6TH ANNUAL SOUTH ASIA BIOSAFETY CONFERENCE

September 15 – 17, 2018
The Westin, Dhaka, Bangladesh

SOUTH ASIA
BIOSAFETY PROGRAM

ORGANIZED BY

The South Asia Biosafety Program
ILSI Research Foundation
Biotech Consortium India Limited

WITH SUPPORT FROM

Asia-Pacific Association of Agricultural Research Institutions (APAARI)
Asia-Pacific Consortium on Agricultural Biotechnology and Bioresources (APCoAB)
Bangladesh Academy of Sciences
Bangladesh Association for Plant Tissue Culture & Biotechnology (BAPTC&B)
Bhutan Agriculture and Food Regulatory Authority
Department of Environment, Bangladesh
Institute for International Crop Improvement - Donald Danforth Plant Science Center
International Society for Biosafety Research (ISBR)
Ministry of Environment, Forest, and Climate Change, India
National Academy of Agricultural Sciences, India
United States Agency for International Development

ILSI Research Foundation

The South Asia Biosafety Program (SABP) is dedicated to assisting India and Bangladesh in further strengthening institutional governance of biotechnology. Managed by the ILSI Research Foundation, SABP works with its in-country partners to:

- Identify and respond to technical training needs for food, feed and environmental safety assessment.
- Develop a sustainable network of trained, authoritative local experts to communicate both the benefits and the concerns associated with new agricultural biotechnologies to farmers and other stakeholder groups.
- Facilitate systems for permitting the safe conduct of experimental field trials of new crops developed using biotechnology so that scientists and farmers can evaluate them.
- Raise the profile of biotechnology and biosafety on the policy agenda within Bangladesh and India and to address the policy issues within the overall context of economic and agricultural development, international trade, and environmental sustainability.

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

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08:00-09:00 **Delegate Registration**

09:00-10:30 **Inaugural Ceremony**

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Regional Harmonization: Contribution by the South Asia Biosafety Program
Dr. Vibha Ahuja, Chief General Manager, Biotech Consortium India Limited, India

Address by Guest of Honor
Mr. David Westerling, Deputy Director, Economic Growth Office, United States Agency for International Development, Bangladesh

Address by Special Guest
Prof. Dr. Quazi Abdul Fattah, President, Bangladesh Academy of Sciences, Bangladesh

Address by Special Guest
Dr. Md. Kabir Ikramul Haque, Executive Chair, Bangladesh Agricultural Research Council (BARC), Bangladesh

Address by Special Guest
Dr. Sujata Arora, Advisor, Ministry of Environment, Forests and Climate Change, India

	Address by Chief Guest Mr. Md. Abdullah Al Mohsin Chowdhury, Secretary, Ministry of Environment, Forest and Climate Change, Bangladesh
	Address by Inaugural Ceremony Chair Dr. Sultan Ahmed, Director General, Department of Environment, Bangladesh
	Vote of Thanks Dr. Bhavneet Bajaj, Scientific Program Manager, ILSI Research Foundation, USA
10:30-11:00	**Tea Break**
11:00-13:00	**Plenary Session I: Biosafety Regulation and Capacity Building Initiatives in South Asia**
	Chair: Dr. Sultan Ahmed, Director General, Department of Environment, Bangladesh
	Co-Chair: Dr. Rishi Kumar Tyagi, Coordinator, Asia-Pacific Consortium on Agricultural Biotechnology and Bioresources (APCoAB), Asia-Pacific Association of Agricultural Research Institutions, Thailand
	Update on Biosafety Regulation in Bangladesh Mr. Md. Solaiman Haider, Director (Planning), Department of Environment, Bangladesh
	Regulations for Food Derived from Genetically Modified Organisms in India Dr. Lalitha Gowda, Member, Genetic Engineering Appraisal Committee and Former Chief Scientist, CSIR-Central Food Technology Research Institute, India
	Biosafety Regulation and Capacity Building Initiatives in Sri Lanka Ms. Surani Pathirana, Assistant Director, Biodiversity Secretariat, Ministry of Mahaweli Development and Environment, Sri Lanka
	Biosafety Regulation and Capacity Building Initiatives in Bhutan Mr. Jambay Dorji, Planning Officer/Focal for Biosafety (GMO), Bhutan Agriculture and Food Regulatory Authority, Bhutan
	Biodiversity, Biosafety, and You Dr. Flerida Carino, Professor, Institute of Chemistry, University of Philippines Diliman, Philippines
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13:00-14:00	**Lunch**
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	Chair: Dr. Zeba Seraj, Professor, University of Dhaka, Bangladesh
	Co-Chair: Dr. P.K. Chakrabarty, Assistant Director General (Plant Protection and Biosafety), Indian Council of Agricultural Research, India
	Genome Editing for Rice Improvement Dr. Inez H. Slamet-Loedin, Cluster Lead - Trait and Genome Engineering, International Rice Research Institute (IRRI), Philippines
	Bio Prospection of Plant Diversity for Novel Insecticidal Proteins/Genes for Next Generation GM Crops

Dr. P. K. Singh, Principal Scientist and Leader for Insect Defense, Genetics and Plant Molecular Biology Division, CSIR-National Botanical Research Institute, India

Engineering Herbicide Resistance in Rice for Effective Weed Management in Agriculture
Dr. M. K. Reddy, Group Leader, Crop Improvement Group, International Center for Genetic Engineering and Biotechnology (ICGEB), India

Biotechnological Approaches for Engineering Resistance to the Insect Herbivore Helicoverpa armigera *in Pigeonpea*
Dr. Rohini Sreevathsa, Senior Scientist, ICAR-National Research Center on Plant Biotechnology, India

Engineering Abiotic Stress Tolerance in Monocots and Path To Commercialization
Dr. Jos van Boxtel, Principal Scientist, Arcadia Biosciences, USA

16:30-17:00 **Tea Break**

17:00-18:00 **Lightning Round for Students and Early Career Researchers**

Chair: Dr. Andrew Roberts, Deputy Executive Director, ILSI Research Foundation, USA

Blending Gene Expression with Phenomics to Decipher Salt Tolerance Determinant
Sabrina M. Elias, University of Dhaka, Bangladesh

*Alternatively Spliced Form of the Vacuolar Na^+/H^+ Antiporter (*OsNHX1*) Gene: Aspire to Combat Salinity Stress in Rice*
Hamida Nooreen Mahmood, University of Dhaka, Bangladesh

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Tabassum Sunfi, University of Dhaka, Bangladesh

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Mohammad Umer Sharif Shohan, University of Dhaka, Bangladesh

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Rakshita Singh, CCS Haryana Agricultural University, India

Engineering Insect Resistance in Rice
Yaiphabi Kumam, Tamil Nadu Agricultural University, India

Comparative Nutritional Equivalence Evaluation of Transgenic Chickpea Seeds Harboring either a Cry1Ac *or a* Cry2Aa *Gene*
Rubi Gupta, Assam Agricultural University, India

Genetic Engineering of Sugarcane with EXPA1 *and* BRK *Genes Increases Water Deficit Stress Tolerance and its Biosafety Concern*
Ashwin Narayan, ICAR-Sugarcane Breeding Institute

18:00-19:00 **Poster Session**

19:00-21:00 **Welcome Reception**

Day 2: September 16, 2018

09:00-10:30 **Plenary Session III: Research Advances in the Development of Transgenic and Gene Edited Products in South Asia**

Chair: Dr. Abul Kalam Azad, Director General, Bangladesh Agricultural Research Institute, Bangladesh

Co-Chair: Dr. B. Venkateswarlu, Former Vice-Chancellor, VNM Krishi Vidyapeeth, Parbhani and Member, GEAC, India

Keynote: Opportunities to Address South Asia's Productivity and Food Security Challenges Using New Breeding Technologies
Dr. Swapan Datta, Professor, University of Calcutta, India

Development of Pro-Vitamin A Rich Biofortified Banana Fruit by Using Transgenic and Genome Editing Approaches
Dr. Siddharth Tiwari, Scientist, National Agri-Food Biotechnology Institute, India

Bt Brinjal: A Genetically Engineered 'Minor' Crop Comes of Age in Bangladesh
Dr. Jahangir Hossain, Country Coordinator, Feed the Future South Asia Eggplant Improvement Partnership, Bangladesh

10:30-11:00 **Tea Break**

11:00-13:00 **Plenary Session III: Research Advances in the Development of Transgenic and Gene Edited Products in South Asia (continued)**

Biotechnological Strategies for Immunity to Aflatoxin Contamination in Groundnut
Dr. Pooja Bhatnagar-Mathur, Theme Leader (Cell, Molecular Biology, and Genetic Engineering), International Crops Research Institute for the Semi-Arid Tropics, India

Status of Bt Cotton Research and Biosafety Measures in Bangladesh
Dr. Md. Farid Uddin, Executive Director, Cotton Development Board, Bangladesh

Research Advances in the Development of Transgenic and Gene Edited Products in South Asia
Dr. Pradeepa Bandaranayake, Director, Agricultural Biotechnology Center, University of Peradeniya, Sri Lanka

International Collaboration, Open Science, and Open Data Sharing to Manage Worrisome Wheat Blast in South Asia by Genomics and Genome Editing Approaches
Dr. Tofazzal Islam, Professor, Department of Biotechnology, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh

Advancement of GM Potato Research at BARI for Late Blight Disease Resistant Varieties
Dr. Md. Mosharraf Hossain Molla, Principal Investigator, Bangladesh Agricultural Research Institute, Bangladesh

13:00-14:00 **Lunch**

14:00-18:00	**Parallel Workshops**
	Parallel Workshop I: Science Communication - The Importance of Audience Engagement
	Parallel Workshop II: Detection of Genetically Modified Crops and Tour of Diagnostic Lab
	Parallel Workshop III: Synthetic Biology and Digital Sequence Information under the Convention on Biological Diversity

Day 3: September 17, 2018

09:00-10:30	**Plenary Session IV: Animal, Arthropod, and Aquatic Biotechnology - Biosafety Research, Risk Assessment, and Regulation**
	Chair: Dr. Md. Kabir Ikramul Haque, Executive Chairman, Bangladesh Agricultural Research Council, Bangladesh
	Keynote: Advancing Animal Biotechnology Innovation in South Asia – Challenges and Opportunities Dr. Subeer Majumdar, Director, National Institute of Animal Biotechnology, India
	Research Progress on Genetically Modified Food and Ornamental Freshwater Fishes with Understandings on Ecological and Health Concerns Dr. Hirak Kumar Barman, Principal Scientist, Fish Genetics and Bio-Technology Division, Central Institute of Freshwater Aquaculture, India
	Approaches for Managing Field Trials of Genetically Engineered Algae Dr. Tomal Dattaroy, Lead - Regulatory Affairs and Biology, Reliance Industries Limited, India
	Genetically Modified Insects Take Flight Dr. John Teem, Senior Scientific Program Manager, ILSI Research Foundation, USA
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	Chair: Dr. Vibha Ahuja, Chief General Manager, Biotech Consortium India Limited, India
	Understanding Effective Communication in Agribiotechnology & Biosafety Dr. Mahaletchumy Arujanan, Executive Director, Malaysian Biotechnology Information Center, Malaysia
	Challenges in Communicating a Biotechnology Product: The Golden Rice Experience Ms. Temina Lalani-Shariff, Director Communication and Stakeholder Engagement, International Rice Research Institute (IRRI), Philippines
	"Science Diplomacy": A Tool for Connecting Science to the World Dr. Manoj Kumar Patairiya, Director, CSIR-National Institute of Science Communication and Information Resources, India
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12:30-12:45	**Poster Session and Lightning Round Awards**
1245:-13:45	**Lunch**

13:45-17:00	**Plenary Session VI: Biosafety Risk Assessment and Regulation of Gene Edited Plants**
	Chair: Dr. B. Sesikeran, Former Director, National Institute of Nutrition, India
	Co-Chair: Prof. Zia Uddin Ahmed, Fellow, Bangladesh Academy of Sciences
	Keynote: What is Gene Editing? Context for Plant Breeding and Regulation Dr. Andrew Roberts, Deputy Executive Director, ILSI Research Foundation, USA
	Gene Editing and International Forums: The Convention on Biological Diversity and the Cartagena Protocol on Biosafety Dr. Karen Hokanson, Research Specialist, Department of Horticultural Sciences, University of Minnesota, USA
	Risk Assessment and Regulation of Gene Edited Organisms in Australia Dr. Heidi Mitchell, Director, Plant Evaluation Section, Office of the Gene Technology Regulator, Australia
	Global Regulatory Outlook for Genome Edited Crops Dr. Valasubramanian Ramaiah, Regulatory and Stewardship Lead, Corteva Agriscience (DowDuPont), India
	Gene Editing Applications in Agriculture Dr. Donald MacKenzie, Executive Director, Institute for International Crop Improvement, Donald Danforth Plant Science Center, USA
	Panel Discussion
17:00-17:15	**Closing Remarks, Adjournment, and Tea**

SPEAKER BIOGRAPHIES

PLENARY SESSIONS

Vibha Ahuja, Ph.D.

Chief General Manager, Biotech Consortium India Limited, India

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Dr. Vibha Ahuja holds an M.Sc. (Hons.) and Ph.D. in microbiology from India. She is presently serving as the Chief General Manager at the Biotech Consortium India Limited. Dr. Ahuja has worked at BCIL since 1993 and has more than 20 years of experience in undertaking project consultancy in the area of biotechnology, during which she has dealt with projects connected with biosafety and regulatory aspects, particularly with reference to genetically modified organisms (GMOs), biodiversity conservation, and environmental/ industrial biotechnology. These projects include undertaking capacity building activities in the area of modern biotechnology related to the use of GMOs, imparting training through seminars, workshops, and national and international training programs, as well as preparing well-researched publications for various stakeholders related to biosafety issues, etc. She is experienced in issues related to the Indian regulatory framework and the Cartagena Protocol on Biosafety and is well versed with relevant decisions and developments. She has been actively working in South Asian countries such as Bhutan, Bangladesh, Sri Lanka, and Malaysia.

Mahaletchumy Arujanan, Ph.D.

Executive Director, Malaysian Biotechnology Information Center, Malaysia
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Mahaletchumy Arujanan is the Executive Director of Malaysian Biotechnology Information Centre (MABIC) and Editor-in-Chief of *The Petri Dish*—the first science newspaper in Malaysia. She has a degree in Biochemistry and Microbiology from Universiti Putra Malaysia, master's in Biotechnology, and Ph.D. in science communication from the University of Malaya. Maha is listed as the world's 100 most influential people in biotechnology by Scientific American Worldview 2015. She is also listed in the honorific list of Women in Biotechnology Law and Regulation as part of *Biotechnology Law Report 2015,* published by Mary Ann Liebert Inc., among 23 other women scientists and lawyers. Maha won the 2010 Third World Academy of Science Regional Prize for Public Understanding of Science for East, Southeast Asia, and Pacific Region.

She is actively involved in the public understanding of biotechnology locally and internationally, as well as in issues like policies, regulations, communication, business, ethics, religion, and education. Maha developed the first science communication training module for scientists in Malaysia and runs training workshops. She established the *Asian Short Course on Agribiotechnology, Biosafety Regulations, and Communication* with a pilot course in Aug 2018. She is also an Adjunct Lecturer with Monash University, Malaysia and AIMST University. She sits on several universities' industry advisory panel, Selangor State Bio Council, National Bioethics Council, and various committees.

Maha is listed as a speaker on the Economic Bureau Biotechnology Outreach Fund under the US State Department Economic Bureau, Agriculture Policy Office. She has excellent working relationships with various ministries, government agencies, research institutes, public and private universities, industries, and various international organizations. Maha is also known for her non-traditional approaches in communicating biotechnology, such as fashion shows and carnivals. She has published chapters, papers, and articles on science/biotech communication and biotechnology development.

Pradeepa Bandaranayake, Ph.D.

Director, University of Peradeniya, Sri Lanka
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After completion of a bachelor's degree in agriculture with a specialization in agricultural biology, Dr. Pradeepa Bandaranayake joined the Department of Crop Science of the Faculty of Agriculture as a Lecturer in December 2003. She completed an M.Sc. in biotechnology in early 2004 and registered for an M.Phil. in crop science in the same year, which was successfully completed in 2006.

In 2005, she won the prestigious Fulbright Fellowship for graduate studies offered by the government of the United State of America, being one of the three recipients of this fellowship from Sri Lanka. As a Fulbright Fellow, she joined the University of California, Davis (UC Davis), which was the number one ranked graduate program in the world for agriculture. There, she joined the Department of Plant Sciences and pursued two degrees in parallel-a master's degree in Horticulture and Agronomy at the Department of Plant Sciences and a Ph.D. in Plant Biology at the Department of Plant Biology. She successfully completed the M.Sc. degree in September 2007 and the Ph.D. degree in 2011, with specialization in molecular biology, biochemistry, and genomics with designated emphasis in biotechnology. During the Ph.D. program, she obtained industry experience at the world's leading biotechnology industry, Monsanto Company, as an Intern. During her graduate studies, she secured several prestigious awards offered to outstanding students and researchers by the University of California and outside organizations. She also attended special professional development programs

while in graduate school and during many later visits to UC Davis. She still has collaborative projects with UC Davis and visits every year to pursue collaborative work.

In March 2013, she joined the Agricultural Biotechnology Center (AgBC), University of Peradeniya, Sri Lanka as a Senior Lecturer, where she was appointed as the Director. During her five-year tenure at AgBC, she was able to raise its status to "Center of Excellence in Biotechnology" in the country, as identified in its mission statement.

Currently, Pradeepa conducts her research in molecular biology, biochemistry, genomics, and biotechnology, leading several foreign and locally funded projects. Gene expression, transcriptomics, gene silencing, gene editing, and over expression of genes in plant secondary metabolic pathways are the key focus areas of those projects. She has co-authored more than 15 scientific journal publications and over 40 conference publications. Currently, she supervises nine Ph.D. students and three M.Phil. students. She serves in several national level committees in biotechnology and related areas.

Hirak Kumar Barman, Ph.D.

Principal Scientist, Fish Genetics and Bio-Technology Division, Central Institute of Freshwater Aquaculture, India

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Dr. H. K. Barman has been working as a scientist at the Indian Council of Agricultural Research since July 1996. He is instrumental in establishing the Aquaculture Biotechnology Center at ICAR-CIFA, Kausalyaganga, Bhubaneswar, India. He was the first scientist to provide evidence of genetic relationships among Indian major carps. He has contributed significantly to generating transgenic and targeted gene editing techniques in Indian major carps, as well as other small aquarium freshwater fishes, so as to develop model carps lacking the *TLR22* gene and ornamental color fishes, aiming towards a rainbow revolution. He unraveled key pathways of eukaryotic chromatin organization and epigenetic regulations via gene targeting approach in the chicken DT40 cell line. His contributions includle developing specific and reliable purification protocol of carp and catfish spermatogonial stem cells *vis-a-vis* production of fertile sperm *in vitro* from proliferating spermatogonial cells. His significant contributions towards unravelling mechanisms of expressions of spermatogonial stem cell marker genes, such as *Pou2, Plzf, Nanog,* and *Sox2*, for the first time is acclaimed worldwide. Dr. Barman has also demonstrated an alternative strategy of gene manipulation using spermatogonial stem cell technology for undertaking basic and applied biology research. He has also contributed detailed transcriptome analysis of fish and shellfishes in response to abiotic stressors.

He has published around fifty scientific research articles in peer-reviewed international journals, including several book-chapters, technical manuals, and popular articles. He has mentored several students for Ph.D. and MSc degrees. He is officiating as Chairman of the Institutional Biosafety Committee (IBSC) and also as a member of the scientific panel on GMOs, FSSAI (Food Safety and Standards Authority of India), Ministry of Health and Family Welfare, Government of India

Pooja Bhatnagar-Mathur, Ph.D.

Theme Leader – Cell, Molecular Biology and Genetic Engineering, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India

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With over 15 years of scientific experience in molecular biology and modern biotechnological approaches, Pooja has been working at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and is involved in developing biotechnological tools towards candidate gene discovery and validations, genetic and genome engineering, as well as translational research activities in grain legumes and dry land cereals of SAT, including groundnut, pigeonpea, chickpea, sorghum, and millets.

In her role as Theme Leader of Cell, Molecular Biology, and Genetic Engineering, she and her team combine multiple platforms to develop and test new research interventions specifically targeting constraints for which no genetic traits are available in conventional plant breeding applications. This involves combining forward and reverse biological engineering tools and technologies for organizing the overwhelming physical details of natural biology (gene sequences, protein properties, and biological systems), in order to provide biotechnological solutions for traits that are difficult to address using conventional plant breeding tools. Some of her more recent engagements integrate cutting edge scientific innovations to design and build new biological functions. She has been actively involved in translational research activities, including biosafety assessment of transgenic products, and building the capacities of stakeholders in different target countries of Asia and Africa to comply with international and national biosafety regulations.

Pooja has several advanced certifications from the World Intellectual Property Organization (WIPO) on several components of intellectual property management for commercialization of biotech products. So far, she has over 80 research publications in various international peer reviewed journals and books, as well as several popular articles and blogs in various newsletters.

Jos van Boxtel, Ph.D.

Principal Scientist, Arcadia Biosciences, USA
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Jos van Boxtel holds a Ph.D. in Agricultural Sciences/Plant Breeding from Wageningen University in the Netherlands. His Ph.D. research work was conducted at CIRAD, Montpellier, France, studying the genetic transformation of coffee. From 1995 to 1999, he was a post-doctoral fellow studying virus resistance in cowpea through genetic engineering at the John Innes Centre in the United Kingdom. From 1999 to 2002, he returned to CIRAD, this time studying salt and drought tolerance in rice through genetic engineering. Before joining Arcadia in 2003, he had worked for one year with Prof. Eduardo Blumwald at the University of California, Davis on salt tolerant rice. In addition to the production of transgenic plants for various Arcadia projects, Jos' Plant Transformation Group works on innovating plant gene modification techniques, which can be used for enhancing environmental and health benefits of agricultural crops. Since 2009, Jos has picked up the additional tasks of leading the science group in Arcadia's Asia and Africa-targeted rice and wheat improvement projects for abiotic stress tolerance and quality traits.

Flerida Cariño, Ph.D.

Professor, Institute of Chemistry, University of the Philippines, Diliman, Philippines
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Dr. Flerida Cariño is a full professor of Biochemistry at the Institute of Chemistry, University of the Philippines, Diliman and was the former Director of the Institute of Chemistry and the Institute of Environmental Science and Meteorology of the same university. She holds a Ph.D. from Texas A&M University and has done research on insecticide resistance genetics, biochemistry, and molecular biology. Dr. Cariño also was the Physical Scientist member of the National Committee on Biosafety of the Philippines from 1994-2008, when the biosafety regulatory system was reorganized and responsibilities were reassigned to several government agencies. Dr. Cariño is currently the Physical Scientist member of the Department of Science and Technology Biosafety Committee and has been a regular participant in Philippin biosafety activities since 1994. She has served as faculty/trainor in several local and international training programs on food safety and environmental risk assessment of genetically modified organisms. A member of the Philippine delegation to the Conference of Parties to the Convention on Biodiversity and the Cartagena Protocol on Biosafety since 2008, she has also represented the Philippines in several

ASEAN and APEC meetings related to biotechnology and Biosafety. She was a member of the Scientific Advisory Board of the Organization for the Prohibition of Chemical Weapons (OPCW) from 2011-2017.

Swapan Datta, Ph.D.

Professor, University of Calcutta, India
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Dr. Swapan Datta is a well-known plant scientist with vast experience in plant biotechnology, agricultural science, and global agriculture policy, including intellectual property rights. He was Vice Chancellor at Visva-Bharati University, Santiniketan (2016-2018) and DDG (ICAR), New Delhi (2009-2015), Rashbehari Ghosh Chair Professor, University of Calcutta (2005-2015), Visiting Faculty at UC-Davis, USA (1989), Senior Scientist at ETH-Zurich, Switzerland (1987-1993), FMI Fellow at Basel (1989), Senior Scientist & HarvestPlus Global Rice Crop Leader at IRRI, Philippines (1993-2005), and DAAD Fellow, BBA, Instiute of Resistance Genetics at Gruenbach, Germany (1985-1986). Dr. Datta is elected fellow of several national and international fellowships, including FNA, FASc, FNASc, FNAAS, and FTWAS.

Dr. Datta and his team developed genetically engineered rice, e.g., golden indica rice, high iron rice, bacterial blight/sheath blight resistant rice, single microspore derived embryogenesis and double haploid wheat, barley and rice, etc. Recently, his group developed an efficient genetic transformation system in chickpea, pigeon pea, and jute. His group's work on GM hybrid Bt rice is well established in China and derived from the MH63 line.

He is the recipient of several prestigious awards, including the Paul Johnnes Brouhl Memorial Medal (2009) and Panchanan Maheshwari medal for significant contributions in Embryogenesis and Plant Biotechnology. He has published 150+ research papers in plant biology, plant genetic resources, and plant biotechnology, which appeared in *Nature, Science, Nature Biotechnology, Nature Genetics, Plant Biotechnology Journal, Theoretical Applied Genetics, Crop Science, Rice, Breeding Science, Plant Journal*, etc., with 10594 citations and 51 h-index as of today.

He has supervised 34+ Ph.D. students from different countries, and they are now recognized scientists and faculty in China, Bangladesh, Myanmar, Vietnam, Europe, USA, and India.

Tomal Dattaroy, Ph.D.

Lead - Regulatory Affairs and Biology, Reliance Industries Limited, India
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Tomal Dattaroy completed a Ph.D. in biotechnology from CSIR-National Chemical Laboratory, Pune. He has a diverse profile in crop science research, which includes molecular fingerprinting (AFLP and microsatellites) of sorghum, biochemistry of plant RNA polyadenylation and RNA turnover, and genetic engineering of plants for resistance to biotic stresses. Tomal has also worked on characterization of cold active proteases from Bacillus for the processing of leather. He has patents granted on novel promoters to his credit. Tomal is currently with Reliance Industries Limited (RIL), Navi Mumbai, India and is responsible for coordinating the overall regulatory matters related to biological sciences for RIL. His primary focus is on biosafety matters related to cultivation of algae. In that context, he has organized a session entitled, "ERA of GM Algae" at the ISBGMO14 in Guadalajara, Mexico in June 2017. He is now representing the Business and Industry Advisory Committee (BIAC) at the OECD in the OECD's Special Working Group on Microorganisms, which is focused on guidelines for cultivation of GM algae.

Jambay Dorji

Planning Officer/Focal for Biosafety (GMO), Bhutan Agriculture and Food Regulatory Authority (BAFRA), Bhutan

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Mr. Jambay Dorji is serving as Planning Officer/Focal for Biosafety in the Bhutan Agriculture and Food Regulatory Authority (BAFRA), Ministry of Agriculture and Forests, Thimphu, Bhutan. He has a Master's degree in Food Safety from Wageningen University. He has experience in GMO detection and was involved in the introduction of GMO test parameters at the National Food Testing Laboratory by using qPCR. He is also involved in the formulation of the Biosafety Act of Bhutan 2015 and its Rules and Regulations 2018. He is also one of the members in the Biosafety Technical Working Group, which addresses/recommends biosafety concerns to the National Biosafety Board—the highest decision making body pertaining to GMO. He also serves as Technical Manager for the National Food Testing Laboratory, as required under ISO/IEC 17025. He is responsible for formulating the agency's five year plan, including projects, coordinating with relevant agencies, and liaising with development partners.

Lalitha Gowda, Ph.D.

Member, Genetic Engineering Appraisal Committee and Former Chief Scientist, CSIR-Central Food Technology Research Institute, India

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Dr Lalitha R. Gowda retired as Chief Scientist, CSIR-Central Food Technological Research Institute, Mysore in June, 2014. She obtained her Ph.D. in Biochemistry from Baylor University, Texas, USA and had post-doctoral training at the Department of Biochemistry, University of Cambridge, UK. Her research and teaching career spans over 35 years in the areas of structural biology of plant proteins, food science, detail-focused analytical food safety, and food safety regulations. She has 85 published papers in high impact peer reviewed journals of international repute. She has mentored twelve students for their doctoral degrees in biochemistry and guided thirty-five master's students through their dissertation.

She is currently a member of the Scientific Committee of Food Safety and Standards Authority of India and Genetic Engineering Appraisal Committee (GEAC) under Ministry of Environment, Forests & Climate Change.

Md. Solaiman Haider

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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 did 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 is the Member Secretary of the Biosafety Core Committee (BCC). He has hands-on experiences gathered from international trainings, seminars, workshops, negotiation meetings on environment, biodiversity and biosafety issues in the countries like the USA, Canada, Germany, France, Switzerland, the Netherlands, Egypt, Jordan, Iran, South Korea, Tanzania, Kenya, India, Sri Lanka,

Nepal, Bhutan, Thailand, Cambodia, Vietnam, China, Hong Kong, Indonesia, Malaysia, and Japan. As an environmental expert, he possesses vast experience in presenting papers as a resource person on various topics of environment, biodiversity, biosafety, climate change, and on implementation of sustainable development goals. As a focal person on Biodiversity and Biosafety issues in the 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, as well as SOPs for confined field trials of GE plants and data recording formats. He is also the Project Director of the UNEP-GEF funded Implementation of Biosafety Framework of Bangladesh.

Md. Kabir Ikramul Haque, Ph.D.

Executive Chairman, Bangladesh Agricultural Research Council (BARC), Bangladesh
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Dr. Md. Kabir Ikramul Haque joined the Bangladesh Agricultural Research Council (BARC) as Executive Chairman on December 28, 2017. Earlier, he served as the Member Director (Fisheries) of BARC and Director, Project Implementation Unit (NATP Phase-I and NATP Phase-II) in the same organization. He also holds the position of Chairman of the Governing Board of SAARC Agriculture Center and is General Secretary of the Bangladesh Fisheries Forum.

Dr. Haque obtained a B.Sc. (with honors) in Fisheries from the Bangladesh Agricultural University (BAU), Mymensingh in 1984. Later, he obtained a post graduate from the same University in Fisheries Biology and Limnology in 1985. He completed his Ph.D. in Hydrobiology (Fisheries) in 1995 from Kharkov State University, Ukraine.

He began his career as Scientific Officer at the Bangladesh Fisheries Research Institute (BFRI), Mymensingh in 1987. He subsequently joined BARC as Principal Scientific Officer (Fisheries) in 2007 Dr. Md. Kabir Ikramul Haque has 31 years of working experience in the field of agricultural research management, project management, and policy development. He has contributed substantially to developing agriculture policies and research priorities for Bangladesh's agriculture (Agricultural Research Vision 2030 and Beyond). Dr. Haque also contributed to developing many technologies.

He has visited the USA, Germany, Canada, China, Thailand, India, and some other countries for professional purposes related to agricultural research. He is an enthusiastic scientist and has a keen interest in research.

Karen Hokanson, Ph.D.

Research Specialist, Department of Horticultural Science, University of Minnesota, USA
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Dr. Karen E. Hokanson is currently a Project Specialist in the Department of Horticultural Sciences at the University of Minnesota. She has been working in the area of biotechnology regulation and capacity building in developing countries for the past 20 years, including early in her career as a Biotechnologist for USDA APHIS, contributing to regulatory policy and scientific review of applications for the release of GM crops. Dr. Hokanson worked for many years with the USAID-sponsored Program for Biosafety Systems (PBS), providing technical guidance on regulatory systems to governments in developing countries, and with the Donald Danforth Plant Science Center, providing regulatory support for biotechnology projects in developing countries. She currently serves as the Regulatory Lead for the USAID FtF Biotechnology Potato Partnership (FtFBPP) project led by Michigan State University, developing late blight resistant potato for Bangladesh and Indonesia. Dr. Hokanson has participated regularly as an observer from the public research sector in the negotiations of the Cartagena Protocol on Biosafety.

Jahangir Hossain, Ph.D.

Country Coordinator, Feed the Future South Asia Eggplant Improvement Partnership, Bangladesh

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Dr. Md. Jahangir Hossain completed college in 1976, graduated from the Bangladesh Agricultural University in 1982 and obtained a master's degree in the field of horticulture from the same university in 1987 with a thesis titled "Application of tissue culture technique for the production of virus free potatoes." Dr. Hossain obtained his Ph.D. from the same university in 2006 with a thesis titled "Potato microtuber production and dormancy breaking".

Dr. Hossain joined as Scientific Officer at the Bangladesh Agricultural Research Institute (BARI) in 1983 and started his research carrier in potato tissue culture and virus free potato production. He was team leader of the tissue culture group of the Tuber Crops Research Center (TCRC) of BARI from 1983 to 2006. Dr. Hossain held the position of Director of TCRC for two years (2015 and 2016). Dr. Hossain has published about 80 research papers in national and international journals.

Dr. Hossain joined as Country Project Director of Feed the Future Biotechnology Projects (Potato and Brinjal) in 2017. Dr. Hossain is blessed with two sons and one daughter.

Md. Tofazzal Islam, Ph.D.

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Dr. Md. Tofazzal Islam is a professor at the Department of Biotechnology of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Bangladesh. He did his Ph.D. in Applied Biosciences at Hokkaido University in Japan. Dr. Islam received postdoctoral research experiences at Hokkaido University (Japan), University of Goettingen (Germany), University of Nottingham (UK), and West Virginia University (USA) under fellowships from the Japan Society for the Promotion of Science (JSPS), Alexander von Humboldt Foundation, Commonwealth Scholarship Commission, and Fulbright Visiting Scholar Program, respectively. Prof. Islam is an internationally reputed scientist in molecular plant-microbe interactions and biotechnology. He has published articles in many international journals and book series (>200 peer-reviewed articles, total citation 1,738, h index 24, i10-index 48; RG score 39.06). He established state-of-the-art research facilities at BSMRAU with external funding from the World Bank, USDA, Bangladesh Academy of Science, British Council, Krishi Gobeshona Foundation, and Government of Bangladesh. Currently, he is dedicated to establishing the Institute of Biotechnology and Genetic Engineering (IBGE) by upgrading the Department of Biotechnology at BSMRAU.

Temina Lalani-Shariff

Director Communication and Stakeholder Engagement, International Rice Research Institute (IRRI), Philippines

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As IRRI's Director of Communication and Stakeholder Engagement, Temina oversees the institute's global branding, communication, and advocacy strategy. She brings over 20 years of experience in branding, donor development, and management expertise.

Temina is passionate about knowledge and its potential to impact individuals and transform communities. Over the course of her career, she has worked with universities, research institutions, and civil society organizations in South and Central Asia, Africa, and North America to generate support

from governments, private funders, and stakeholders. An entrepreneur at heart, she established and grew a boutique public relations firm early in her career.

Temina holds MBA degrees from the Kellogg School of Management and the Schulich School of Management, a graduate degree in Communication Studies from the University of Calgary, and a B.A. in International Politics from the University of Alberta.

An avid community volunteer, Temina most recently served on the Board of the Calgary Public Library and as Chair of Communications and Community Relations for the Ismaili Council for the Prairies. Previously, she served as a Board member of River Valley School, a private Montessori school, Ten Thousand Villages, and the International Association of Business Communicators.

In this role, Temina brings her skills in strategic partnerships, business development, communications, public relations, and organizational transformation to help IRRI meet its goals. She describes herself as an adaptable leader and team-builder and is committed to fostering an environment of creativity, innovation, and inclusion where people can do their best work.

Donald MacKenzie, Ph.D.

Executive Director, Institute for International Crop Improvement at the Donald Danforth Plant Science Center, USA

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Donald MacKenzie is the Executive Director of the Institute for International Crop Improvement (IICI) at the Donald Danforth Plant Science Center. He manages 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 the 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, 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.

Subeer Majumdar, Ph.D.

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Dr. Subeer S. Majumdar obtained his Ph.D. from the National Institute of Health & Family Welfare, New Delhi, India. He did his Postdoctoral Research at the School of Medicine, Southern Illinois University, Carbondale, USA and at the Department of Cell Biology and Physiology, University of Pittsburgh, USA. He worked at the National Institute of Immunology, New Delhi prior to assuming responsibility as Director of the National Institute of Animal Biotechnology, which is committed to the development of sustainable and globally competitive livestock industry through innovative technology. His lab works in the field of animal biotechnology and his present research focuses on the production of therapeutic proteins

for animal and human in the milk of farmed animals, generating new methods of transgenesis for biomedical research and to facilitate production of transgenic cattle, goat, and buffalo and finding alternatives to knock out technology, utilizing shRNA to generate transgenic animals for studies of functional genomics.

Heidi Mitchell, Ph.D.

Director, Plant Evaluation Section, Office of the Gene Technology Regulator, Australia
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Heidi Mitchell is the Director of the Plant Evaluation Section at the Office of the Gene Technology Regulator (OGTR). The section conducts human health and environmental risks assessments for dealings involving the intentional release of genetically modified plants into the Australian environment.

Heidi joined the OGTR in 2006 as an evaluator, preparing risk assessments for a range of crop trials, including cotton, white clover, sugarcane, ryegrass, and tall fescue. She has also worked in the Regulatory Practice section of the OGTR at the interface between scientific risk assessment and operational regulatory policy. Heidi has been involved in work around the scope of the gene technology legislation. She has represented Australia at OECD and CBD SBSTTA meetings and presented talks at domestic and international conferences on regulation of GMOs in Australia.

Heidi has a Ph.D. in plant biochemistry and post-graduate research in plant-fungal interactions and on using bacteria other than *Agrobacterium* for plant transformation. She has published research papers in peer-reviewed journals, including *Nature*.

Md. Mosharraf Hossain Molla, Ph.D.

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Dr. Md. Mosharraf Hossain Molla was awarded a Ph.D. in Biotechnology (2010) and an 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 20 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 3-R-gene GM potato variety development for late blight resistane in Bangladesh, in collaboration with Michigan State University, USA. He has 25 research publications in renowned national and international journals. Dr. Molla has significant contributions to improving potato and banana through biotechnological approaches, which is widely utilized in biotech labs in Bangladesh, benefiting farmers.

Manoj Kumar Patairiya, Ph.D.

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Prof. (Dr.) Manoj Kumar Patairiya is currently the Director of the CSIR-National Institute of Science Communication and Information Resources, New Delhi, India. Earlier, Dr. Patairiya was Additional Director General of the Broadcasting Corporation of India, where he was responsible for setting up a 24x7 Satellite TV Channel on Agriculture and external broadcasts. A well-accomplished scientist, science communication researcher, and practitioner, Dr. Patairiya has also served as Advisor in the Ministry of Science & Technology, Government of India. Dr. Patairiya specializes in biosciences, communication media, management, and policy. He is decorated with prestigious national and international awards. He has a number of publications and two Indian patents to his credit. He has edited and co-edited widely acclaimed books: *Sharing Science* and *Science Meets Communication*. He has been Visiting Professor at Chungnam National University, South Korea and University of Sao Paulo, Brazil. He is the President of the Society for Information Science, and the Founding Fellow of the Academy of Engineering & Technology of the Developing World. Dr. Patairiya is the Vice Chair of the AASSA Special Committee on SHARE Communication. He is Outstanding Professor of the Academy of Scientific & Innovative Research (Ac-SIR), an institution of national importance established by an Act of Parliament.

Surani Pathirana

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Ms. Surani Pathirana is a post graduate in environment science. She is presently working as the Assistant Director attached to the Biodiversity Secretariat of the Ministry of Mahaweli Development and Environment, Government of Sri Lanka. She is actively involved in activities related to implementation of the Convention on Biological Diversity (CBD) and the Cartagena Protocol on Biosafety in Sri Lanka. The Ministry of Mahaweli Development and Environment is the focal point for the aforementioned convention and the protocol.

Valasubramanian Ramaiah, Ph.D.

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Valasubramanian Ramaiah is an agriculture biotechnology professional with 20 yrs of demonstrated experience in the seed and agribiotech Industry. He joined Corteva Agriscience, the 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 ten 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, as well as scientific and regulatory policy outreach and acceptance with stakeholders. Before joining Corteva Agriscience, Valasubramanian worked as Principal Scientist with Maharashtra Hybrid Seeds Company Ltd. between 1999-2006. He also served as 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.

M. K. Reddy, Ph.D.

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Dr. M. K. Reddy received an M.Sc., M. Phil., and Ph.D. from the University of Hyderabad. He then continued his research at the International Center for Genetic Engineering and Biotechnology (ICGEB). For the past 30 years, he has been actively involved in various research programs at ICGEB aimed at understanding plant adaptation to environmental stresses in order to develop transgenic strategies to engineer stress tolerant transgenic crop plants. He developed several PCR-based strategies to isolate differentially expressed genes as an alternative to DNA chip technology, as well as high throughput directional genome walking methods to isolate several stress responsive promoters. Recently, he developed rice plants simultaneously resistant to more than one herbicide with different modes of action to control weeds without causing any injury to the rice crop by introducing targeted mutations in rice EPSP synthase and acetolactate synthase (ALS) encoding genes. In addition he developed phosphite-mediated weed control in rice by overexpressing phosphite dehydrogenase, which can convert phosphite into phosphate, whereas the non-transgenic weeds cannot metabolize phosphite and their growth is severely restricted. Currently, he is using targeted genome editing technology to improve the architecture of rice plants to enhance yield. Dr. Reddy has been awarded with INSA-DFG Fellowship, DBT-Overseas-Associateship, and Tata Innovation Fellowship. He has been elected as Fellow of the National Academy of Sciences, India.

Andrew Roberts, Ph.D.

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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 ILSI RF, 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*.

Zeba Seraj, Ph.D.

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Dr. Zeba Seraj is Professor of Biochemistry and Molecular Biology at the University of Dhaka. She works on the molecular biology of salinity tolerance in rice. Her Plant Biotechnology Laboratory, in collaboration with both national and international institutes like BRRI, IRRI, and ICGEB, has produced saline tolerant rice using DNA-marker-assisted selection, as well as genetic transformation. Some of these lines are under trial at ACI and BRRI. Recently, her team has engaged in genomic selection, with University of Texas, Austin, using modern sequencing technologies. She is the Founder-Director of cBLAST (Center for Bioinformatics Learning Advancement and Systematics Training), an on-line portal for learning bioinformatics at the University of Dhaka. Her lab and ICDDRB have produced stable mucosal vaccines using rice as a delivery system. She is on Youtube with her invited TedX talk on 'how to save crops from sea level rise and salinity', received the Dean's Award (2013) and Annanya Prize (2016) for her research, and was elected as BAS fellow in 2018. She has been the recipient of numerous research grants, has more than 65 peer-reviewed publications, and is a regular reviewer in many prestigious journals in her field of research. She has served for many years as a member of the core-committee on biosafety, which is a scientific advisory body providing feedback to the National Committee on Biosafety. She has been a Visiting Researcher at the University of Texas, Austin since 2013.

Boindala Sesikeran, M.D.

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Dr. B. Sesikeran is the former Director of the National Institute of Nutrition (NIN-ICMR), located in Hyderabad, India. He is a pathologist by training and conducted research in the areas of nutrition, food safety, and toxicology for 30 years. He has over 120 publications and authored chapters in three books. He developed the Guidelines for Probiotics in Foods, Guidelines for GM Food Safety, Guidelines for Biosimilar Drugs, Recommended Dietary Allowances, and Dietary Guidelines.

Dr. Sesikeran was the Director of the National Institute of Nutrition NIN between 2006 and 2012. He is presently Chairman of the Review Committee for Genetic Manipulation (RCGM), Member of the Scientific Panel on Nutraceuticals FSSAI, Chairman of the Working Group on Foods for Sportspersons FSSAI, Fellow of the National Academy of Medical Sciences, Fellow of the International Medical Scientists Academy, Fellow of AP & Telengana Academies of Science, and President of the Nutrition Society of India.

He is also Public Trustee of ILSI India, Member of the Nestle Council on Nutrition Affairs, Trustee of the Heinz Nutrition Foundation, India, Member of the Infant and Young Child Nutrition Council of India (IYNCI), Member of the Advisory Council on Science for Coca Cola, India, and Member of the GSK Scientific Advisory Board.

P. K. Singh, Ph.D.

Principal Scientist and Leader for Insect Defense, CSIR-National Botanical Research Institute, India

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Dr. P. K. Singh is Principal Scientist in CSIR-National Botanical Research Institute, India. He has over 20 years of research experience in the area of plant biotechnology. His research interest is genetic engineering of crops for insect resistance. In his early days, he developed a novel method for artificial synthesis of double stranded DNA and became the first Indian to synthesize an agronomically useful gene (*cry1EC*, an engineered Bt gene) artificially. The gene in transgenic cotton lines offered high resistance to *Spodoptera litura*, a polyphagous insect pest. Cry1EC-cotton is with the Indian Cotton Seed Industry for pyramiding with other Bt-cotton events. Subsequently, he worked with Unichem Pharmaceuticals, India to explore the possibility of producing recombinant antigen in transgenic tobacco that could be developed into vaccine for rabies. He has experience in the biotech industry as well. He worked with ReaMetrix Inc., San Carlos, CA as Scientific Director. He developed several protein-based fluorescent reagents at ReaMetrix, which were used by academia and industry (ABI, Eppendorf Array Technology, Quantum Dot Corporation, Beckman Coulter, etc.).

His current focus is on identifying novel proteins for the control of sap sucking pests and the development of sucking pest resistant crops through genetic engineering. He has devised an innovative method of isolating novel insecticidal proteins from plants and cloning their genes. He has developed whitefly resistant GM cotton using a novel gene (*Tma12*) isolated from an edible fern (*Nature Biotechnology*, 2016). He aims to stack whitefly resistant cotton with BT-cotton and deregulate three-gene-cotton for commercial cultivation. He also aims to introduce *Tma12* in all the crops through a global mission that are susceptible to whitefly and suffer from viral diseases that it vectors.

He has mentored 16 students for Ph.D. degrees and authored more than 55 peer reviewed research articles, including a full-length a research paper in *Nature Biotechnology,* and 7 patents. He was the recipient of the CSIR Technology Award in 2005.

Inez H. Slamet-Loedin, Ph.D.

Cluster Lead - Trait and Genome Engineering, International Rice Research Institute (IRRI), Philippines

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Inez Slamet-Loedin is a Cluster Leader of the Trait and Genome Engineering-Strategic Innovation Platform at the International Rice Research Institute. She is an elected fellow of The World Academy of Sciences (TWAS) for the advancement of science in developing countries, and an adjunct professor at the University of the Philippines in Los Baños. She has over 25 years of experience working on genetic engineering and recently, genome editing for rice improvement.

Over the course of her career, she has worked for the Indonesian Institute of Sciences-LIPI (her current appointment is supported by LIPI), was appointed for a number of years as a biotechnology committee member at the ASEAN Committee on Science and Technology (COST), was a UNEP consultant, a CBD expert on biosafety clearinghouses, and a member of the Indonesian biosafety technical team. She was a postdoctoral fellow at the Institute of Molecular Plant Science in Leiden (Netherlands) and obtained a Ph.D. at the Department of Life Science at the University of Nottingham (UK) and an agriculture engineering degree at Bogor Agricultural University (Indonesia). She received the Ministry of Agriculture and Presidential awards for advancement of biotechnology for food security in Indonesia, and earlier, the LIPI best young scientist award. In 2017, her research team received the 2016 IRRI Best Scientific Team award and the Los Baños Science Community award.

Rohini Sreevathsa, Ph.D.

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Dr. Rohini Sreevathsa completed her Ph.D. from the Chemistry (Biochemistry) Department, Bangalore University, in 2002. Simultaneously, she worked as a research fellow in the Department of Biochemistry, Indian Institute of Science, Bangalore. During this tenure, she developed a novel tissue culture-independent *Agrobacterium tumefaciens*-mediated in planta transformation protocol. Her expertise in transgenics won her the DST-Young Scientist Fast Track project in 2004. She worked on her project at the UAS, GKVK, Bangalore. Further, she continued to work as a research scientist and was actively involved in the development of several promising transgenics for both biotic and abiotic stress tolerance in various crop species. She has a good number of papers and book chapters to her credit. Her contribution in the area of agricultural biotechnology has won her a membership in the prestigious National Academy of Sciences, India. Presently, she is working as Senior Scientist at ICAR-NRCPB, New Delhi. Her main area of research now is to develop pod borer resistance in pigeon pea by Bt insecticidal crystal proteins following a transgenic approach. Furthermore, efforts are also underway to decipher and extrapolate the pod borer resistance mechanism in the wild relative of pigeonepea.

John Teem, Ph.D.

Senior Scientific Program Manager, ILSI Research Foundation, USA
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Dr. John Teem joined the ILSI Research Foundation as a Senior Scientific Program Manager in 2016. He was formerly a professor in the Biological Science Department of Florida State University where he worked on the human genetic disease cystic fibrosis. He subsequently left biomedical research to join the Florida Department of Agriculture and Consumer Services as an invasive species biologist. His recent work involves risk assessment of genetic biocontrol strategies to eradicate pest species utilizing gene drive technology.

Siddharth Tiwari, Ph.D.

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Dr. Siddharth Tiwari has an academic background in genetics (Master) and Plant Biotechnology (Doctoral). In July 2010, he joined as Scientist-C in the National Agri-Food Biotechnology Institute (NABI)—an autonomous institute of the Department of Biotechnology (DBT), Ministry of Science and Technology, Government of India, located at Mohali, Punjab, India. Dr. Tiwari has established a solid foundation, both theoretically and experimentally, in the area of plant tissue culture and genetic engineering, especially of banana, wheat, and ground nut. Presently, he is working on the metabolic engineering of staple crops (banana and wheat) for nutritional-enrichment. For this, he is utilizing modern biotechnological approaches like transgenic and cisgenic depletion of anti-nutrient (by RNAi) and genome editing (by CRISPR-CAS). Dr. Tiwari has very recently demonstrated, for the first time, the application of CRISPR-CAS-based genome editing in the cultivated variety of the Indian banana. This is also a first-ever published report on genome editing in any fruit crops from India. This work has been widely acclaimed in academic circles. The scientific achievements of Dr. Tiwari's lab was telecasted on March 10, 2018 by Rajya Sabha National Channel in the program Science Monitor.

He is a recipient of the prestigious DR. YSR Bio-Asia Innovation Young Scientist Award (2010) and the Young Scientist Award (2010) at the 97th Indian Science Congress Association (ISCA), Kerala University,

Trivananthapuram. His research findings have been published in peer reviewed journals of high impact factors such as *Biotechnology Advances, The Plant Journal, Functional & Integrative Genomics, Frontiers in Plant Science, Journal of Experimental Botany, Plant Cell Reports, Plant Cell, Tissue and Organ Culture (PTOC),* and *PLoS ONE*. He is presently working as Scientist-D at NABI and focusing on his research on pro-vitamin A biofortification in banana fruit.

Md. Farid Uddin, Ph.D.

Executive Director, Cotton Development Board, Bangladesh
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Dr. Md. Farid Uddin started his career in the private sector and has been working with different organizations such as non-governmental organizations, research institutes, governmental organizations, multinational companies, and international organizations, in different disciplines and different crops for 30 years. He worked as a horticulturist in different horticulture centers under the Horticulture Development Project funded by ADB for more than three years. Then, he joined the Cotton Development Board as Senior Training Officer and organized the training program of CDB

He worked in the FAO-EU regional project for cotton IPM funded by the EU and executed by the FAO for three years, from 2001 to 2004, as Expert Facilitator in Bangladesh. He also worked with the FAO in Kyrgyzstan for two months as an FAO international expert. He has many research articles published in national and international journals and attended many national and international workshops and conferences.

Then, he became Deputy Director of the Cotton Development Board. Later, he worked as Additional Director of the Cotton Development Board and now, he is working as Executive Director, looking after the research and development activities of the Cotton Development Board. He is doing all the coordination for the release of Bt cotton in Bangladesh through biosafety rules and guidelines. He is also coordinating mutation breeding-related activities with the IAEA.

Throuhgout his career, he has attended different professional training events, workshops, seminars, and conferences, at home and abroad, mainly in Thailand, China, India, the Phillipines, Vietnam, Uzbekistan, Kyrgyzstan, Turkey, Zimbabwe, Italy, Austria, and Bangladesh, which were organized by the Government of Bangladesh (GOB) and other donor agencies. He obtained his Ph.D. in Cotton Agronomy from Jahangir Nagar University, Bangladesh.

B. Venkateswarlu, Ph.D.

Former Vice-Chancellor, VNM Krishi Vidyapeeth, Parbhani (retired) and GEAC, India
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Dr. B. Venkateswarlu holds a Ph.D. in microbiology. He served on the Indian Council of Agricultural Research for over 35 years as Senior Scientist, Principal Scientist, and Director. He also served as Vice Chancellor of Maratwada Agricultural University Parbhani until recently. Dr Venkateswarlu made extensive contributions in the areas of biofertilizers, PGPR, microbe mediated abiotic stress tolerance in plants, climate change impacts on rainfed crops, and other areas of biotech applications in dryland agriculture. He has published over 250 research papers, 20 books, and 100 conference presentations, with total citations of 4500 and an H index of 32 (Google Scholar). He has received three national awards from ICAR and several memorial lecture awards from professional societies in India. He was conferred the Outstanding Crop Scientist Award by the International Crop Science Society. Dr. Venkateswarlu is a Fellow of the National Academy of Agricultural sciences and Andhra Pradesh Academy of Sciences. He has served as Member, Chair, and Co-Chair of several review/expert committees of the Ministry

of Agriculture, Rural Development, ICAR ,DBT, and planning commission, etc. He has travelled widely and has extensive international exposure.

LIGHTNING ROUND FOR STUDENTS AND EARLY CAREER RESEARCHERS

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Dr. Sabrina M. Elias is an assistant professor at the School of Life Sciences, Independent University, Bangladesh. She completed her doctoral degree as a fellow in Monsanto's Beachell-Borlaug International Scholars Program, a joint program administered by the University of Dhaka, University of Nebraska-Lincoln, University of Texas at Austin, and the International Rice Research Institute (IRRI). She completed her M.S. and B.Sc. (with honors) from the Department of Biochemistry and Molecular Biology at the University of Dhaka. Her academic training and work experience include both domestic and international perspectives on research and implementation of bioinformatics, next generation genomics, phenomics, and molecular biology focusing on Bangladeshi rice genomic diversity and abiotic stress tolerance of rice.

Dr. Elias is working with Dr. Zeba Seraj's group in the Plant Biotechnology Laboratory at the University of Dhaka as a post-doctoral research associate on abiotic stress tolerance factors in the crop genome. Additionally, she has experience working with rice photosynthesis genomics at the Australian National University and in the National Jute Genome Sequencing Project of Bangladesh. She is also a course designer and lecturer at the Center for Bioinformatics Learning Advancement and Systematics Training (cBLAST), an online bioinformatics course hub. Her presentation at the South Asia Biosafety Conference (2018) focuses on the investigation of salt tolerance determinants of rice from a Bangladeshi indigenous salt tolerant landrace Horkuch, using a combined genomics, transcriptomics, and phenomics approach.

Rubi Gupta

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Rubi Gupta is a doctoral candidate in the Department of Agricultural Biotechnology and an SRF at the DBT-AAU Center, Assam Agricultural University, India. Currently, she is working on genetic improvement of grain legumes using gene technology under the supervision of Dr B. K. Sarmah, ICAR National Professor (Norman Borlaug Chair). Her research focuses on risk assessment of transgenic chickpeas harboring Bt genes at different biological/molecular levels (transcript, protein, and metabolites).

Earlier in her career, Ms. Gupta served as a junior research fellow at the International Center for Genetic Engineering and Biotechnology, New Delhi, where she worked on cloning genes in plant transformation vectors for overexpression in rice plants and characterization of the pathway of the SUB1 locus. She is also a recipient of the BCIL trainee position and has worked at Daiichi Sankyo India Pharma, where she learned the use of molecular biology tools for drug development. She completed her M.Sc. in Biotechnology from Gauhati University.

Yaiphabi Kumam

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Yaiphabi Kumam is a Ph.D. candidate at Tamil Nadu Agricultural University, Coimbatore, India. He is currently working on genome editing in rice for resistance against biotic stress. He completed his undergraduate degree from Assam Agricultural University, Jorhat and his master's degree from TNAU, Coimbatore. Having focused on agriculture during his studies, he aspires to work in areas related to problems faced by farming communities in the field.

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Hamida Nooreen Mahmood completed her B.Sc. and M.Sc. at the University of Dhaka, Bangladesh in Biochemistry and Molecular Biology, earning the prestigious Dean's Award for Academic Excellence. She is now working as a lecturer in the same department. As part of her master's thesis, she worked on an antiporter gene conferring salt tolerance in rice. She is very interested in molecular biology, especially in the field of epigenetics, and wishes to continue her research in that area.

Ashwin Narayan

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Ashwin Narayan is a research scholar at the Indian Council of Agricultural Research (ICAR)—Sugarcane Breeding Institute (SBI), Coimbatore, India. He has been working in the field of sugarcane biotechnology for past six years and has considerable expertise in sugarcane genetic engineering, transcriptome analysis, and sugarcane molecular farming, which is evident in his publication history. After receiving his Master of Science degree from Vellore Institute of Technology, Vellore, he continued his career in the field of biotechnology. His research on sugarcane started with the molecular characterization of the Saccharum and Erianthus species, and he is currently working on developing water deficit stress tolerant sugarcane through genetic engineering. Part of this work, which was presented at an international conference, won him the Best Poster Award. He has published seven research papers in international peer-reviewed journals and three chapters in books. One book chapter titled "Unraveling the Sugarcane Genome: Progress Made So Far and Challenges Ahead" in Sugarcane Biotechnology: Challenges and Prospects, published by Springer, gives a detailed account of work related to the study of the sugarcane genome carried out to date and work that should be carried out in the future. Mr. Narayan has also presented his research at many international and national conferences.

Mohammad Umer Sharif Shohan

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UniversityDhakaMohammad 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.

He was the recipient of the Summer Research Grant from the University of Queensland, Australia. Recently, he was awarded the Research Internship grant from IRCMS, Japan for work related to NGS data. He is also the recipient of the prestigious Faculty of Biological Sciences, University of Dhaka Dean's Award and the National Science and Technology Fellowship 2017-18 from the Government of Bangladesh. He is an avid traveller and has visited 26 countries to date.

Rakshita Singh

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Rakshita Singh is pursuing a Ph.D. at CCSHAU, Hisar, India and is working on the very important problem of salinity stress in pigeon pea. Her research focuses on development and characterization of transgenic pigeon pea plants for salinity tolerance. She is working with Dr. Pushpa Kharb and has learned a lot under her guidance. In additioan to her research, she also provides hands-on training on plant tissue culture and techniques in molecular biology to undergraduate and post graduate students. Having a scientific temperament., she is passionate about and devoted to science.

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Tabassum Sunfi is currently working as a research associate at the Plant Biotechnology Laboratory, Department of Biochemistry and Molecular Biology, University of Dhaka, where she also completed her M.Sc. She is currently involved in ongoing projects at this prestigious laboratory and serves as a mentor to graduate students.

ABSTRACTS

PLENARY SESSION I:
BIOSAFETY REGULATION AND CAPACITY BUILDING INITIATIVES IN SOUTH ASIA

Update on Biosafety Regulation in Bangladesh

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The economic potential of modern biotechnology in agriculture, health, energy, and the environment is well recognized. However, there are concerns that the GMOs derived from biotech may pose risks to human health and the environment. Moreover, mixing of genes from unrelated organisms might create an imbalance in the natural integrity of the living world. The policy of the Government of Bangladesh is to address the potential risks arising from any kind of use of GMOs with utmost importance. To address the issues of health and environmental safety associated with modern biotechnology, its products or its applications, Bangladesh has already put in place biosafety regulatory systems in accordance with the obligations under the Cartagena Protocol on Biosafety to the Convention on Biological Diversity (CBD). The country is a party to the Protocol as it was ratified on May 24, 2000. The Ministry of Environment and Forest (MOEF) is the designated National Competent Authority and the Focal Point for implementing the Protocol. The biosafety system in Bangladesh has been built upon transparent procedures for receiving applications, evaluation and decision making. A mechanism for monitoring, enforcing and a system for providing information to the stakeholders as well as public awareness and participation has also been incorporated in the national biosafety framework. The biosafety system is comprised of various authorities, mainly, the National Committee on Biosafety (NCB), Biosafety Core Committee (BCC) and the Institutional Biosafety Committee (IBC). The Biosafety Guidelines of Bangladesh have been drawn up to safeguard the interests of Bangladesh in relation to the potential risks associated with the use of GMOs and their introduction into the country. Biosafety guidelines became a legal document with the enactment of the Biosafety Rules of Bangladesh. MOEF has already institutionalized the NCB that is responsible for decision making and overseeing biosafety

of GMOs. The BCC has also been operationalized to assist the NCB in terms of safe management of biotechnology activities in the laboratories and in the field as well as during the commercialization of biotech products. Institutional biosafety committees (IBC) and biological safety officers (BSO) are in place in the research establishments. Field level biosafety committees (FBC) have been formed for specific cases of confined trials with GM crops. The concerned ministries that are working on the research and development of GMOs have operationalized National Technical Committees (NTC) in their respective areas of biotechnology. Such technical committees can review the technical merits of the applications and forward them to the NCB for final consideration. The technical committees working on promoting research and development of biotech are: National Technical Committee on Crop Biotechnology (NTCCB) in the Ministry of Agriculture; National Technical Committee on Medical Biotechnology (NTMB) in the Ministry of Health and Family Planning; and National Technical Committee on Fisheries and Livestock Biotechnology (NTCFLB) in the Ministry of Fisheries and Livestock. Aside from the Biosafety Guidelines, Biosafety Rules and National Biosafety Framework, Bangladesh has also developed guidelines for the safety assessment of foods derived from genetically engineered (GE) crops, monitoring documents (monitoring and enforcement manual, inspector's manual, data recording formats, etc.) for the confined field trials of GE plants. The Biosafety Policy of Bangladesh has beendeveloped and is in the process of government approval. The Environmental Risk Assessment (ERA) guidelines has already been gazetted. Details on the development of biosafety systems in Bangladesh will further be revealed during the face-to-face presentation in the conference.

Regulations for Food Derived from Genetically Modified Organisms in India

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Genetic manipulations/modifications (GM) have revolutionized fundamental plant research and accelerated strategic improvements to boost yields, increase resistance to disease and pests, and enhance nutritional value or tolerance of droughts or floods. The use of GM crops in food products and as ingredients gives rise to a number of questions and therefore, governmental regulations are in place in most countries around the world. In India, all GMOs, including GE plants, are regulated as per the Rules for the Manufacture, Use, Import, Export, and Storage of Hazardous Micro-Organisms/ Genetically Engineered Organisms or Cells (Rules 1989), notified under the Environment (Protection) Act, 1986. Section 22 of the Food Safety and Standards Act, 2006 provides *inter-alia*, that no person shall manufacture, distribute, sell or import any GM article of food except as otherwise provided under the Act and regulations made thereunder. The Food Safety and Standard Authority of India (FSSAI) has initiated work on framing regulations on GM-Food, which were thus far regulated by the Genetic Engineering Appraisal Committee (GEAC) under Rules 1989. Once in place, FSSAI will be responsible for food safety aspects. All other aspects, including environmental impacts, would be assessed by the GEAC. FSSAI has also framed the draft Food Safety and Standards (Labelling and Display) Regulations that specify threshold levels for labelling requirements of GM foods. A network of four laboratories gazette-notified by the government, with state-of -the-art facilities for GMO analysis, has been put in place as part of UNEP-GEF supported project implemented by the Ministry of Environment, Forest & Climate Change. This presentation will provide an overview of the rules and regulations for GMOs and GM food in India.

Biosafety Regulation and Capacity Building Initiatives in Sri Lanka

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The Ministry of Mahaweli Development and Environment in Sri Lanka is the National Focal Point for the Convention on Biological Diversity (CBD) and the Cartagena Protocol on Biosafety (CPB).

In Sri Lanka, importation, distribution or marketing of Genetically Modified (GM) Foods and Genetically Modified Organisms (GMOs) related products are not banded by Law. However, the importations

of GM products are controlled through the customs. If there is any requirement to GM products for food products, approval should be obtained from Chief Food Authority which is under the Ministry of Health and for other products from Ministry of Mahaweli Development and Environment according to the National Policy on Biosafety. But detection and testing on GM goods is not in a well - developed standard in Sri Lanka.

At present, the government of Sri Lanka has initiated a project on "Implementation of the National Biosafety Framework in accordance with the Cartagena Protocol on Biosafety" funded by GEF and implemented by Ministry of Mahaweli development and Environment through Food and Agriculture Organization of the United Nations. The main objective of this project is to strengthen Sri Lanka's regulatory, institutional and technical capacities for the effective implementation of the National Biosafety Framework and hence safe handling of LMO or GMO.

The project focuses on strengthening policy, institutional, and regulatory frameworks for biosafety, especially for the immediate enactment of the Biosafety Act and the endorsement of the Master Plan, strengthen the technical capacity of the relevant institutions to conduct risk assessments, risk management, and risk communication, helping to upgrade the infrastructure of key laboratories so that they can effectively carry out biosafety-related activities required for the reliable identification and detection of LMOs. Further project focuses on supporting targeted education and outreach campaigns to raise awareness about biosafety and enhance public participation in decision-making.

Biosafety Regulation and Capacity Building Initiatives in Bhutan

Jambay Dorji

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The Bhutan Agriculture and Food Regulatory Authority (BAFRA), Ministry of Agriculture and Forests have been designated as the National Food Safety Authority since 2003 and responsibility to implement Biosafety Act of Bhutan 2015 was given recently. For the ease of implementation of the provisions of the Act, the Biosafety Rules and Regulations was formalized and approved for implementation on March 8, 2018. However, right after the enactment of Biosafety Act 2015, BAFRA has been focusing on awareness creation on GMO through posters and animations, as the subject of GMO is relatively new to Bhutan.

The Act has been cautiously drafted considering the Country's current interest and keeping in view the country's food security needs. The Biosafety Act of Bhutan 2015 completely bans any activity involving GMO in viable forms and food products derived from GMOs will be regulated as per the existing regulations, guidelines, manuals and procedures.

The application of economic potentials of modern biotechnology in agriculture, health, energy and environment are relatively new to Bhutan, however, some form of biotechnological applications is modestly used in various departments within the Ministry of Agriculture and Forests. Bhutan's major concern is to ensure safety of the citizens and safeguarding its pristine environment from harmful effect of GMO if any.

To this effect training on GM Food Safety Assessment and Risk Communication was imparted to Biosafety Technical Working Group, relevant stakeholders and private companies with technical and financial support from Food and Agriculture Organization (FAO) of the United Nations from July 23rd-27th 2018. As part of the outcome of the training deliberation, Biosafety Risk Communication Strategy document including Standard Operating Procedure to manage GMO incidences will be developed with support from FAO.

GMO testing facilities are in place, however human resource capacity needs to be strengthened. Surveillance on presence of GMO by using qPCR and test kits are carried out as part of routine monitoring purpose.

Biodiversity, Biosafety, and You

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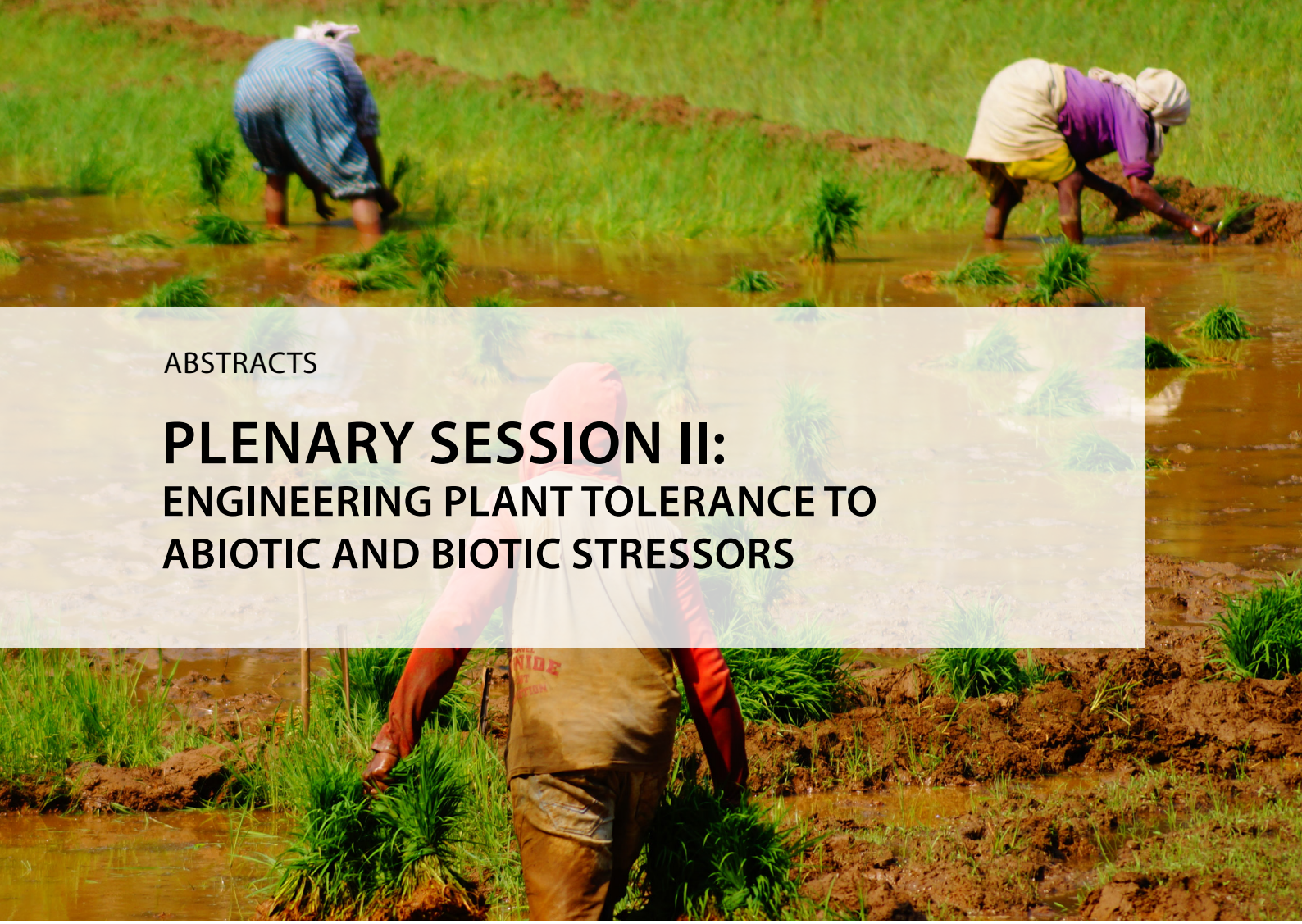
The Convention on Biological Diversity (CBD) is an international legally-binding treaty dedicated to promoting sustainable development. Conceived as the practical implementing tool of Agenda 21 of the Rio Earth Summit of 1992, it also covers rapid developments in biotechnology through the Cartagena Protocol on Biosafety, which in turn addresses technology development and transfer, benefit-sharing and biosafety issues. A supplementary protocol, the Nagoya–Kuala Lumpur Supplementary Protocol on Liability and Redress to the Cartagena Protocol on Biosafety, provides rules and procedures addressing liability and redress if damage (or a high likelihood of damage) results from the introduction of living modified organisms. The Nagoya Protocol on Access and Benefit Sharing is a supplementary protocol to the CBD. Parties to the Convention meet every two years, in a Conference of Parties (COP) that also serve as the Meeting of Parties (MOP) to the Cartagena Protocol and the Nagoya Protocol. The COP/MOP meetings address issues related to technology scanning, risk assessment and management, capacity buiiding, and benefit sharing, among others.

The COP/MOP will be held this year on 17-29 November in Sharm El-Sheikh, Egypt. Of special interest to the biosafety community are the draft decisions prepared by the secretariat of the CBD and the protocols. Specific items in the draft decisions may bear heavily on national policies on biotechnology, biosafety, digital sequences, gene editing, digital sequences and novel technologies. These items will be highlighted, to articulate concerns and stimulate discussions that help inform positions that may be taken by parties to the convention.



ABSTRACTS

PLENARY SESSION II:
ENGINEERING PLANT TOLERANCE TO ABIOTIC AND BIOTIC STRESSORS

Genome Editing for Rice Improvement

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The discoveries of site-specific nucleases and their combination with nucleic acids and catalytic proteins have propelled the application of genome editing to the forefront of trait improvement in crops. At IRRI, gene-editing technology has been used to obtain multiple variants of rice resistant to bacterial leaf blight and RTSV (Rice Tungro Spherical Virus) which mimic naturally occurring resistance. Both diseases have significant impact on rice production in Asia and Africa. To obtain rice variants resistant to both diseases independently, we utilized the clustered regularly interspaced short palindromic repeats/Cas9 gene editing method (CRISPR/Cas9). Additionally, gene editing can be applied to improve micronutrient content of crops. Micronutrient deficiencies including iron and zinc affect more than 30 percent of the global population, mainly women and children. In parallel with the CRISPR CAS 9 editing, we utilized an alternative editing tool—transcription activator-like effector nucleases (TALENs)—to insert a rice gene at a specific locus to increase iron and zinc content in the grain. Such targeted editing of the genomes of crops will facilitate crop improvements in a broad range of traits.

Bio Prospection of Plant Diversity for Novel Insecticidal Proteins/Genes for Next Generation GM Crops

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Whitefly (*Bemisia tabaci* species complex) is one of the highly invasive insect pests on several field crops of agricultural, horticultural, and ornamental importance all over the world. High temperature, humidity, dense cropping, and nitrogen content in tropical and sub-tropical zones promote multiplication of this insect. Crops grown in polyhouses are also badly affected by this pest. The insect damages crops by sucking phloem sap, promoting growth of sooty mold and spreading plant viruses. Its outbreak is reported to cause widespread devastation in 1.5 million hectares of Bt-cotton crop in North India, in 2015.

Known insecticidal proteins viz; Cry toxins, enzyme inhibitors, lectins, chitinases, ribosome inactivating proteins etc. are either not toxic or cause low toxicity to whitefly, thus transgenic crops resistant to whitefly have not yet been available for cultivation. Moreover, researchers have not explored alternative strategies for identifying new insecticidal proteins in last two decades.

Plant biodiversity is a vast resource of biologically active molecules. It has been seldom explored for new proteins (genes) with a targeted function. We screened untapped plant resources for insecticidal activity and identified a few potential plants. Our endeavor led to the isolation of 5 new insecticidal proteins; three proteins were toxic to whitefly and other two possess insecticidal property against cotton aphids. All proteins are unique in their sequences.

One of the insecticidal proteins (named as Tma12, 21.6 kDa) that kills whitefly (LC50 1.9 µg/ml) is purified from a fern *Tectaria macrodonta*. The protein is exclusively toxic to whitefly and does not affect other crop insects and beneficial insects. The insecticidal protein was initially characterized as a chitin binding protein with minor chitinolytic activity. Subsequently, the crystal structure established it as a Lytic Polysaccharide Monooxygenase (LPMO). It is notable that LPMO is found in microorganisms only and they use this enzyme in the digestion of complex carbohydrates. Tma12 is the first LPMO from a terrestrial plant. However, its role in source plant is yet to be elucidated.

Tma12 is produced in transgenic cotton. The optimally expressing transgenic cotton lines show excellent protection against whitefly. These lines control whitefly population by inhibiting and hampering colonization. Defense in transgenic cotton by virtue of expression of Tma12 was equivalent to 3-4 sprays of chemical pesticides. Absence of viral diseases and its DNA in transgenic and presence in non-transgenic cotton leaves of 4-5-month plants shows that the transgenic strategy offers significant control over viral diseases.

T. macrodonta, the source of insecticidal protein, is an edible fern. It is consumed as vegetable in Nepal and used in concoction for gastric diseases in Central India. In a limited study, purified Tma12 in sub-chronic doses did not produce any symptomatic change in model animals. This suggest that deployment of Tma12 in crop for protection against whitefly and viral diseases might be safe. Nevertheless, detail safety study with purified proteins and transgenic plant are required to meet the requirement of regulatory guidelines.

This is for the first time a new insecticidal protein is discovered from lower plant biodiversity. Whitefly and virus resistant transgenic crops have been an unmet need of agriculture biotechnology worldwide; our research has fulfilled the gap. This gene can be deployed in more than 10 crops to protect the yield without application of hazardous pesticides. We aim to stack Tma-12-GM cotton with two other Indian Bt-cotton events (Cry1Ac-cotton and Cry1EC-cotton) for broad insect resistance in Indian cotton varieties.

Engineering Herbicide Resistance in Rice for Effective Weed Management in Agriculture

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Weeds are the most serious biological constraints in agriculture causing crop production losses of worth several billion dollars worldwide annually and also spending billions of dollars to remove or control weeds in agriculture. Manual weeding over large areas is difficult in terms of availability of labor and the associated monitory cost. Moreover, manual weeding is very time consuming and slow. In such a scenario, chemical weed control is extremely important. Such technologies were not developed in India and not accessible to Indian farmers. Our group developed rice plants simultaneously resistant to more than one herbicide with a different mode of action to control the weeds without causing any injury to rice crop. We have selected two broad-spectrum non-selective systemic herbicides sulfonylurea for pre-emergent application and glyphosate for post-emergent application. Sulfonylurea is a very strong inhibitor of acetolactate synthase, an important plant enzyme involved in branched chain amino acids valine, leucine, and isoleucine. Similarly, glyphosate is a strong inhibitor of EPSP synthase, another important plant enzyme involved in aromatic amino acids phenylalanine, tryptophan, and tyrosine. We followed herbicide target site modification strategy to develop herbicide tolerance in rice without introducing any foreign gene. We have introduced selective amino acid substituting mutations in EPSPS and ALS that interfere with the ability of the herbicide to interact with these important plant enzymes. The mutated EPSPS and ALS retain their normal functioning of the enzyme in the presence of the herbicide. The transgenic rice plants that constitutively overexpress mutated rice EPSP synthase and Acetolactate synthase did not showed any growth retardation even at 6-fold higher herbicide that is recommended for weed control in agriculture. We also developed phosphite based pre- and post-emergent weed-controlling technology with several added advantages. We have constitutively expressed codon optimized synthetic phosphate dehydrogenase encoding gene in transgenic rice that able to metabolize PO3 as a P fertilizer but not the non-transgenic control rice. Our results clearly show that PO3 can act as fertilizer for transgenic crop and simultaneously act as herbicide on the weeds.

Biotechnological Approaches for Engineering Resistance to the Insect Herbivore *Helicoverpa armigera* in Pigeonpea

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Environmental and biological stresses are major challenges confronted by plants as they are a source of living for a large number of insect pests, some of them being devastating. Helping the plants fight and mitigate these insect attacks is an important aspect of crop improvement programs. Pigeonpea is one of the important pulse crops of India and is infested with a plethora of insect pests. Most devastating are the pod borers, *Helicoverpa armigera* and *Maruca vitrata*. Lack of availability of germplasm for resistance to Helicoverpa in pigeonpea has resulted in the promotion of biotechnological approaches for insect resistance. Advancement in plant tissue culture, transformation and molecular biology have greatly benefited crop improvement programs and genes for insect resistance can now be moved into plants more quickly and deliberately. Since the time plant research in this area has gained momentum, innumerable genes and strategies have been identified and used for the development of pest resistant crops. There have been many potent genes ranging from the Bt ICPs to Bt vip and other genes to mitigate insect pests. Some of the genes have changed the entire scenario and have effectively demonstrated the success of the technology and the identified genes. However, economically important crops like pigeonpea are less amenable to tissue culture and hence require the development of non-conventional methodologies for genetic engineering. Further, along with the proven insecticidal genes, recent studies have demonstrated the utility of crop wild relatives as a resource for exploiting insect resistance traits. Combating one of the major pests of pigeonpea, Helicoverpa armogera (pod borer) using biotechnological tools will be presented.

Engineering Abiotic Stress Tolerance in Monocots and Path to Commercialization

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As an agro technology-developing company, Arcadia has put emphasis on research aimed at several agricultural input traits. Drought Tolerance or Water Use Efficiency (WUE) through genetic engineering has a prominent place within this framework. One approach, through overexpression of a sunflower transcription factor, generated WUE soybean which is currently close to commercialization. Another approach is through overexpression of a cytokinin gene controlled by a senescence-induced promoter, which has been particularly successful in monocotyledonous crops, like rice and sugarcane. We have demonstrated a delay of drought-induced senescence in these crops, which led to better yield retention under longer periods of reduced water availability or shorter periods with total absence of watering. This approach was implemented to develop African rice with 3 stacked traits: Nitrogen Use Efficiency (NUE), WUE and Salt Tolerance (ST). NUE is based on the overexpression of an alanine amino transferase gene controlled by a stress-inducible promoter. Consecutive years of comparative field trials led to the selection of one NUE rice lead event that is currently being trialed for regulatory approval. Furthermore, in collaboration with BRRI Bangladesh, currently several sets of potential salt tolerance genes are tested in rice.

ABSTRACTS

PLENARY SESSION III:
RESEARCH ADVANCES IN THE DEVELOPMENT OF TRANSGENIC AND GENE EDITED PRODUCTS IN SOUTH ASIA

Keynote: Opportunities to Address South Asia's Productivity and Food Security Challenges Using New Breeding Technologies

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Low productivity and sustainable food security are a serious challenge in South Asia, which needs to meet the food requirement of an ever expanding population that has now reached to almost 1.9 billion in this region. Climate change can cause 23% decline in major crop production from major food crops (maize, rice, wheat, and soybean). Selection of superior genotype, conventional breeding, mutation breeding, transgenesis in plant breeding and genome editing (use of CRSPR/Cas9) offers the new tools for crop improvement with time using available genome sequencing data. GM crops area globally has expanded from 1.7 Mha in 1996 to 189.9 Mha in 2017. The major GM crops include soybean, maize, cotton, canola, alfalfa, tomato, rice, wheat, potato, papaya, mustard, brinjal, etc. Researchers, educators, and policymakers are concerned with the constraints of development/regulatory issues of GM crops in South Asia but thus far, have yet to find the way to overcome negative campaigning by activists. However, the South Asia region (8 Asian countries) and Pacific region planted 19.11 Mha of biotech crops. Genome editing helped in developing seed production technology, as well as reducing linkage drag of precise molecular breeding. Less browning mushroom, improved maize grain yield, and hybrid rice/sorghum were developed using this system (MS45, Ms26, ARGOS8-Cas9). Scientists, social activists, and policymakers must appreciate modern science and make the best use of integrated science in all disciplines of agronomy, physiology, and molecular biology for comprehensive genome editing with the advancement of time and accept further innovative technology for crop improvement in future.

Development of Pro-Vitamin A Rich Biofortified Banana Fruit by Using Transgenic and Genome Editing Approaches

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Vitamin A deficiency (VAD) is a severe health problem, especially in South-East Asia and Africa. Currently, pharmaceutical supplementation has been implemented to alleviate VAD. However, the toxicity risk is associated with high-dose of vitamin A supplementation. Biofortification of staple crops is a feasible and cost-effective means of delivering micronutrients to populations that may have limited access to diverse diets and other micronutrient interventions. Banana plays a significant role towards nutritional security in the world. The application of conventional breeding for genetic improvement in banana is complicated due to the ploidy level and nature of parthenocarpic fruit development. Thus, the use of modern biotechnological applications could be considered as a promising approach for pro-vitamin A improvement in banana fruit. We enhanced pro-vitamin A (β-carotene) in banana by gain-of-function (over-expression), and loss-of-function (CRISPR/Cas9) approaches. 1-deoxyxylulose-5-phosphate synthase (DXS), phytoene synthase (PSY) and lycopene epsilon-cyclase (LCYE) are known as rate-limiting enzymes in the carotenoid biosynthesis pathway. DXS provides the substrate flux while PSY performs first committed step towards the carotenoid biosynthesis, whereas LCYE acts at a branching point and diverts lycopene towards α-carotene. DXS2 and PSY1 were found as promising candidates for over-expression study. Besides, targeted gene editing was established in banana by editing of phytoene desaturase (PDS) gene through CRISPR/Cas9 approach, and subsequently, it was implemented for mutation of LCYE gene in the banana genome. We noted increase β-carotene content in fruits of LCYE edited banana lines, whereas α-carotene and lutein were decreased. The best DXS2 overexpressing line is showing the nearly 20-fold higher content of β-carotene with respect to control in fruits. Our results demonstrate that genome editing through CRISPR/Cas9 and overexpression of DXS2 can be applied efficiently for pro-vitamin A biofortification of banana.

Bt Brinjal: A Genetically Engineered 'Minor' Crop Comes of Age in Bangladesh

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Brinjal is among the leading vegetable crops in Bangladesh, providing an important source of income for smallholder Bangladeshi farmers. A critical challenge to brinjal production is widespread infestations by Eggplant Fruit and Shoot Borer (EFSB), resulting in ~30-60% loss of crop yield, despite application of broad-spectrum insecticides sprayed ~2-3 times/week, with ~100 sprays/season. Cost of insecticide-dependent approaches result in 35-40% of the total cost of cultivation for farmers, raising questions on environmental, health and economic sustainability in the long run.

The South Asia Eggplant Improvement Partnership (FtFBP) in Bangladesh was conceptualized with a vision to boost food security, enhance economic growth and improve environmental quality by introduction and integration of genetically engineered product into the cropping systems. After regulatory approval in Bangladesh, four varieties (Event EE1) were distributed to ~20 farmers who harvested Bt brinjal in 2014. The adoption in subsequent years has increased rapidly. Today, over 25,000 farmers (18% of eggplant farmers) have adopted the technology in about 3,500 acres (5% of brinjal growing area). This was made possible through (i) building institutional/human capacity to carry out product stewardship, post-release crop performance monitoring, impact on farming community/environment; (ii) training farmers on good stewardship practices to promote durability of technology; (iii) strengthening extension systems/communication efforts to promote science-based public awareness of GM crops. The project now focuses on strengthening the existing extension systems, farmer-led groups, community organizations and communication practitioners to promote science-based public awareness of GM crops. It will also build institutional and human capacity to carry out responsible product stewardship to sustain the technology.

Bt brinjal was developed through the USAID-funded Agricultural Biotechnology Support Program II and the Feed the Future South Asia Eggplant Improvement Partnership. Partners include the India-based Maharashtra Hybrid Seed Company (Mahyco), Cornell University, Sathguru Management Consultants, USAID, and the Bangladesh Agricultural Research Institute (BARI). To learn more visit http://bteggplant.cornell.edu.

Biotechnological Strategies for Immunity to Aflatoxin Contamination in Groundnut

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Aflatoxin contamination in food crops poses major challenges for vulnerable populations of South Asia and Sub-Saharan Africa. The toxin-producing mold *Aspergillus flavus* thrives in poor soils, and prevalence of conducive climatic and poor crop storage conditions in drylands accentuates the contamination in wide range of food crops such as corn, groundnut, coconut, chilies, nuts, etc. Besides being an acute public health concern, aflatoxin contamination can cause significant post-harvest losses posing tremendous barriers on the trade of several agricultural commodities.

Conventional control strategies currently deployed are not likely to resolve the problem of aflatoxin contamination, thereby necessitating a multidisciplinary approach for action. Host plant resistance offers a possible cost-effective solution but is limited by low genetic diversity making conventional breeding approaches challenging in most crops. This presentation highlights the progress been made at ICRISAT where high level of resistance has been achieved in groundnut using a pronged biotechnological approach where, 1) overexpression of defensins boost the resistance of groundnut against the invading *A. flavus,* providing agronomically useful levels of aflatoxin control; and 2) functional inhibition of the aflatoxin biosynthetic pathway genes through host-induced gene silencing (HIGS) again resulting in remarkable resistance. Transcriptomic signatures revealed key mechanisms such as regulation of aflatoxin synthesis, packaging, export control and role of reactive oxygen species-scavenging enzymes that render better protection to the resistant events. The events were tested against several *A. flavus* morphotypes and demonstrated significant decrease in aflatoxin contamination (<1-2 ppb). These results are of high significance since currently there are no resistant groundnut lines/varieties available that demonstrate resistance levels even remotely closer to the US or EU legislative limitations. Results demonstrating the proof-of-concept technology for developing near-immune ground lines with negligible aflatoxin levels and a translational road map for bringing together these complementary technologies in regionally adapted groundnut germplasm will be discussed.

Status of Bt Cotton Research and Biosafety Measures in Bangladesh

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Bt-cotton developed by Hubei Provincial Seed Company, China containing the Cry 1A Bt gene, was approved by National Committee on Biosafety (NCB) of Bangladesh for contained trial in December 2014. This approval was preceded by the approval from Institutional Biosafety Committee of Cotton Development Board, National Technical Committee on Crop Biotechnology (NTCCB) Core Group headed by the Executive Chairman of Bangladesh Agricultural Research Council, National Technical Committee on Crop Biotechnology (NTCCB) headed by the Secretary of Ministry of Agriculture, Biosafety Core Committee (BCC) headed by the Director General of Department of Environment. Bt cotton hybrid seed of variety HSC-4 was obtained through the Material Transfer Agreement between Hubei Provincial Seed Company and Cotton Development Board. Following the Biosafety Guidelines of Bangladesh, 2008 Bt cotton contained trial was initiated on July 2015. Bt cotton gene was identified in PCR method, Bt protein was detected through Lateral Flow Immuno Strip test. For the bioassay of Bt Cotton, mass rearing of cotton bollworm (*Helicoverpa armigera*), trial in net cage and trial in plastic pot were done. The presence of Bt gene and Bt protein in cotton plats were confirmed, however, the cotton plant did not show any resistance against bollworm. As such, CDB has taken initiative to introduce Bollgard II Bt cotton hybrids, developed by Maharashtra Hybrid Seeds Company (Mahyco),

in Bangladesh and obtained permission from NCB in February 2017. After having permission from the NCB, Mahyco did not agree to share the Bt Cotton Seeds for regulatory trials in Bangladesh. Followed by CDB has signed MoU with JK Agri- Genetics Ltd. to introduce Bt cotton hybrids containing truncated Cry 1Ac gene and obtained permission from NCB in October 2017. Contained trail with two Bt hybrids, JKCH 1947 Bt, JKCH 1050 Bt, were initiated on 7 August 2018 after having approval from the Institutional Biosafety Committee of Cotton Development Board.

Research Advances in the Development of Transgenic and Gene Edited Products in South Asia

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Crop production needs to increase globally to assure food and nutritional security of growing population. Advancements in biotechnological tools over last three decades have revolutionized crop improvement programs. It has broadened the agricultural research area, bringing in new opportunities to develop novel plant varieties by transgenic or cisgenic approaches, gene silencing approaches, with deletion of detrimental traits or addition of significant characters with RNA guided genome editing technology. Further, advances in genome sequencing approaches provide access to large and complex genomes of crops and their wild relatives, helping to identify a wide spectrum of genetic variation and association of genetic diversity with diverse agronomic phenotypes. While the technological innovations progress in North America and some part of the world, some regions including South Asia are having their own challenges in adapting novel approaches. The progression of research and development in transgenic technology throughout the biotechnology legacy within Sri Lanka will be discussed. It also includes information on some current research in progress under controlled laboratory conditions and challenges facing while taking the products beyond the lab.

International Collaboration, Open Science and Open Data Sharing to Manage Worrisome Wheat Blast in South Asia by Genomics and Genome Editing Approaches

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Wheat blast is caused by a filamentous fungus *Magnaporthe oryzae* Triticum pathotype (MoT). It has been a threat to wheat production in South America since its first emergence in Parana state of Brazil in 1985 through host jump from a local grass. The first outbreak of this worrisome plant disease in Bangladesh in February 2016 devastated more than 15,000 hectares of wheat in eight districts and decreased 16% of the total wheat production in the country. In a rapid response to that new threat of food security of Bangladesh, we (31 researchers from 4 continents) applied field pathogenomics and open data sharing approaches and determined the genetic identity and origin of the disease within weeks. Using whole transcriptomics analyses of infected and uninfected (healthy) leaf tissues of wheat from across the infected districts of Bangladesh, we confirmed that the emergence of wheat blast is Bangladesh was caused a South American lineage of *Magnaporthe oryzae* suggesting that the wheat blast fungus was most likely introduced from South America. In 2017, the blast fungus spread to three new districts and some areas in neighboring West Bengal of India and thus posing a serious threat to the food security of South Asia. Genetic resources for the resistance breeding are limited and fungicide application seem unreliable. A larger scale international collaboration and application of novel approaches are needed to mitigate this wheat killer. To share our data with the global scientific community, we uploaded the whole genome sequences of a large number of wheat blast fungal strains in open wheat blast website (http://wheatblast.net), which were isolated from the infected field of Bangladesh. Whole genome sequences of four potential wheat blast biocontrol bacteria were also uploaded. We are currently working on genome editing of the S-genes in wheat by using CRISPR/Cas9 technique to develop new blast-resistant wheat varieties for Bangladesh. The CRISPR/Cas9 construct

was also released. We urge South Asian researchers and other international scientific community to work together for mitigating this enemy of wheat before it becomes catastrophic in South Asia.

Advancement of GM Potato Research at BARI for Late Blight Disease Resistant Varieties

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Tuber Crops Research Centre (TCRC), BARI and Michigan State University (MSU), USA is working jointly to develop 3-R-gene GM potato variety for late blight disease resistant. 3-R- genes viz. Rpi-mcq1, Rpi-blb2 and Rpi-vnt1.1 have been isolated from *Solanum mochiquense, Solanum bulbocastanum* and *Solanum venturii*, respectively. The Simplot Plant Science plasmid along with nptII selectable marker gene has been used to develop the GM Diamant event. Transgenic events have been developed through *Agrobacterium* mediated gene delivery system. At MSU, 16 3-R-gene events using the CIP construct have been identified as superior by MSU. These events are being under trial for efficacy test against the *Phytophthora infestans* isolate US-23 again at MSU this summer. The best performing Diamant events from Simplot Plant Sciences will be imported in Bangladesh during August-September, 2019 and the most superior event will be released as GM Diamant variety after contained, confined and regulatory field trials are conducted at BARI. On the other hand, 1-R-gene GM potato having RB (Rpi-blb1) is at advanced stage to release as GM potato in Bangladesh. PCR based molecular analysis is in progress for more purity of transgenic events.

ABSTRACTS

PLENARY SESSION IV:
ANIMAL, ARTHROPOD, AND AQUATIC BIOTECHNOLOGY - BIOSAFETY RESEARCH, RISK ASSESSMENT, AND REGULATION

Keynote: Advancing Animal Biotechnology Innovation in South Asia – Challenges and Opportunities

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The term biosafety in the research related to animal implies the risk assessment of the outcome of such modern research on the wellbeing of human and animal health. The pace of animal biotechnology research is very slow in many developing countries in South Asia for a number of reasons, which include lack of facilities, resources, and most importantly defined regulations. Primarily for us, animal biotechnology is used as a means to improve fertility through embryo transfer (ET) and artificial insemination (AI), conserving animal genetics resources, augmenting reproduction, diagnosis of disease using sensitive kits, and improving nutrient availability. Recently, report of buffalo cloning from India and China is notable. Assessing and inferring the risk and challenges related to such animal experiments in these countries are cumbersome due to lack of infrastructure and regulations. Few outcomes of such assessment in western world show the dark side of the technology like, GH transgenic swine have been found to have arthritis, growth hormone over-expression has increased risk of mastitis in cattle, insertional mutations may alter other essential biological processes, mosaicism, leading to transfer of transgenes to only some offspring, etc. We may use this available knowledge to put up a new dimension in developing policies regarding biosafety and risk assessment for South Asian countries. Manipulation of genes for transgenesis to improve traits (disease resistant or more milk yield) on one hand is extremely useful, but it must be seen that breeds which have stabilized over thousands of years in various agro-climatic conditions in this region of world should not be put through challenges of re-stabilization due to genetic modifications. Although targeted gene insertion

in modern biotechnology can reduce this risk, only time will let us know the real status of animals manipulated in this way. Failure in the development of any new technology due to poor biosafety or wrong risk prediction, may discourage the new ventures in this field.

Research Progress on Genetically Modified Food and Ornamental Freshwater Fishes with Understandings on Ecological and Health Concerns

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Advancements in the low-cost DNA sequencing technologies at the genomic and transcriptomic levels heightened our understandings of structure-functional relationships of genes at a global level, from model animals/fishes to non-model large animals/fishes. Knowledge gained from sequencing technologies accelerated in vivo understandings of gene functions using transposon mutagenesis tools. Additionally, gene editing tools such as zinc finger nuclease, transcriptional activator-like effector nucleases and CRISPR (clustered regulatory interspaced short palindromic repeats)/CRISPR-associated nucleases made it possible targeted gene disruptions at a pre-determined chromosomal loci at an affordable cost across global laboratories. Currently, targeted gene modifications/integrations expanded horizon from conventional stem cells to a wide range of somatic cell lines across species from laboratory animals to farmed animals/fishes. It is possible to transfer these technologies from the laboratory to land for the development of a consumer-friendly sustainable farming system. Progress and implications of gene integration and disruptions both in ornamental fishes and food fishes like carps will be highlighted. Issues linked with further fine-tuning with regards to improved efficacy and specificity, while reducing off-target effects of gene editing tools will be addressed.

There are health and environmental concerns with genetically modified organisms (GMOs). CRISPR/Cas9 mediated editing generates indels and hence supposed to be free from transgene – nontoxic and non-allergen. Random alterations at genomic level can also occur naturally or by cross-breeding. Contrary to this, alterations via gene editing techniques should be considered relatively more precise; provided off-target effects are minimized. Establishment of consensus on accurate off-target detection methods remain a challenge for researcher. Scientifically, myostatin gene edited animals including fish species (altering few nucleotide bases and transgene-free) with hypertrophic skeletal muscle could be considered as safe to eat. Building of global consensus is essentially required regarding permissible number of indels to selective genes (case-by-case). Confined rearing of genetically modified large-bodied food-fishes (e.g. cage-culture of carps) avoids ecological concerns. However, cage-confined cultivation of carps was not commercially viable. It is essential to generate genetically modified carps; those could well be cultivated in a confinement and at the same time economically profitable. It has been difficult to comply with all risks associated with GMOs. Possibly we need to agree to disagree on certain aspects, while devising science-based regulatory framework. The above aspects will be discussed during presentation.

Approaches for Managing Field Trials of Genetically Engineered Algae

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Algae and cyanobacteria are promising biological systems for applications in the biofuel, novel food, feed and nutrition industries. These phototrophic systems have the added advantage of robust growth in different aquatic systems such as marine water, waste water and freshwater. Additionally, these microorganisms play an important role in bioremediation by controlling and biomonitoring of organic pollutants in aquatic ecosystems. Algae and cyanobacteria are capable of being cultivated in non-agrarian land, a key point in the current food versus fuel debate for crop plants being grown for biofuels.

Genetic modification, such as transgenesis and genome editing, have opened up a plethora of options for deriving the maximum benefits from algae and cyanobacteria. Experts are now formulating the

guidelines for biosafety of these two classes of microorganisms which in many ways would have to be different from those practiced for transgenic crop cultivation. The discussion here will be a perspective to collaborate with the regulators to come to a conclusion on the proposed biosafety guidelines for managing field trials of genetically engineered algae (both in open ponds as well as in contained photobioreactors), with an overview of the unique risks involved and the possible mitigation

Genetically Modified Insects Take Flight

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Genetically modified insects represent an alternative approach for the control of pest species affecting agriculture or human health. The strategies used vary with respect to the complexity of the biotechnology utilized, the infrastructure needed to sustain control efforts, and the limitations that exist regarding species that can be targeted. While the genetic engineering may be novel, the strategies fall within a continuum of biocontrol activities using conventional organisms. At one extreme, sterile-release represents a control strategy that is relatively low-tech but has high requirements for infrastructure to sustain control. At the other extreme, gene drive represents a strategy requiring a technology-intensive input at the development stage, but (theoretically) low requirements for sustaining control, and a broad range of potential pests that can be targeted. Between these two extremes, there are genetic biocontrol strategies that represent intermediates with regard to the extent of the complexity of the genetic modification to the insect and the efficacy of control that can be achieved. This presentation will present an overview of genetically modified insects that are presently under development for use in controlling agricultural pests or vectors of human disease. Case studies will be compared to the illustrate how trade-offs exist between genetic modifications that increase efficiency of genetic biocontrol, but also increase persistence of the GE insect in the environment and, potentially, the risk of unintended effects.

ABSTRACTS

PLENARY SESSION V:
THE THEORY AND PRACTICE OF EFFECTIVE SCIENCE COMMUNICATION

Understanding Effective Communication in Agribiotechnology & Biosafety

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What is unique about communicating agribiotechnology and biosafety? What do we need to understand to create the impact and intended results? This is the expected outcome of my presentation. Very often, communicating agribiotechnology and biosafety is attempted the same way as communicating science or as educating public in science. The popular communication efforts adopted is usually one-way educational approach that focuses on the technical aspects of science. The usual perception is that public opinion can be shaped or changed by providing scientific information. However, we fail to understand that values that are formed by belief and emotion cannot be changed with science. The issues surrounding GM crops and it regulations are very emotional, sentimental, historical, cultural and also laden with vested interest. The diversity of the public, their concerns, values, trusted sources, tools and background knowledge also require customized communication strategies. In many cases, efforts to communicate about GM crops have followed a linear, educational, one-way delivery, focused mainly on technical elements of the science. Target audience by providing them scientific facts that is against their ideology on agribiotechnology will only further alienate them from the values and views we want them to adopt. Effective communication strategies must combine science with emotion and values, be relevant to the target audience, address their concerns and resonate with them. We need to find a middle path with our target audience by establishing shared values and interests. Trust and empathy are two key elements to successfully convince our audience and shape their ideology. There is an immediate need to enhance science and risk communication skills among scientists and regulators and revamp our communication strategies.

Challenges in Communicating a Biotechnology Product: The Golden Rice Experience

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Biotechnology can be seen as a very challenging topic to communicate. It is hard to talk about this topic because it is abstract, highly technical, related to other complex concerns, and preconceived notions of people about it is hard to change. Hence, biotechnology is generally absent from mainstream media coverage and instead its coverage has focused on more sensational health and environment issues. A well-known example of a product of biotechnology is Golden Rice, a genetically engineered type of rice that contains beta-carotene, a source of vitamin A. Currently, Golden Rice regulatory application assessments in Bangladesh and the Philippines proceed at a measured pace and could benefit from increased political support and engagement of influential stakeholders to facilitate understanding and solicit the support of key stakeholders and the eventual end-users. The biotechnology policy landscape in Bangladesh and the Philippines has attained some level of regulatory clarity, albeit at different levels of progress. As such, there is a need to strengthen communication and engagement initiatives in support of stakeholder buy-in, particularly among regulators and policymakers.

This paper looks into the experience of the Healthier Rice Project in implementing a communication and stakeholder engagement strategy that evolves at each stage of the project—from early development to its current phase of regulatory applications. In consideration of the goals of the current phase of the project and the communication support required to achieve these goals, these three principles continue to inform our approach to communication: transparency, purpose, partnership & collaboration. While an overall project-wide communication and stakeholder engagement is a central theme—country-specific initiatives are spearheaded by IRRI's national research partners in Bangladesh and the Philippines and other participating organizations within each country, where IRRI provides technical support at the country level and explore opportunities for communication outreach and engagement at the regional and global levels.

"Science Diplomacy": A Tool for Connecting Science to the World

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Science is universal and must reach out to all around the world. Good and true science is to be shared between the nations for larger benefit of today's well-connected societies as scientific research transcends countries and continents. Publication of a quarterly digest "*Science Diplomacy*" is an effort to share top scientific research, technological advancements, innovations and key policy aspects with different nations especially who have science and technology cooperation with India. Something like 22% Indian research papers are an outcome of collaborative research with different countries. The engagement of our researchers with their counterparts in these countries shows the growing science diplomacy that India enjoys with many countries. CSIR-NISCAIR is the pioneer in science communication in general and scholarly and encyclopedic publications in particular. Science Diplomacy is one of the recent initiatives towards its commitment to communicating and sharing science to all stakeholders and promoting science outreach and public engagement. Science Diplomacy' offers a platform to broaden and strengthen science and technology cooperation further. Much of the high quality scientific research gets highlighted through English journals published in India and abroad. 'Science Diplomacy' is a new initiative offering a quarterly digest of India's top scientific research, innovation and policy developments in major foreign languages and vice-versa. Dr. Harsh Vardhan, Science & Technology, Earth Sciences, Environment, Forests & Climate Change Minister of India, besides Mr. Abdul Latif Roshan, Higher Education Minister of Afghanistan and Mr. Yafes Osman, Science & Technology Minister of Bangladesh, released the first issue in Japanese-English at the 3rd India International Science Festival, Chennai on October 13, 2017. A new avenue for taking the results of Indian scientific research abroad can be opened up if the research output could be conveyed in some of the major foreign languages as well in the form of a digest to be available in major foreign languages besides English and Hindi. Science could thus be harnessed as a diplomatic wedge benefitting English as well as non-English

readers across the globe by disseminating selected scientific breakthroughs and connecting larger readership both in English and non-English regions across the world to Indian science. Diplomatic missions, research and development organizations and institutions, science academies, universities, libraries and mass media, etc., in different countries will get such important content in their respective language(s) in both print and online versions. The introductory issues published in Japanese-English to begin with and subsequently will be made available in other foreign languages, i.e. Chinese, French, German, Russian and Spanish; other languages may be added depending on the need and feasibility. The publication has completed almost one year and an assessment shows the uniqueness of the idea that has the potential of further collaborations in SHARE Communication especially in AASSA member countries especially for language versioning and dissemination.

ABSTRACTS

PLENARY SESSION VI:
BIOSAFETY RISK ASSESSMENT AND REGULATION OF GENE EDITED PLANTS

Keynote: What is Gene Editing? Context for Plant Breeding and Regulation

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Modern plant breeding encompasses a wide variety of tools and techniques that can be employed to develop now varieties of crop plant. These methods change over time, and recently, a lot of attention is being devoted to a suite of techniques that are collectively referred to as gene editing. But what are these techniques, and how do they differ from other fashionable technologies and terms like synthetic biology and gene drive? Understanding the use, and frequent misuse of these terms is important to understand current developments in biosafety regulation. This presentation will provide an overview of the technologies currently being employed and their potential uses in crop breeding. It will also review sources of confusion between gene editing and other technologies and introduce some important background for understanding the current global discussion of biosafety regulation for gene edited products.

Gene Editing and International Forums: The Convention on Biological Diversity and the Cartagena Protocol on Biosafety

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The Convention on Biological Diversity is an international agreement on the conservation and sustainable use of biological diversity, and the Cartagena Protocol on Biosafety is a protocol to the Convention on Biological diversity that is for the safe handling, transport and use of living modified organisms (LMOs) resulting from modern biotechnology that may have adverse effects on biological

diversity. Discussions related to gene-editing have been taking place in both forums, as a potential 'new and emerging issue' under the Convention, and as a potential specific issue requiring further guidance on risk assessment under the Protocol. As such, gene editing will be included in the discussions during the 14th Conference of the Parties (COP) to the Convention, and the 9th Conference of the Parties serving as the Meeting of the Parties (MOP) to the Protocol taking place in November 2018. This presentation will share the history of the discussions under these forums leading up to COP14/MOP9 and the main points to be discussed there related to gene editing.

Risk Assessment and Regulation of Gene Edited Organisms in Australia

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In Australia, the Gene Technology Regulator (the Regulator) is responsible for authorising the release of GMOs into the Australian environment. The Regulator's decisions on whether to authorise the release of a GMO under the Gene Technology Act 2000 (GT Act) must be based on an assessment of whether any risks to people or the environment can be managed, ie an environmental risk assessment (ERA) which is based on sound science.

However, whether an organism is a GMO or not is not a science-based decision. This decision is primarily a legal decision about whether it fits the definitions in the legislation. The current definitions were constructed in the 1990's, based on what could be achieved using gene technology at that time. Techniques for modifying genes have advanced rapidly in recent years and the Regulator has initiated a review of the Gene Technology Regulations in order to try to clarify what is regulated in Australia. This review is an interim process as a review of the Australian gene technology scheme is also underway, which can make broader, policy-based decisions on what should be regulated to protect human health and safety and the environment.

In this talk I will discuss the approaches that we take to regulate GMOs developed using gene editing and also how the Australian regulation of organisms produced using gene editing is being reviewed.

Global Regulatory Outlook for Genome Edited Crops

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CRISPR-Cas, one of the most discussed tools of genome editing, enables targeted and precise improvement of commercially important agricultural crops and unquestionably is a breakthrough plant breeding innovation. CRISPR-Cas genome editing has received wide attention among the scientific society, regulators, policy makers, and media. Global regulatory policies for genome editing is an important factor for the broad application of this tool to successfully bring genome edited products faster to market to benefit both farmers and consumers. A growing number of countries, including global agricultural production leaders such as the United States, Argentina and Brazil, have determined that plant varieties developed through plant breeding innovations, such as CRISPR-Cas genome 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. An undue regulatory burden and risk-disproportional policies for genome edited crops will stifle innovation and significantly limit application of this technology to a few high-return crops and traits. In this presentation, we focus on analyzing the current status of the regulatory frameworks for genome edited crops around the world and, share our experience with the next generation waxy corn developed through CRISPR-Cas technology.

Gene Editing Applications in Agriculture

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Recent advances in gene editing techniques have the potential to revolutionize plant breeding for the growing number of crops whose genomes have been sequenced. Gene editing using CRISPR/Cas9 has emerged as one of the most promising techniques owing to its relative efficiency, ease of use, and ability to do multiplex editing. The low cost and reduced time needed to test modifications using CRISPR-based methods could dramatically speed up the progress of breeding programs. The possibility of a reduced regulatory burden for developers could open the field for innovative products from public researchers and small enterprises, who have been disadvantaged in delivering crop improvements using transgenic approaches. This presentation will review some of the applications of CRISPR/Cas9 gene editing with an emphasis on the introduction of pest and disease resistance traits.

ABSTRACTS

LIGHTNING ROUND
FOR STUDENTS AND EARLY CAREER RESEARCHERS

Blending Gene Expression with Phenomics to Decipher Salt Tolerance Determinant

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Purpose: Rice production is being affected by increased salinity in soil due to climate change. To meet the demand of overgrowing population, rice cultivation and enough production is a need of time which requires rice with both salt tolerance and high yielding traits. Engineering such rice requires correct combination of genes and regulators. Understanding the mechanism of salt tolerant landraces with adaptive capability to withstand the harsh environment can give insights on potential candidate genes for conferring tolerance. We focused on understanding the salt tolerance mechanism from gene expression and phenomics analysis in a set of tolerant and sensitive rice originated from same parents.

Methods: We have made reciprocal cross of salt tolerant landrace Horkuch and high yielding variety IR29. The F2 population was genotyped using DArTSeq™ for discovering SNP markers followed by construction of linkage map. In a subset of F3 population expression differences were observed under 150mM salt stress by RNAseq. Expression QTLs (eQTL) for both seedling and reproductive stage were mapped using the linkage map and RNAseq data. An image-based non-destructive automated and continuous phenotyping over 3 weeks of salt stress was carried out on a selected F3 and F5 sub-populations followed by QTL identification for the digital traits and relative growth rates from visual image data

Results: Image analysis over days gave us longitudinal data, separating the early and late responses to salt stress, more informative than the endpoint records measured in conventional phenotyping. Combining the phenomics and eQTL data, early growth indices were found to be enriched with

transport, osmotic response and the later stages were enriched with genes associated with growth, carbohydrate metabolism, organ development.

Conclusions: The phenome supported eQTL data gave a comprehensive scenario regarding potential candidates involved in growth, transport and yield under salt stress to choose right combination of genes for engineering salt tolerant high yielding rice.

Alternatively Spliced Form of the Vacuolar Na^+/H^+ Antiporter (*OsNHX1*) Gene: Aspire to Combat Salinity Stress in Rice

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Purpose: Soil salinity is the most challenging problem that restricts the production of rice worldwide and therefore, it has become very important to produce more saline tolerant rice varieties. Vacuolar NHX transporters play significant roles in accumulating Na^+ in vacuole in the case of high Na+ exposure. The OsNHX1 gene produces three transcripts transcript-1 (2265bp), transcript-2 (2394 bp) and transcript-3 (1820 bp) through alternate splicing. Among them, transcript-3 (1820 bp) seems more unique for encoding a truncated protein at C terminus. To discover the role of transcript-3 in high yielding rice variety BR-28, transgenic T1, T2 and T3 plants were extensively characterized for their salt tolerance properties. On the other hand, the hypothesis that, truncated transcript-3 may indulge its constitutive expression due to the lack of Calmodulin (Ca^{2+} binding protein) binding site in the C terminal regulatory region is also being tested.

Methods: Na^+/H^+ vacuolar antiporter transcript-3 cDNA were cloned under the control of the CaMV35S promoter and transformed into farmer popular high yielding but salt sensitive rice variety BR-28 by in planta transformation method. The best lines were selected by molecular and physiological analysis and advanced to the T3 generation.

Results: Different physiological parameters under salt stress at seedling stage, indicated that transgenic plants were significantly ($P<0.005$) more tolerant than WT. Moreover, the expression analysis of transcript-3 in WT and transgenic plants under different conditions (light/dark, with/without salt stress) showed light and salt stress causes a far greater increase in transcript-3 (~200 fold) compared to WT. Thus, transcript-3 provides durable salinity tolerance.

Conclusions: Constitutive expression of transcript-3 may provide durable salinity tolerance.

Key words: Transcript, OsNHX1, Antiporter, In planta transformation, Salinity tolerance

Fluorescence Based Kompetitive (Competitive) Allele Specific PCR (KASP) for High-Throughput SNP Marker Detection and Validation

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Purpose: Considering the enormous potential of DNA markers in plant breeding and recent advances in single nucleotide polymorphism (SNP) genotyping for its promising role in crop improvement, it has become inevitable for the plant breeders to adopt the capacity of SNP marker development and marker assisted selection (MAS).While, gene cloning allows insertion of a single gene, MAS enables insertion of multiple loci for pyramiding of different tolerance mechanisms, leading to a higher level of tolerance. Cost of utilizing high throughput SNP detection system is possibly the major hindrance in implementing marker assisted selection (MAS). In the current work, we have attempted to establish fluorescence-based Kompetitive Allele Specific PCR (KASP) technology for easy and efficient detection of SNP alleles. KASP was applied for the validation of the identified salt tolerance quantitative trait loci (QTL) with an aim to select potential donor (tolerant) allele/plant for use in marker-assisted breeding.

Methods: A mapping population at F6 and F7 with the salt tolerant rice landrace Horkuchand sensitive but high yielding IR29, was used to establish KASP genotyping. Specific salt tolerance SNP-based QTLs had been previously identified at the F2-3 stage from this mapping population, with IR29 and

Horkuch. KASP markers were designed for these loci and genotyping was done with the DNA of the F6 and F7 population for molecular validation. Physiological analysis was also done in both seedling and reproductive stages. Later correlation analysis of both physiological and molecular data was done to select appropriate donor plant.

Result: KASP genotyping was successfully established as fluorescence based SNP detection method by detecting seven out of eight SNPs. From the correlation between physiology and molecular analysis few F6plants have been found as potential donors multiple traits or QTLs.

Conclusion: In the overall study KASP genotyping method was found more suitable as a marker validation system than other methods due to its speed, high accuracy, low cost, flexibility in assay design and fluorescence based detection method. The method is now being used in a breeding program for introgression of multiple QTLs in a commercial Rice variety.

Two Amino Acid Substitution Model Across Membranes in the *Oryza* Species HKT1;5 Transporter from Salt Tolerant Rice Landraces for a Beneficially Low Na^+/K^+ Ratio

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Maintenance of a proper Na^+/K^+ ratio within the plant when there is high sodium concentration in the soil is a vital requirement for its survival and growth. The High Affinity K^+ Transporter (HKT) and its homologs play a critical role in plants during salinity stress. Among different HKT family transporters, HKT1;5 is mainly responsible for maintaining the shoot K^+ concentration under NaCl stress. HKT1;5 also has functional variability among salt sensitive and tolerant varieties. In the present study, alignment of 23 sequences of HKT1;5 from *Oryza* species and wild halophytic rice called, *Porteresia coarctata* showed 4 major amino acid substitutions (140 P/A/T/I, 184 H/R, D332H, V395L), which significantly vary in salt tolerant and sensitive varieties. The 3D structure of HKT1;5 was generated using Ktrab potassium transporter as the template. Among the 4 substitutions, the conserved presence of aspartate (332) and valine (395) close to the Na^+/K^+ channel in the predicted 3D structure of HKT1;5 was observed for the tolerant genotypes. This led to the hypothesis of a combined model with two amino acid (Asp and Val) substitutions in the membrane of the HKT1;5 transporter for maintaining a beneficial ratio of Na^+/K^+. Moreover, these two substitutions likely have a synergistic effect on the functioning of HKT1;5 in salt tolerant varieties. Presence of valine creates a small van der Waals force, which affects pore rigidity. The model explains how this may increase Na^+ transport from xylem sap into xylem parenchyma and further to soil using other transporters like SOS1. Furthermore, it is proposed that the presence of Aspartate at the 332 position creates a strong inward rectification of K^+ ion from xylem parenchyma into xylem vessel which neutralizes the membrane depolarization due to Na^+ efflux. These two substitutions of HKT1;5 transporter probably help tolerant varieties to maintain appropriate Na^+/K^+ ratio and survive during salt stress through working in a coordinated manner.

Genetic Engineering for Development of Salt-Tolerant Pigeon Pea Plants

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Stress which arises due to environmental conditions such as salinity, drought and extreme temperature disrupts the normal metabolism of plants. Salinity is one such major stress which causes considerable loss in crop productivity. Development of transgenics has been used to deal with increasing salinity problem. In this study, OsRuvB, a DNA helicase, working under the control of CaMV35S promoter has been used to develop salinity tolerant transgenic pigeon pea plants. The transgenic lines have been developed using an efficient *Agrobacterium*-mediated transformation protocol and the transformation efficiency was found to be 35%. Southern hybridization and real- time PCR confirmed the stable transgene integration and the copy number in the transgenic lines. To assess the efficacy of transgene the transgenic and wild type plants were exposed to 75mM NaCl stress. Observations for various physiological parameters clearly indicated that transgenic pigeon pea plants have enhanced tolerance

to salt stress. The underlying mechanism still needs to be elucidated for the functioning of the gene in a strikingly different manner under salt stress conditions as was evident from the results.

Engineering Insect Resistance in Rice

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Amongst the biotic factors that hamper the yield of rice production, lepidopteran pests cause the most severe damage. Use of chemical pesticides to control the pest attack has left behind unwanted residual impact in the environment. Employing genetic engineering as a part of plant breeding programme has several advantages over using conventional plant breeding alone in developing insect resistant rice cultivars. Bt-mediated insect resistance strategy is one of the successful strategies widely employed to control pests of crops such as maize and cotton. At TNAU, genetic engineering in rice was carried out with an objective to generate marker-free transgenic rice lines resistant to Lepidopteran pests of the elite rice cultivar ASD16, expressing *cry2AX1* gene by *Agrobacterium*-mediated transformation. Rice transformation by using immature embryos was implemented by using co-integrate vector harbouring reporter and antibiotic selection genes and binary vector containing *cry2AX1* gene which resulted in the generation of twenty putative transgenic rice plants. Ten out of the twenty putative transgenic lines were positive for the presence of *cry2AX1* gene, indicating co-transformation of the selectable marker gene and the gene of interest in these plants. The Cry2AX1 protein concentration in the PCR positive T0 plants was determined by quantitative ELISA. Three of the best ELISA positive lines were chosen for Southern blot hybridization. In order to identify marker-free transgenic plants, segregation analysis of T1 progeny was carried out. This resulted in the identification of marker-free transgenic plants in one of the events.

Comparative Nutritional Equivalence Evaluation of Transgenic Chickpea Seeds Harboring Either a *cry1Ac* or a *cry2Aa* Gene

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Purpose: A comprehensive nutritional assessment of transgenic crops is required to demonstrate the substantial equivalence of the transgenic crop compared to its non-transgenic counterpart. In the present study, we performed a comprehensive nutritional evaluation of Bt chickpea lines harboring either a *cry1Ac* or a *cry2Aa* gene with its non-transgenic counterpart to assess the safety of the transgenic lines.

Method: We focused primarily on analysis of proximate, amino acids, fatty acids, minerals, vitamins and anti-nutritive components. In addition, the in vitro protein digestibility of the Bt chickpea seeds were also evaluated (using transient pepsin and trypsin hydrolysis) owing to its contribution to the high protein quality of the chickpea seeds besides the amino acid composition.

Results and Conclusions: No significant differences were detected in the proximate components, amino acids, minerals, vitamins and anti-nutrients of the Bt chickpea when compared with their non-transgenic counterparts. Although a significant difference in the trypsin inhibitor , crude fate and a few fatty acid composition of Bt chickpea line harboring *vry2Aa* gene was observed, but values were within the range reported for chickpea varieties and should not have potential risk. The in vitro protein digestibility of the transgenic lines suggested no potential change in the protein quality of the Bt chickpea lines.

Genetic Engineering of Sugarcane with EXPA1 and BRK Genes Increases Water Deficit Stress Tolerance and Its Biosafety Concern

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Sugarcane is a tropical high water demanding crop. Drought is one of the most limiting factors for sustainable sugarcane production and contributing up to 50 % yield loss in India. To enhance water deficit stress tolerance in sugarcane, two different cell wall related genes viz., Expansin (*EaEXPA1*) and Brick (*SsBRK1*) were isolated from wild relative of sugarcane namely *Erianthus arundinaceus* and *Saccharum spontaneum* respectively and over expressed in a popular sugarcane variety Co 86032 of tropical India. Trangenic were produced using *Agrobacterium* mediated transformation. Constitutive port ubi882 promoter isolated from *P. coarctata* was used to drive the transgenes and hygromycin as selection marker. Transgene integration was confirmed through PCR analysis. Thirty two Expansin transgenic events and twenty nine BRK transgenic events were screened in replicated CRD design for soil moisture stress tolerance at the formative phase of V1 transgenics by withholding irrigation for 10 days under potted conditions. Our studies have shown that over expression of EaEXPA1 and SsBRK1 genes enhanced the performance sugarcane variety under water deficit stress condition. Physiological, molecular and morphological parameters were used to assess drought tolerance. Expansin gene is a cell wall loosening protein which helps the plant cell during growth as well as during different stress condition by maintaining the cell integrity. The BRK gene is also known to be involved in actin polymerization which again helps in maintain cell integrity. Thus overexpression of these genes in sugarcane results the plant to withstand during the water deficit stress conditions.

To date, there are no reports of pollen transfer from cultivated sugarcane to its wild relatives and rare natural seed sett occurs across the country. Due to vegetative propogation, transgene could be fixed in the first generation. The gene of interest used for overexpression was cloned from E. arundinaceus and S. spontaneum, both are wild relative of sugarcane. Therefore, it is expected that these transgenics could be safe to environment. Moreover during the sugar/sucrose production form sugarcane the juice is subjected to very high temperature that results in degradation of native proteins. Therefore, sucrose is purified product free from proteins. Hence, biosafety issues are relatively low with sugarcane transgenics.

ABSTRACTS & BIOGRAPHIES

POSTER SESSION

Comparative Study of Genetic Diversity of *Sonneratia apetala* Buch.–Ham. Growing in Sundarbans and Different Coastal Islands of Bangladesh

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Sonneratia apetala Buch.-Ham. is one of the most important species of Sundarban mangrove forests (SMF). Leaf samples of *S. apetala* were collected from three ecological zones (oligohaline, mesohaline and polyhaline) of SMF during 27 March to 2ndApril 2016 and 9-14 April 2017. Forty leaf samples were taken for DNA extraction using CTAB technique. Only best 15 DNA samples of 3 ecological zones (8 from oligohaline zone, 6 from mesohaline zone and 1 from polyhalline zone) were used. The band size was estimated by comparison with 1 kb-plus DNA ladder. In *S. apetela,* PCR products with expected sizes were amplified for 10 primer sets (5 RAPD and 5 EST-SSR). The GenAlEx6.5 software were used for the genetic diversity indices calculation using PCR products of 5 SSR primers. Observed heterozygosity (Ho), and expected heterozygosity (He) were also calculated.The SSR analysis showed average observed homozygosity was 0.8585 which was higher than average expected homozygosity 0.5640. The dendrogram revealed a grouping of 9 individuals with identical genotypes in which six individuals were from the oligohaline zone; two from the mesohaline zone and one from the polyhaline zone. From the heterozygosity analysis by populations it was found that the observed heterozygosity (Ho= 0.333) was little higher than the expected heterozygosity (He = 0.289) for oligohaline populations and for the mesohaline populations observed heterozygosity (Ho= 0.300) was also higher than the expected heterozygosity (He = 0.219). From this study, it was found that the heterozygosity of *S. apetala* population of oligohaline and mesohaline zone in SMFwas almost similar (Ho= ~ 0.3).When this result was compared with the afforested *S. apetala* population of three coastal islands, it was found that *S.*

apetala population of SMF formed different cluster and it appeared that seeds for coastal afforestation may not have been collected from these zones of SMF.

The Government of Sri Lanka is Partnering with the Food and Agriculture Organization of the United Nations and the Global Environment Facility to Strengthen Capacities for the Safe Use of Living Modified Organisms

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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 Biosafety regulations and the Biosafety Master Plan. Also, several materials for enhancing public awareness about biosafety and the understanding of biotechnologies and which target predetermined specific stakeholders were developed. These were published in English and the two local languages (Sinhalese and Tamil). Additionally, the first issue of the tri-lingual Biosafety newsletter, aimed at informing the public about biosafety and biotechnologies, was launched at a press conference. To enhance the ownership of the project by the widest possible stakeholder base, and hence the eventual applicability of its outputs, national institutions are being contracted to drive the implementation of a significant proportion of the project's expected deliverables. 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.

Does MoT3 Assay Specific for Diagnosis of Wheat Blast?

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The blast fungus *Magnaporthe oryzae* is comprised of lineages that exhibit varying degrees of specificity on about 50 grass hosts, including rice, wheat and barley. Reliable diagnostic tools are essential given that the pathogen has a propensity to jump to new hosts and spread to new geographic regions. Of particular concern is wheat blast, which has suddenly appeared in Bangladesh in 2016 before spreading to neighboring India. In these Asian countries, wheat blast strains are now co-occurring with the destructive rice blast pathogen raising the possibility of genetic exchange between these destructive pathogens. We assessed the recently described MoT3 diagnostic assay and found that it did not distinguish between wheat and rice blast isolates from Bangladesh. The assay is based on primers matching the WB12 sequence corresponding to a fragment of the *M. oryzae* MGG_02337 gene annotated as a short chain dehydrogenase. These primers could not reliably distinguish between wheat and rice blast isolates from Bangladesh based on DNA amplification experiments performed in separate laboratories in Bangladesh and in the UK. Specifically, all eight rice blast isolates tested in this study produced the WB12 amplicon. In addition, comparative genomics of the WB12 sequence revealed a complex underlying genetic structure with related sequences across *M. oryzae* strains and in both rice and wheat blast isolates. We, therefore, caution against the indiscriminate use of this assay to identify wheat blast.

Dr. Dipali Rani Gupta obtained a B.S. (with honors) in Agriculture in 2003 and an M.S. in Horticulture in 2005 from Bangladesh Agricultural University, Mymensingh. She then completed a Ph.D. in Molecular Biology in 2011 from Tottori University, Japan. Dr. Dipali is currently an assistant professor at the Department of Biotechnology, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh.

Stewardship of Bt Eggplant in Bangladesh

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Bangladesh becomes the 29th country of the world to approve commercial cultivation of genetically modified crop (Bt Eggplant) in 2013. Four varieties were distributed to 20 farmers who harvested Bt eggplant in 2014. Adoption in subsequent years has increased rapidly so that, in 2018, 27,012 farmers used this technology and gained experience in managing the first GE crop. Bangladesh Agricultural Research Institute (BARI) is leading to expansion of Bt eggplant among the farmers through USAID supported project. As a part of stewardship, BARI is being trained the farmers and extension workers, prepared production technology manual, creating awareness among the stakeholders, on-farm trials, baseline susceptibility, refuge management, capacity building for researchers, field monitoring, good quality seed production, packaging, distribution and tracing, expression of Bt gene in the product, agronomic and economic performance, consistent communication with stakeholders etc. The performance of Bt eggplant is quite satisfactory so far and lot of awareness and interest has been grown among the farmers around. Partnership in the development and expansion of Bt eggplant may be a milestone for futures other GMO crops development in Bangladesh.Wilt resistant, hybrid development, refuge mixing, incorporation of multiple genes etc. are needed for good stewardship in future.

Fate of Bt Protein in the Cooked Fruits of Bt Eggplant Varieties/Lines

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The cooked eggplant fruits are usually consumed as roasted to prepare 'Bharta', fry in oil as 'Bhazi' and boiled for curry. The objective of the study was to determine whether the Bt protein was present in the Bt eggplant fruits after cooking. The uncooked Bt fruits and the non-Bt fruits were used as positive and negative control, respectively. Fruits were roasted in gas burner, fried in soybean oil and boiled in water for 5-6 minutes when it appeared as edible. It was replicated in four times. The protein extracts from these samples were quantified by lateral flow strip method using commercially available by DGX020-DesiGen Xpresstrips Kit (Mahyco, India) and qualitative ELISA following standard operating procedure developed DeiGen Diagnostics, Dawalwadi, Jalna, India. The result was based on the observing test line in lateral flow strip and cut-off value in ELISA method. Result revealed that uncooked i.e fresh samples were positive and the cooked samples Bt brinjal and non-Bt samples were negative regarding Cry1Ac protein in both methods. This is the plus point from the food safety view of Bt eggplant.

Feed the Future Biotechnology Potato Partnership 3r-Gene Project

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Core Concept: The Feed the Future Biotechnology Potato Partnership is a five-year project to develop and commercialize a three-R gene construct for late blight resistance in farmer-preferred varieties of potato in Indonesia and Bangladesh. The project consists of agreements between USAID, Michigan State University, the University of Minnesota, University of Idaho and the J.R. Simplot Company, a private sector potato company, to produce and steward the three R-gene potato for distribution to small-holder farmers and commercialization.

Component Parts: The project consists of two institutional partnerships, one in Bangladesh and one in Indonesia, through which the project team will 1) develop a three R-gene construct for a late blight resistant potato in farmer preferred varieties; 2) build institutional capacity to carry out the project research and accompanying field trials; 3) develop adequate regulatory dossiers for deregulation; 4) develop a communications strategy to inform the public and stakeholders of the benefits of the LBR potato; and 5) further build institutional capacities necessary to carry on such product development in the future.

Project Social Impact Goals: The project will work with partner research institutions in Bangladesh and Indonesia in order to ensure that the project achieves locally driven results. By the end of the project, the capacities present in the project team will be duplicated in the project partners with the goals of 1) reducing the use of harmful pesticides; 2) improving health and reducing malnutrition; 3) reducing pre- and post-harvest losses; 4) improving the social and economic standing of women; and 5) catalyzing economic growth.

Achievements: As a new biotech partnership started in Bangladesh with the implementing agency as Bangladesh Agricultural Research Institute (BARI), project documents were executed. The Memorandum of Understanding (MoU) between Bangladesh Agricultural Research Council (BARC) and Michigan State University (MSU) was signed at MSU, the Letter of Agreement (LoA) was signed between Bangladesh Agricultural Research Institute (BARI) and MSU, and the project launching ceremony was held at BARC, in Dhaka in December 2017. The Hon'ble minister of Agriculture, Begum Matia Chowdhury attended the inaugural session of the launching program as chief guest. In 2017, three scientists from the Tuber Crops Research Centre (TCRC) completed 4 months of training in three disciplines (potato breeding, potato pathology and potato tissue culture) at MSU. Recently, improvements to the lab facilities at TCRC have been completed. The facility was visited by the NTCCB core committee, and received certification for GM potato research. TCRC has also received potato tubers, developed by hydroponic method, and non-GM variety tissue culture materials from MSU which are being propagated at TCRC.

Dr. Md. Jahangir Hossain completed college in 1976, graduated from the Bangladesh Agricultural University in 1982 and obtained a master's degree in the field of horticulture from the same university in 1987 with a thesis titled "Application of tissue culture technique for the production of virus free potatoes." Dr. Hossain obtained his Ph.D. from the same university in 2006 with a thesis titled "Potato microtuber production and dormancy breaking".

Dr. Hossain joined as Scientific Officer at the Bangladesh Agricultural Research Institute (BARI) in 1983 and started his research carrier in potato tissue culture and virus free potato production. He was team leader of the tissue culture group of the Tuber Crops Research Center (TCRC) of BARI from 1983 to 2006. Dr. Hossain held the position of Director of TCRC for two years (2015 and 2016). Dr. Hossain has published about 80 research papers in national and international journals.

Dr. Hossain joined as Country Project Director of Feed the Future Biotechnology Projects (Potato and Brinjal) in 2017. Dr. Hossain is blessed with two sons and one daughter.

Overexpression of G-Protein Beta Subunit Gene (OsRGB) Confers both Heat and Salinity Stress in Rice

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Combined stresses of transient or persistent high temperature and soil salinity due to climate change is being considered as the prime barrier of restricting crop production to the desired level and leads to food insecurity in agro-based economy worldwide. For mitigating the undesirable effect of combine stresses, one way is genetic transformation approach to develop crop plants with improved heat and salinity stress tolerance. Some candidate genes and transcription factors have already been reported to show tolerance against single abiotic stress to a good extent but not multiple stresses mutually. G-proteins are one of the candidates for tolerance that modulate hormonal and stress responses and ultimately regulate diverse developmental processes in plants. In the current study, constitutive overexpression of the rice G-protein beta subunit has shown improved tolerance against both heat and salinity separately and in combination in rice plants. In planta transformation of high yielding rice variety BRRI Dhan 55 with beta subunit of rice G-protein was confirmed at T1 by Semi- quantitative RT- PCR to select the best-expressing plants, followed by Southern hybridization. Transgenic lines were advanced subsequent generations for attaining homozygosity. Physiological characteristics analysis showed that transgenic lines have higher germination rate, root length, shoot length and plant height compared to wild type under heat stress condition. Under salt, heat and combined stress condition significantly lower amount of chlorophyll loss, low electrolyte leakage, low MDA content and low H2O2 content shown in transgenic lines compared to WT type. The transcription levels of stress responsive genes (OsAPX1, OsSOD, OsHKT1, OsHSP1, OsHSP2 and OsCOR47) were significantly up-regulated in RGB- transformed BR55 compared with WT. The transgenic plants will now be tested under combined 80mM salt stress and 42°C heat at the panicle initiation stage to see if RGB provides protection against yield losses

Bioinformatics Approach of Structural Modeling and Molecular Dynamics Simulation of Pattern Recognition Receptor CORE

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Plants being sessile organisms are continually being subjected to pathogens prevailing in their environment. Understanding the theory behind it would be a great step towards making the plants disease resistant. There are two ways in which plant defences are enhanced- first through antimicrobial compounds and secondly by structural interaction between the pathogen-associated molecular pattern (PAMP) and the pattern-recognition receptor (PRR). The first method invokes biosafety issues where as the second does not. Which is why it is an important sector to study when considering improvements to plant's defence mechanisms. To combat the pathogens, plants employ PRRs which detect PAMPs and impart pattern-triggered immunity (PTI) to the plant, which is their first line of defence. PTI is initiated when PRRs bind with PAMPs and activate the defence signals with the help of other co-receptors. In order to acquire a better understanding of the mechanism properly 3D structural modelling of the PAMPs and analysis of their structures is imperative. Recently many developments in the workings of PRRs have been seen but little work has been done for the discovery and characterization of PAMPs. This study describes the computational 3D modeling approach of a PAMP protein, CSP22 and its important characteristics. The primary structure, secondary structure and molecular dynamics analysis for 50 ns were conducted for CSP22 proteins using HHpred, I-TASSER and Quark. Of which I-TASSER gave the most stable structure thus concluded by using validation tools such as ERRAT and Ramachandra Plot, and analysing the RMSD values both before and after the MD simulation. The protein shows an increased stability profile for higher simulation times which may be an important property for PAMPs to activate the defense mechanism in plants. This structural study

has given us the base to choose genes to enhance defense mechanism without incorporating any antimicrobial protein(s) in transgenic plants.

Tanvir Jawad lives to innovate. A researcher at heart, Tanvir started his academic life training to be a pharmacist at the University of Asia Pacific. After completing his B. Pharm., in order to further pursue research opportunities, he moved to BRAC University and enrolled in the biotechnology program. His current field of study is bioinformatics and proteomics. His research interests cover Patter Triggered Immunity (PTI)—the first line of defence in organisms—observed using molecular dynamics simulations and structural modelling.

Tanvir was awarded the First Prize at the 9th National Annual Quality Convention on Education for a presentation on chronic depression. He also previously participated in and won prizes at multiple intra university poster presentation competitions.

Microsatellite Profiles Indicate Multiple Introductions of Invasive Alien Species *Lantana camara L.* in Bangladesh

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Purpose: *Lantana camara* L. is one of the worst invasive plant species worldwide. The present study attempted to elucidate the introduction patterns of the species in Bangladesh for enhanced understanding about their control and proper management.

Method: Plant leaf samples were collected from three different geographical regions under the three administrative divisions namely Dhaka, Sylhet and Chottogram of Bangladesh. A total of nine microsatellite markers were used to conduct genotypic profiling of the species. DNA band profiles obtained were used in genetic analyses including Nei's genetic distance and dendrogram using the computer software Popgen32 to examine genetic similarity among the populations, if any. GenAlEx6.5 software was used to perform Mantel test and Principal Coordinate Analysis (PCoA) in order to examine whether the isolation of the populations was due to geographic distance and to reveal whether any clustering existed among the samples, respectively.

Result: Data of the present study demonstrated a high genetic variability both within and among populations of *L. camara* L. Significant genetic distance and clear clusters appeared among the populations of the species. Population of *L. camara* L. selected from Dhaka was clearly separated from those of the other two geographic locations as revealed by both PCoA biplots and dendrogram analysis. Mantel test showed a significant positive correlation ($R2 = 0.5375$, $P = 0.010$) between genetic distance and geographical distance indicating isolation of the populations by geographic distance.

Conclusion: Results of the present study indicated multiple introductions of *L. camara* L. in Bangladesh followed by range of expansion, gene flow and eventually gradual homogenization of population.

Saila Kabir completed a B.S. from the Department of Botany, Faculty of Biological Science, University of Dhaka, during which she studied plant anatomy, physiology, taxonomy, plant breeding, mycology, microbiology, genetics, biotechnology, ecology, and other subjects related to plant science, earning a degree and the Dean's Award in 2016. She later completed an M.S. in Botany with a major in Plant Molecular Ecology. To conduct research for her M.S. thesis, she obtained the National Science and Technology Fellowship from the Ministry of Science and Technology, Government of the People's Republic of Bangladesh.

The title of her M.S. thesis was "Adaptation and genetic diversity of invasive alien species Lantana camara *L. in selected areas of Bangladesh." The main objectives of the study were to understand the morphological*

adaptation through leaf traits and also to investigate the genetic diversity of the populations of L. camara *L. from different parts of Bangladesh by using microsatellite markers. It has been found that among different morphological traits, leaf stomata might be more responsive in their adaptation. Multiple genetic clustering and significant positive correlations between geographic distance and genetic distance were also found. In the process of completed her thesis, she learned various ecological and genomic approaches. Her future plans include continuing her studies to gain more knowledge on genomic approaches that will be helpful in answering various ecological questions including origin, distribution, and dispersal of plant species, as well as solving various environmental problems.*

Mohammad Zabed Hossain, Ph.D. is a professor at the Department of Botany, University of Dhaka. His area of research and teaching is plant ecology. His current research topics include plant-microbe interactions, abiotic stresses (e.g. arsenic, salinity and drought) on plants, and adaptation mechanisms and distribution of plants. At present, he has supervised 12 students enrolled in Ph.D., M.Phil., and M.S. programs. He has a total of 38 papers published in different scientific journals, from publishers including Elsevier, Springer, Wiley, and SAGE. Over the years, he has received several research grants from various agencies such as the International Foundation for Science, the 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. He was awarded a prize in an essay writing competition in the category of university teachers and scientists, organized by SAIC (SAARC Agriculture Information Center) on the occasion of the SAARC Chartered Day and International Year of Soils in 2015.

*Dr. Hossain completed a B.Sc. (with honors) and M.Sc. from the Department of Botany, University of Dhaka in 1995 and 1997, respectively. He obtained 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." He then pursued post-doctoral study at the Department of Plant Biology and Forest Genetics, Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden between 2009-2011, after obtaining a fellowship from the Swedish Institute with the research topic: "Microbial ecology of the bacteria associated with the root nodules of blue lupin (*Lupinus angustifolius *L.) in Swedish soils".*

Agronomic Performance of GR2E BRRI dhan29 Golden Rice Across Multiple Environments and Growing Seasons in Bangladesh

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To confirm that BRRI dhan29 (BR29) GR2E rice was substantially equivalent agronomically to the recurrent parental line, BR29, grain yield and other phenotypic measurements were collected from confined field experiments at five locations during both the 2017 and 2018 boro rice growing seasons in Bangladesh. A total of 15 agronomic parameters were recorded and of these, three were significantly different between GR2E BR29 and non-transgenic control BR29. During the 2017 boro season flag leaf width, grain length, hundred grain weight were lower for GR2E BR29, while in the 2018 boro season days to flowering and maturity were higher, and hundred grain weight and grain length were lower for GR2E BR29. Across all locations and years, the GR2E entry was consistently about 1–2 days later to flowering and time to maturity compared to the BR29 check. While grain yield of GR2E was 13.3 percent higher than BRRI dhan29 in 2017, and approximately 3.8 percent lower than control BRRI dhan29 in 2018, in the combined analysis over seasons and locations yield differences were not statistically significant. The combined analysis of the agronomic and phenotypic data generated over locations and growing seasons for GR2E rice and its non-transgenic control support the conclusion that the genetic modification resulting in event GR2E did not have an unintended effect on plant growth habit and general morphology, vegetative vigour, or grain yield. From the data and observations, there were no indications that GR2E rice exhibited any fitness advantage that would make it more

invasive or persistent in the environment, or have altered susceptibility to pests or diseases, than conventional rice. GR2E introgression line IR112060 GR2E:2-7-63-2-96 can be used for the purposes of breeding advancement as well as variety release in future based on its consistent performance across locations and seasons.

Dr. Md. Abdul Kader is Senior Scientific Officer in the Plant Breeding Division of the Bangladesh Rice Research Institute (BRRI). He is Principal Investigator of the Golden Rice, Zinc Enriched Rice, Rainfed Lowland Rice, Drought Tolerant Rice, and Premium Quality Rice research programs. He was awarded the BRRI Gold Medal in 2015 for his outstanding contribution to rice research and development. He obtained a Ph.D. in Plant Breeding and Genetics from Bangladesh Agricultural University, Mymensingh and is a specialist in molecular and conventional breeding, hybrid rice breeding, GMO, and bio-fortification research. He leads field trials of transgenic and non-transgenic rice, marker assisted backcrossing in the molecular biology laboratoy, and monitors research activities in the transgenic screenhouse of BRRI.

He has attended various international and national on-the-job training events such as "Marker Assisted Introgression of Drought Grain Yield QTLs in BR11" and "Product Profiling for Rice Varieties in Bangladesh' at the International Rice Research Institute (IRRI), Philippines. As a renowned scientist, he has published 23 full-length research articles in national and international journals and 48 popular scientific articles, books, booklets, leaflets, folders, bulletins, etc. He was Project Manager for the BRRI part of the Integrated Agricultural Productivity Project (IAPP-BRRI) and is also leading the Rainfed Lowland Rice and Drought Tolerant Rice research component of the Transforming Rice Breeding Project.

Evaluation of Potentiality to Utilize *Porteresia coarctata* (Roxb.) for Developing Salt Tolerance in Cultivated Rice

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Coastal areas of Bangladesh cover about 20% of the country, which is about 30% of the net arable land area. Rice cultivation in the coastal belts of Bangladesh is becoming increasingly difficult due to an increase in soil salinity. Development of a salt tolerant variety has become a necessity for better production of rice. This study has been conducted to evaluate the potentiality of salt tolerant property of *Porteresia coarctata* (Roxb.) Tateoka, for its utilization in developing salt tolerance in cultivated rice variety. *Porteresia coarctata* is an endemic halophyte, natural tetraploid (2n = 4x = 48), wild relative of rice growing all over the coastal belts of Bangladesh. Morphological and anatomical features of *P. coarctata* has been found to be associated with the salt tolerant properties such as thicker waxy layer, sunken stomata and higher amount of mechanical tissues. To validate the morphological and anatomical features semi-quantitative RT PCR was performed with known Na^+/H^+ antiporters i.e. OsSOS1 and OsNHX1 primers to check their expression levels in *P. coarctata*. It was also observed that the expression level of both the genes was quite higher and more stable in *P. coarctata*. Therefore, the wild relative of rice *P. coarctata* could be considered as a better candidate in utilizing its properties in developing salt tolerance in cultivated rice through biotechnological approaches

Masnun Homaira Maisha is a research student at the Plant Breeding and Biotechnology Laboratory of the Department of Botany, University of Dhaka, Bangladesh. She is pursuing an M.S. degree and is involved in a research project for the improvement of rice, including the development of salt tolerance in cultivated rice. Currently, she is working on evaluating a wild relative of rice called Porteresia coarctata *for its potential utilization in developing salt tolerance. The title of her M.S. thesis is "Evaluation of*

Potentiality to Utilize Porteresia coarctata *(Roxb.) for Developing Salt Tolerance in Cultivated Rice through Wide Hybridization".*

She obtained her B.S. (with honors) from the University of Dhaka in 2017. She is interested in developing salt tolerance and increasing rice production through biotechnological approaches.

High Quality and Safe Lychee Fruit Production by the Application of Chitosan Biopolymer

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Indiscriminate use of pesticides to protect fruits are sometimes fatal to human health and environment. To protect the delicious lytchee fruits, producers in Bangladesh and India indiscriminately spray chemical pesticides to their orchards. The outbreak of sudden illness and deaths of children nearby the lytchee orchards in Bangladesh and India was found link to the exposure of toxic pesticides used in lychee orchards in the affected areas. Therefore, a novel approach is needed to safe lychee production. Chitosan is a biopolymer derived from the chitin of the exoskeleton of shrimp, crab and cell wall of fungi. Recent studies show that, application of commercially available chitosan increases the yield, diseases resistance and fruit quality. This study aimed to apply chitosan at varying doses (100, 250, 500 and 1000 ppm solution) to a lychee orchard in Meherpur district of Bangladesh. Our results indicate that chitosan at 500 pm protect lychee fruits from various pests equivalent to synthetic pesticides. Interestingly, application of chitosan at 500 ppm significantly increased contents of phenolics (334.41µg Gallic acid/g), flavonoids (880.73 µg Quercetin/g), vitamin C (178.03 µg/g) and total antioxidant activity (622.06 µg BHT/g) in lychee fruits compared to untreated control. Our findings suggest that the biopolymer chitosan could be used as a natural alternative to human health hazardous synthetic chemicals for sustainable and safe lychee production in South Asia.

Biosafety and Risk Assessment for Transgenic Potato

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Single-R-gene and 3-R-gene containing transgenic events of Diamant potato variety developed through *Agrobacterium* mediated gene delivery system are in advanced stage to release as GMO potato in Bangladesh. Food safety, unintentional transgene escape into wild varieties, effect on ecologically relevant organisms, allergenicity due to added foreign gene and short durability of transgene are the major concerns for transgenic potatoes among the peoples. But research revealed that GM potato is safe to human and the environment. It is non-flowering and doesn't have weedy behavior. No negative impact on human health and biodiversity has ever been documented for potatoes bred with these genes from wild relatives. Therefore, we anticipate no risks posed by these genetically engineered potatoes with these R genes.

Dr. Md. Mosharraf Hossain Molla was awarded a Ph.D. in Biotechnology (2010) and an 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 20 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 3-R-gene GM potato variety development for late blight resistane in Bangladesh, in collaboration with Michigan State University, USA. He has 25 research publications in renowned national and international journals. Dr. Molla has significant contributions to improving potato and banana through biotechnological approaches, which is widely utilized in biotech labs in Bangladesh, benefiting farmers.

Expression Analysis and Cloning of Ca^{2+}-ATPase and NHX1 Involved in Na^{+} Homeostasis from Wild Halophytic *Porteresia coarctata* (Uri-dhan).

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Purpose: *Porteresia coarctata,* locally called Uri-dhan is the only salt-loving distant relative of rice. This halophyte has distinct morphology and leaf architecture which enables the plant to exclude much of the salt, while also tolerating the rest. The tetraploid tolerates salt stress up to 40dS/m and therefore can be used as a resource for genes that function to alleviate salt stress by maintaining Na^{+} homeostasis.

Methods: From literature mining, likely transporters responsible for excreting salt in *P. coarctata* were identified and analyzed. Two transporters Ca^{2+}-ATPase and NHX1 were selected for Real-Time PCR to determine their expression pattern. Gateway technology pENTR™/D-TOPO® cloning kit was used for subsequent cloning by LR recombination in a Gateway destination vector. The PCR product with gene specific primers was directionally cloned into the TOPO vector to generate an Entry clone. The entry vector was transformed into chemically competent E.coli cells and colonies analyzed to select positive transformants followed by plasmid isolation.

Results: The expression of Ca^{2+}-ATPase gradually increased with increase of salt stress in both root and leaf. In leaf, the expression is very significantly upregulated at 400mM salt stress while in root this was at both 200mM and 400mM. In leaf and root, the expression of NHX1 gradually increased with increase of salt stress and was significantly upregulated at 400mM salt stress. So these were targeted for cloning and subsequent transformation into sensitive commercial rice. One positive clone was confirmed sent for sequencing for final confirmation.

Conclusion: *P. coarctata* can complete its life cycle and can set rice-like grain in sea water (40dS/m). Therefore the current work can successfully evaluate the potential of the genes of this halophytes to confer a high level of salt tolerance to commercial rice.

Fahmida Habib Nabila recently completed a B.Sc. in Biochemistry and Molecular Biology from the University of Dhaka. She is currently pursuing an M.Sc. in the same department and is working on her thesis project under the supervision of Dr. Zeba I. Seraj. In her thesis, she is observing expression analysis and performing cloning of several genes involved in Na^{+} homeostasis from halophytic Porteresia coarctata. *Ms. Nabila is well-versed in Linux,R and Python software. She is also working on some bioinformatics projects related to drug designing and epitope prediction. Ms. Nabila can speak Bengali, English, French, and Hindi fluently and has very good communication skills.*

GMOs: Solution or Problem?

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GMOs, often classified as genetically modified foods, have changed the way that people view their food. Although genetic modifications have occurred throughout history with selective breeding and growing methods, genetic engineering scientific advances have allowed this practice to advance to the genetic level. In the modern GMO, plants can be resistant to specific pesticides and herbicides while becoming

adaptive to changing environmental conditions. The primary advantage of genetically modified foods is that crop yields become more consistent and productive, allowing more people to be fed. As there are no unmixed blessings on earth, also GMOs are not without disadvantages. Changes to foods on a genetic level combine proteins that humans are not used to consuming. This may increase the chances of an allergic reaction occurring. Since 1999, the rates of food allergies in children has increased from 3.4% to 5.1%.The current food biotechnology debate illustrates the serious conflict between two groups: 1) Agri-biotech investors and their affiliated scientists who consider agricultural biotechnology as a solution to food shortage, the scarcity of environmental resources and weeds and pests infestations; and 2) independent scientists, environmentalists, farmers and consumers who warn that genetically modified food introduces new risks to food security, the environment and human health such as loss of biodiversity; the increase of antibiotic resistance, food allergies and other unintended effects. This poster reviews major viewpoints which are currently debated in the food biotechnology sector in the world, on benefits and risks of Biotech-crops for human health, ecosystems and biodiversity. In this context, although some regulations exist, there is a need for continuous vigilance for all countries involved in producing genetically engineered food to follow the international scientific biosafety testing guidelines containing reliable pre-release experiments and post-release track of transgenic plants to protect public health and avoid future environmental harm.

Zerin Nawar is a student at North South University, majoring in Biochemistry and Biotechnology and plans to pursue a master's degree overseas. Her interests include clinical genetics, cancer immunology, cell signaling, and GM foods. After finishing her studies and gaining some experience abroad, she would like to return to Bangladesh and help the people of her country lead a better life through biotechnological innovations. She wishes to make GM foods more widespread, safe to eat, nutritious, greener, and cheaper. She views the South Asia Biosafety Conference as the perfect opportunity to learn about biosafety concerns and solutions to date.

Her hobbies include music, travelling, reading books, and fashion. In her free time, she conducts private tutoring. Last year, she worked as a research assistant and did surveys for Bangladesh BRF on their Chikungunya research.

Establishment of Tissue Culture Protocol of Two Bangladeshi Sunflower Varieties (*Helianthus annuus L.*)

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Purpose: Sunflower (*Helianthus annuus* L.) is a commercially valuable, seed propagated crop with a high oil content, but poor germination and other factors pose problems in its cultivation. Biotechnological techniques, such as, tissue culture and gene transfer systems, have been used for improvement of most crops. This study aims to develop a tissue culture protocol using two Bangladeshi varieties: BARI Surjomukhi-2 and BRAC Hysun 33, to be used for transformation in future.

Method: In this study, effect of different auxins and cytokinins on shoot and root regeneration were observed. Later, acclimatisation of regenerated plantlets and reproducibility of the protocol was checked. Immature embryonic axes were inoculated on MS medium supplemented with four different combinations of the hormones BAP and NAA. Regenerated shoots were transferred to ½MS media containing the rooting hormone IBA. All plantlets that formed roots were transferred to soil for hardening.

Results and Discussion: BRAC Hysun 33 showed best shooting in media containing a combination of NAA and BAP, while BARI Surjomukhi-2 gave best shoot formation in MS media with only BAP. There were no difference in percentage rooting with respect to IBA concentration, but root formation was seen best with shoots that had been grown in the hormone treatment that gave best shooting

response. For both varieties, plants that formed longer roots and underwent shooting with both NAA and BAP survived better in hardening. BRAC Hysun 33 was the better variety, with most surviving plantlets and more numbers of flowers, buds and viable seeds.

Nadia Obaid is a recent graduate aspiring to be a scientist. Since an early age, she has been fascinated by biology and anything related to how living things function. Genetics has always held a special place in her heart. To turn her passion into a career, she enrolled in the biotechnology program at BRAC University in 2013. She decided to specialize in plant biotechnology and tissue culture, which she believes is the key to increasing food safety all over the world. She recently obtained a B.S. in Biotechnology and wrote her thesis on improving sunflower production via tissue culture. She hopes to start her M.S. sometime soon. Her interests are writing, painting, cooking, and solving any type of puzzle she can get her hands on.

Strategies to Sustain the Bt Brinjal Technology, Reduce Time for Biosafety Research and Accelerate Adoption

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After regulatory approval, four Bt brinjal varieties were distributed to 20 farmers who harvested Bt brinjal in 2014. Adoption in subsequent years has increased rapidly and in 2018 over 25,000 farmers used this technology! Reports indicate farmers have a 6-fold increase in net economic return and dramatically reduce insecticide spraying, which benefits farmers, consumers and the environment. Key strategic interventions to make the technology durable, reduce time for biosafety research to bring in new varieties and accelerate adoption of the technology are discussed. Refuge in Bag: To ensure Bt plants remain effective, product developers have been urging farmers to plant a refuge of non-Bt plants, however, compliance with refuge planting remains a challenge. Refuges are a key component to prevent insects from rapidly developing resistance to Bt plants. An alternative to farmers planting a separate refuge is the strategy called Refuge in Bag (RIB). In this strategy a small proportion of non-Bt seeds are mixed with Bt seeds in the same packet or bag, thereby requiring grower compliance. We are investigating this strategy for Bt brinjal. Event-based approval: The biosafety profile of a parent Bt plant (an 'event') does not change when it is utilized to develop new hybrids/parents. There is no scientific rationale for requiring a case by case regulation of approved events as the biosafety assessment of the event has been completed before the product was approved for environmental release and commercialization. Event-base approval is the global standard and adopting it in Banglades would enable its regulators to approve varieties suited for a region at a faster pace. Opening doors to private seed companies: Private seed companies can complement government efforts associated with seed production and distribution, currently being done only by BARI and BADC. If an opportunity is provided to a few select high quality, private seed companies, they will be able develop and distribute varieties that meet farmers' needs and complement the efforts of BARI and BADC.

Vijay Paranjape is an experienced seed industry professional with over 25 years of experience in diverse areas of agricultural biotechnology, both in academics and industry. Currently, he is Vice President & Practice Lead at Sathguru Management Consultants, Hyderabad, focusing on the agriculture input sector, intellectual property, technology management, and international development projects. He advises private and public sector clients on innovation advancement opportunities, R&D strategy, technology scouting & assessment, technology commercialization, IP strategy and valuation, and

IP policy and regulatory framework development. He is also involved in the implementation of international development projects – Feed The Future Biotechnology Program (funded by USAID) for Bt Eggplant in Bangladesh and Delivering Genetic Gains in Wheat (Bill & Melinda Gates Foundation), which is aimed at mitigating the threat of the wheat stem rust in South Asia. Vijay is Associate Director for the USAID-funded Bt Eggplant Project in Bangladesh, where he advises and oversees project activities being carried out in Bangladesh.

Development of Durable Blast Resistant Wheat by Genome Editing Using CRISPR-Cas9 System

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Wheat blast is a fearsome disease in 3 million hectares of wheat cultivated area in South America. The first epidemic of wheat blast in February 2016 in Bangladesh affected more than15,000 hectare of wheat in 8 districts with yield loss up to 100%. Using novel field pathogenomics and open data sharing approaches, 31 scientists led from 4 continents rapidly determined that the emergence of wheat blast was caused by a South American lineage of *Magnaporthe oryzae* (BMC Biol. 2016, 14:84). Novel approaches are needed to mitigate this threat of food security as resistance sources for breeding resistance and control by fungicides were found unreliable in ambient weather condition of this worrisome disease. The objective of this study is to develop durable blast resistant wheat varieties by genome editing of S-genes through CRISPR-Cas9 system. First generation of targeted edited wheat seedlings were obtained by editing 5 orthologous S-genes of rice associated with blast resistance. The project is collaborated by researchers in Bangladesh, UK and Canada. The CRISPR-Cas9 genome edited seedlings are now under progress of screening for blast resistance. It is expected that targeted mutagenesis of wheat using CRISPR-Cas9 would lead novel blast resistant wheat variety for Bangladesh and beyond that could easily be released to the farmers within few years.

Sanjoy Kumar Paul completed a B.Sc. (with honors) in Agriculture and an M.S. in Biotechnology from Bangladesh Agricultural University, Mymensingh. During his master's course, he worked as a research fellow at the Biotechnology Laboratory in the Bangladesh Institute of Nuclear Agriculture, Mymensingh. He has technical expertise in the Marker Assisted Selection (MAS) program. After completion of his master's, he joined the Palli Karma Sahayak Foundation, an institution for employment generation, in 2008 as Assistant Project Coordinator. In 2010, obtained the position of Senior Officer at Janata Bank Limited, a reputable bank in Bangladesh. In 2012, he was selected as a Bangladesh civil service (BCS) cadre Officer. He currently belongs to the BCS Agriculture cadre and works as anagriculture officer in Bhaluka Upazila, Mymensingh. He is also pursing a Ph.D. at the Department of Biotechnology in Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur and is continuing research in the field of biotechnology.

Molecular Cloning, Characterization, and Expression of a Growth Regulatory Gene from *Artemisia annua*

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Artemisia annua produces artemisinin (qinghaosu) which is effective against the malarial parasite Plasmodium falciparum and cancer cells in a similar manner. A cDNA coding growth regulatory gene has been cloned from *A. annua*. The gene had high homology with the steroid 23-alpha-hydroxylase produced-gene of *A. thaliana, Oryza sativa* and *Zinnia elegans*. The full-length cDNA was 1708 bp long, containing an open reading frame of 1443 bp that encodes 481 amino acids. The gene was transformed with the full-length cDNA driven by S35 promoter through *Agrobacterium*-mediated transformation.

On the other hand, RNAi technique was applied in an attempt to suppress the gene in the plant to identify function of the gene. The transgenic plants were checked by gene expression through PCR technique using plant genomic DNAs and expected PCR bands were obtained. The plants transformed with the full-length cDNA was normal but the plants transformed with RNAi showed dwarfism which was rescued by application of brassinolide, indicating these mutants were deficient in the synthesis of brassinosteroid. These results suggest the gene regulates brassinosteroid biosynthesis in plant.

Dr. Mahmuda Umme Rayhan a research associate under the Division of Biotechnology, Bangladesh Rice Research Institute, Bangladesh. Her research focuses on gene cloning, screening of transgenic plants, characterization of different genes, and development of markers. Dr. Mahmuda has six years of field experience as a project coordinator the Cereal Systems Initiative for South Asia (CSISA), IRRI and Harvest Plus Challenge Program, IRRI. She spent six months as graduate research assistant under the laboratory of Natural Product Chemistry, Seoul National University, Korea. Dr. Mahmuda obtained a B.Sc. (with honors) in Agriculture from Bangladesh Agricultural University and a Ph.D. in Crop Science and Biotechnology and an M.S. in Agricultural Biotechnology from Seoul National University, Korea.

Healthier Rice at IRRI - Last Mile Delivery of Golden Rice and New Nutritional Goals of Improved Zn and Fe

Russell Reinke

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Globally, two billion people suffer the effects of micronutrient malnutrition (or hidden hunger). This project aims to develop healthier rice varieties specifically designed to address key micronutrient deficiencies. These healthier rice varieties will provide a direct and daily source of good nutrition (vitamin A, iron, and zinc) into those who need it most, ensuring that all, including those most vulnerable (children, pregnant, and lactating women), will have the capacity to better withstand diseases, and the opportunity to survive and thrive. The project will see the deployment of Golden Rice (with β-carotene), regulatory approval for high-iron and zinc rice, and the development of lines in which β-carotene, high-iron and zinc are combined in modern high-yielding rice varieties.

Dr. Russell Reinke is a rice breeder with significant experience developing varieties for the Australian NSW Rice Industry in the Riverina region of south-west NSW and northern Victoria. He has a particular interest in developing highly productive varieties while matching grain quality to market requirements.

Russell spent three years as IRRI's representative in South Korea, conducting breeding related research focused on developing varieties suitable for temperate rice production environments, specifically to discover and characterize new genes and QTLs for agronomic traits, grain quality, disease and insect resistance, and cold tolerance in japonica *and* indica *backgrounds. During this time, he also coordinated the activities of the Temperate Rice Research Consortium.*

His current responsibilities are in rice biofortification, using conventional breeding for high zinc rice varieties, and developing and deploying transgenic varieties with pro-vitamin A (Golden Rice) and high iron and zinc.

Development of Greening (HLB) and Canker Resistant Citrus Cultivars through Genetic Engineering

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Citrus is a nutrient-rich delicious fruit and one of the most popular fruit in the world. Citrus processed juice products play an integral role in human nutritional requirements, is one of the most important fruit crops growing worldwide. In recent years citrus industries are under severe threat by the outbreak of endemic pathogens huanglongbing (HLB) and canker. Citrus HLB also known as citrus greening or yellow dragon disease is considered the most serious diseases of citrus. Until now no effective commercial cultivars have shown resistance to HLB. The progress of the cloning of candidate genes and transfer to them into the targeted tissues has opened new avenues for augmenting disease resistance in citrus. Therefore, identification and cloning of suitable candidate genes and optimization of efficient transformation protocols are needed for citrus improvement programs for both rootstock and scion development. Our main research objective was to produce genetically modified citrus cultivars those are resistant to endemic HLB and canker. In this study identification and cloning of diseases combating genes and efficiently producing resistant citrus cultivars using modern biotechnology are discussed.

Isolation and Construct Preparation of a Vacuolar H^+-ATPase from *Porteresia coarctata* for the Development of Salt Tolerant Rice

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Soil salinity is one of the major environmental stresses in Bangladesh that affect the rice plant growth adversely in varying degrees at all stages of its life cycle thus reduces the grain yield. So, development of transgenic rice varieties with high yield and resistance to salt stress will enable the cultivation of rice plants in the coastal saline areas of Bangladesh. In this study, a cDNA that encode for V-ATPase from *Porteresia coarctata* was isolated and cloned for construct preparation followed by transformation in rice to develop salt tolerant transgenic rice variety. This gene was reported to be involved in different salt tolerance mechanism in plant. First collected *Porteresia coarctata* plants were put into the Yoshida nutrient solution for one month followed by salinized with 100 mM NaCl for 7 days. Then RNA was extracted from leaf sample of salt treated plants using Qiagen kit. Primer for Vacuolar H^+ ATPase (PVA1) salt tolerant gene was designed from *Porteresia coarctata* sequence for isolating the gene. cDNA was synthesized from isolated RNA and then analyzed the sequence . Sequence of amplified PCR products was 99% identical with *Porteresia coarctata*. Then PCR product was clone into TOPO TA cloning vector. Positive clone were confirmed by colony PCR. BP reaction was carried out to enter the gene to entry vector. LR reaction will be carried out to enter expression vector. Transgenic lines will be developed using this construct that will contribute to stable food production for the growing population of the country.

Dr. Shahanaz Sultana has been working as Senior Scientist at the Biotechnology Division of the Bangladesh Rice Research Institute (BRRI) since 1998. Her research interests are focused on rice breeding using different biotechnological tools for the development of rice varieties with desired traits and genetic engineering for the development of stress tolerant rice varieties. She is involved in the development of high yielding modern rice varieties such as BRRI dhan86, BRRI dhan87, and BRRI dhan89. She has published 20 scientific articles in international and national journals. She has also participated in several training events and workshops held in the USA, Australia, the Philippines, Thailand, India, Singapore, and Malaysia.

Salinity Intrusion and Coastal Agriculture: Adaptation Strategies Using Salt-Tolerant Plant-Growth Promoting *Rhizobacteria* for Sustainable Food Security

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Purpose: The salinity level in the coastal ecosystem and agricultural lands is being increased gradually due to the climate change effect, and Bangladesh is no exception to suffer salinity intrusion that threats its food security. In order to bring the salinity-affected lands under agriculture, the application of salt-tolerant, plant growth-promoting rhizobacteria (PGPR) as biofertilizer could be a method of choice to improve plant's nutrient uptake ability, their growth promotion and tolerance to salinity. The current research reports the isolation of a salt-tolerant PGPR, identified as Bacillus aryabhattai MS3 from a coastal rice field of Bangladesh.

Method: To observe the potentiality of MS3 as biofertilizer, first some in vitro experiments were performed under salt stress (200mM salt) viz. nitrogen fixation, production of Indole-3- acetic acid, solubilization of phosphorus and siderophore production. Then in soil conditions (pot experiment), a salt-sensitive rice variety, *Oryza sativa* BR-28 was fertilized with MS3 in presence of two controls (*E. coli*-added, and without inoculants). A semi-quantitative transcriptomic analysis was performed on the cultivated rice plants to see particular salt responsive gene expressions.

Results: Under laboratory condition, the strain showed profound plant growth-promoting activities including nitrogen fixation (11%), production of IAA (25 to 30 µg/ml), phosphorus solubilization (2 to 4.5 µg/ µL) and siderophore production (10-20% unit) under 200 mM salinity. While in soil, rice growth under non-saline condition was comparable in between biofertilizer-added and control pots, the scenario was statistically significant when challenged with salts, 46% and 8% survival were recorded respectively. The PGPR supported the plants under salinity by increasing the availability of nutrients, accelerating IAA and chlorophyll production, enhancing proline accumulation, and decreasing malondialdehyde formation. The semi-quantitative reverse transcription-PCR demonstrated that the bacterium selectively up-regulated the plant expression of NHX1 gene under salinity, thereby conferring tolerance to salt stress.

Conclusion: Overall, the application of salt-tolerant biofertilizer could be a non-transgenic innovation to support plant growth ensuring food security for vulnerable for coastal lands under changing climate conditions.

Shahnaz Sultana received her B.Sc. and M.Sc. degrees in Microbiology from the University of Dhaka, Bangladesh. She is currently working as a lecturer in a well-known university in Dhaka. Prior to joining the university, she was appointed as a Research Assistant in a laboratory of the Microbiology Department, University of Dhaka.

Attending scientific conferences has been her hobby. She dreams of becoming a leading researcher and to be able to contribute meaningfully to society. Until now, she has been associated with research works to achieve sustainable agriculture in Bangladesh under changing climate conditions.

Shahnaz received the Best Student of the Year award for both her academic and cultural excellence in 2008 from Motijheel Government Girls High School. She also received the prestigious Dean's Award for the outstanding academic performance during her Bachelor of Science examinations from the biological sciences faculty of the University of Dhaka. She has also worked as an office secretary in the 10th Asian Federation of Biotechnology (AFOB) Regional Symposium (ARS) -2018 international conference that was held in Bangladesh.

Genomic Approaches for Determination of Genetic Identity and Origin of Wheat Blast

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Blast is a plant disease of 50 species of grasses including two major food crops, rice and wheat. It is caused by a filamentous and heterothallic ascomycete fungus, *M. oryzae* (anamorph *Pyricularia oryzae*). Wheat blast, caused by *M. oryzae* Triticum (MoT) pathotype, was first emerged in Parana state of Brazil in 1985 through host jump from a local grass and then spread to several South American countries. It is now a major constraint to wheat production in 3 million hectares' wheat growing areas in Brazil, Argentina, Bolivia and Paraguay. In appeared for the first time in Bangladesh in 2016 and devastated more than 15,000 hectares of wheat with yield losses up to 100%. In a rapid response to a new threat of food security of Bangladesh, we (31 researchers from 4 continents) applied field pathogenomics and open data sharing approaches and determined the genetic identity and origin of the disease within weeks. In phylogenomics analyses, the Bangladeshi MoT isolate was shown to be closely related to the highly aggressive wheat infecting South American MoT strain, suggesting that the wheat blast fungus was most likely introduced from South America (BMC Biol, 2016, 14:84). This year wheat blast was detected in the new areas of Bangladesh and also in West Bengal of India. Our findings revealed that field pathogenomics and open data sharing approaches are effective in rapid determination of any emerging fungal disease which is a threat to the food security of a country or a region.

Musrat Zahan Surovy obtained a B.S. (with honors) in Agriculture in 2011 and an M.S. in Biotechnology in 2014 from Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh. She is currently an assistant professor at the Department of Biotechnology of Bangabandhu Sheikh Mujibur Rahman Agricultural University, where she started working as a lecturer in 2016. She is life member of the Bangladesh Association for the Advancement of Science (BAAS) and a member of Krishibid Institution of Bangladesh and the American Society of Microbiology.

Molecular Characterization of Tomato Leaf Curl Virus Resistance in Wild Tomato (*Lycopersicon esculentum* Mill.) Germplasm of Bangladesh

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Tomato Leaf Curl Virus (ToLCV), transmitted by the whitefly (Bemisia tabaci) is regarded as the most important tomato infecting virus based on its prevalence, severity and damage. Seven Ty genes have been reported in some wild tomato conferring resistance to TYLCV or ToLCV including Ty-1, Ty-2, Ty-3, Ty-3a, Ty-4, Ty-5 and Ty-6. The molecular markers linked to these genes can be used efficiently in molecular plant breeding for gene pyramiding to produce ToLCV resistant lines. Thus, the current study was aimed to analyze the germplasm of different wild tomato accessions of Bangladesh and confirm the existence of the ToLCV resistant gene/s (Ty-1 to Ty-5) using molecular markers. About 124 lines belonging to 7 local accessions of the tomato germplasm collected from PGRC, BARI were raised in the open field of Botanical garden, University of Dhaka where whitefly populations prevailed allowing for ToLCV transmission. The phenotypic study scored the lines as resistant, mildly infected, moderately infected and as susceptible based on a modified arbitrary disease scale and their recorded symptoms. ToLCV infections in susceptible lines were confirmed through RCA analysis. The lines were screened for the presence of Ty genes in PCR analysis using gene specific primers. Most of the resistant lines (20) showed the presence of more than one Ty gene and one line scored as resistant, contained Ty-5 gene alone, indicating its high resistance properties. The presence of a disease enhancing beta satellite molecule in susceptible scored lines harboring all six Ty genes suggests that this may compromise Ty

gene mediated resistance. Out of the 11 resistant lines identified with the presence of all six Ty genes and negative Rolling Circle Amplification (RCA) results indicating no viral replication, five lines were subjected to sequence analysis of their Ty genes. These lines could be used as potential donor parents in breeding programs for ToLCV resistance.

Combinatory Effect of *HARDY* and *PDH45* Genes Enhance Salinity Tolerance in Rice

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Purpose: HARDY gene isolated from *Arabidopsis* and helicase gene from *Pisum sativum* (PDH45) are known to improve abiotic stress tolerance in different crop plants. In this study, farmer popular variety BRRI dhan27 (BR27) was transformed with HARDY gene under constitutive CaMV and stress inducible rd29a promoter by separate transformation events. Another line was generated which contains both CaMV_HARDY and CaMV_PDH45 genes. The aim of the study was to compare these three lines both at seedling stage and reproductive stage to observe the promoter effect as well as single and double gene effect in salt tolerance. Effect on downstream gene expression was also analyzed by real time PCR.

Methods: BR27 was transformed using *in planta* transformation method. Successful transformation events were confirmed by PCR and southern blot. Salt stress treatment was carried out at both Seedling and reproductive stage. Real-time PCR was carried out to analyze the downstream gene expression.

Result: At T2 generation at least two plants were selected from each of three constructs by PCR analysis and leave disk assay and advanced to T3 generation. 14 day old T3 seedlings from these lines were subjected to 120mM NaCl stress to evaluate their performance under salinity stress. The double gene transformed plants showed best improvement compared to BR27 background, followed by rd29a_HARDY and CaMV_HARDY. Moreover, after continuous salinity stress (8dm/s) at reproductive stress, the double genes containing transgenics showed significantly better yield and spikelet fertility compared to wild type and other transgenics. In downstream gene analysis, among 10 stress related genes, 8 genes were upregulated in all transgenic plants compared to wild types. After the 100mM NaCl stress, most of the genes were upregulated in rd29a_HARDY transgenic compared to normal and stressed transgenic plants.

Conclusions: Tissue culture independent *in planta* transformation method was used because high yielding varieties show poor regeneration in tissue culture dependent method. In this study double gene transformed plants showed significantly better salt tolerance than single gene in both seedling and reproductive stage. Between the two promoters, inducible rd29a was more efficient than CaMV.

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In vitro Regeneration and *Agrobacterium*-Mediated Genetic Transformation of Lentil Using an Antifungal Protein Gene

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Lentil (*Lens culinaris* Medik.) is one of the main sources of dietary protein in many parts of the world. However, lentil is usually characterized by low yield potential due to susceptibility to various diseases and pests. The investigation was aimed to develop an efficient *Agrobacterium*-mediated genetic transformation protocol to integrate fungal disease resistant gene in lentil. Two microsperma varieties of lentil cultivated in Bangladesh, namely, BARI masur-3 (BM-3) and BARI masur-6 (BM-6) were used for *in vitro* regeneration and genetic transformation using *Agrobacterium* strain LBA4404 containing two different gene constructs, (I) pBI121GUS containing a scorable reporter gene GUS (β-glucuronidase) as well as a selectable marker gene *nptII* and (II) pCAMBIA2300enh35SAFP containing *nptII* as well as an antifungal protein gene (AFP). Explants of cotyledonary node, cotyledon-attached decapitated embryo (CADE) and cotyledon-attached embryo without shoot tip (CAES) were exploited to develop a transformation compatible *in vitro* regeneration system. CAES explants were mostly used as profuse rooting was achieved although CADE produced highest percentages of multiple shoots through direct organogenesis using MSB5 medium supplemented with 1.0 mg/l zeatin and 0.1 mg/l NAA. Induction of *in vitro* flowers and seeds were tried to avoid the root formation stage where regenerated shoots failed to produce effective roots. For *Agrobacterium*-mediated genetic transformation, an optical density of 0.8 (at 600 nm) with 30 minutes of incubation and 3 days of co-cultivation period was found to be optimum for transformation confirmed by histochemical GUS assay using gene construct I. Transformation using gene construct II, above mentioned parameters were applied to obtain adequate transformation efficiency. Transformed shoots were selected using 200 mg/l kanamycin as all control shoots died at this concentration of kanamycin. Molecular analysis of the putatively selected transformed shoots was carried out to study the integration of desired gene within the lentil genome.

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Transgenic in Legume Crops: Biotic and Abiotic Stress Resistant *Vigna* spp.

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Vigna is a genus of family Leguminoceae (Fabaceae) and subgenus Papilioniceae consisting of 8 subgenera and approximately 150 species. Major crops of Vigna are *Vigna radiata* (mungbean) and *V. mungo* (urdbean) belong to the subgenus Ceratotropis with 3 more species *V. aconitifolia* (mothbean), *V. angularis* (azuki bean) and *V. umbellata* (rice bean). All contribute as a major source of protein in vegetarian diet, associate nitrogen fixing bacteria and are a rich source of diversity in India and other countries of Asia and Africa. Vigna crops are grown diverse agro-ecological regions with varying degree of biotic and abiotic constraints. There is a requirement for cultivars resistant to biotic and abiotic stresses and nutritionally rich.

Biotic stress affected the overall profitability of a Vigna crop, reducing both yield and seed quality. On the other hand abiotic stress such as pre harvest sprouting in mungbean is the major reason of yield loss. Strategies to improve resistance by conventional breeding have been narrowed down due

to the lack of desirable and satisfactory levels of genetic variability in germplasms. Conventional crop improvement methods complimented with modern biotechnology tools and genetic engineering are expected to play important role in the generation of high yielding, stress resistant varieties of Vigna crops. Conclusively several studies have attempted for novel gene transfer in Vigna crops with different marker genes and stress resistant genes but the protocol for stable transformation along with the regeneration into a fertile plant with root shoot and leaves is still lacking.Thus a reproducible, fast and efficient regeneration protocol compatible to transformation need to be developed to raise abiotic and biotic resistant.

Design of Biocontainment Facilities for Small and Large Animal Biomedical Research

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An overview of various biocontainment facility guidelines, design requirements, various services schematics shall be discussed in brief for establishing ABSL2, ABSL3, ABSL3 Ag facilities.

Ravi Kumar Tummalachalra is a mechanical engineer and has been working on design and construction activities to establish cleanrooms, bio-containments, and animal facilities for the last 19 years. He is the Founder Engineer and CEO of Cleanrooms Containments. The focus of his work is on the life sciences and particularly the biotech and healthcare industry. He has worked as a consultant for biotech industries and Indian government projects and is a member of the American Biological Safety Association, European Biological Safety Association, International Veterinary Biosafety Working group, American Society for Heating, Refrigeration & Air-Conditioning Engineers, Society for Biosafety of India, Contamination Control Society of India, and Biotech Consortium India Limited.

Presentation Development of Abiotic Stress Tolerant Eggplant (*Solanum melongena* L.) Breeding Lines through *Agrobacterium*-Mediated Genetic Transformation

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This investigation was carried out for the development of an efficient *Agrobacterium*-mediated genetic transformation protocol to integrate abiotic stress (drought and salinity) tolerant gene in eggplant (*Solanum melongen*a L.). Two varieties of local popular eggplant, namely, BARI Begun-4 (Kazla) and BARI Begun-5 (Nayantara) were used for this purpose. Cotyledonary leaves explants from these two varieties of eggplant were used to establish an *in vitro* plant regeneration system compatible to *Agrobacterium*-mediated genetic transformation. MS medium supplemented with different concentrations and combinations of BAP and Kn were used for in vitro shoot development from cotyledonary leaves explants. The best response towards multiple shoot regeneration was found on MS medium supplemented with 2.0 mg/l BAP and 0.5 mg/l Kn. Regenerated shoots of the two eggplant varieties were cultured on full strength of MS medium for root induction. Transformation experiments were performed using *Agrobacterium* strain LBA4404 containing pCAMBIA1301-PDH45 conferring hygromycin resistance *hptII* gene and salinity tolerant PDH45 gene. In case of *Agrobacterium*-mediated genetic transformation, an optical density (O.D.) of 0.3-0.5 (at 600 nm) with 30 minutes of incubation and 48 hours of co-cultivation period was found to be optimum for transformation. Transformed shoots were selected using 20 mg/l hygromycin. Genomic DNA was isolated from transformed shoots and stable integration of PDH45 genes was confirmed by polymerase chain reaction (PCR) analysis.

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