic conditions and could be grown in most types of well drained soil with pH ranging between 4.5 and 8.5. It is a highly cross pollinating species.

Due to resistance in malarial parasite *Plasmodium* species to the quinine based antimalarial drugs, WHO in the year 2002 recommended the use of artemisnin based combination therapy (ACT) for the treatment of malaria. Since artemisnin concentration is very poor and varies from 0.1-0.6 % in the leaves of *Artemisia annua*, there is a huge gap between demand and supply for the production of ACTs. Consequently, the cost of ACTs became high and unaffordable by the people living in Southeast Asia and Africa that are endemic to malaria. Scientific efforts, therefore, have been made worldwide to increase artemisnin content in the leaves of the *Artemisia annua* plant by developing varieties with high artemisnin content through breeding and genetic engineering approaches. We have also developed a transgenic *Artemisa annua* variety with 1.2% artemisnin by overexpressing *HMGR* and *ADS* genes driven by ubiquitin and 35S promoters. The ubiquitin promoter and *HMGR* as well as *ADS* genes used by us in this study were of plant origin. We planned field trials of this variety and got approval from GEAC, Ministry of Environment and Forests, Government of India. The key parameters for field trials and the challenges faced during this process will be discussed.

Social Mobilization Strategy Towards Positive Regulatory Outcome of the Golden Rice Field Trial Application in the Philippines

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Creating an enabling environment for regulatory approval is a necessary step towards fostering widespread public acceptance and adoption of transgenic biofortified food crops like Golden Rice. In the Philippines, public participation has been embedded as a crucial element of the national biosafety regulatory framework under the new Joint Department Circular (JDC) No.1, Series of 2016. Golden Rice is the first crop to undergo field trials under this new regime; as such, an examination of the initiatives undertaken to ensure public participation and secure approval may provide insight into effective stakeholder engagement practice for regulatory applications and policy advocacy.

This paper unpacks the local social mobilization strategy implemented by the proponents of the Golden Rice Project in the Philippines, led by PhilRice, to raise stakeholder awareness of, (policy) support, and ownership for the project through the inform, engage, and commit (IEC) framework: 1) INFORM - conducted dialogues and briefings for local stakeholders about the project and how it can address a social problem (i.e., vitamin A deficiency), its adherence to due process, and credibility of the proponents; 2) ENGAGE - cultivated and mobilized local champions to testify to the project's relevance to community needs, and 3) COMMIT - expanded outreach activities to demonstrate commitment to community welfare beyond the project lifecycle. Results indicate positive regulatory outcomes. Local resolutions from the local government units (LGU) to support the conduct of the Golden Rice field trial in their areas were acquired, and finally, biosafety permit Number 10-001 was issued by the Bureau of Plant Industry (BPI), a biosafety regulatory body under the Department of Agriculture. This enabled the Philippine Golden Rice project team to officially commence field trials in PhilRice San Mateo, Isabela and in PhilRice Central Experiment Station (CES), Nueva Ecija, as witnessed by regulators from BPI and Department of Health (DOH) and authorized persons from the community, LGU, and PhilRice.

ABSTRACTS

PLENARY SESSION VII:
PUBLIC SECTOR GE CROP DEVELOPMENT AND DEPLOYMENT

Impacts of Bt Brinjal (Eggplant) Technology in Bangladesh

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Brinjal (eggplant) is a high-value crop widely grown and consumed in Bangladesh. Brinjal is highly vulnerable to the fruit and shoot borer pest, and farmers spray the crop heavily with pesticides. Farmers' spending on pesticides reduces their income, and increased pesticide use heightens their risk of contracting pesticide-related illnesses and facing related medical costs. Developing modern, pest-resistant crop varieties can help tackle these issues.

In 2017-2018, IFPRI and the Government of Bangladesh partnered to estimate the impacts of Bt brinjal on production systems, producer welfare, and health outcomes.The study was designed by IFPRI's Bangladesh Policy Research and Strategy Support Program (PRSSP), implemented by the Ministry of Agriculture under the Department of Agricultural Extension (DAE) and the Bangladesh Agricultural Research Institute (BARI), and coordinated by the Agricultural Policy Support Unit (APSU).

This keynote presentation will feature the Bt brinjal research design and key results from the impact evaluation on key outcomes.

Genetically Engineered Crop Development and Deployment in Africa: The Case of Pod Borer Resistant (PBR) Cowpea

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Cowpea (*Vigna unguiculata* Walp) is a major food and animal feed crop in Africa. Cowpea production is inhibited by the legume pod borer (*Maruca vitrata* (*Lepidoptera: Crambidae*)), which is the most significant insect pest of the crop. Development of cowpea varieties resistant to damage by *M. vitrata* by traditional breeding was not successful and the management of the insect pest relies on use of synthetic insecticides, which are often ineffective. In search for a more viable tool for control of *M. vitrata*, AATF, in collaboration with public/private organizations, is implementing the development and deployment of transgenic cowpea that possesses resistance to *M. vitrata* via expression of the Cry1Ab insecticidal protein from *Bacillus thuringiensis* (Bt). The PBR cowpea was produced by *Agrobacterium tumefaciens*-mediated transformation of organogenic explants derived from embryo axes of mature seed with plasmid pMB4 resulting in the introduction of the *cry1Ab* gene from *B. thuringiensis* subsp. kurstaki strain HD-1 and the neomycin phosphotransferase II gene (nptII) from *Escherichia coli* as a selectable marker. Cowpea variety IT86D-1010 was transformed and several Bt-Cry1Ab expressing events were tested under severe artificial infestation. Following the efficacy tests in confined environment, event 709A was selected as a parental line to introgress the Bt trait into farmer-preferred varieties. In confined experimental field trials and in confined farmer-managed field trials, PBR-cowpea consistently gave higher grain yields (20-80%) than the conventional cowpea variety and reduced the need for insecticidal sprays from 6-10 to 2 per season. The Nigeria

National Biosafety Management Agency (NBMA) has reviewed the regulatory dossier and issued permit for commercial release of the product in Nigeria, and the product is advancing towards deployment and cultivation by farmers.

Role of the Public Sector in Transgenic Research

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The huge success of Bt cotton in India has paved way to successful transgenic production for various traits in crop plants. It included not only the amenable crops for genetic transformation, but also difficult to maneuver crops for transgenic production. Public sector organizations in India have focused and succeeded in the production of genetically modified lines from the genotypes under cultivation *in vogue* that are agronomically superior and ready to be accepted by farmers. These genotypes *in vogue* need short time of breeding for development of a final product. The transgenes of interest are either borrowed or synthesized by many public sector organizations. One of the challenges is that the terms and conditions at the time of obtaining transgenes allowed free operation for public sector, but later there were unforeseen limitations for product development. In addition, high budget requirements for biosafety assessment in the development of the GM product imposed reservations on proceeding further with field trials. In the case of those gene constructs synthesized domestically, the need for elaborate biosafety evaluation for the transgene involving huge costs and long time periods was another difficulty.

Sorghum is fifth most important cereal crop cultivated by marginal farmers of dry land agriculture systems and one of the difficult to transform crops. At the ICAR-Indian Institute of Millets Research, Hyderabad, India, successful transgenic production and identification of promising lines for resistance to sorghum stemborer were achieved after intense efforts. Initial contained field evaluation for a couple of transgenic events was conducted; however, they could not be taken further due to policy restrictions of biosafety evaluation in India.

Genome editing technologies with a possibility to obviate biosafety procedures coupled with *in planta* genetic transformation and/or back cross breeding for a couple of cycles can help in overcoming unintended changes/off-target activity and can motivate transgenic research and products in future.

Development of Cassava Brown Streak Disease Resistant Cassava Event 4046

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Cassava production in Eastern and Central Africa is constrained by two viral diseases, cassava mosaic disease (CMD) and cassava brown streak disease (CBSD). While resistance is available against CMD, robust resistance to CBSD has, to date, not been identified in the existing cassava germplasm. CBSD is caused by two whitefly-transmitted virus species: Cassava brown streak virus (CBSV) and Ugandan cassava brown streak virus (UCBSV). This serious virus disease causes necrotic root rot, rendering affected storage roots unsuitable as food or feed. Stems of infected plants carry the virus into the next crop, since cassava is propagated by stem cuttings, exacerbating the dissemination and damage from CBSD. Through a collaborative project between the Kenya Agricultural and Livestock Research Organization (KALRO), the National Crops Resources Research Institute (NaCRRI) of Uganda, and the Donald Danforth Plant Science Center (DDPSC, USA), cassava event 4046 has been developed, which demonstrates robust resistance to CBSD. The resistance is based on ribonucleic acid interference (RNAi) gene silencing of CBSV and UCBSV coat protein (CP) genes. Event 4046 was produced via *Agrobacterium*-mediated genetic transformation of cassava cultivar TME 204 with plasmid p5001, to integrate an inverted repeat of near full-length CP genes cloned from CBSV and UCBSV fused in tandem to target both virus species. Event 4046 was selected based on resistance to CBSD and other desirable agronomic characteristics. Event 4046 cassava has been through multiple regulatory field trials in both Uganda and Kenya and the necessary regulatory studies have been completed. Applications for general environmental release and placing on the market are planned for submission to Kenyan and Ugandan regulatory authorities in the fall of 2019. The approval and subsequent introduction of new varieties containing event 4046 will address one of the most significant constraints to cassava production and improve smallholder incomes in Kenya and beyond.

Bringing Bt Eggplant to Resource-Poor Vegetable Farmers in Bangladesh and the Philippines

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In 2003, a public-private partnership was formed between Mahyco, Cornell University, Sathguru, the United States Agency for International Development, and public sector partners in India, Bangladesh, and the Philippines under the Agricultural Biotechnology Support Project II (ABSPII). ABSPII ended in 2014 and a new agreement was awarded in 2015 under the USAID-funded Feed the Future South Asia Eggplant Improvement Partnership. Its main objectives were to scale up Bt eggplant to Bangladeshi farmers, provide capacity building within Bangladesh agricultural institutions, and work with the University of the Philippines-Los Baños to develop, submit, and shepherd a regulatory dossier for the Philippines that meets international standards.

In 2014-15, the Bangladesh Agricultural Research Institute (BARI) provided seeds or transplants to its On-Farm Research Division (OFRD) to conduct research/demonstration trials on 108 farmer fields in 19 districts. Adoption has grown annually. In 2017-18, BARI provided seeds to 581 farmers in 40 districts and seeds were distributed to farmers through the Department of Agricultural Extension to 7,601 farmers in 2017-18, and for sale through the Bangladesh Agricultural Development Corporation to an additional 19,430 farmers, making a total of 27,612 farmers in 2018. The BARI team has been trained on Excellence Through Stewardship practices as part of our capacity building efforts.

Studies in Bangladesh have documented that Bt eggplant provides virtually complete control of the eggplant fruit and shoot borer (EFSB), dramatically lowers pesticide use, reduces overall production costs, increases yields and profits, and reduces exposure to toxic pesticides. Studies have also documented the lack of effects on non-target organisms, developed treatment guidelines for other arthropod pests and documented the baseline susceptibility of EFSB populations to the protein expressed in Bt eggplant. Similar studies have occurred in the Philippines where efforts are underway to submit a regulatory dossier so Filipino farmers can reap similar benefits.

ABSTRACTS & SPEAKER BIOGRAPHIES

LIGHTNING ROUND

FOR STUDENTS AND EARLY CAREER RESEARCHERS

A Preliminary Survey on Sri Lankans' Knowledge and Understanding of Biosafety and GMOs

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Biosafety and Biotechnology are new subject areas for Sri Lankans. In the country, debates are progressing among scientists on the benefits and potential risks of biotechnology. A study was conducted to ascertain the understanding, knowledge, and perceptions of different stakeholders on genetically modified organisms and foods (GMO/GMF). Given the heterogeneity of the public, the following were chosen to represent the Sri Lankan population: government officials, farmers, scientists, educators, growers, importers, environment-related organizations, the general public, and media. The research was conducted using the mixed-mode methodology of both qualitative and quantitative. A general questionnaire, focus groups discussions, and key informant interviews were undertaken. Responses from different stakeholders were gathered and statistically analyzed.

Among the surveyed segments of the society, government officials and the education and research community had the highest level of knowledge on GMOs. Among the other stakeholder groups, more than 50% showed a poor understanding of GMOs. Growers and importers, biotech-related organizations, media, and some fractions of the general public were uncertain about the difference between genetic engineering and conventional breeding techniques. More than 60% of participants in all sectors believe GMO products are available in Sri Lanka. The majority of 68% of participants think that Sri Lanka would benefit from GMOs if they are proven safe. Overall, results revealed that there is a significant knowledge gap in the areas of biotechnology and biosafety, which leads to misconceptions. This survey, although preliminary in nature due to its scale and size of respondents, suggests that vigorous public awareness programmes are needed to provide science-based and accurate information on GMOs and biosafety. Social media and television came out as the most sought after resource where Sri Lankans seek information on GMOs and biosafety. This study will provide the baseline information for the development of Sri Lankan public awareness strategy for biosafety and GMOs.

Mihiri Kandanarachchi has a B.A. from Limkokwing University, Cyberjaya, Malaysia and MBA from Cardiff Metropolitan University, Cardiff, UK. Mihiri has seven years of work experience in marketing and awareness creation. At present, Mihiri is working as a Public Awareness Outreach Strategy Implementation Specialist for the Food and Agriculture Organization of the United Nations in Sri Lanka. Mihiri has worked in the biosafety area for past one and half years, providing her expertise and knowledge in awareness and public outreach to support the FAO/GEF project "Implementation of the National Biosafety Framework in accordance with the Cartagena Protocol on Biosafety." implemented by the Ministry of Mahaweli Development and Environment Ministry, Sri Lanka.

DNA Barcoding and Characterization of Non-Edible Oil Feedstock with Potential for Biodiesel Production in Bangladesh

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Energy security, fluctuating petroleum prices, resource depletion issues, and global climate change have driven countries to consider adding alternative and renewable energy options to their conventional energy share. The use of biofuel such as non-edible oils-based biodiesel is as an option over conventional diesel and could be important for the development of a sustainable and eco-friendly energy resource. Biodiesel, in addition to its renewable origin, poses both environmental and economic benefits. Although feedstock, such as edible vegetable oils, play a vital role in biodiesel production, the usages of it has been restricted due to the food versus fuel dilemma. Hence, researchers are now focusing more on non-edible vegetable oils, which could sustain biodiesel production and use. The aim of the study was to identify potential non-edible oil plants available in Bangladesh for biodiesel production, using DNA barcoding. We also assessed biodiesel production technologies, various biodiesel feedstock, need for potential non-edible feedstock, potential non-edible oil plants (distribution, biology), and selected criteria showing the potentiality of non-edible feedstock (seed oil yield, oil yield, free fatty acid (FFA) content, cold filter plugging point, oxidation stability, easiness to grow in marginal land, and availability in tropical areas).

Farhana is a graduate student who completed her M.S. degree on plants used for biodiesel production.

Strigolactones Positively Regulate Defense Mechanisms to Enhance Resistance Against Sheath Blight of Rice (*Oryza sativa*)

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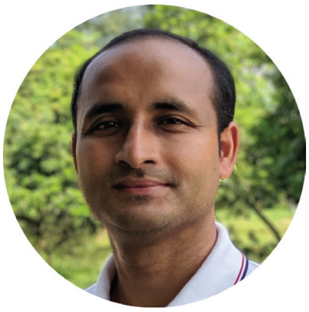
Sheath blight due to *Rhizoctonia solani* infection has been emerged as a devastating disease in rice, resulting in 25% rice yield reduction worldwide. Protection against *R. solani* is thus needed to maintain sustainable rice production for the ever-increasing world population. Phytohormones play the essential roles of regulating plant protection mechanisms against pathogen attack. Strigolactones (SLs) are the most recently defined class of phytohormones with significant roles in plant growth, development, and stress tolerance. However, the association of SLs in sheath blight disease development or protection is yet to be examined. The current study sought the possible involvement of SLs in rice defense responses against *R. solani* by using SL-deficient (d10, 17, and d27) and –signaling (d3) rice mutants. Our field data showed that both SL-deficient and –signaling rice mutants developed sheath blight disease, as evidenced by typical symptoms, including irregular lesions with grayish inner and dark brown margin colors on rice sheath and leaf blades. Isolation of the pathogen from infected leaves, and subsequent inoculation to detached rice leaves of SL–mutants confirmed that impairment of either SL–biosynthesis or –signaling resulted in increased susceptibility towards *R. solani*. Improved growth-related attributes, such as plant biomass, and a remarkably higher level of photosynthetic pigments, water status, and total soluble sugar in wild type (WT) compared with SL-mutants indicated that WT plants resisted *R. solani* infection by physiological adjustments. Biochemical data on stress indicators like hydrogen peroxide and lipid

peroxidation product malondialdehyde underpinned that SL-mutants suffered oxidative stress due to *R. solani* infection, leading to poor growth performance. Comparative analysis on yield-associated data revealed that rice yield was severely compromised in SL-mutants infected by *R. solani*. Our findings highlight that defects in SL–biosynthesis and –signaling was associated with the development of sheath blight disease in rice, thereby suggesting a novel role of SLs in positive regulation of rice defense against *R. solani*. Furthermore, our results provided solid foundation for developing *R. solani*-resistant rice variety through genetic engineering of the SL-biosynthesis pathway in order to reduce sheath blight-caused loss of rice production.



Dr. Mohammad Golam Mostofa is an Associate Professor of Biochemistry and Molecular Biology at Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh. He received his B.Sc. and M.S. degrees in Biochemistry and Molecular Biology from the University of Dhaka, Bangladesh. He also obtained his M.S. in Agriculture from Kagawa University in 2012, and Ph.D. in Plant and Environmental Sciences from Ehime University in 2015, Japan, having received the Monbukagakusho Scholarship. In September 2016, he joined the Signaling Pathway Research Unit at RIKEN Center for Sustainable Resource Science, Japan as a JSPS postdoctoral researcher for 2 years.

Dr. Mostofa has been involved in plant biology research, focusing on the physiological, biochemical, and molecular aspects of abiotic stress responses in plants, particularly on crosstalk between phytohormones and signaling molecules in the regulation of plant adaptation to environmental stresses for a couple of years. He has gained vast experiences in studying the functions of various signaling molecules such as salicylic acid, nitric oxide, trehalose, hydrogen sulfide, and methylglyoxal in mediating the responses and tolerance of plants to heavy metal toxicity, salinity, drought, and high temperature. From his research findings, Dr. Mostofa has published 35 research articles in reputed international journals, including PLoS Genetics, Free Radical Biology and Medicine, Environmental and Experimental Botany, Frontiers in Plant Science, Scientific Reports, and Chemosphere. He has also published a book chapter and co-edited a book for Springer. He has experience in serving as a Guest-Editor for special issues of the International Journal of Molecular Sciences and Biomed Research International. His research findings have already received much attention from scientific communities, as reflected by their high citations (approx. 1000), with an H-index of 17 (Goggle Scholar) within the short span of his research career (7.5 years). Dr. Mostofa's current research focuses on how the phytohormones strigolactones and signaling molecules like smoke-derived karrikin and hydrogen sulphide help plants withstand abiotic- and biotic-stress-induced difficulties during their life-cycles.

Metagenomics and Phylogenetic Studies for Identification of *Enterococcus spp.* Causing Streptococcosis in Tilapia (*Oreochromis niloticus*)

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Tilapia (*Oreochromis niloticus*) is one of the most popular and commercially important species. Recently tilapia is reported to be highly susceptible to streptococcosis. Streptococcosis is caused by Gram positive bacteria belonging to the genus *Streptococcus, Lactococcus, Vagococcus,* and *Enterococcus*. However, very few studies have been conducted on the involvement of *Enterococcus* in streptococcosis in tilapia. The present study was designed to identify the *Enterococcus spp.* in tilapia through metagenomics analysis, phylogenetic, and *in vivo* pathogenicity of the isolates. DNA was extracted from the skin and gut of healthy (control group) and naturally infected fish and metagenomics analysis (genus level) was done based on 16S rRNA gene sequences where *Enterococcus* was found as the dominant bacteria, followed by *Phyllobacterium* and *Mesorhizobium* in the skin of infected fish, but seven diverse bacteria were identified from the skin of healthy fish *viz*., *Deinococcus, Acetobacteroides, Simplicispira, Cloacibacterium, Tahibacter, Flavobacterium*, and *Acidovorax*. On the other hand, the most abundant genera on the gut of diseased tilapia were *Leifsonia, Photobacterium, Aurantimicrobium, Aeromonas, Acinetobacter, Pseudomonas, Vogesella* and *Cryobacterium*. Twelve bacterial isolates were obtained from diseased tilapia collected from different regions of Bangladesh. Phylogenetic analysis based on 16S rRNA gene sequencing revealed seven isolates as *E. faecalis* and other five isolates as *E. hirae*. Artificial infection challenge test was carried out to characterize the virulence of the isolates. Among seven *E. faecalis* isolates, three were high virulent (70-80% mortality), three were moderate virulent (50-60% mortality), and the rest of the isolate was avirulent. Two out of five *E. hirae* isolates were high virulent, one was low virulent, and the remaining two were avirulent. This is the first report on metagenomics based identification of *Enterococcus* involved in the streptococcosis in tilapia and *E. hirae* as a causative agent of streptococcosis.

Tasmina Akter is a third-year Ph.D. at the Institute of Biotechnology and Genetic Engineering (IBGE), Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur. Her doctoral research is to investigate the molecular identification of streptococcosis in diseased tilapia, identification of virulence genes, and development of a vaccine against the streptococcosis disease. She is working both in the field and laboratory to find out the disease causing organisms in tilapia. She is also working as an Assistant Professor in the Faculty of Fisheries at BSMRAU.

Tasmina finished her master's degree from the Technical University of Denmark (DTU) in 2016 at the Department of Aquatic Science and Technology. Before then, she completed another M.S. in Fisheries Management in 2009 and a B.S. in Fisheries in 2007 from Bangladesh Agricultural University (BAU).

In vitro Regeneration and *Agrobacterium*-mediated Genetic Transformation of Local Varieties of Mungbean (*Vigna radiata (L).* Wilczek)

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An efficient *Agrobacterium*-mediated transformation compatible with *in vitro* regeneration protocols was developed for two important varieties of mungbean (*Vigna radiata (L.)* Wilczek) cultivated in Bangladesh, namely Binamoog-5 and BARI Mung-6. Two different zygotic embryo derived explants, such as cotyledonary node (CN) and cotyledon attached decapitated embryo (CADE) were used for direct organogenesis of shoot. MS supplemented with 4.0 µM BAP was found to be the best for the development of the highest number of multiple shoots from CADE in both the varieties of mungbean, while in the case of CN, the best shoot formation was achieved on MS containing 4.0 µM BAP and 0.5 µM NAA in both varieties. Half strength of MS with 2.0 µM IBA was found to be most effective for producing healthy root from regenerated shoots. Following root induction, the *in vitro* raised plantlets were successfully transplanted to soil for their establishment. Considering overall responses, genetic transformation efficiency was found to be better with the CADE explant using *Agrobacterium tumefaciens* strain LBA4404 harboring the binary plasmid pBI121 conferring *GUS* and *nptII* genes. Different factors influencing transformation was optimized during this study. Selection of transformed shoots was carried out by gradually increasing the concentration of kanamycin and such transformed shoots were eventually selected using 200 mg/l kanamycin. Stable expression of the *GUS* gene was detected in various parts of regenerated transformed plantlets. Transformed shoots were rooted on half strength MS containing 2.0 µM IBA and 100 mg/l ticarcillin. Rooted transformed plantlets were successfully transferred to soil. Stable integration of *GUS* and *nptII* genes in the putative transformed shoots was confirmed through PCR analysis.

Sujay Bhajan is a Ph.D. Research Fellow at the Plant Breeding and Biotechnology Laboratory, Department of Botany, University of Dhaka.

Genetic Transformation Aimed at Overexpressing Glyoxalase III has Enhanced Salinity Stress Tolerance in Sugarcane

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Co-authors(s): Anunanthini P., Dharshini S., Appunu C.

Sugarcane (*Saccharum sp.*) is an important commercial crop and major source of sugar in the world. Salinity is a significant factor limiting agricultural productivity and affecting about 9 x 108 hectares worldwide. About 5% (20 million hectares) of the land for sugarcane cultivation is saline, thereby affecting the germination, growth rate, cane yield, and sucrose content. Metabolic reactions get elevated during plant stress response, which leads to the increased production of methylglyoxal (MG), a cytotoxic compound. Our study on comparative gene expression

profiles (qRT-PCR) of Glyoxalase I, II, and III under salinity stress conditions revealed differential transcript expression with higher levels of Glyoxalase III (Gly III), which led us to produce a salinity tolerant sugarcane variety through overexpression of Gly III (Acc. No.: MG701311) driven by the Port ubi882 promoter (isolated and characterized from *Porteresia coarctata*).

Transgene integration was confirmed through polymerase chain reaction using gene specific and promoter specific fusion primers. Three month old putative transgenic plants (V1) were assessed for salinity stress (100mM and 200mM) tolerance under controlled glasshouse conditions. Physiological parameters like relative water content, chlorophyll content, photosynthetically active radiation, and electron transport rate analysed have revealed higher values for transgenic events compared to untransformed (UT) control. Total proline examined at different time intervals confirmed that transgenic events had less proline content compared to UT control. All the events analysed for overexpression of Gly III under salinity tolerant assay had an elevated expression level when compared to UT control. These parameters suggest that transgenic events overexpressing Gly III should be a better choice for sustainable agriculture, which can benefit farmers of salt affected areas. Biosafety issues are relatively low in sugarcane transgenics since it is vegetatively propagated and pollen transfers from cultivated sugarcane to its wild relatives hardly occurs.

Mr. V.M. Manoj is a doctoral research scholar from the ICAR-Sugarcane Breeding Institute, Coimbatore, India and is focused on developing abiotic stress tolerant crops for sustainable agriculture. He completed his M.S. from Nehru Arts and Science College, Coimbatore, India and has been working at Reliance Life Sciences, Navi Mumbai, India as a Quality Control Officer in the Microbiology Department for 2 years, before registering for a Ph.D. program under the guidance of Dr. C Appunu, Senior Scientist, ICAR-Sugarcane Breeding Institute, Coimbatore. Mr. Manoj had isolated a number of abiotic stress tolerant genes from high tolerance wild varieties of sugarcane and commercial cultivars, which were submitted to the NCBI databank (MG701311, MG989489, KX235998, KX235997, MF581041, KX235994, KX235993, etc.). He recently published a share of his research in discovering a stress tolerant gene for overexpression studies in a peer-reviewed journal (DOI: https://doi.org/10.1186/s12864-018-5349-7). He has also produced transgenic sugarcane crops through particle bombardment and has analyzed the increase in tolerance levels of a commercially cultivated sugarcane variety (Saccharum hybrid Co 86032). He is now focused on the CRISPR/Cas tool for genome editing aimed at producing stress tolerant crop plants to encourage farming and agriculture.

Are Root Characteristics/Architectural Traits of Rice Plants a Better Indicator of Salt Tolerance?

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The highest temperature on record, as well as a massive ice melt, has brought the threat of climate change to our doorstep. In the coming decades, therefore, the growth rate and survival of rice will be seriously impacted, creating implications for the global supply of staple foods. Transgenic rice may thus be considered as an alternative in such circumstances. But, we need to have specific criteria for efficient selection of plants or transgenics with salt tolerance characteristics. We have developed several transgenic plants in our laboratory over several years, with the genes *SNAC1, PDH45, G-protein-beta, NHX1 2.3, DST,* and *NHX1 transcript 3*. These transgenic plants were produced in different rice genetic backgrounds, such as BR28, 27, 55, 56, and 49. Generally, screen-house conditions are adapted to mimic the proper natural conditions to check on the tolerance ability of transformed plants. However, very hot temperature (42°C-43°C) damage the control and treated plants so that the apparent grain yield is not as justifiable a measurement of plant performance. In such circumstances, we wanted to look at whether root characteristics could be a vital point to consider when the quality of transgenic rice plants is checked. We have found that transgenic NHX1 2.3kb (background BR 28), NHX1 Transcript 3 (background BR 28), SNAC1 (background BR55) shows better root length and better root weight compared to that of their WT parent, as well as the tolerant control. Further, we have also checked on the grain setting ability and found that all the transgenic plants set grains similar to their WT parent. Thus, identification of root architecture traits at length and weight shall help breeding programs develop better varieties for salt stress conditions.

*Mohammad Umer Sharif Shohan finished his B.Sc. and M.Sc. in Biochemistry and Molecular Biology from the University of Dhaka. He completed his M.Sc. thesis project under the supervision of Dr. Zeba I. Seraj, where he looked into the mechanism of halotolerance of wild rice variety "*Porteresia coarctata.*" Mr. Sharif currently specializes in CAGE, NET-CAGE, mRNA-seq, and NET-RNA-seq data analysis. He is well versed in Linux, R, python, STAR, bowtie2, SeqMonk, and IGV software.*

Mr. Sharif was the recipient of the Summer Research Grant from the University of Queensland, Australia. Recently, he was awarded a Research Internship grant from IRCMS, Japan for working with the NGS data. He is also the recipient of the prestigious Faculty of Biological Sciences, University of Dhaka, Dean's Award. He was also awarded National Science and Technology Fellowship 2017-18 by Government of Bangladesh for his M.Sc. thesis project. Apart from research work, Mr. Sharif is a keen traveler, with a bucket touching 26 countries to date.

Towards Development of β-ODAP-free Grasspea (*Lathyrus sativus* L.)

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Grass pea is an important pulse crop known for having climate resilient traits. However, the presence of β-ODAP in seeds and other plant parts makes it unsuitable for continuous consumption as a staple food. Removal of β-ODAP from its seeds and other plant parts is hence essential. Conventional breeding fails to develop β-ODAP free variety of grass pea, as the trait is highly influenced by the external environment. Genetic-engineering/genome-editing technology, which precisely modifies the target gene without any influence of the external environment, appears a feasible approach for eliminating β-ODAP from grass pea. However, use of this technology requires a suitable regeneration protocol amenable to genetic transformation. We performed regeneration studies on grass pea, which indicated its high response to regeneration. Notably, embryonic axis explant was found to be the most suitable explant for *Agrobacterium*-mediated transformation in grasspea. Further, to identify the target gene for genome editing, we looked back at the previously reported ODAP biosynthesis pathway, which indicated the involvement of oxalyl-CoA synthetase and ODAP synthase enzymes. We have identified the gene sequence of both the enzymes using bioinformatics, PCR, and transcriptome data analysis. Genome editing using the CRISPR/CAS9 tool can now be effectively used in grass pea for the elimination of β-ODAP. However, some biosafety issues are associated with the elimination of the β-ODAP from grass pea using CRISPR/CAS9 technique. First, knocking out the key ODAP biosynthesis pathway genes might lead to accumulation of oxalate and β-(isoxazolin-5-on-2-yl)alanine (BIA), the precursor of ODAP biosynthesis—both are considered as anti-nutrients. However, plants have a mechanism to metabolize these precursors. For example, oxalate in plants is metabolized by a oxalyl-CoA synthetase dependent pathway. A similar oxalate degradation pathway also exists in grasspea, as evident by the transcriptome data. However, it is not yet known that how these two pathways, i.e., oxalate degradation and ODAP biosynthesis pathway in grasspea are interlinked. Second, since CRISPR/CAS9 technology uses *Agrobacterium*-mediated genetic transformation for the introduction of CRISPR/CAS9 cassette into plants, this limits their usage from the regulatory viewpoint as CRISPR/CAS9-based product in European countries are considered to be transgenic. Better understanding of regulatory pathway of ODAP biosynthesis and DNA-free genome editing using CRISPR/CAS9 ribonucleoprotein complexes shall result in realization of ODAP free grasss pea, fit for safe consumption.

Neetu Singh was awarded an M.Sc. degree in 2008 and Ph.D. degree in October, 2014, both in Molecular Biology and Biotechnology from ICAR-Indian Institute of Pulses Research, Kanpur. Her M.Sc. and Ph.D. work is on isolation, cloning, and characterization of various tissue, developmentally regulated and constitutive promoters, and she also developed tissue specific activation tagging population in Arabidopsis *for the isolation of genes of agronomic importance. She joined the Agricultural Research Service (ARS) in July, 2014 and the Indian Institute of Pulses Research, Kanpur in 2016. Presently, she is working on grasspea (*Lathyrus sativus*), where the presence of neurotoxin β-ODAP (BOAA) is a major concern. She is trying to eliminate this toxin from the grasspea using molecular biology tools, such as TILLING and CRISPR/CAS9 based genome editing. So far, the few important genes related to the toxin biosynthetic pathway have been identified. The gene sequence of one toxin biosynthetic pathway* *related enzyme was submitted to GenBank with accession No. MH469748. Simultaneously, she is also working on "Development of Regeneration and Transformation Protocol in Grasspea for Introduction of CRISPR/CAS9 Cassette for Stopping 'Toxin Biosynthesis'". A highly efficient regeneration system in grasspea using embryonic axis explants has been developed and a Agrobacterium-mediated transformation protocol using a transient* GUS *assay has been optimized. This research has very wide implications in the field of crop improvement/agriculture. It will lead to the development of* Lathyrus *varieties free from toxin β-ODAP, which will provide health and nutritional security for humans and animals and sustainability to agriculture under changing climatic conditions, as this crop has the inherent capacity to tolerate adverse climatic conditions.*

Spatio Temporal Expression of Cry1Ac Protein in Bt Eggplant Varieties and Susceptibility of Brinjal Fruit and Shoot Borer to Cry1Ac Protein

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Young Leaf, shoot, flower, and fruits were collected from four Bt-brinjal varieties BARI Bt Begun-1, BARI Bt Begun-2, BARI Bt Begun-3, and BARI Bt Begun-4 at 90, 120, 150, and 180 DAT in both winter and summer seasons. Lyophilized plant samples were assayed by Quantitative ELISA to determine the expression of Cry1Ac protein. Data were analyzed by Sigmaplot software. At the early fruiting stage (90DAT), the Cry1Ac protein expression varied from 32.11 to 33.58 ppm in leaf, 26.24 to 28.51 ppm in shoot, 17.53 to 24.79 ppm in flower, and 19.278 to 24.53 ppm in fruit during the winter season, while it was 25.73 to 33.58 ppm in leaf, 19.28 to 29.62 ppm in shoot, 20.07 to 27.63 ppm in flower, and 22.41 to 30.28 ppm in fruit during summer season. Decreased Bt protein expression was observed at the later fruiting stage in both seasons, although there was a fluctuation tendency during the winter season. Bt protein level was above the critical level to control brinjal fruit and shoot borer effectively in all the samples tested. Eighteen populations of BFSB were collected from the main brinjal growing areas in 17 districts of Bangladesh during 2018–2019. Bioassays were performed with different concentrations of Cry1Ac and untreated control. Median lethal concentrations (LC50) ranged between 0.035 and 0.358 ppm, the LC95 values of the populations ranged from 0.647 to 6.936 ppm.

Saiful Islam has been working as a Scientific Officer at the Biotechnology Division of the Bangladesh Agricultural Research Institute (BARI) since 2011. He has eight years of research experience as a scientist in the field of plant biotechnology. He obtained a B.Sc. in Agriculture in 2009 from Patuakhali Science & Technology University. He completed his M.S. in Biotechnology from Bangladesh Agricultural University in 2011 and another M.S. in Biological Sciences from University of Camerino, Italy in 2014. To conduct research for his M.S. thesis, he obtained the National Science and Technology Fellowship from the Ministry of Science and Technology, Government of the People's Republic of Bangladesh. His research interests are focused on tissue culture, molecular cell biology, and genetic Engineering for the development of climate-resilient new varieties with desired traits. Saiful Islam is working on molecular research and screening of transgenic Bt-brinjal in Bangladesh. He has research publications in the field of plant science in renowned national journals. He has also participated in several training events and workshops held at home and abroad. Attending scientific conferences and presenting research finding has been his hobby. He dreams of becoming a leading researcher in the field of plant biotechnology and contributing to food security of Bangladesh.

Success of Wide Hybridization on the Genetic Improvement of Indica Rice

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Genetic improvement of yield potential of the Indica Group rice (*Oryza sativa* L.) is essential for sustainable rice production in Asia, to develop high yielding varieties to feed the increasing population in the reality of climate change. To improve the yield potential of an Indica group rice IR64, wide hybridization were performed with 10 Japonica Group Varieties (New Plant Types, NPTs), and introgression lines (INLs) were developed by the IRRI-Japan Collaborative Research Project.

We investigated a total of 333 INLs (BC3-derived lines) for biomass production, harvest index, and panicle characteristics under irrigated lowland and upland conditions to find their reactions under these conditions. Association and QTL mapping were performed to detect the respective QTLs or gene for the traits. These lines showed improved performances compared to IR64. Based on the association analysis between the phenotype and the genotype of 333 INLS, QTLs were detected for almost all traits, especially for number of panicles (PN), fertile seeds (FS), total spikelet number (TS), and harvest index (PW/WT). Moreover, a single recessive gene, *ltn2*, for low tiller in rice, has been mapped on chromosome 7 through QTL mapping, as one of the unique traits that showed different reactions. These INLs have been used as materials for rice breeding for the Indica Group variety and genetic studies to identify genetic factor(s) for yield improvement. The success of the wide hybridization, introduction of these INLs into other Asian countries including Bangladesh, and their prospects for high yielding variety development will be discussed.

Dr. Md. Nashir Uddin has been teaching as an Assistant Professor in the Department of Biochemistry and Microbiology at North South University, Bangladesh, since January 2017. Prior to this position, he worked at JIRCAS and the University of Tsukuba, Japan. He earned his Ph.D. in 2016 and M.S. in 2012 from the University of Tsukuba, Japan in Agricultural Sciences with a major (Lab.) in Plant Genetics, Genomics, and Breeding Sciences. His research has mostly focused on the yield potential improvement of cereal crops (e.g., Rice, Sorghum, and Oats) under various abiotic stresses (nutritional, drought, etc.) through wide hybridization using genomics and statistical tools. He has expertise in genome mapping through QTL and association mapping, QTL/gene-environmental interaction analysis, and linkage map construction using SSR or SNPs markers. He is familiar with the analysis of nitrogen use efficiency under soil and hydroponic conditions. He reported a low tillering gene, ltn2, which is unique in that it lowers the tiller number in rice. His research findings were published in many international journals including Field Crops Research, Plants, and Breeding Science, etc.. He received the MEXT Scholarship (by the Government of Japan) twice for his higher studies in Japan and was awarded many conference travel grants to the USA, the Philippines, Thailand, and Malaysia.

Morphological and Molecular Diversity Among the *Pyricularia oryzae* Cavara Isolates Causing Wheat Blast in Bangladesh

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Wheat blast, a devastating disease of wheat, is caused by *Pyricularia oryzae* Cavara, which emerged for the first time in Bangladesh in 2016. Since then, wheat blast has become a serious threat to wheat cultivation in Bangladesh. To study the diversity among this explosive fungus in Bangladesh, 24 monoconidial isolates from the districts of Meherpur, Chuadanga, Kustia, and Jhenaidaha were obtained through single spore isolation technique. In this study, considerable morphological variations among the selected isolates were observed. The colony color varied from white, grey, white cottony mass, and grayish black, and the colony diameters of different isolates ranged from 4.3 to 8.4 cm. The conidial sizes of different isolates in this study were found: 9.98-34.03 × 4.33-10.9 µm. The average size of the conidia was observed: 17.34 × 6.11 µm. However, variation was not noticed with respect to conidial shape. All the isolates produced pyriform, hyaline to pale olive, 2-septate, and 3-celled conidia. Molecular identification of the selected isolates were done on the basis of sequence similarity in the ITS region of rDNA. Phylogenetic tree based on the sequences of the ITS region formed three major clusters and revealed high genetic variation in this highly conserved region of the isolates. It was also found that isolates were clustered in the dendrogram irrespective of their area of origin. The knowledge generated in this study will help better the understanding of this newly evolved pathogen in Bangladesh and its population structure, which has the potential to contribute to the field of breeding for blast disease resistance.

Md. Abdullah Al Noman was a student at the Department of Botany, University of Dhaka, graduating in 2017. He joined the Mycology and Plant Pathology Laboratory to pursue his M.S. degree. The main focus of his research was the wheat blast pathogen. His M.S. thesis title was "Variability among Pyricularia oryzae Cavara isolates causing wheat blast in Bangladesh."

ABSTRACTS & SPEAKER BIOGRAPHIES

POSTER SESSION

Abstracts and speaker biographies for the Poster Session are published as submitted and without any post-submission editing.

Regulatory Trials of Transgenic Cotton Crop in Bangladesh

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Cotton is an important fiber crop of global significance. The production of cotton is affected by infestation of many pests that include tissue feeding insects (bollworms). Yield losses due to bollworms (directly damaging fruiting points) are highly significant compared to the other pests. Under severe infection losses may be reaching up to 80% of total yield, in addition to the extra-costs incurred on insecticide usage for managing bollworms. JK Agri-Genetics Ltd, India (JKAL), transferred truncated Cry1Ac Bt gene into cotton plants via genetic transformation, where cotton plants produce this crystal protein on its own, making them resistant to bollworm complex. JKAL transgenic event is commercially called Event 1.

As we have been looking to the high potential of Bt cotton in Bangladesh, Cotton Development Board (CDB) of Bangladesh has signed MTA with JKAL for introduction of Bt cotton hybrids containing X-gene (Truncated Cry 1 Ac).Hence CDB and JKAL have identified two Cotton hybrids JKCH 1947 Bt and JKCH 1050 Bt for introduction in Bangladesh. Right now the regulatory Bt Cotton trials in Bangladesh are ongoing.

Md. Akhteruzzaman in his early professional career had been served as Scientific Officer in Soil Resource Development Institute of Bangladesh (from August 1989 to July 1998),then he switch over to Cotton Development Board and right now served as Additional Director in the board.

Biosafety Credentials of GR2-E BRRI dhan29 Golden Rice

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Biosafety refers to the prevention of large scale loss of biological integrity, focusing on both ecology and human health. Genetically modified organisms are generally believed to have potential risk of losing of such integrity. However, this is mostly based on emotion, not driven by science. Stewarded biosafety measures can ensure safe use of GMO or LMO for research and development and ultimately to direct use by the end-users. Golden Rice, the genetically modified rice for pro-vitamin A, which was developed through an *agrobacterium* transformation taking psy gene from corn, crt1 gene from a food-grade soil bacterium Pantoea Ananatis and pmi gene from a common human intestine bacterium (Eschresia coli), has been gone through rigorous screening under a series of assessments pertaining food, feed and environment related safety issues. All these assessment showed that the golden rice is as safe as the other regular rice as food and feed. No unintended effects of the transgenes were observed in any agronomic traits of the recipient background variety (BRRI dhan29) indicating Golden rice is also environmentally safe. The proximity analysis showed no significant difference in any of the compositional attributes of the transgenic Golden Rice and its non-transgenic background. No toxicity and allergenecity was observed in any of the sixteen food safety related assessments conducted for GR2-E Golden rice, rather it was found that this Golden rice could supplement at least 40-50% of the estimated average requirement for vitamin A if taken regularly even after storage of two months at ambient temperature.

Partha S. Biswas is a Principal Plant Breeder in the Bangladesh Rice Research Institute. He has been working there since 1998. During his long breeding career he worked to develop rice varieties with increased yield and enhanced nutritional quality. He has also worked for the development of high yielding rice varieties for cold prone areas in Bangladesh. So far, his breeding programs have developed several thousands of breeding lines and released 10 high yielding rice varieties, of which five are zinc biofortified rice. He has been working with Golden Rice (GR) since 2008. He and his colleagues introgressed GR2-E locus from Kaybonnet Golden Rice event GR2E into BRRI dhan29, a widely cultivated rice variety in Bangladesh during his PhD thesis research at IRRI, Philippines. Recently, he completed two years Post Doctoral Fellowship research at IRRI Philippines. He has published 38 research articles in reputed national and international peer reviewed journals. He also serves different universities of Bangladesh as research supervisor of MS and PhD students. He is connected with different professional organizations that promote breeding and biotechnology for crop improvement.

Appearance & Incidence of Invasive Pest Fall Army Worm (*Spodoptera frugiperda, Lepidoptera: Noctuidae*) in India: Step & Approaches for Its Management—An Overview

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The insects generally known as pests are most important groups of animals on Earth. Recently a major invasive, migratory & exotic insect pest called Fall Army Worm was observed in India infesting Maize crop. Basically, FAW is native to America and first reported by J.E. Smith, in 1797. While in June 2016 it was also detected in Africa, and spread rapidly about in 44 countries within two years. FAO declared it as food security threat in African continent.

FAW is polyphagous insect pest and feed on more than 80 plant species with maize, sorghum, sugarcane, rice, millet, cotton, napier grass etc. It has four stages in his life cycle viz. egg, larvae, pupae & moth. The eggs are creamish to grey and laid in clusters. The larvae feed on the top leaves & make pin holes, and also infest the tassel, stalk, whorl, ears, cob as well. Early instar larvae are green in colour and later turn brown to black. Young larvae spun silk thread for movement. The pupa (Cocoon) formed in soil. The moths are grey- brown in colour and can fly up to 100 km per night.

In India, it invaded in June 2018 as reported in Karnataka state, thereafter spread in more than 20 states. As per survey report, the area affected due to FAW during 2018-19 in India was 245,254.40 ha with highest damage 211300.0 ha in Karnataka state. Directorate of PPQ & S Faridabad and its 35 CIPMC,s are engaged in survey & surveillance programmes for diseases & pest management and dissemination of package & practices to the farmers. CIB & RC has recommended usage of certain pesticides for trial, and certain bio-pesticides are also useful for control & management.

Dr. Harish Chandra Sr. Scientist/ Joint Director (Entomology) is M.Sc. Zoology (Entomology) from Agra University Agra, Ph. D. Life Sciences (Microbiology) from Manipur University, Imphal, Manipur and MBA from IGNOU, New Delhi, and having laboratory diagnosis training in HIV/ AIDS from Regional Institute of Medical Sciences Imphal, Manipur. Also Member of Editorial Board, Bulletin of National Sericulture Academy Bhubaneswar, Odisha and Member of Indian Science Congress Association, Kolkata, India. He has published 60 Research & Scientific papers (Abstract & full papers). Attended 19 Seminars/ Conference and participated in 11 training programmes in his credit.

He had served as Joint Director (Entomology) in Central Insecticide Board & Registration

Committee and Integrated Pest Management Division, Directorate of PPQ & S, DAC & FW, CGO Complex, Faridabad during the period from 31st March, 2015 to 14th April, 2019, then handling Pesticide & Bio-pesticide registration and regulatory activities in CIB & RC, and diseases & pest survey & surveillance programmes, dissemination of package & practices through Farmer's Field Schools within India and monitoring of bio-control lab at CIPMC,s. He had also served as Scientist in Central Silk Board (Govt. of India) and worked on silkworm Germplasm conservation & maintenance, also worked on many research projects like biofertilizer, integration of new technology, problems of unfertilized eggs in silkworm, soil testing & recommendation at farmers level, and serves as mentor to farmers & stockholders Presently working at RSRS, CSB (Govt of India), Sahaspur, Dehradun on silkworm & its food plants and a project on Bio-pesticides is in pipeline. Awarded for invited lecture in 97th Indian Science Congress, Tiruvananthapuram, 2010 and International Conference ICAAAS – 2018, organized at JNU New Delhi.

Impact Assessment of Bt Cotton on Microbial Community Structure and Function

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In India, the area under Bt cotton increased, from 10.8 million hectares in 2016 to 11.4 million hectares, in 2017 (ISAAA, 2017). The transgenic agriculture is associated with the tangible benefits and intangible risks. Amongst the intangible risk, of special concern is the impact of transgenic crops on aboveground and belowground ecological integrity. To gauge the ecological impact of Bt cotton, a field experiment for two consecutive years was established with MRC 6301+ Bt, and its near isogenic line at IARI field, India. Mapping of microbial community structure by phospholipid fatty acids profiles in rhizosphere samples of Bt Cotton and it's near isogenic lines indicated the significant difference in microbial community structure pattern through out the cropping season. Principal component analysis of the PLFA data showed 36 % of the total variation by PC1 and 24 % by PC2. Phospholipid fatty acid biomarkers such as branched (i150; a15:0; i17:0), straight monosaturated (18:1w9) and polyunsaturated (18:2 w6) delineated the microbial community composition of transgenic crop, from its near isogenic line at different crop stages. There was no significant difference ($p<0.05$) in culturable community of inorganic phosphate and organic phosphate dissolving bacteria as well as nitrogen fixing bacteria. Shannon diversity index was significantly high ($p<0.05$) in Bt cotton rhizosphere as compared to its isogenic line. Guild utilization pattern showed that microbial community in Bt cotton rhizosphere could utilize more complex compound such as phenolics, polymers and amines as compared to simple compounds by its near isogenic line. Plots planted with Bt cotton revealed more structural and functional microbial diversity.

Dr. Anita Chaudhary is working as Principal Scientist in ICAR-IARI. She did her graduation, post graduation and Doctorate in the field of microbiology from Panjab University, Chandigarh, India. She did her MBA from IGNOU. She has contributed immensely in the field of environment impact assessment of climate change and transgenic crops. She has also developed the methodology for determination of vulnerability index for doing the vulnerability assessment of agriculture in India at the state and district scale. She has developed the microbial consortium which can help the plants become climate resilient towards drought. She has won the gold medal during her post graduation and Indo-US professorship in Microbiology by American Society of Microbiology. She was a visiting Scientist to the Michigan State university and Arizona State university. She has given many lead talks in the national and international conferences. She has handled various national and international projects and has published 55 papers in the peer reviewed esteemed journals and various technical manuals and has authored a book.

Estimation of Neomycin Phosphotransferase (NPT) Concentration in Transgenic Chickpea Seeds and Biosafety Perspectives

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Chickpeas are primarily consumed as seeds (whole/split) in several culinary preparations and various value additions. Neomycin phosphotransferase II (nptII) sourced from Tn5 transposon of Escherichia coli is the most common antibiotic selection marker mostly used in genetic transformation of chickpea against amino-glycoside antibiotics like kanamycin monosulphate, G418, neomycin and paromomycin. Kanamycin normally inhibits protein synthesis in plants by binding to ribosomes resulting in bleaching of plant. However, in the transgenic plants, NPTII protein also known as the amino-glycoside-3-phosphotransferase II [APH(3`)II] catalyzes the phosphorylation of kanamycin, once it enters into plant cells, rendering to inactive state and therefore, unable to shutdown the protein synthesis machinery in plants.

Presence of NPTII proteins (products from kanamycin resistance gene) in transgenic chickpea seeds may raise biosafety concerns related to human health in particular. We estimated the NPTII protein from immature seeds and mature dried seeds of five different transgenic chickpea lines expressing NPTII. Quantitative ELISA studies indicate that the amount of NPTII proteins decrease, as chickpea plants approach physiological maturity with dried mature seeds having lower NPTII content, 0.98-1.32 ng/mg Total Soluble Protein (TSP) as compared to immature seeds (1.63-3.84 ng/mg TSP). Based on extensive studies on NPTII protein produced in a range of genetically engineered crops, allergenicity predictions, reported enzymatic activity under simulated conditions, clinical observations, and the protein content, transgenic chickpea expressing/harboring NPTII protein poses no discernible biosafety concerns.

Dr Alok Das is currently working as Senior Scientist, Division of Plant Biotechnology, IIPR, Kanpur. His research interest includes genetic engineering (IR trait) and biosafety aspects of transgenic chickpea and pigeonpea, developing genome editing platforms and speed breeding of pulses.

Targeting Mosquito-Borne Illness Using Modern Genome Engineering Technologies

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Vector-borne diseases account for up to 17% of human infections, causing about a million deaths worldwide every year. Mosquitoes contribute to this with malaria and a long list of arboviral diseases that include dengue, yellow fever, various types of encephalitis, and West Nile fever. Mosquito-borne arboviral diseases are a huge burden on the world population and this needs immediate solutions. Most of the affected countries are economically poor and the solutions need to be deployed in large scale and cost-effectively. Current methods to control vector-borne arboviral infections are too expensive to deploy or they don't work efficiently. New efficient methods need to be developed. Wolbachia infected mosquitoes have been shown to reduce flavivirus infections. But there are accumulating evidence of enhanced flavivirus infections in Wolbachia carrying mosquito demanding a re-evaluation of the effectiveness of the method. One of the methods that utilize genome engineering is attractive. Genetically modified insect control has been discussed, but the lack of suitable technology to propagate the modified genome into the population was a challenge. With the discovery of new tools and technologies through genetic engineering, this has become possible. There are no such efforts being carried out in Asia that involves transgenic vector control strategy. We at Tata Institute for Genetics and Society are exploring to exactly fill this lacuna using these technologies to control Malaria and flaviviral diseases like Dengue, Zika, and West Nile viruses.

Dr. S.K. Dasgupta is presently engaged with the Tata Institute for Genetics and Society, Bangalore India as a Group Leader. He presently looks after the regulatory and other compliance issues related to Genetically Engineered organisms and leads the communication and stakeholder engagement activities of the organization. Prior to this he has spent more than 20 years with the Mahyco group leading the Research and Development and the regulatory, intellectual property and other compliance activities of its sister company Sungro Seeds Pvt. Ltd. During his tenure at Sungro he was associated with the development of Bt brinjal and testing of Bt cauliflower, cabbage and chickpea. He also led the research activities of another group company GBIT and led the flagship research program of testing the Genetically Engineered Aedes aegypti mosquito with self-limiting technology in collaboration with Oxitec, UK. GBIT under his leadership successfully conducted the contained field cage trials with these mosquitoes which was tested for the first time in this subcontinent under these conditions.

Conferring Herbicide Tolerance in Fibre Crop-Jute Through Transgenesis and Genome Editing

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Jute, also known as Golden Fibre, is the cheapest natural fibre crop grown over 8 lakh hectares. Its products have diverse uses and being hailed worldwide as a natural alternative to synthetics enriching the lives of people and the environment. For the improvement of jute, the application of modern biotechnology is essential especially for traits for which diversity in natural germplasm is very rare. Weeds are the most serious production constraint in jute- grown predominantly in high rainfall areas of Eastern India and Bangladesh. Labour demand for weeding operation is high in the early phase of the crop cycle, and manual weed control is increasingly becoming infeasible. Therefore, farmers use several types of narrow-spectrum herbicides which lead to several environmental pollutions. Herbicide-tolerant crops allow the use of single broad-spectrum herbicide anytime during the growing season. These offer farmers the flexibility to apply herbicides only when needed and therefore ultimately reduces total input of herbicides.

The use of transgenesis and precise genome editing technologies with CRISPR/Cas9-Cas12 offer great promise for improvement of jute. Under the ICAR-NPTC funded project on "Herbicide Tolerance in Jute", ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore, India has made significant progress in studying herbicide tolerance and in vitro culture system in tossa jute (Corchorus olitorius L.). Jute germplasm haves been screened for one season for tolerance to glyphosate both in vitro and in field. The current effort is to develop an efficient method to introduce multiple discrete point mutations in the jute EPSPS and ALS gene using CRISPR/Cas9 to make major herbicides glyphosate and imazethapyr non-toxic to jute plant. The available jute transcriptomes were searched for EPSPS genes and the following two transcripts were identified in Corchorus capsularis, gi|757195277| and >gi|757233259|. Nucleotide and protein BLAST analyses revealed the conserved motifs, glyphosate-EPSPS interaction sites, and key amino acids were identified. The following amino acids play a major role in glyphosate binding and therefore are potential targets for mutation and genome editing: K104, N182, A183, G184, Q267, D429, V430, E459, R506, E508, K535. Strategies are being developed to finalize the selection of genomic target sites for editing and search for off-targeting. For genetic transformation, in vitro regeneration from different explants and elongation of shoots followed by rooting was achieved successfully. The progress of our work and the pros and cons of herbicide-resistance in crops as technology will be discussed in this presentation.

Dr. Subhojit Datta studied Agricultural Sciences from Visva Bharati and Molecular Biology & Biotechnology from IARI, New Delhi. He joined the Indian Agricultural Research Service (ARS) in 2000 and has made outstanding contributions in the genetic improvement of jute and pulses using transgenics and genomics-assisted breeding. Dr. Subhojit Datta has made outstanding contributions in the genetic improvement of jute and a number of pulse crops using genomics, transgenics and genomics-assisted breeding. One of his major contributions is the development of efficient transgenic systems for inherently recalcitrant chickpea and pigeonpea including their reproducible regeneration protocols in vitro. This has resulted in the development of first-ever Bt chickpea and pigeonpea in India, with cry1Ac- and cry1Aabc-induced stable resistance to pod borer. His other major contributions include development of mapping resources and generation of a large number of functional EST-SSR markers using next-generation transcriptomics. Dr. Datta also devised novel ways to enhance marker repertoire in pulse crops for molecular breeding by establishing the cross-genera transferability of genic and genomic microsatellites across major pulses. He had been associated with drafting the jute and pigeonpea genome sequence, exclusive Indian effort toward WGS. Using a large set of SNPs derived from orthologous genes, Dr. Datta resolved the genetic pattern of domestication vis-à-vis multiple post-domestication origins of chickpea and pigeonpea. He has developed and integrated a user-friendly database, named "JuteMarkerdb" with detailed information molecular markers in jute.

Dr. Datta is recipient of several awards- ICAR National Fellow, ISCA Young Scientist Award; BOYSCAST Fellowship; CREST Fellowship, ISPRD Fellowship and also worked at University of California, USA.

Functional Genomics Enabled Identification and Validation of Salt Tolerance Determinants in Rice

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Multiple salt tolerance responsive regions have been identified from a reciprocally crossed population of tolerant and sensitive rice. The salt tolerant landrace Horkuch was crossed with high yielding variety IR29 in order to capture both traits in the progenies. We have identified Quantitative Trait Loci (QTL) from 2 developmental stages using SNP markers and observed variations in the gene expression level upon salt stress in the progenies using RNAseq. In addition, high throughput image analyses data of continuous stress in the seedling stage was obtained, which is longitudinal rather than endpoint. Combination of these data helped us identify multiple regions in the genome which can be the causative player in the tolerance mechanism. Two promising QTLs for potassium content and root length in seedling stage and a yield QTL in the reproductive stage was our primary target for further investigations. Functional network analyses and the overlapping genomics, transcriptomic and phenomics data driven candidate genes and expression QTLs (eQTL) were selected for overexpression and CRISPR-Cas9 based down regulation. Initial focus was given to potassium transporters like AKT1, KAT1 and potassium channel associated with the QTL regions or differential expression along with some membrane channel protein. We are characterizing the genes by observing their effect in gain and loss of tolerance. In the initial screening, plants with edited AKT1 gene showed better performance. Moreover identified QTLs containing plants are being used as donor plants in marker assisted breeding program in collaboration with BRRI.

Dr. Sabrina M. Elias is currently appointed as an Assistant Professor at Department of Biochemistry and Biotechnology, School of Life Sciences, Independent University, Bangladesh. She has completed her Doctoral study as a fellow of Monsanto's Beachell-Borlaug International Scholars Program, jointly in University of Dhaka, University of Nebraska Lincoln, University of Texas at Austin and International Rice Research Institute (IRRI). She did her MS and BSc (Hons) from Department of Biochemistry and Molecular Biology at University of Dhaka. Her academic training and work experience have included both domestic and international perspectives on research and implementation of bioinformatics, next generation genomics, phenomics and molecular biology focusing Bangladeshi rice genomic diversity and abiotic stress tolerance. She has been working in the Plant Biotechnology Laboratory, Dr. Zeba Seraj's group at University of Dhaka as Post-Doctoral research associate on abiotic stress tolerance factors in crop genome. Besides she has experience on working with rice photosynthesis genomics at Australian National University and in National Jute genome sequencing project of Bangladesh. Dr. Elias is also associated as a course designer and lecturer at Center for Bioinformatics Learning Advancement and Systematics Training (cBLAST), an online bioinformatics course hub. Her current presentation focuses on investigation of salt tolerance determinants of rice from a Bangladeshi indigenous salt tolerant landrace Horkuch, using a combined genomics, transcriptomics and phenomics.

Progress of the Project to Strengthen Capacities for the Safe Use of Living Modified Organisms by the Government of Sri Lanka in Partnership with the Food and Agriculture Organization of the United Nations and the Global Environment Facility

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The Government of Sri Lanka is leveraging the ongoing 4-year (2017 to 2020) project, "Implementation of the National Biosafety Framework in accordance with the Cartagena Protocol", which is funded by the Global Environment Facility, to strengthen national capacity for the safe adoption and use of the products of modern biotechnologies. The Food and Agriculture Organization of the United Nations is the implementing agency. The project shall strengthen the regulatory, institutional and technical capacities for the effective implementation of the National Biosafety Framework. We present the progress made since the inception of the project in January 2017. These include the revision of the Biosafety Act and the drafting of the Biosafety Regulations, the Biosafety Master Plan, and the Manual on Administrative and Operational Procedure for Living Modified Organisms (LMOs). Initiation of the development of guidelines for risk assessment, risk management and risk communication of LMOs

by collaborating with the National Science Foundation and the Biotech Consortium India Limited (BCIL) was a key milestone. Further, national laboratories for LMO detection and identification were assessed in collaboration with BCIL and the Agriculture Biotechnology Centre (AgBC) of the University of Peradeniya. A survey was conducted to collect baseline data on the level of understanding of the stakeholders on biosafety in Sri Lanka in order to develop the public awareness strategy. Also, several materials for enhancing public awareness about biosafety were developed. Additionally, the third issue of the bi-annual and tri-lingual Biosafety Newsletter was released. We aver that a lasting legacy of the project would be a citizenry that is empowered to make evidence-based decisions regarding biotechnologies and their products; legal and policy instruments that guide their safe use and release into the environment; and strong institutions and skilled personnel that enable the handling of the products of biotechnologies in accordance with globally agreed norms.

Mr. Shanaka Gunawardena, the National Project Manager for the Food and Agriculture Organization of the United Nations, Sri Lanka (Project: Implementation of the National Biosafety Framework in accordance with the Cartagena Protocol on Biosafety).

Biocontrol of Wheat Blast Disease by Plant Probiotic Bacilli

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Wheat blast disease caused by the fungus Magnaporthe oryzae Triticum (MoT) pathotype is emerged as a new threat to the wheat production in Bangladesh. Genetic resources for breeding blast resistance are limited, and control of blast disease by fungicides application are found unreliable. New approaches are needed to combat this cereal killer on the run. Discovery of probiotic bacteria from the internal tissue of host plants (endophytes) and apply them in protection of the host plant from disastrous pathogens is a biorational approach for ensuring sustainable agriculture and food security. Six bacterial isolates were identified by screening more than 600 probiotics that suppressed mycelial growth of MoT. Among them, three isolates (BTS-4, BTLK6A and BTS-5) remarkably protected wheat plants from MoT infection both in vitro and in vivo. The percentage of blast disease suppression in BTS-4, BTLK6A and BTS-5 treated plants were 89, 88, and 87, respectively. The blast disease severity in the untreated control was 100%. Cell free culture supernatant of these bacteria remarkably inhibited germination and induced cell lysis of the fungal conidia indicating the involvement of secondary metabolites wheat blast disease suppression by these bacteria. Analysis of the whole genome sequences revealed that all these isolates are belonging to the genus Bacillus and they possessed genes responsible for production of diverse antimicrobial substances. Furthermore, the activities of peroxidase, ascorbate peroxidase, and catalase in bacteria treated plants were significantly increased, whereas H2O2 concentration was decreased in bacteria treated plant at 72 h after MoT inoculation. Taken together, our results suggest that biocontrol of wheat blast disease by probiotic bacilli is linked with antibiosis and induction of systemic resistance in wheat plants.

I am working as an Assistant Professor at Institute of Biotechnology and Genetic Engineering, Bangabandhu Sheikh Mujibur Rahman Agricultural University. I completed her B. Sc.Ag and M.S. (Hort.) from Bangladesh Agricultural University and Ph.D. from Tottori University, Japan.

My major research foci are molecular biology of wheat blast fungus Magnaporthe oryzae, development of blast resistant wheat variety by genome editing. I am also interested in molecular diagnosis plant pathogens and their biological control. Reduction of fertilizer use by plant probiotic bacteria is another interesting area of my research.

CRISPR/Cas9 Mediated Genome Editing for Improving Productivity in Wheat

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The discovery of Clustered Regularly Interspaced Short Palindromic Repeats CRISPR Associated protein-9 nuclease (CRISPR/Cas9) gene editing system has revolutionized research in nearly 20 crop species so far for various traits including yield improvement, biotic and abiotic stress management. The genome editing technologies can accelerate wheat breeding by allowing the introduction of precise and predictable modifications directly in an elite background. This technique is very useful to modify favourable/unfavourable small genome size to obtain a significant outcome in terms of product or variety. Wheat is a hexaploid (AABBDD) species having 17 GB genome size which contains about 124,201 gene loci. Recently, the International Wheat Genome Sequencing Consortium released the fully annotated high quality reference genome of bread wheat variety 'Chinese Spring'. This will enhance the introgression efficiency of more novel target genes responsive to various biotic, abiotic, quality and agronomical traits improvement through CRISPR/Cas9 system. CRISPR technology is useful both in precise enhancing the activity of positive-regulator genes and in eliminating the negative-regulator genes that affect the trait of interest. However, there are only few reports available for validation of CRISPR technique in wheat.

ICAR-IIWBR being the nodal institute for wheat research in India has taken initiative to establish a CRISPR-based genome editing facility. The main focus will be to produce novel wheat genotypes with target traits and use them in wheat breeding programs. Before initiating the work, we intensely reviewed the different components and conditions required for genome editing and also published the first exclusive review of genome editing in wheat. Presently, working on improving yield and abiotic stress tolerance traits by genome editing in wheat. We have developed the wheat specific Cas9 vectors and designed the sgRNA for TaGW2-A1, TaMS1 and TamiR398 genes for improving grain weight, male sterility for hybrid production and drought tolerance, respectively. The SgRNA's have been cloned to Cas9 binary vector, sequenced and transformed into *Agrobacterium* EHA105. Their further transformations into wheat system are under progress by using our well established reproducible regeneration and transformation system, to develop CRISPR/Cas9 knock outs with improved trait of interest in developing climate resilient wheat genotype.

Dr. Mamrutha HM has done her B.Sc (Agri), M.Sc and Ph.D in Crop Physiology from University of Agricultural Sciences, GKVK, Bengaluru. She joined ARS service on 2nd May 2011 and reported at IIWBR on 5th September 2011 and from that time she is associated in wheat co-ordination and research work.

She has attended 13 training programmes on different subjects like Physiology, CRISPR/Cas9, Molecular biology, Bioinformatics and Statistics held at different parts of the country and also at Abroad. These trainings helped in enhancing in depth knowledge of the subject and in conducting quality research and publications. She has experience in teaching as a Co-supervisor for Ph.D students, as a mentor for PAT training scientist, M.Sc students and also acted as a resource person in different trainings held at ICAR-IIWBR and also in other institutes. She is a coordinator at IIWBR for constituting and conducting physiology trials and nurseries across India. She is associated in establishing Tissue culture lab and Controlled environment green house facility at ICAR-IIWBR. She acted as Co-course director in three training programmes and as a consultant for validating 1-MCP chemical for Dow-Agro Sciences Company. Acting as a reviewer in 10 peer recognised journals including Journal of Plant Physiology and Biochemistry. She is the life member of two professional Societies.

She contributed in development and identification of threewheat varieties for two major wheat growing zones of India and are directly involved in increasing income of the farmers and also associated in identification and registration of three wheat genetic stocksrelatedto Heat tolerance, Photosynthesis and with wheat quality. She has been instrumental in development and standardization of insitu field phenotyping techniques for improving precision in wheat field phenotyping. She was actively involved in identifying physiological traits and novel molecular markers associated with drought and high temperature stress tolerance in wheat. Developed a genotype independent and highly reproducible regeneration and Agrobacterium transformation system in Indian wheat genotypes for quick production of transgenic wheat. She was also associated in identification of novel abiotic stress responsive genes from stress hardy crop finger millet and their transformation into wheat crop. At ICAR-IIWBR, she has initiated work on CRISPR/Cas9 mediated genome editing to improve abiotic stress tolerance.She was associated in three international projects in collaboration with CIMMYT, BBSRC and CSIRO, Australia. She worked as the Principal Investigator (PI) in one external funded, in two institute projects. And as Co-PI in three institute projects and contributed significantly in fulfilling objectives of the projects in terms of developing product or technology.

Published 19 research articles in peer review journals, 2 review articles, 33conference proceedings, 10 e-pubications, more than 30 popular articles and 14 book chapters. Edited 14 different reports and manuals, submitted 37 sequences to NCBI data base and attended 12 different national and international seminars and conferences. She has been awarded with prestigious RD Asana gold medal award from Indian society of Plant Physiology during 2016 and IIWBR best field scientist award during 2015. Received best oral presentation award and an IUBMB international travel fellowship award. She was an invited member in several national level interactive meetings. Visited Italy, Germany, Mexico and USA for different project meetings and for attending conferences.

Development of Yellow Mosaic Disease Resistant Mungbean (*Vigna radiata (L.)* Wilczek) through Biotechnological Approach

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Co-presenters: Sujoy Kumar Bhajon, M. Imdadul Hoque, and R.H. Sarker

Mungbean yellow mosaic disease (YMD) caused by mungbean yellow mosaic virus (MYMV) is responsible for the yellow mosaic disease causing maximum yield loss of mungbean in Bangladesh. RNAi-based antiviral strategy has been under taken with the goal of developing YMD resistant mungbean lines. For this purpose, an antiviral construct (asCP-AC2/pBI121) was developed through targeting the coat protein (CP) and silencing suppressor gene (AC2) of MYMV. The cloned construct was transferred to *Agrobacterium tumefaciens* strain LBA4404. Transgenic plants were regenerated from the leaf disc explants of tobacco plants (Petit Havana) to check the transformation ability of the antiviral construct. A protocol for *Agrobacterium*-mediated genetic transformation and regeneration was developed for locally grown mungbean variety (BARI Mung-3) using GUS and nptII genes. Following infection and co-cultivation, multiple shoots were regenerated from the cotyledon attached decapitated embryo explants. Best response (80%) towards multiple shoots regeneration was observed on MS medium containing B5 vitamins supplemented with 5.0 µM BAP. Bacterial suspension having an OD600 of 0.6 in an incubation period of 30 minutes with 3 days of co-cultivation period was found to be best for transformation of cotyledon attached decapitated embryo explants. Transformed shoots were selected using 150 mg/l kanamycin. Successful integration of asAC2-CP genes into the transgenic mungbean plantlets was confirmed by polymerase chain reaction (PCR) using CP forward and AC2 reverse primer. To obtain complete plantlet micrografting was carried out using in vitro regenerated shoots due to their low frequency of root development in rooting medium. The highest percentage (55 %) of successful grafting was obtained using 3.0 cm long scions and 14-days old rootstocks. Successfully micro-grafted plants produced flowers and seeds following proper hardening of grafted plantlets.

Dr. Mohammad Nurul Islam is professor of Botany in University of Dhaka, his major research interest is developing geiminivirus resistant Mungbean and Tomato plants through Biotechnological approach as well as Molecular breeding. He is trained Genetic Engineering and Biotechnology from the Plant Molecular Biology lab, International centre for Genetic Engineering and Biotechnology, New Delhi, India. He has attended training workshop on genome editing through CRSPR-cas9 technology. He has published more than 40 research articles. Supervised 23 MS, one M.Phil, two Ph.D students and one Post-doct fellow. He is serving as an associate executive editor of the Bangladesh Journal of Plant Tissue Culture and Biotechnology. He is a life member of Bangladesh Botanical Society, Bangladesh Association of Plant Tissue Culture and Biotechnology, Global Network of Bangladeshi Biotechnologist, Bangladesh Bioinformatics and Computational Biology Association, Bangladesh Biosafety and Biosecurity Association. Treasurer: Bangladesh Association of Plant Tissue Culture and Biotechnology and Section Head: Out reseach section of Global Network of Bangladeshi Biotechnologist.

Isolation and Identification of Dye Degrading Bacteria from Textile Sludge to Eradicate Environmental Hazards and Maintain a Sustainable Environment

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The textile industries of Bangladesh are contributing the huge wealth and prosperity but in the process, they are silently destroying the water bodies and the surrounding. Textile dye wastewater is the highly colored contain complex chemical, toxic compounds and heavy metal. The government categories textile dyeing industries as “Red industries” (most polluting) under the Bangladesh Environment Conservation Act, 1995 and the Environment

Conservation Rules, 1997 and made Effluent Treatment Plants (ETPs) mandatory for the factories. Yet most of them do not have any ETP as chemical and physical method need constant monitoring and highly expensive to operate. The industry is budding, so is the pollution. Microbial bioremediation offers easy and affordable solution to this problem and help to maintain a sustainable environment. Keeping the above situation in mind, my research on isolating a dye degrading bacteria is opted. The research is still on progress. Up to now, one decolorizing bacteria isolate has been isolated from industrial textile sludge with the ability to decolorized 1% of commercially available Reactive Violet 5R (RV5R) dye. Almost 90% of RV5R dye was decolorized after 48 hours incubation at 37oC and 80 rpm. The cultural, morphological and physiological characteristics of that bacteria isolate have been detected. To identify the bacteria isolate several biochemical test has been undergoing now. ABIS microbiology software will be used to justify and determine to identify the bacterial isolate. My future goal is to identify the bacterium isolate at genomic level and also determine which stretches of DNA contain the genes that cause the decolorization and which stretches carry regulatory instructions, turning genes on or off. If everything goes perfectly, this bacterium will certainly leave an impact in making a sustainable environment for our country.

Afia Kamal is a student of biotechnology at BRAC University, Dhaka, Bangladesh. Currently, she has been doing her undergrad thesis under the supervision of a Brac University's senior lecturer of MNS Department. She has been researching on isolating a dye degrading bacteria. She also did internship at International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) and at Institute for developing Science and Health initiatives (ideSHi). Amazed by watching banana DNA isolation at the science fair of her collage days, triggered her inner interest to know more about the genetics and molecular mystery of biology. She always has this intrinsic nature to dig deeper and finding the root of the things that is unknown to her. Reading book, gardening, cooking, listening music and knowing what is new are the hobbies of her. She loves having productive conversation which has the both side of perspective of some particular issues. Travelling and challenges excites her most. She hiked almost 3235 feet up to the peak of Keokradong, one of the highest peaks in Bangladesh. As an admirer of nature, give her to be an empath towards the natural environment. To leave an impact as a citizen of country and a dweller of the world always compelled her to do more and better to make life easier and livable for others. Feeling responsible as a human she started working besides her study. She has been working as an intern in Center for Emotional Intelligence and Innovation at Brac University. Her work is to assist in the research of Emotional Intelligence and the social aspect of it. This is where she found a platform to do some social work and connect with the people of different background and place. Her aspiration is to think of an innovative way to connect the biotechnology and genetics with the sustainable development of the world and work on it.

Development of 3R-Gene Late Blight Resistant Potato Variety in Bangladesh: Prospect and Progress

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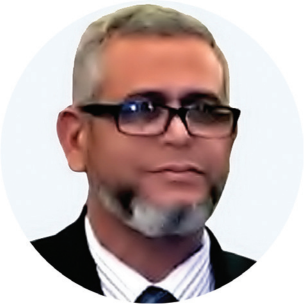
Co-presenters: S. Islam, M. Begum, F. Akhter, S. Hoque, K. Zarka, P.S. Wharton, K. Hokanson, and D. Douches

Late blight caused by Phytophthora infestans is a devastating disease in cultivated potato throughout the world which can cause yield loss up to 80%. In Bangladesh, farmers use 500 tons of fungicides to protect the crop at a cost of around 100 crore taka. Tuber Crops Research Centre (TCRC), BARI, Michigan State University (MSU), USA and Simplot Plant Sciences Co., USA have been working jointly to develop a 3R-gene GM potato variety for late blight disease resistance. Three late blight R-genes viz. Rpi-mcq1, Rpi-blb2 and Rpi-vnt1.1 have been isolated from Solanum mochiquense, S. bulbocastanum and S. venturii, respectively. Simplot Plant Sciences Co. engineered the 3R-gene containing plasmid vector pSIM4392 to transform the GM Diamant events using *Agrobacterium* mediated plant transformation. Ten 3R-gene events have been selected as late blight resistant with a single insert of the tDNA by Simplot Plant Sciences Co. These events are undergoing molecular screening and field trials for efficacy against the Phytophthora isolates at MSU. Pending regulatory approval from Bangladesh authorities, the two best performing GM events will be imported to Bangladesh for contained (CT) use and confined field trial (CFT) during the next potato growing season. The most superior event will be released as a new potato variety after full regulatory approval, following regulatory and multi-locations trials. For efficacy testing, Phytophthora isolates have been collected from the different agro-ecological zones of Bangladesh and molecular based diversity of pathogens has been analyzed. P. infestans found in Bangladesh are Blue 13 and Pink 6 isolates showing both A1 and A2 mating types. Pure cultures of Phytophthora isolates have been made at Plant Pathology lab of TCRC that will be used for artificial inoculation during contained use, confined field trial and regulatory trials of GM potato events.



Dr. Md Mosharraf Hossain Molla has been awarded Ph.D in Biotechnology (2011) and MS in Horticulture (1995) from the Bangladesh Agricultural University, Mymensingh. Dr. Molla graduated in Agriculture Science (B. Sc. Ag. Hons.) from the same University in 1989. He also received Post-doctoral training on Marker Assisted Breeding from the Noble Research Institute, Ardmore, Oklahoma, USA. Currently, Dr Molla is working as Principal Scientific Officer (PSO) at the Tuber Crops Research Center (TCRC), Bangladesh Agricultural Research Institute (BARI). He is responsible for leading the Tuber Crops Biotechnology team at TCRC. He joined at BARI as Scientific Officer in 1995 and was promoted to Senior Scientific Officer in 2005. As a Biotechnologist, Dr, Molla has 21 years of professional experience. Dr. Molla and his team's major areas of research are: Plant cell, tissue and organ culture; marker assisted breeding and genetic engineering of tuber crops. He is also Principal Investigator of the Feed the Future-Biotechnology Potato Partnership (FtF-BPP) Project, which is dealing with 3R-gene GM potato variety development for late blight resistance in Bangladesh, in collaboration with Michigan State University, USA. He has 27 research publications in renowned national and international journals. Dr. Molla has significant contribution to improve potato and horticultural crops through biotechnological approaches which has wide access to biotech labs in Bangladesh and benefiting farmers.

Agrobacterium Mediated Transformation of *PsCIPK* and *PsCBL* Genes to Enhance Salt and Submerge Tolerance in Indica Rice (*Oryza sativa* L.)

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Co-presenters: Md. Fahim Khan, Md. Nazmul Hasan, Md. Hammadul Hoque, and Md. Ashrafuzzaman, Shahjalal University of Science & Technology, Bangladesh, Emails: fahimgebsust@gmail.com, nayeemsust15@gmail.com, hammadulgeb@gmail.com, azamanbt@gmail.com

An efficient *Agrobacterium* transformation method for 2 varieties (BR 28, BR 29) and 2 cultivars (Kalijira, Kalobiruin) of indica rice O. sativa L. with PsCIPK, PsCBL genes were developed. Maximum calli initiation rate was 82±2.29% using N6 medium supplemented with 3 mg/L 2, 4-D from the mature seeds of Kalijira. After co-cultivation, the fresh growing calli were selected using 50 mg/L kanamycin. Maximum GUS positive response (88.8±2.25%) was found using 150 µM acetosyringone from the transformed calli of Kalijira. The highest percentage of regeneration frequency (66±3.38%) was observed using N6 media supplemented with BAP 3.0 mg/L and NAA 1.5 mg/L from the fresh growing calli of Kalijira. However, the rest of the varieties and cultivars used in the current study showed less response in terms of calli initiation rate, GUS positive response, and regeneration frequency than the Kalijira. PCR amplification of the reporter gene (GUS) from isolated DNA of the regenerated plantlets confirmed transformation of PsCIPK and PsCBL genes. In vitro evaluation of salt and submerge tolerance capacity of the regenerated transgenic plantlets showed more resistance than the wild plants.

Dr. Md. Shamsul Haque Prodhan was born in 1st September 1971, in the village Narandi, P.O. Narandi, Upazila Manohardi and Narsingdi District in Bangladesh. He got Talent pool Scholarship securing the first position in 1981 and stood the first position in Center Examination in Manohardi Upazila. Later on, admitted in Pabna Cadet College (PCC) in 1984 and passed SSC in 1988 with first-class (star mark) and securing government scholarship. He attended HSC examination from the same institution Pabna Cadet College in 1990 with first-class (star mark) and awarded as the best cadet for the year 1990 from Pabna Cadet College.

Mr. Prodhan selected from the ministry of education in 1991 for the undergraduate program and awarded the Indian Council for Cultural Relations award (Indian Government Scholarship) for B.Sc. Ag. (Honors) from Bidhan Chandra Krishi Viswa Vidyalaya, Kalyani, West Bengal, India. Later on, in 1997 April Mr. Prodhan was selected from the ministry of education, Bangladesh for Masters program and awarded Japan Government Scholarship (Monboshu kagaksho) in 1997 at Tokyo University of Agriculture, Tokyo Japan under the supervision of Professor Dr. Yasokazon Hirai. During this period he visited several countries for research and education purpose. Dr. Prodhan joined as an Assistant Professor in the Department of Biotechnology, School of life sciences at Shahjalal University of Science and Technology Sylhet in the year 2007. Dr. Prodhan promoted as associated professor March 2012 in the Department of Genetic Engineering and Biotechnology. Dr. Prodhan received Ministry of Science and Technology funded project for Citrus improvement and USDA (United States Department of Agriculture) funded research grant in the year 2012 and acting as a Project Director. He has published near about fifty-four research papers in different peer-reviewed journals and more than forty-seven abstracts and proceedings in different national and international seminars, conferences and symposia.

Screening for Drought Tolerance in Wheat Genotypes by Morphological and SSR Markers

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Drought stress has become a significant abiotic stress for wheat in Bangladesh. Therefore, it has been a priority to find drought tolerant wheat variety. The present investigation was carried out to evaluate locally cultivated wheat genotypes for drought tolerance based on morpho-physiological and molecular traits. Ten locally cultivated wheat genotypes were selected on the basis of our previous research and grown in pots under control (100% field capacity) and drought stress (30% field capacity), applied when third leaf was fully expanded and continued till maturity. The result revealed that drought stress affected the yield contributing characters and led to a significant reduction in grain yield. Significant variations were observed for all morphological and physiological traits among the genotypes. Drought susceptibility index and drought tolerance efficiency were used as criteria for selection of drought tolerance. Sonalika, Sourav and BARI gom-28 were least affected and found to be drought tolerant. Durum, Pavon-76, BARI gom-25 and BARI gom-33 were moderately tolerant while BARI gom-24, BINA gom-1 and BARI gom-20 were severely affected and found to be susceptible. Twenty six wheat genotypes were characterized by thirteen SSR markers linked to drought tolerance. A total of 73 alleles were detected among the 26 wheat genotypes with an average of 5.62 alleles per locus. Polymorphism information content (PIC) and Nei's (1973) gene diversity were 0.69 and 0.73, respectively. Similarity indices based cluster analysis separated 26 genotypes into different groups. Two tolerant genotypes; Sourav and Sonalika and two moderately tolerant genotypes; Durum and Pavon-76 as identified by morphological study were grouped in cluster 1 by the linked SSR markers. These four genotypes, therefore, passed the screening for drought tolerance both in molecular studies by drought linked markers and morphological studies and can suggested for cultivation in the drought prone areas of Bangladesh.

I am a research associate at the Department of Biotechnology, Bangladesh Agricultural University, Mymensingh-2202. I grew up in Gaibandha and moved to the Islamic university, Kushtia Bangladesh to study biotechnology and genetic engineering. After finishing my undergraduate studies, I moved to Mymensingh and complete the Post-graduation in Biotechnology under the supervision of Prof Dr. Shahidul Haque. My post-graduation research experience in the screening for drought and heat tolerant wheat genotypes. My current research area in Molecular biology. I am trying to observe the gene expression level in different salt stress and identify salt-tolerant wheat genotype.

Research Effort on the Development of Phosphorus Deficiency Tolerant Variety in Bangladesh

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Soil fertility is very important factor for plant growth as plants uptake all their necessary elements from soil. Phosphorus is one of the most important element. Phosphorus is part of the nuclei acid structure that is responsible for the protein regulation synthesis. The structures of both DNA and RNA are linked by phosphorus. Plants perform complex energy transmissions to complete their production cycle, photosynthesis (ATP is formed during photosynthesis and contains phosphorus as part of its structure), storage and transfer of energy, respiration which requires phosphorus. The value of phosphorus in plants is proper development of the roots and hastening of maturity, Promotes crop uniformity, increases disease resistance, facilitates nitrogen fixation abilities of legumes, improves overall crop quality and so on. The available phosphorus in Bangladesh soils could be considered between low and medium. Approximately 6% of the total land is severely deficient, 50% are strongly deficient and 44% are moderately deficient. Phosphorus availability is pH dependent. The total Phosphorus content in surface soils is very low: only 0.6% on average (compared to 0.14% of Nitrogen and 0.83% of Potassium). [1] Only 10% to 30% of a crop's Phosphorus requirements come from fertilizers. The remainder comes from the native soil. [2] When phosphorus concentration in the leaves is below 0.2% this indicates the phosphorus deficiency. Plants require phosphorus from the early stages of development because it is hard to reverse the effects of the deficiency when signs of stunt growth appear. Lack of phosphorous is addressed through application of Phosphorus Fertilizer in the soil that is why growers/farmers are spending a verse amount of money every year. The possible solution can be the development of P-deficiency tolerance variety and the bicarbonate Phosphorus

(sodium bicarbonate) test measures the amount of Phosphorus before sowing seeds. The possible outcomes will help the farmers in financial way, and the yielding of crops will be higher that will meet up the demanding of rice. This can be a good contribution to science and national economy.

Israt Jahan Samy, pursuing degree of Biochemistry and Biotechnology (B.Sc.), developed an interest in GMO, plants and DNA research by doing her different lab courses during her bachelor study. Studying in two different individual subjects that is interconnected by the system, developed a curiosity of multiple aspects of Biology and technology. Attitude towards nature always fascinates and attracts her, how the modern technology is using for the betterment of the people and discovering the new topics from environment for the research. Due to this, she decided to take course that will help her to quest her thirst in the combination of biology and technology (2016). She also consulted one of her professor about her interest in rice, GMO and plants and further prospects. She is highly interested to be an intern of biotechnological project or training. To know about her surroundings and communicate with other Biotechnologist and Microbiologist, she had joined the 1st Summer School for Young Biotechnology and Biochemistry (2019).

When she was in high school, she made herself attached with different science clubs and participated many events in her college. She had attended Science Fair, where she displayed her Urban Development project that was related with energy and environment with her team member. She also had been working as volunteer in her school's program and also participated in Red Crescent Health-Care related program. She had a passion to collect stamp and coins of different countries and province. She had also done some activities like Model United Nation, Summer School in China, where she had learnt about a little bit of Chinese cultures and language during her undergraduate. She had attended a Bioinformatics training program, where making 3D structure of protein fascinates her a lot.

Besides her academic activities, she always kept herself busy in other activities. She has dream to complete her PhD abroad. She wants to occupy herself with top researchers in various revolutionary project. She wants to lead her life the way she always dreamed of. When she is not preoccupied with other activities, she loves to watch nature and animal related videos, Sci-fi movies. She also loves to spend her time by writing poem or doing painting. Beside these, she loves to spend time with her pets and kids. From the affection towards kids, she is working as home tutor of four kids. In few months Israt Jahan Samy is going to be graduated and she will be one step closer to her Dream work.

Genetic Structure of the Populations of Sal (*Shorea robusta* Roxb. ex Gaertn.) in Bangladesh by Analyzing ISSR Profiles

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Sal (Shorea robusta Roxb. ex Gaertn) belonging to the family Dipterocarpaceae is one of the most well-known timber producing plant in the world and dominant species in the deciduous forest of South Asian countries including Bangladesh. Anthropogenic disturbances have caused fragmentations of this forest causing threats to the genetic diversity of the species. Nevertheless, information on genetic structure of Sal populations is relevant for proper management and conservation of this forest. The objectives of the present study, therefore, were to comprehend the genetic diversity of S. robusta within and among populations distributed in the selected Sal forest stands of Bangladesh. This study also focused on the population history of this species by analyzing ISSR (Internal Simple Sequence Repeats) marker profiles. Plants were collected from the major Sal forest patches under the districts of Dhaka, Tangail, Cumilla and Dinajpur that represented different geographic locations. Genomic DNA was extracted from mature leaf samples using modified CTAB method. PCR followed by gel electrophoresis was done by using standard protocols. The dendrogram generated by ISSR marker presented two clear groupings of the samples: samples collected from the forests of Cumilla and Dinajpur showed more genetic similarity and they were distant from Tangail sample. A possible explanation of this grouping might be that Cumilla and Dinajpur shared recent population history. This study also showed 69% molecular variance present within population and 31% among populations. Outcomes of this study could be used for developing conservation strategies of these forests.

My name is Pragga Saha Sharmi. I have completed my graduation in Department of Botany,University of Dhaka. After that, I have done my master's (Thesis) in Plant Ecology and Environment Laboratory, from the same university. Molecular Ecology was the topic of my specialization. Studying genetic diversity of the dominant tree species of deciduous forest in Bangladesh was my concern. In future, I also like to persuade my interest in ecology in advance level.

Expression of Taste Modifying Miraculin Protein in Transgenic Lettuce

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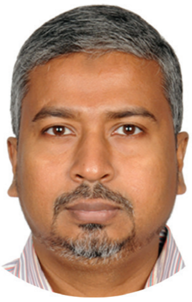
Miraculin is a basic glycoprotein is found in a shrub that is native to West Africa (Richadella dulcifica) known as miracle fruit plant. Though miraculin is not taste sweet itself but it chages the sour food to sweet in the human tongue for up to 2 h afterward. Miraculin has great potential as an alternative low-calorie sweetener for diabetic and dietetic people but there are limited natural sources for this protein. This distinctive effect and limited availability have created the interest of this protein to introduce into another edible plant to ensure the production of recombinant alternative sweetener through molecular pharming. Lettuce (Lactuca sativa L.) is a valuable horticultural crop and now growing worldwide. We are studying the stable *Agrobacterium*-mediated miraculin gene transformation on lettuce using ubiquitin promoter and characterizing the gene expression pattern to the transformed progeny. Five days old lettuce (cv. Kaiser) cotyledons were co-cultured with *Agrobacterium* tumefacience strain GV2260 harboring the binary vector Ubiquitin:MIR. Primary transformants were selected by shooting and rooting on kanamycin existed medium and the putative transgenic lettuce lines were revealed by genomic PCR analysis. Expression of miraculin protein in transformed plants also was authenticated by western blot analysis. Miraculin expression on lettuce can be a good alternative of available protein. Our result revealed that lettuce is an efficient platform for the genetically stable expression for recombinant miraculin production on a commercial scale.



Dr. Abdullah Mohammad Shohael is a Professor at the Department of Biotechnology and Genetic Engineering and additional director of the Institutional Quality Assurance Cell(IQAC) in the Jahangirnagar University, Bangladesh. He has completed his Ph.D. in Agricultural Biotechnology from the Chungbuk National University, South Korea. After completed his Ph.D. he has joined International Rice Research Institute (IRRI) The Philippines as a research collaborator. Dr. Shohael received several prestigious postdoctoral research experiences worldwide. He completed his JSPS Postdoctoral fellowship from Tsukuba University, Japan (2007-2009). Before joining as an assistant professor at Jahangirnagar University he was working as a research associate at the University of Florida, USA (2009-2011). Prof. Shohael is an internationally reputed scientist in commercial production of plant cells through bioreactor culture for the metabolic interest. He has published articles in many international journals and books (total citation 694, h-index 13, i10-index 15; RG score 19.36). Dr. Shohael was the first department chair of the Biotechnology and Genetic Engineering Department at Jahangirnagar University. He established a modern plant biotechnology laboratory in his department. He received fundings from the Ministry of Education, Ministry of Science and Technology, University Grants Commission and Jahangirnagar University Bangladesh. He has research collaboration in different universities and institutes in Korea, India, Japan, and The Philippines. Currently, he is taking the initiatives to establish the Biosafety and Biosecurity Institutional committee at his University as a coordinator.

RNAi-Based Transgene Conferred Extreme Resistance to the Geminivirus Causing Apical Leaf Curl Disease in Potato

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In recent years, geminiviruses have emerged as serious threats to many crops including potato in the tropics and subtropics. Tomato Leaf Curl New Delhi Virus-Potato (ToLCNDV-Potato) is one such examples that has been reported for the first time from northern states of India in the year 1999. Affected plants become severely stunted with apical leaf curl, crinkled leaves, and conspicuous mosaic. Though potato genotypes with multiple disease resistance have been identified in India using marker assisted selection (Sharma et al. 2014), no specific source of resistance in potato has yet been reported for ToLCNDV-Potato. RNAi induced by double stranded RNA molecules

like short hairpins, short interfering RNAs and long distance dsRNA has been developed as standard tools in gene function studies and as antiviral strategies. The AC1 gene was PCR amplified from field-infected potato leaves, cloned and sequenced (JN393309). Transgenic plants encoding the hairpin loop AC1 gene (Replicase), were raised in Kufri Pukhraj and Kufri Badshah potato cultivars by using *agrobacterium* mediated transformation methods. Transgenic lines when challenge inoculated with ToLCNDV-Potato showed different levels of resistance for all three constructs. Though a reduction in viral titer was observed in transgenic lines and showed most significant results as shown by reduction in the level of symptom expression in glasshouse screening as well as real-time data of in vivo virus concentration.

Series of clonally propagated plants have been evaluated for their bio-efficacy against apical leaf curl virus with infectious clone of ToLCNDV by employing agro inoculation technique.

The inoculated plants were maintained under controlled PALCV screen house. Maximum and typical symptoms of apical leaf curl were observed only in non-transgenic control K. Pukhraj and categorized as highly susceptible (Score 5) according scale developed from CPRI, Shimla compared to 0 score for symptomless, healthy and highly resistant KPLC2-53 event lines. Molecular characterization like transgene integration and copy number in selected transgenic lines were determined southern blot analysis and results revealed that most of the lines showed more than one copy number integration.

To know the site of integration, performed flanking sequence analysis using genome walking method. Selected promising ToLCNDV transgenics, i.e. KPLC2-53 and GTLC2-127 events, for genome walking as described by Thirulogachandar et al. (2011). The Right border flanking sequence of the event KPLC2-53 showed 99 % homology with the "Solanum lycopersicum chromosome 7" and that of event GTLC2-127 showed 98 % similarity with "Solanum tuberosum group chromosome 11". The authenticity of the identified sequences was confirmed in the selected events by event PCR using primers specific to the pBI121 T-DNA region and flaking sequence (potato genome sequence). The expected amplified product i.e 539 bp from KPLC2-53 and 756 bp from GTLC2 -127 events and the absence of the fragments in other events confirmed the integration of the T-DNA/transgenic DNA in the potato chromosome.

Using flanking sequence, the standard genetic code will be used to determine whether these amino acid sequences were identifiable proteins from potato, each of them was used as a query sequence in the BLASTP sequence matching algorithm, using the default parameters and searching the non-redundant protein sequences database and species name S. tuberosum as a delimiter. Results indicated no conserved domain have been detected for the obtained flanking sequences. Indicates that, inserted site have not disturbed the potato genome.

I am working (Scientist, Central Potato Research Institute, Shimla, India) on molecular plant pathology since 9 year on potato pathogen management and involved in development of transgenic and functional validation for potato improvment. Proved the concept of single effector genes are not sufficient in imparting resistance to Phytophthora infestans using RNAi technology, which is globally challenging fungus in response to imparting resistance against potato late blight (Published in FIG Journal). Besides, research efforts in understanding the functionality of genes in potato-phytophthora interaction using dsRNA and VIGS technology would become the development of new generation RNAi fungicides (Filed for patent). First time proved the RNAi mediated resistance to Bacterial wilt resistance in potato, since the lack of potato genetic resistance to Ralstonia solanacearum. (Patent filing is in process). Besides contributed to the RB transgenics events (Ready for BRL trails) and cDNA microarray analysis for identification of genes involved in late blight and heat tolerance genes. He supervises the 1 NPDF on "Generation of functional genetic resources in Potato using Activation Tagging" and 2 PhD students in the area of potato biotechnology. Development of ToLCNDV (gemini virus) resistant transgenic potato and identified potential events in popular potato cultivar and seeking permission for event and BRL trials. Co-ordination of Agriculture Biotechnology Support project-II (ABSP-II) for development and identification of RB transgenic event in Kufri Jytoi and its having stable field resistance to late blight. It involves Cornell University, Ithaca, USA, Wisconsin University, USA and CPRI as the partner institutes. The project is designed to develop durable late blight resistance in Indian popular potato cultivars in susceptible background. Its published in BMC genomics, 2016 and in Functional Plant Biology, 2018.

Total published research papers: 39 and 3 book chapters and got patent on dsRNA based bio formulation for the management of potato late blight.

Identification of Microbial Bioindicators for Assessment of Seawater Contamination in Ship Dismantling Zone of Chattogram

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Co-presenters: Sabrina Amin, Sanjida Alam, Sharmin Akter, Yasir Mohamed Riza, University of Science and Technology Chittagong (USTC), Bangladesh; Farhana Haque, University of Malaya, Malaysia

Ship breaking,one of the major industries of Bangladesh, is dismantling around 200 ships each year in Sitakunda, Chattogram. Although it possesses economic significance, it has become a pertinent socioecological concern because of different hazardous materials (heavy metals, carcinogenic compounds, poisonous fumes and other persistent organic pollutants) leeching into sea water. The use of microbial bioindicators (heavy metal and antibiotic resistant) in detecting contamination level of sea water is advantageous due to its abundance, rapid growth rate, reproducibility, ease of testing,and ability to detect biological and physiochemical changes at lower levels.In addition, certain species produce stress proteins when exposed to heavy metals (benzene and cadmium), acting as an early warning sign of contamination. Furthermore, microbial bioindicators can indicate the cumulative effects of different pollutants, consequently being a sign of the qualitative status of an ecosystem. In this study, we aimed to investigate sediment bacteria as a bioindicator to show the presence of contaminants. To assess the suitability of bacteria as bioindicators, this study includes antibiotic sensitivity test using selected antibiotics and Minimum Inhibitory Concentrations (MICs) against heavy metals (As, Ni, Co, Cr, Cu, Cd, Pb, Hg and Zn).This ongoing study aims at exploring the feasibility of bioremediation technology to decontaminate hazardous zones.

Prof. Amam Zonaed Siddiki received the DVM and M.S. in Parasitology degrees in Veterinary Sciences from the Bangladesh Agricultural University (BAU) in Mymensingh, Bangladesh, and the Ph.D. degree from the Department of Preclinical Veterinary Sciences, University of Liverpool, England, UK under Commonwealth Scholarship scheme in 2006. He joined as a Lecturer in the Department of Pathology and Parasitology, CVASU in 2000 and served as an Assistant Professor from 2002 until 2008 and an Associate Professor from 2008 until 2013. Currently, he holds a position of Professor in the Department of Pathology and Parasitology, CVASU. His research interests are in the areas of parasitic genomics, proteomics, bioinformatics, molecular diagnostics, DNA Barcoding, computational biology and system biology with phylodynamics and NGS data analyses strategies. Prof. Siddiki has a strong record of research in his area as evident by receiving a number of awards and fellowships from different prestigious organizations like The British Council, Government of Australia, US Dept. of Agriculture (USDA), UK Commonwealth Scholarship Commission, DAAD (Germany), Fulbright scholarship commission (USA), ICGEB (Trieste, Italy), Matsumae Foundation (Japan), ENSF (Italy) and TWAS (Italy).

Introgression of Mangrove Aemdhar in Rice for the Improvement of Salt Tolerance

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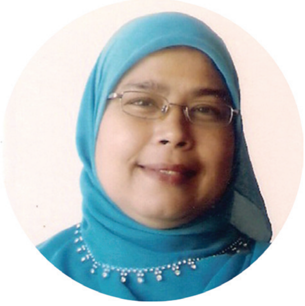
Co-presenters: Md. Enamul Hoque, Ph.D., Jannatul Ferdous, Ph.D., and Shampa Das Joya, BRRI, Bangladesh

Rice is one of the foremost cereal crops in Bangladesh and the world but soil salinity is increasing threat of its productivity by affecting all of its growth stages. Saline areas are gradually expanding due to global warming as well as climate change. Salt stress induces the generation of reactive oxygen species (ROS) in plant that causes cell damage. Monodehydro ascorbate reductase (MDHAR) is an important enzyme of ascorbate-glutathione cycles. It scavenges ROS efficiently thus it is vital for the protection of cellular component against oxidative injury created by salt stress. That is why it is important to develop salt tolerant high yielding rice varieties that permit to cultivate in the saline area for sustainable agriculture. Therefore, introgression of MDHAR from a mangrove plant (Acanthus ebracteatus), was carried out to improve salt tolerance of modern high yielding rice varieties. Two high yielding rice varieties BRRI dhan28 and BRRI dhan29 were crossed with transgenic rice plant containing mangrove AeMDHAR. Putative transformants were confirmed by PCR with gene specific primers. After confirmation by PCR selected plants containing AeMDHAR were used for backcrossing. Two backcrosses were made and confirmed with gene specific primers. Five backcrosses followed by several years selfing will be done to get homozygous fixed lines. Advanced lines having AeMDHAR in the background of BRRI dhan28 and BRRI dhan29 will be tested for salt tolerance at both seedling and reproductive stage. These salt tolerant lines can be grown in salt affected area in coastal region which will be enhanced the rice production of Bangladesh.



Dr. Sultana has been working as a Principal Scientist at Biotechnology Division of Bangladesh Rice Research Institute (BRRI). Her research interest focused on the development of rice varieties with desired traits using different biotechnological tools and genetic engineering for the development of stress tolerant rice varieties. She actively involved in the development of high yielding modern rice varieties viz. BRRI dhan86, BRRI dhan87, BRRI dhan89 and BRRI dhan92. She has published 20 scientific articles in international and national journal. She also participated in several training and workshop held in USA, Australia, Phillipines, Thialand, India, Singapore and Malaysia.

Biosafety, Risk Assessment, and Risk Management Associated with a Futuristic Release of Transgenic *Aedes aegypti* Linn. (*OX513A*) for Dengue Control in India

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With most conventional technologies proving ineffective an urgent need to deploy innovative control methods involving modified insect vectors of human diseases such as dengue, chikungunya etc. mainly transmitted by Aedes aegypti have been warranted. Currently three methods look promising, viz., (i) Release of Insects carrying a Dominant Lethal gene (RIDL) technique, (ii) the bacterium Wolbachia-driven paratransgenic technique, and (iii) refractory mosquito technology. Both the RIDL and Wolbachia-based technologies have been widely used in field in several countries; in some of these the Wolbachia-based technique has also been extended to another emerging vector, Aedes albopictus. Due to transgenic or paratransgenic character these innovative strategies, and their agents, have invariably inveigled attention of the regulators, policymakers and vector control agencies in DECs, including particularly India where, to take advantage of these promising technologies and initiatives, research activities are underway that relate to biosafety, risk assessment and management, and ethical–social–cultural (ESC) aspects so that a convincing deployment of these technologies could be considered as part of an integrated vector control programme.

Two NGO organizations, viz., (i) International Institute of Biotechnology and Toxicology, IIBAT, in Kilpauk, Chennai, and (ii) Gangabishan Bhikulal Investment and Trading Limited's (GBIT's), Maharashtra Hybrid Seeds Company Limited (MAHYCO) in Jalna, primarily undertook these innovative initiatives with due authorization and progress periodically monitored. Of these, GBIT-MAHYCO, as evidenced by the institute's research publications and other information channels in public domain, has reportedly accomplished extensive experimentation with the RIDL Aedes aegypti in both the laboratory and simulated field conditions alluding toward its beneficial deployment in suppressing the vector population in nature. And yet the RIDL technology needs a careful planning and all measures and precautions as to the biosafety, risk assessment and risk management, besides appropriate regulations, will need be scrupulously brought in action in order to evaluate the benefits.

Born 23 July, 1951, I completed MSc (Zoology) in 1974 and PhD (Entomology/Zoology) in 1978. I joined first the Malaria Research Centre (now National Institute of Malaria Research) in 1981 on a WHO-TDR research project on tribal malaria in south Gujarat, and subsequently the ICMR mainstream as Senior Research officer at Vector Control Research Centre, Pondicherry in 1984. I got promoted to Assistant Director and later Deputy Director at Desert Medicine Research Centre, Jodhpur in 1990 and 1995. Again I was promoted as Joint Director in 2000 and as Scientist 'G' (Director) & Director in-Charge in 2005 at the Centre for Research in Medical Entomology, Madurai (TN) till emeritation in 2013, whereupon the Government of India rewarded me a two-year extension. Through a highly distinguished career spanning >35 yrs I had the privilege to research in most States and UTs in the country. Soon after emeritation, I was appointed the Visiting Professor first at Bharathidasan Univ. (2015-16), and subsequently at Punjabi Univ. (2016-17). Since 2018 I am serving as the Advisor, VIT Univ., Vellore (TN) as well as the Consultant BCIL - FAO Sri Lanka Project on GMO and Biosafety.

I have published >605 scientific titles, plus 34 books, incl. a WHO Training Manual, "Biosafety for human health and the environment in the context of the potential use of genetically modified mosquitoes (GMMs): A tool for biosafety training based on courses in Africa, Asia and Latin America, 2008–2011"(2015). I was rated among the top 15 most productive authors on dengue (2004-2012) in India. In addition, I am also serving on expert committees of ICMR, DRDO, DST, DBT-RCGM, ZSI etc. I am originator of the annual Conferences of Medical Arthropodology, commenced 2007, in India. I represented India in preparing the OECD's Consensus Document on the dengue/Yellow Fever vector mosquito, Aedes aegypti Linn, published in 2018.

SOUTH ASIA
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