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South Asia Biosafety Program

BANGLADESH

Seminar on Novel Plant Breeding Tools and Omics Platforms for Advancing Crop Improvement

Abida Anjum, MS Research Student, Department of Botany, University of Dhaka

Audience, including students and faculty members, at the seminar on Novel Plant Breeding Tools and Omics Platforms for Advancing Crop Improvement at the Department of Botany, University of Dhaka (21 March 2024).

The Plant Breeding and Biotechnology Laboratory of the Department of Botany, University of Dhaka organized a seminar on "Novel Plant Breeding Tools and Omics Platforms for Advancing Crop Improvement" on 21 March 2024, at the Central Gallery of the Department of Botany.

The speakers for this seminar included: (1) Hasan Pervej Ahmed, International Program Development Manager, Global Institute for Food Security (GIFS), University of Saskatchewan, Canada, (2) Dr. Andrew Sharpe, Bangabandhu Research Chair in Food Security at GIFS, University of Saskatchewan, Canada, (3) and Dr. Pankaj Bhowmik, Senior Research Officer and Scientific Support Lead, Sustainable Protein Production (SPP) Program, National Research Council, Canada.

Hasan Pervej Ahmed presented the various programs related to GIFS at the University of Saskatchewan. He elaborated on the activities related to the scientific collaboration between GIFS and Bangladesh, specifically the current and future programs between the Bangladesh Agricultural Research Council (BARC) and GIFS. He also highlighted the significance of the partnership to promote sustainable food production in Bangladesh by advancing knowledge transfer and technology development for agricultural research in Bangladesh. Dr. Andrew Sharpe discussed ongoing activities through the GIFS-Bangladesh partnership program and explained the advantages of this partnership program in transforming the agricultural scenario of Bangladesh using the strength of GIFS through knowledge transfer and technology development for agricultural research in Bangladesh.

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Dr. Sharpe has been rigorously working on establishing partnership programs for agricultural advancement and sustainability. In addition, he also delivered a talk highlighting his vast experience in genomic research, particularly on crops like canola and wheat. Dr. Pankaj Bhowmik presented his research findings on various crop plants in establishing cell and tissue culture protocols, as well as plant genetic transformation studies. He discussed his research activities on genome editing of different crop plants. He also shared his knowledge and research experiences with the audience and the challenges in overcoming various constraints during his research work.

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Speakers with faculty members from the Department of Botany, University of Dhaka, at the seminar (21 March 2024).

Students and faculty members of the Department of Botany participated in this seminar. During the seminar, the audience interacted with the speakers on various topics. Prof. Dr. Rakha Hari Sarker, Professor, Department of Botany, moderated the seminar and introduced the speakers at the beginning of the program. During his introductory remarks, Prof. Sarker explained the importance of modern breeding approaches in developing new crop varieties for sustainable food production and food security in Bangladesh. Prof. Dr. Mihir Lal Saha, Chairman of the Department of Botany, offered the vote of thanks. Dr. Tahmina Islam, Associate Professor of Botany, coordinated all arrangements for this seminar at the University of Dhaka.

INDIA

Inter-Country Knowledge Sharing Webinar on the Biosafety-Related Target 17 of the Global Biodiversity Framework

Dr. Vibha Ahuja, Chief General Manager, Biotech Consortium India Limited

The Global Biodiversity Framework (GBF), adopted in December 2022 under the Convention on Biological Diversity (CBD), has 23 global targets to be achieved by 2030 by countries. Target 17 relates to biosafety measures for Living Modified Organisms (LMOs) resulting from modern biotechnology. Many countries are currently updating their National Biodiversity Targets (NBTs) and National Biodiversity Strategy and Action Plans (NBSAPs) to fulfill their obligations under the framework.

In this context, an "Inter-Country Knowledge Sharing Webinar on the Biosafety-Related Target 17 of the GBF" was organized on 22 March 2024. An initiative under the GEF multi-country biosafety capacity building project (ID 10991) on promoting the safe application of biotechnology through multi-country cooperation on the implementation of National Biosafety Frameworks in Asia, the seminar was organized jointly by the Korea Institute for Promoting Asia Biosafety Cooperation (KIPABiC) and Biotech Consortium India Limited (BCIL), with support from the United Nations Environment Programme (UNEP), Korea Biosafety Clearing House (KBCH), and the National Project Coordinators of Bangladesh, India, Mongolia, and the Philippines.

Experts from Bangladesh, India, Mongolia, the Philippines, and the Republic of Korea shared their experiences and strategies for mainstreaming biosafety measures.

The webinar aimed to facilitate discussions and knowledge sharing among stakeholders on biosafety-related Target 17 of the GBF and its mainstreaming in NBSAPs. The webinar received 640 registrations from participants representing 42 countries across various sectors, such as government, international organizations, research, academia, private sector, NGOs, and civil society, all involved in biodiversity conservation, biotechnology, and biosafety.

Structured into two sessions, the webinar covered an overview of the GBF, followed by discussions on mainstreaming Target 17 into NBSAPs. It included a mix of presentations, panel discussions, and Q&A sessions to engage with the audience. Experts from organizations like the UNEP, Secretariat of the CBD, BCIL, and Regional Agricultural and Environmental Innovations Africa provided insights on the Kunming-Montreal GBF, Implementation Plan, capacity-building initiatives for the Cartagena Protocol on Biosafety, and biosafety measures. Furthermore, experts from Bangladesh, India, Mongolia, the Philippines, and the Republic of Korea shared their experiences and strategies for mainstreaming biosafety measures into NBSAPs.

The webinar received positive feedback from participants, and many expressed their appreciation for the informative content, well-delivered presentations, and the opportunity for interaction through Q&A Sessions. The audience expressed interest in future offline workshops for beginners who could benefit from technical material provided in advance. Other suggestions included engaging grassroots-level workers and expanding partnerships with more countries, particularly in regions like West Africa.

LINKS

Project Information
thegef.org/projects-operations/projects/10991

Concept Note, Agenda, and Presentations
drive.google.com/drive/folders/15CDVWUzDCfwVZINsogTlY7hby0rsDdTs?usp=sharing

Webinar Recording:
youtube.com/watch?v=6CbOqo4PpXw

BANGLADESH

Biosafety Resource Book Series: Frequently Asked Questions – Genome Edited Plants

Dr. Aparna Islam, Professor, Brac University and AFSI Fellow

On 4 April 2024, the third book in the *Biosafety Resource Book Series* entitled *Frequently Asked Questions: Genome Edited Plants* was published by the South Asia Biosafety Program (SABP). This book aims to familiarize readers with the science of genome editing, its prospects, and applications, with special emphasis on genome edited plants. It also provides a brief overview of global policies on the research translation pathways to take the research products from the laboratory to consumers.

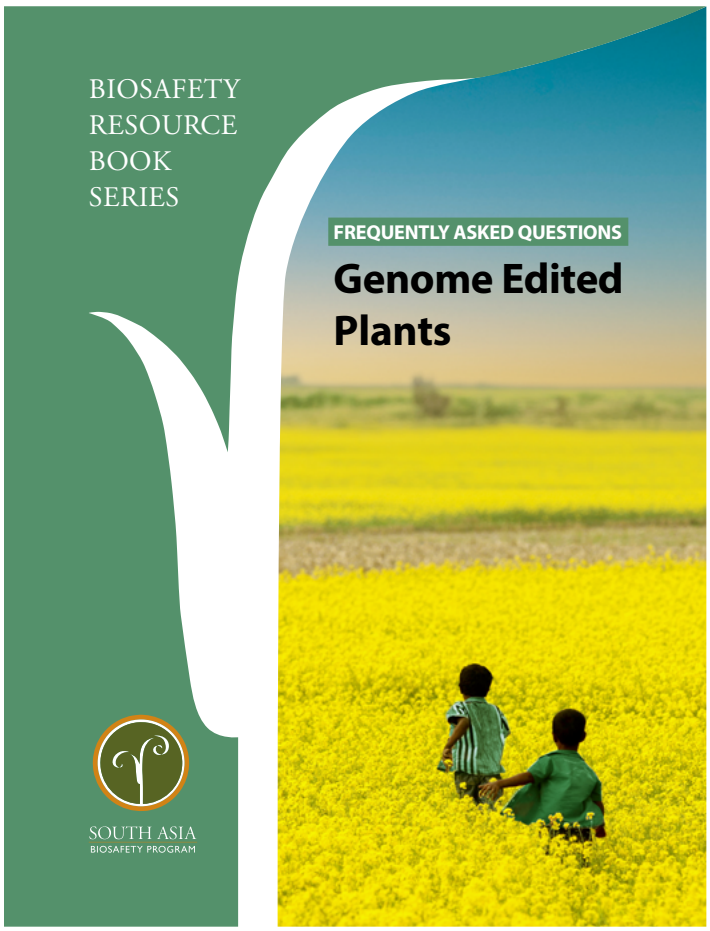
In 2020, Dr. Emmanuelle Charpentier and Dr. Jennifer Doudna received the Nobel Prize for Chemistry for their work on CRISPR-Cas, a genome editing technique. This recognition came after observing the ease of application of this technique and this tool's accuracy in bringing out the desired genetic changes in an organism.

Genome editing, or gene editing, refers to a group of techniques or tools that can edit the genome of an organism to incorporate desired characteristics to benefit humans and the environment. These tools include Zinc-Finger Nucleases (ZFNs), Transcription Activator-like Effector Nucleases (TALENs), CRISPR-Cas, etc. Among these, the CRISPR-Cas system provides opportunities to edit the genome in a more precise and rapid manner to improve crops, animals, and microbes. The book contains information about these basic concepts at the beginning.

We know that crop improvement methodologies range from conventional breeding to mutation, genome editing, and genetic engineering. The book contains information about these methodologies to give the audience a clear idea about them. With a focus on genome editing, especially on the CRISPR-Cas system, this publication discusses this technique's importance, prospects, current research, and commercialized products that are already available in the market.

Many countries have made policies to enable the timely introduction of products of genome editing for commercial use. Consequently, many such products, including high GABA tomato, high oleic soybean, and milder flavored mustard, are on the market in countries like Japan and the USA. The book contains information about genome edited products, as well as the science used to create specific traits.

The adoption of genome editing continues to have a positive impact on agricultural sustainability and food and nutritional security. Looking at the potential of this suite of technologies and the opportunities to improve crops, plant scientists in Bangladesh are using them for their research. To support their efforts, the Ministry of Agriculture (MoA), Government of Bangladesh approved the "Standard Operating Procedures for Research and Release of Genome Edited Plants of Categories of SDN-1 and SDN-2 in Bangladesh" in December 2023, so genome edited plants can successfully move closer to consumers. In the final segment, the book briefly discusses this SOP.



Islam, A. and Ahuja, V. (2024) Frequently Asked Questions: Genome Edited Plants, South Asia Biosafety Program (SABP), Agriculture & Food Systems Institute (AFSI), Washington, DC. (ISBN: 978-984-35-6427-6)

LINKS

FAQ on Genome Edited Plants
bangladeshbiosafety.org/biosafety-book/book3/

Biosafety Resource Book Series
bangladeshbiosafety.org/biosafety-books/

2023 Standard Operating Procedures
bangladeshbiosafety.org/bangladesh-doc/sop-genome-edited-plants-bangladesh-2023/

BANGLADESH

Site Directed Nucleases in Gene Editing: Types and Methods

Ifthikhar Zaman, Department of Mathematics and Natural Sciences, Brac University

STUDENT SHOWCASE

To encourage written discourse on topics related to biosafety and biotechnology among the younger generation, the *SABP Newsletter* dedicates space in select issues to spotlight pieces written by students residing in South Asia. Since articles with the "Student Showcase" tag are meant to reflect the actual views and capabilities of the author(s), they are not revised for content and only lightly edited to conform with the newsletter's style guide.

In modern biotechnology, new techniques are evolving every day to improve the genetic makeup of an organism for the betterment of humankind. To do so, a group of tools has been used to make changes within the genome or gene of an organism through either a small deletion, a substitution, or by adding a number of nucleotides or a gene, using variants of site-directed nucleases (SDNs). SDNs are DNA-cutting enzymes that are directed to cut a specific site of a genome/gene[1]. In

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Laboratory worker evaluating the efficiency and precision of gene editing tools under different experimental conditions. © Luchschen | Dreamstime.com

this article, different classes of SDNs, along with different SDN systems, are discussed.

Before going into the details of SDNs, let's talk about gene editing and how it differs from genetic modification. Gene editing represents a group of modern biotechnological tools that allow genetic material (usually a few base pairs) to be added, removed, or altered at particular locations in the genome, conferring gene silencing, gene knock-out, or a change in gene activity. Whereas genetic modification refers to adding a gene from any source into the organism of interest, different classes of SDN enzymes are used to make edits to a genome. There are three SDN classes: (1) SDN-1, where precise single point InDel mutations are made, (2) SDN-2, where several nucleotides are inserted or edited using a small template, and (3) SDN-3, where longer strands (whole gene or regulatory sequence) is inserted using a template. SDN-3 is similar to genetic modification.[1]

Until now, several SDN systems have been adapted for gene editing or modification, from older systems, such as Zinc-Finger Nucleases (ZFNs) and Transcription Activator-like Effector Nucleases (TALENs), to the modern and most precise CRISPR/Cas system. All these systems have the same basic function–after entering the cell, they induce double-stranded breaks (DSB). Then, the breaks can be repaired by either Non-Homologous End Joining (NHEJ) or Homology Directed Repair (HDR). HDR requires a template, but NHEJ does not. As a result, in the case of NHEJ, InDels can happen randomly (SDN-1), and in the case of HDR, a template is used for precise editing and even gene insertions (SDN-2, 3).[1]

Genome editing is now at the forefront of science and gaining popularity worldwide. Genome editing offers precise modifications to the genome, facilitating faster development of desired traits in crops.

ZFNs are artificial restriction enzymes first used in genome editing in 1994.[2] They are generated by fusing a zinc-finger DNA-binding domain, which can be engineered to target specific DNA sequences, to a DNA-cleavage domain. In this system, the DNA-binding domains of each ZFN typically contain between three and six individual zinc finger repeats and can each recognize between 9 and 18 bps. On the other hand, the DNA-cleavage domain uses a non-specific cleavage domain from the type II restriction endonuclease FokI, which must dimerize in order to cleave DNA. As a result, a pair of ZFNs are required to target non-palindromic DNA sites. To let the two cleavage domains dimerize and cleave DNA, the two individual ZFNs bind to opposite strands of DNA with their C-termini, which uses a linker sequence. After the break, if no template is provided, NHEJ (SDN-1) works, and InDel mutations occur.

On the other hand, in many studies, HDR (SDN-2) was done. This method can be used to alter the genomes of many organisms, including plants and animals. For example, it can be used to disable dominant mutations in heterozygous individuals (SDN-1,2), rewrite the sequence of an allele by invoking the homologous recombination (HR) machinery to repair a double-stranded break using a supplied DNA fragment as a template (SDN-2), and in gene therapy (SDN-1,2,3). However, off-target activity, low efficiency, immunogenicity, high cost, and high difficulty make it harder to work with.[3]

Next, TALENs, which are more precise and efficient than ZFNs, were discovered in 2009 and used in gene editing in 2010.[4] They are made by fusing a TAL effector DNA-binding domain to a DNA cleavage domain. The DNA-binding domain contains a repeated highly conserved 33–34 amino acid sequence with divergent 12th and 13th amino acids known as Repeat Variable Diresidue (RVD). RVDs are highly variable and effectively recognize specific nucleotide sequences. The DNA cleavage domain, which has type II restriction endonuclease FokI like ZFNs, works to cleave the DNA recognized by this domain. After cleavage, either NHEJ or HDR can happen, depending on the availability of a template. There are many applications of TALENs, for example, from efficiently modifying plant genomes and developing tools for the production of biofuels to generating stably modified human embryonic stem cells, IPSC clones, human erythroid cell lines, knockout animal models, etc. TALENs are easier and less costly to work with than ZFNs. Moreover, TALENs recognize single nucleotides, whereas ZFNs recognize three nucleotides. As a result, it is far more straightforward to engineer interactions between TALEN DNA binding domains and their target nucleotides than ZFNs[5].

Lastly, the most precise SDN system discovered to date and used in gene editing is the CRISPR/Cas system. Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) are repeated DNA sequences used by bacteria along with Cas proteins as a defense mechanism. CRISPR was first discovered in 1987 and the CRISPR/Cas technology was patented by Nobel laureates Jennifer Doudna and Emmanuelle Charpentier in 2012[4]. In this system, a guide RNA (gRNA) helps direct a Cas protein to bind with a target DNA at the Protospacer Adjacent Motif (PAM) site (sequence recognition), and the Cas protein then induces double-stranded breaks with blunt ends (nucleotide cleavage). Then, depending on the availability of a template, breaks are repaired by NHEJ or HDR. This system contains several components, which are CRISPR RNA (crRNA) containing the gRNA that locates the correct segment of host DNA along with a region that binds to tracrRNA to form an active complex, Cas enzymes that can cleave DNA, and lastly, if needed, a repair template that allows insertion of a specific DNA sequence into the host segment broken by Cas enzymes. Various types of Cas enzymes with different characteristics

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have been discovered, and among them, the Cas9 enzyme is mostly used. Moreover, other enzymes like Cas12 are gaining popularity for plant genome editing, Cas13 is used for RNA editing, and Cas14 is used to cut ssDNA without requiring a PAM site for recognition. Though sometimes this system can have off-target activity, it is far less than the other two systems. As a result, this technology profoundly impacts biotechnology and medicine, facilitating precise, cost-effective, and straightforward genome editing in living organisms. It has applications in agriculture, pharmaceuticals, and cancer treatment.[6]

Genome editing is now at the forefront of science and gaining popularity worldwide. Genome editing offers precise modifications to the genome, facilitating faster development of desired traits in crops and animals, leading to more sustainable development. As gene edited products do not contain any foreign genes, many countries consider these products to be similar to mutation breeding products or organisms despite using recombinant technology during the development process. This is because minor changes are made to the genome, which are similar to mutation breeding. Thus, the varietal development pathway is equivalent to the conventional mutation breeding process. This approach harnesses the benefit of genome edited products to tackle challenges in agriculture and medicine. In light of this, many countries have commercialized genome edited products like fish, vegetables, and other organisms. Research in medical science is also progressing rapidly, giving genome editing technology a crucial role in advancing science and providing solutions to problems that we currently face.

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RESOURCE SPOTLIGHT

Organisation for Economic Cooperation and Development's (OECD) Resources on Biosafety and Novel Food-Feed Safety

Dr. Bhavneet Bajaj, Manager–Scientific Programs, Agriculture and Food Systems Institute

The OECD is an international organization comprising member countries that work with each other on policy issues through collaboration, with representatives from Key Partners, other organizations, and civil society. The work of the OECD is done through convening experts, committees, and working groups (also known as Working Parties - WPs) to share policy experiences, innovate, and review policy implementation and impact.

Two such Working Parties implement the work related to biotechnology. Their goal is to increase the efficiency of the risk/safety assessment process, reduce duplication of effort, and promote harmonized country approaches to reduce costs and the potential for non-tariff barriers to trade. The Working Party on the Harmonisation of Regulatory Oversight in Biotechnology addresses aspects of the environmental risk/safety assessment of genetically engineered (GE) organisms. The Working Party for the Safety of Novel Foods and Feeds addresses the safety assessment of foods and feeds derived from GE organisms.

OECD CONSENSUS DOCUMENTS

The main outputs are the "OECD Consensus Documents," which constitute practical tools for safety assessors, national regulators, applicants for commercial uses of transgenic organisms, and the wider scientific community. These documents compile key science-based information on major crops, trees, animals, and micro-organisms, as well as on introduced traits, which national risk/safety assessors believe to be relevant when comparing new GE products with conventional ones. (**oecd.org/science/biotrack/**)

The documents relating to environmental safety focus mainly on the biology of plants (species and taxonomic group, reproductive biology, potential for out-crossing with related species, centers of diversity, agronomic practices, major uses, and other relevant elements). Two biology documents on animals have also been prepared. (**oecd.org/chemicalsafety/biotrack/consensus-documents-work-harmonisation-regulatory-oversight-biotechnology-by-number.htm**)

The documents for food and feed safety contain information on composition, including the key nutrients, toxicants, anti-nutrients, allergens, and other metabolites where relevant. These publications on crop composition provide solid information and are used by authorities worldwide as key references in the comparative approach conducted as part of their novel food and feed safety assessments. (**oecd.org/chemicalsafety/biotrack/consensus-documents-work-on-safety-of-novel-food-and-feeds-by-number.htm**)

BIOTRACK PRODUCT DATABASE

The BioTrack Product Database is a public database of GE products that is updated voluntarily by officials of OECD member and non-member countries. The database aims to allow regulatory officials to easily share basic information on products of modern biotechnology that have been approved for commercial application in terms of food, feed, or environmental safety. The biotech products are tagged with their "Unique Identifiers" (coding system developed by OECD), thus facilitating the exchange of information between international databases. (**biotrackproductdatabase.oecd.org**)

BIOTECHNOLOGY UPDATE NEWSLETTER

Another publication from the OECD is the *Internal Co-ordination Group for Biotechnology (ICGB) Biotechnology Update Newsletter*, which provides up-to-date information on activities related to biotechnology or the life sciences more generally. It is usually issued twice a year. (Latest issue from March 2024: **oecd.org/chemicalsafety/biotrack/biotech-update-issue-44-march-2024.pdf**)

CALENDAR OF EVENTS

EVENT	ORGANIZED BY	DATE	WEBSITE
INDIA			
Conference on Innovate, Protect, Prosper: The Role of Intellectual Property in Elevating India's Seed Sector	Federation of Seed Industry of India	3 May 2024 New Delhi	https://fsii.in/
International Seminar on Spices KAU 2024 (ISSK 2024)	Kerala Agricultural University	5-7 June 2024 Thiruvananthapuram	http://issk2024.com https://www.kau.in
ISSCT 13th Germplasm & Breeding/ 10th Molecular Biology Workshop	ICAR-Sugarcane Breeding Institute and Society for Sugarcane Research and Development	8-12 July 2024 Coimbatore	https://sugarcane.icar.gov.in/index.php/issctworkshop2024/
Global Conference on Nano Connect 2024	Centre for Agricultural Nanotechnology, Directorate of Natural Resource Management, Tamil Nadu Agricultural University	20-24 August 2024 Coimbatore	https://tnau.ac.in/
INTERNATIONAL			
Nineteenth Meeting of the Compliance Committee under the Cartagena Protocol on Biosafety	CBD Secretariat	30 April-2 May 2024 Montreal, Canada	https://bch.cbd.int/protocol#tab=2
Information Workshop on the Work of the *ad hoc* Technical Expert Groups on Indicators, Synthetic Biology, and Risk Assessment	CBD Secretariat	11 May 2024 Nairobi, Kenya	https://bch.cbd.int/protocol#tab=2
Twenty-Sixth Meeting of the Subsidiary Body on Scientific, Technical and Technological Advice	CBD Secretariat	13-18 May 2024 Nairobi, Kenya	https://bch.cbd.int/protocol#tab=2
Eleventh Meeting of the Conference of the Parties serving as the meeting of the Parties to the Cartagena Protocol on Biosafety	CBD Secretariat	21 October-1 November 2024 Cali, Colombia	https://bch.cbd.int/protocol#tab=2
3rd International Wheat Congress (IWC)	Murdoch University	22-27 September 2024 Perth, Australia	https://www.iwc2024.com/

SOUTH ASIA BIOSAFETY PROGRAM

The South Asia Biosafety Program (SABP) is an international development program implemented in India and Bangladesh with support from the United States Agency for International Development (USAID). SABP aims to work with national governmental agencies and other public sector partners to facilitate the implementation of transparent, efficient, and responsive regulatory frameworks for products of modern biotechnology that meet national goals as regards the safety of novel foods and feeds, and environmental protection.

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CONTACT SABP

BANGLADESH
Dil Afroj Moni
Program Officer
South Asia Biosafety Program
c/o CIMMYT
House-10/B, Road-53, Gulshan-2
Dhaka-1212, Bangladesh
Email: dilafroj@southasiabiosafety.org

UNITED STATES
Layla Tarar
Manager, Communications & Digital Learning
Agriculture & Food Systems Institute
1900 L Street NW, Suite 302
Washington, DC 20036, USA
Twitter: @AgFoodSystems
Email: ltarar@foodsystems.org

INDIA
Vibha Ahuja, Ph.D.
Chief General Manager
Biotech Consortium India Limited
Anuvrat Bhawan, 5th Floor
210, Deendayal Upadhyaya Marg
New Delhi 110 002, India
Email: vibhaahuja@biotech.co.in

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