



# Report on INDIAN SEED CONGRESS 2025

New Delhi, Feb -23-25, 2025





# About National Seed Association of India

National Seed Association of India (NSAI) is the apex body representing the Indian seed industry, playing a leadership role by engaging with the Central and State Governments and working towards policy advocacy for an enabling and favourable policy environment for the growth of the seed industry in the country.

The vision of NSAI is to create a dynamic, innovative, internationally competitive, research-based industry producing high-performance, high-quality seeds and planting materials which benefit farmers and significantly contribute to the sustainable growth of Indian Agriculture. NSAI is also working towards progressive use of biotechnology in crop improvement programmes for productivity enhancement and improving the livelihood of Indian farmers. Increasing the general awareness about crop biotechnology among large number of seed stakeholders, seed technology upgradation and engaging in a continuous dialogue with regulators for the establishment of a transparent, fair and equitable regulatory ecosystem, are some of the other activities of NSAI.

The mission of NSAI is to encourage investment in the state-of-the-art R & D to bring to the Indian farmers seeds of superior genetics and technologies, which are of high performance and can be adopted under different agro-climatic conditions. It actively contributes to policy development relating to seed industry to ensure that the policies and programmes create an enabling environment, including public acceptance, so that the industry is globally competitive.

NSAI regularly communicates the latest information and knowledge related to seed trade to its members besides organizing subject specific Conferences/Seminars/Special lectures and regular training and capacity building programmes. NSAI also promotes harmonization and adoption of best commercial practices in production, processing, quality control and distribution of seeds through regular interactions and networking with global/regional seed industry organizations.

# About Indian Seed Congress

*Indian Seed Congress (ISC) is the flagship event organized by NSAI annually. ISC has emerged as a much-awaited event projecting the latest trends and views of the seed industry, voice its concerns; deliberate on the new technological advances in crop improvement, provide opportunity to the industry to showcase new products and services and network among peers for business development. ISC also provides a platform to the Seed Industry to interact closely with technology developers, sector development officials and policy makers. ISC attracts participation of representatives of all major stakeholders including industry (seed & allied), policy makers, developmental agencies, scientific community and farmers' organizations from India and abroad.*



# Thank You Sponsors

Welcome Dinner Sponsor



Gold Sponsor



Silver Sponsor



Lunch Sponsor



Bronze Sponsor



Hi-Tea Sponsor



Badge and Lanyard Sponsor





# TABLE OF CONTENTS

<b>1</b>	<i>REPORT SUMMARY</i>	<b>9</b>
<b>2</b>	<i>CEO CONCLAVE</i>	<b>11</b>
<b>3</b>	<i>SPEECH OF THE CHIEF GUEST, PROF. VIJAY PAUL SHARMA, CHAIRMAN, CACP, MOA&amp;FW</i>	<b>15</b>
<b>4</b>	<i>ADDRESS BY DR. M PRABHAKAR RAO, PRESIDENT, NSAI</i>	<b>17</b>
<b>5</b>	<i>GLIMPSES OF TECHNICAL SESSIONS</i>	<b>19</b>
<b>6</b>	<i>DELEGATE SECTION</i>	<b>23</b>
<b>7</b>	<i>TRADING TABLE &amp; EXHIBITION SECTION</i>	<b>25</b>
<b>8</b>	<i>PRESENTATIONS MADE DURING THE TECHNICAL SESSIONS</i>	<b>27</b>
<b>9</b>	<i>SESSION-WISE KEY OBSERVATIONS</i>	<b>85</b>
<b>10</b>	<i>SUMMARY OF KEY RECOMMENDATIONS</i>	<b>99</b>
<b>11</b>	<i>LIST OF DELEGATES</i>	<b>109</b>
<b>12</b>	<b>ANNEXURES</b>	
	<i>I. PROGRAMME SCHEDULE OF THE CEO CONCLAVE</i>	<b>133</b>
	<i>II. PROGRAMME SCHEDULE OF THE TECHNICAL SESSIONS</i>	<b>134</b>

---

## OFFICE BEARERS

---

**Dr. M. Prabhakar Rao**  
President

**Shri Dineshbhai Patel**  
Vice President

**Dr. Bibhuti Bhusan Pattanaik**  
General Secretary

**Shri Vaibhav Ravi Kashikar**  
Treasurer

---

## GOVERNING COUNCIL MEMBERS

---

**Shri Chunduri Rambabu**

**Shri Chennamaneni Mithun Chand**

**Shri K. Praveen Kumar**

**Shri Ajeet Mulay**

**Shri Siddhartha S. Sen**

**Shri U. Saravanan**

**Shri Pawan Kumar Kansal**

**Shri M. Ravi Kumar**

**Shri Dilipbhai B. Patel**

**Shri R. D. Patel**

---

## NATIONAL ORGANIZING COMMITTEE

---

**Dr. M. Prabhakar Rao**  
Chairman

**Dr. Bibhuti Bhusan Pattanaik**  
Co- Chairman

**Shri Vaibhav Ravi Kashikar**  
Convenor

**Shri Dineshbhai Patel**  
Co-Convenor

### Members

**Shri Ajeet Mulay**

**Shri Siddhartha S Sen**

**Shri Chunduri Rambabu**

**Dr. Jai Singh**

**Shri M. Ravi Kumar**

**Dr. Y. R. Meena** (Secretary)

**Shri Pawan Kumar Kansal**

---

## NSAI SECRETARIAT

---

**Dr. Y. R. Meena, Executive Director**

**Dr. R. K. Tripathi, Director (Technical)**

**Dr. Deepanker Pandey, Assistant Director**

**Dr. Pramod Sharma, Research Associate**

**Shri Yashpal Saini, Sr. Manager-Admin & Accounts**

**Shri Sher Singh, Office Executive**

**Shri C. M. Nautiyal (Accounts)**

# Report Summary

Indian Seed Congress 2025



The National Seed Association of India (NSAI) successfully organized the 13<sup>th</sup> Indian Seed Congress (ISC 2025) from 23<sup>rd</sup> – 25<sup>th</sup> February, 2025 at Hotel Andaz, Aerocity, New Delhi. ISC 2025 was attended by 431 delegates including professionals from the Indian and global seed industry, prominent scientists, agri-professionals and government officials. The Congress was inaugurated on February 24, 2025, by **Prof. Vijay Paul Sharma**, Chairman, Commission for Agricultural Costs and Prices, with **Dr. P. L. Gautam**, Chancellor, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, gracing the occasion as the Guest of Honour. On this occasion stalwarts of the seed industry, eminent scientist, government officials, seed professionals, students were also present.

The congress was addressed by eminent personalities and professionals including **Dr. P. L. Gautam**, Chancellor, Dr Rajendra Prasad Central Agricultural University, Pusa, Bihar, **Dr. Venkata Subbarao, Kolli**, Partner – Agvaya LLP, **Mr. Siraj Hussain**, Former Secretary (Agriculture), MoA&FW, GOI, **Dr. A. K. Singh**, Vice Chancellor, CSAU&T, Kanpur, **Dr. T. Mohapatra**, Chairperson, PPV&FRA, **Mr. Ajeet Kumar Sahu**, Joint Secretary (Seeds), DAFW, MoAFW, Government of India, **Mr. Ashish Bahuguna**, Former Secretary (Agriculture), MoA&FW, GOI, **Dr. D. K. Yadava**, DDG (Crop Science), ICAR, **Mr. Sanjay Agarwal**, ADG, ICRISAT and Ex. Secretary, DA&FW, Govt of India and **Dr. Sanjay Kumar**, Director, ICAR-NISST, Mau.

On 23<sup>rd</sup> February, 2025, a CEO conclave was organized, which was addressed by **Mr. Pankaj Dubey**, Founder & CEO, DSPIN Consulting Pvt Ltd, **Mr. Simon Wiebusch**, President, Bayer South Asia and Vice Chairman, MD & CEO, Bayer CropScience Ltd (BCSL) **and Mr Dinesh Patole**, Facilitator, Team Dhunn. They enlightened the audience through their long experience and deep knowledge of the subject (The detailed Programme Schedule is at **Annexure I**)

On the next two days i.e. 24<sup>th</sup> February and 25<sup>th</sup> February, 2025, the event involved the showcasing of industry products and services through exhibition stalls of various national and multinational seed/seed related companies, trading tables for B2B meetings and more importantly the six technical sessions spread over two days of ISC 2025, which witnessed high quality presentations/deliberations by renowned scientists, agri-professionals and seed industry experts.

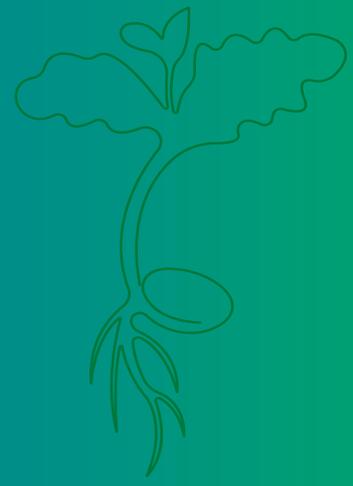
The technical sessions were mainly focused on interaction, discussion, and debate for developing and strengthening the Indian seed sector. These were well appreciated by majority of delegates, especially scientists, researchers and technical professionals working in the industry. Various important topics were covered during the event such as emerging trends in the global seed market; precision breeding through CRISPR-Cas-mediated genome editing; speed breeding; and the use of digital sequence information (DSI). Discussions also focused on the development of Agri Stack, AI-based predictive analytics and crop simulation modeling for precision agronomy, as well as microbiome-based approaches to enhance seed, plant, and soil health for realizing the full potential of plant varieties.

Other key topics included innovations in seed production to build a resilient Indian seed industry, precision farming techniques, and seed-based delivery systems utilizing biologicals and nanotechnologies to improve stress tolerance and crop productivity. The event also highlighted innovative approaches to seed quality certification aimed at boosting exports and making the Indian seed industry globally competitive. Additional focus areas were seed traceability in India, policies and systems for IPR governance relevant to the seed sector, and strategies for strengthening the in-house R&D capabilities of seed companies to attain DSIR recognition.

The Congress witnessed an impressive participation of young seed entrepreneurs, along with seasoned professionals from large, medium, and small enterprises. The trading tables and exhibition area were vibrant hubs of interaction, with delegates actively engaging in meaningful business discussions. Attendee feedback highlighted the substantial business opportunities created during the event, generating strong anticipation for ISC 2025. In response to the growing demand, NSAI has committed to increasing the number of trading tables in future editions of the Indian Seed Congress to better serve participating delegates.

# CEO Conclave

Indian Seed Congress 2025



CEO Conclave is an important component of the Indian Seed Congress organized on the eve of the Congress. This programme is aimed to bring together CEOs of prominent seed companies and other associated industries to sit together in the presence of acclaimed spiritual leaders, behavioural experts, management gurus and seed industry leaders to explore a vision of developing a healthy, competitive and a strong corporate ecosystem of the seed industry in the country. It also provides a multidisciplinary and vibrant forum for the Top management of Seed and Agri-input businesses to have a platform for open interaction on wide range of issues concerning seed sector in the country. The CEO Conclave helps to explore current and future challenges in a fast-changing seed industry environment in order to meet the challenges of creating a healthy work culture within the industry, ensuring a sustained business growth in a highly competitive industry and meeting the expectations of end consumers, i.e. the farmers.

The CEO Conclave was organized on 23<sup>rd</sup> February, 2025 as a pre-Conference activity of the Indian Seed Congress 2025. The conclave was attended by the **top seed industry leaders from India and overseas, management experts, business**

**strategists.** The conclave witnessed deliberations and presentations by eminent motivational speakers, management gurus and seed industry strategists.

Session First of the CEO Conclave was addressed by **Mr. Pankaj Dubey**, who is the Founder & CEO of DSPIN Consulting Pvt Ltd, which supports global and Indian companies in strategy and execution. His insightful talk was centered around the theme “*Mantras for Success*”. He touched upon the critical issues of decision-making skills in a fast-developing industry ecosystem and uncertainties in the business.

The second session, focused on the theme “*Global Perspective of the Indian Seed Sector.*” It was addressed by **Mr. Simon Wiebusch**, President of Bayer South Asia and Vice Chairman, MD & CEO of Bayer CropScience Ltd. A strong proponent of sustainable agriculture, Mr. Wiebusch emphasized the role of technology and digital farming tools in enhancing food quality, reducing farming efforts, ensuring traceability, and improving farmers’ livelihoods.

**Mr. Dinesh Patole**, Facilitator, Team Dhunn interacted with the participants at 06:00- 07:15 PM. The topic of the Third Session was “**United in Rythm, Stronger in Action**”. Mr. Dinesh Patole, who is facilitator of the group, is a master musician, who can play over 20 different instruments with ease. He has played with renowned bands and appeared on Kappa TV and McDowell’s No.1 Yaari, creating life time experience for the audiences. Mr. Patole, with the help of music, demonstrated how important it was to work in sync/discipline within the organization for a healthy work environment leading to a higher productivity.

All participants of the CEO Conclave thanked the organizers for hosting such a remarkable event. Many expressed that the Conclave had profoundly influenced their approach to organizational and self-management, while also reshaping their vision for the future of the Indian seed industry.



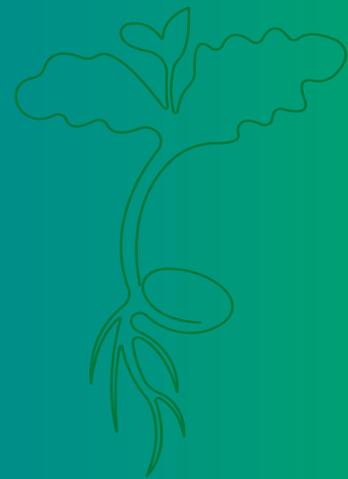




Highlights of Speech of the Chief Guest

# Prof. Vijay Paul Sharma

Chairman, CACP, MoA&FW, GoI



Prof. Vijay Paul Sharma, Chairman, CACP, MoA&FW, GoI, was the Chief Guest during the inaugural session of the 13<sup>th</sup> Indian Seed Congress. Dr. Sharma, delivered an insightful inaugural address, providing a detailed overview of the key agricultural revolutions that have transformed India's farming landscape. He highlighted the significant impact of the Green Revolution, which greatly boosted cereal production, as well as the other major developments, like the cotton revolution, pulse revolution, and the horticultural revolution, which took Indian agriculture to new heights.

Prof. Sharma emphasized that quality seeds played a key role in these transformations, bringing unprecedented growth of agriculture in India. He explained that seeds are the foundation that unlocks the potential of all other farming inputs and technologies, making them essential for the progress of agriculture.

Prof. Sharma then discussed the critical challenges currently confronting Indian agriculture. Among these, he highlighted the steady depletion of land and natural

resources such as water and soil fertility, which pose a direct threat to sustainable food production. He also pointed out the shifting dietary patterns driven by rising incomes and urbanization, which are altering the demand for various food products. These changes, combined with demographic shifts such as an aging farming population and increased rural-to-urban migration, are creating new pressures on the agricultural system.

He mentioned that farmers are changing the crops they grow based on market demand, weather conditions, and governmental policies. However, there was a serious concern over the persistently low yield levels in many crops and the significant yield gaps between what is scientifically achievable and what is being realized on farmers' fields. These inefficiencies must be urgently addressed to ensure national food security and farmer profitability, he said.

Prof. Sharma emphasized that in order to tackle these emerging challenges, the seed sector must keep evolving, as it has exhibited during previous agricultural revolutions. He also stressed the need for increased innovation, wider adoption of advanced breeding technologies, and a stronger focus on sustainability and resilience within the industry.

While expressing strong confidence on the emerging technologies, Prof. Sharma indicated that with the adoption of newer approaches like genomics, molecular breeding, digital farming, and precision agriculture, the seed sector is well prepared to support modern farming. He ended his address with a strong message that the seed industry must take the lead, keep evolving, and play a key role in creating a strong and productive future for Indian agriculture.

# Highlights of the Address by Dr. M. Prabhakar Rao, President National Seed Association of India (NSAI)

Dr. M. Prabhakar Rao, President NSAI, extended a warm welcome to the Chief Guest, Guest of Honour, esteemed dignitaries, and delegates of ISC 2025. Dr. Rao, in his address highlighted the significant contribution made by emerging technologies on the agricultural development of the country. He indicated that it is essential to engage in thoughtful deliberation on these



emerging technologies related to seed sector. This includes advancements in crop breeding methods, particularly the adoption of genomics and molecular breeding techniques, which are driving a new era of precision agriculture.

Dr. Rao also stressed the need for modernization across various facets of the seed industry, including seed production, processing, and packaging infrastructure. He pointed to the importance of strengthening quality management systems to ensure the production of high-quality seeds and the adoption of seed quality enhancement techniques. Additionally, he noted that integrating Intellectual Property Rights (IPR) technologies into seed trade and innovation frameworks is becoming increasingly essential. Such integration, he emphasized, would help create a more competitive, transparent, and innovative seed market, driving progress and growth in the sector.

Addressing the challenges facing the agricultural sector, Dr. Rao acknowledged the necessity of developing new varieties that not only offer high yields but are also suited to the Morden crop production technologies. These include resource-conservation technologies, High-Density Planting Systems (HDPS), Extra-Long Staple (ELS) cotton, and mechanized methods for crop management, harvesting, and processing, especially in light of increasing labor shortages. He mentioned that there will have to be a synergistic collaboration among researchers, policy makers, entrepreneurs, and the seed industry to achieve the full potential of these interventions.

Dr. Rao also highlighted several key industry issues that the National Seed Association of India (NSAI) has actively taken up with different stakeholders to strengthen the seed industry in India. One of the most important issues was the proposal for a **“One Nation One Licence”** system. At present, seed companies are required to obtain separate licenses from each state to sell their seeds, which leads to unnecessary delays and administrative hurdles. NSAI is advocating for a harmonized, single, nationwide licensing system that would allow companies to sell seeds across all states with ease of doing business. This would not only save time and effort for the companies but also help farmers get access to quality seeds more quickly.

Another major initiative was the promotion of a **seed traceability** system through the **SATHI Portal**. Though presently this portal is limited to certified seeds, in the next phase this digital platform will be extended to allow tracking of TL seeds also from their production stage all the way to the end user. It will help ensure that only genuine and high-quality seeds reach the farmers, reducing the risk of counterfeit or substandard seeds in the market. He added that such transparency will build trust and protect both farmers and seed companies.

Dr. Rao further emphasized the need for **strengthening and accreditation of seed testing laboratories** across the country. Many regions still lack proper facilities to test seed quality, which can affect crop performance and farmer incomes. By improving the infrastructure and ensuring that these labs are accredited and well-equipped, the industry can maintain high standards and deliver better results to farmers.

He also emphasized the importance of providing fiscal incentives to promote research and development (R&D) in the private seed sector. Developing new and improved seed varieties requires large investments in research, skilled manpower, and advanced technologies. NSAI believes that providing tax benefits or subsidies for R&D activities will encourage the private seed companies towards innovating their R&D setup, leading to greater advancements in the seed sector and contributing to the overall growth of the Indian agriculture.

Dr. Rao also indicated that in the current scenario, the seed industry is fully geared to harness the benefit of new technological developments by reaching to a better understanding between the technology developing and technology user companies for a balanced trait value sharing, provided a supportive policy ecosystem is in place.

President, NSAI expressed his happiness that large number of seed companies from different parts of the country and abroad had come to participate in the ISC 2025 to deliberate on common issues related to seed sector and to pave a path for further growth of Indian seed industry enabling it to continue providing better quality seeds to the farmers to enhance their productivity and economic prosperity.

# Glimpses of Technical Sessions









# Delegate Section

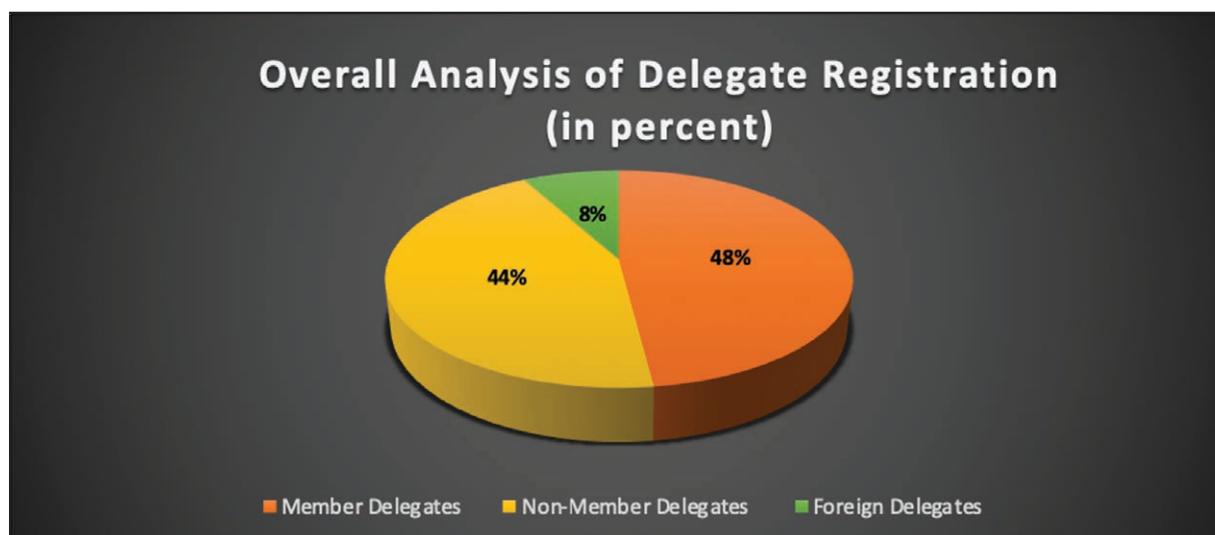
The Indian Seed Congress 2025 witnessed enthusiastic participation from a wide range of stakeholders, including delegates from both public and private sector seed companies, input suppliers to the seed industry, scientists, government officials, and international participants.

The total number of registered delegates for Indian Seed Congress 2025 were 431, out of which Indian participants were 396 besides 35 overseas delegates from fourteen countries (Switzerland, Germany, Italy, Turkey, Seiwon, USA, Amman, Denmark, Lebanon, Sri Lanka, Bangladesh, The Netherland and Greece).

An analysis of the delegate participation in the ISC 2025 is presented below:

## i). NSAI-Member V/S Non-Member participation of Delegates

Out of the total participation of 431 delegates, NSAI-member delegate participation was 48 % (208 delegates) as compared to 44% of the non-member delegates participation (188 delegates) and the overseas delegates participation was 8 % (35 delegates) (Fig 1).

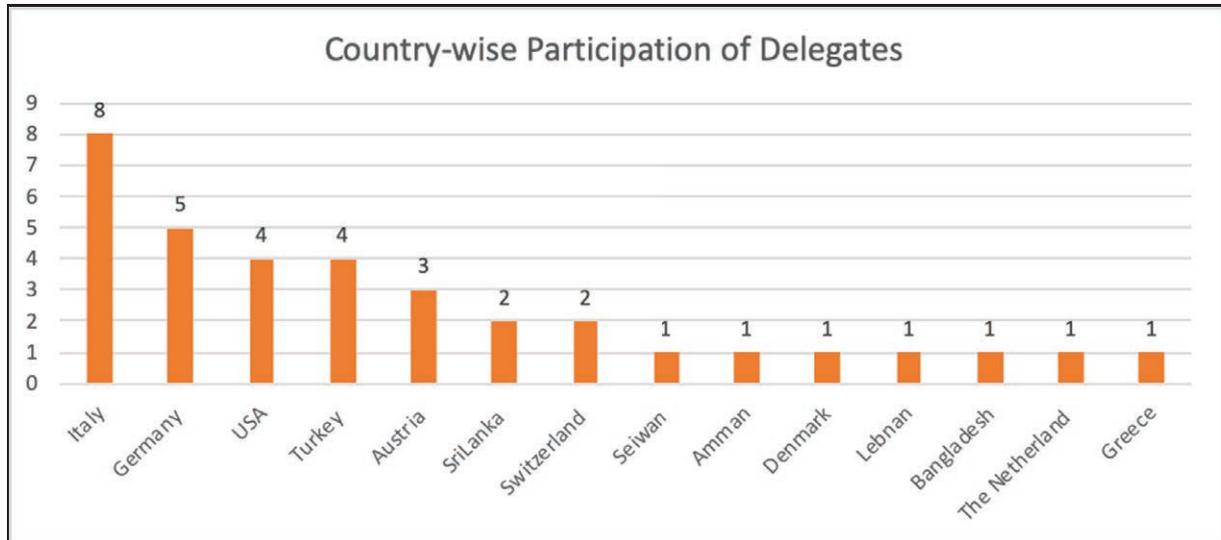


**Fig 1: Overall analysis of registered delegates (in percent)**

## ii). Country wise participation of overseas delegates

The total number of registered delegates was 431 out of which 35 were overseas delegates. Among the overseas participants Italy (8) had the highest number of delegates followed by Germany (5), USA and Turkey (4 delegates from each country), Austria (3), Sri Lanka and Switzerland (2 delegates from each country),

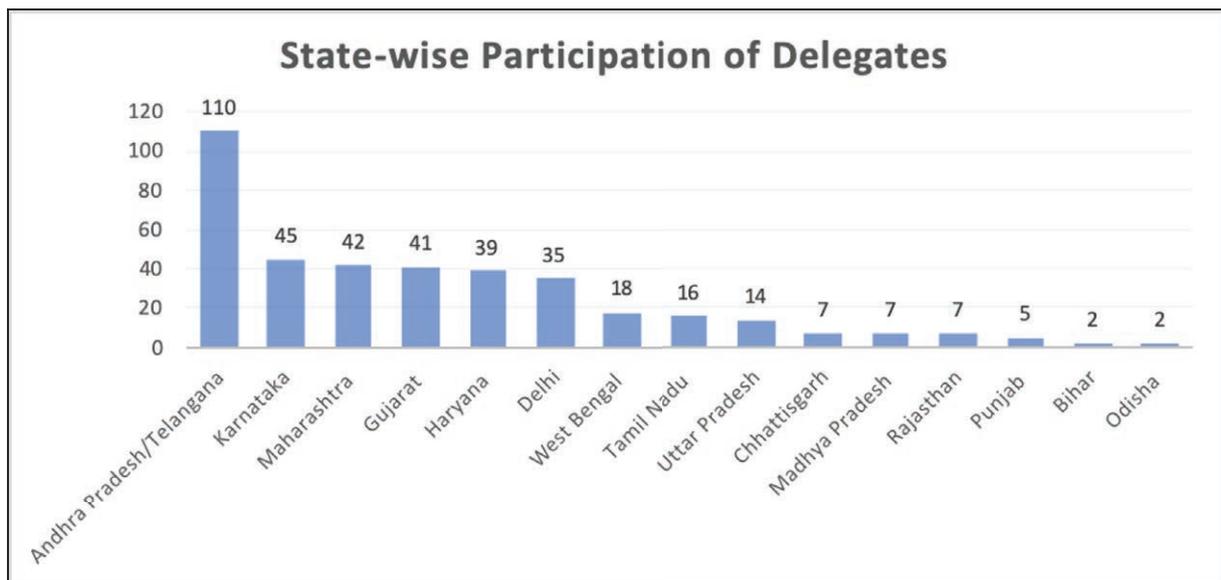
Seiwan, Amman, Denmark, Lebanon, Bangladesh, The Netherland and Greece (1 delegate from each country).



**Fig 2: Country-wise participation of delegates**

**iii). State-wise participation of Indian delegates**

Among the 396 Indian participants, Andhra Pradesh (including Telangana) had the highest delegate participation (110) followed by Karnataka (45), Maharashtra (42), Gujarat (41), Haryana (39), Delhi (35), West Bengal (18), Tamil Nadu (16), Uttar Pradesh (14), Chhattisgarh (7), Madhya Pradesh (7), Rajasthan (7), Punjab (5), Bihar (2) and Odisha (2).



**Fig 3: State-wise participation of delegates**

# Trading Table and Exhibition Stall Section

To promote B2B meetings/interactions amongst the participants (National as well as Global), the National Organizing Committee provided Exhibition Stalls and Trading Tables for the delegates. The achievement is as under:

- ◆ This year, the participation in the Exhibition Stall had an active involvement of industry with 37 stalls occupied, exhibiting their products and services by major companies. The stalls were sold out much prior to the event. The demand for the exhibition stalls was on the higher side.
- ◆ In total 28 trading tables were sold out in ISC 2025





# **Presentations Made During the Technical Sessions**



# Technical Session - I

**Dr. Bharti Malhotra**, Research Manager- Analysis Lead, Crop Science, Agribusiness, S&P Global

**S&P Global**  
Commodity Insights

## Trends in the Global Seed Market: Role of Technological Innovations as a Key Influencing Factor, Strategies and a Decadal Outlook

Dr Bharti Malhotra/Agribusiness, Crop Science, Research Manager  
Feb 24th, 2025

Presentation for the Indian Seed Congress-2025

Crop Science / Trends in the Global Seed Market / February 2025

Introduction to S&P Global  
How do we support the Crop Science markets?  
Seed market performance and key drivers  
2024 regulatory and trait update  
Developments in Asia-Pacific, with special focus on China  
Developments in new breeding techniques

- Regulatory updates
- Trait pipeline

Other important technologies in seeds

- Direct seeded rice
- Hybrid wheat

Summary  
Market outlook  
Questions

Slide deck will be shared post-presentation

**Agenda**

Crop Science / Trends in the Global Seed Market / February 2025

## Our five divisions

focus on distinct markets—and together, they deliver unmatched breadth and depth.

**S&P Global**

- S&P Global Market Intelligence
- S&P Global Ratings
- S&P Global Commodity Insights
- S&P Global Mobility
- S&P Dow Jones Indices

Crop Science / Trends in the Global Seed Market / February 2025

## Our Portfolio

**S&P Global Commodity Insights**

- Agriculture and Bio-fuels
- Metals
- Upstream
- Energy Transition
- Shipping
- Chemicals
- Crude Oil
- Petroleum Refining
- Sustained Power
- LNG

- Assessments & Benchmarks**  
We engage with market participants and employ rigorous methodologies to develop assessments and benchmarks that reflect commodity true value. Along with news and market commentary, our assessments help you make successful trading decisions and manage risk.
- Data & Analytics**  
We integrate analysis and data sets across geographies, commodities and the supply chain for meaningful intelligence that helps you identify and adjust to market disruptions, make decisions with confidence and take action that matters.
- Workflow Solutions**  
We partner with you to enhance workflows, increase efficiency and optimize business processes by leveraging AI driven software and applications, advanced platforms and machine delivery.
- Research & Insights**  
We develop deep, interconnected industry analysis and forecasts across the full energy and commodities value chain. Subscribing to our independent, timely, and real-time market insights and analysis includes access to analysts and Q&A.
- Conferences & Advisory Solutions**  
We provide personalized consulting services on current challenges such as renewables and energy transition, and trade policies, geopolitics, and infrastructure systems, including CER Capital, World Petrochemical Conference, Global Power Markets, and APPEC.

Crop Science / Trends in the Global Seed Market / February 2025

## Agriculture Value Chain

Crop Science / Trends in the Global Seed Market / February 2025

## S&P Global: Full agriculture value chain coverage

- Crop Science**  
News, analysis, consensus data, market size and share, product sales, market analysis, data  
Crop Production: corn, sorghum, biological & seed trait analysis  
Breeds: Conventional, GM and new breeding technologies  
Digital farming and precision agriculture  
Commercial deals and more
- Agriculture and Food**  
Price assessments and news, market analysis, data, Q&A and trade data, wheat, forecasts and outlook for 2025  
Diverse crops: oil seeds, pulses, coffee, cereals, fruits & vegetables, dried fruit, frozen foods, bio-based and more  
Pulver analysis  
Agriculture: Trade and farm policy, energy, government and industry  
Food: Food and health policy, additive and alternative food, safety and security, traceability and supply chains  
Oils and more
- Biofuels**  
Ethanol, biofuels and BAP analysis across to long term forecasts  
Monthly balances and global trade, including port and export data  
Production, processing and transportation  
Commercial factors, capacity, acquisitions and joint ventures  
Coverage of Bloomberg, E&E, Euromonitor, Fluxis, Research & Markets, Statista, and more

Crop Science / Trends in the Global Seed Market / February 2025

## S&P Global: Full agriculture value chain coverage

- Fertilizers**  
Price benchmarks, market analysis, fundamentals and 10-year forecasts across  
Ammonia  
Urea  
Nitrogen  
Phosphorus  
Potash  
Sulfur  
Sulfate  
Sulfuric acid
- Sustainability in Agriculture**  
Policy & Politics: Public policies and corporate sustainability initiatives for understanding regulatory process and quality  
Emissions: Analysis for real-time data, climate and industry for understanding strategy and planning  
Climate Risk: Resilient risk to agriculture, public and private and adaptation of strategies  
Carbon: Asset Development: Generation of clean and sustainable services for carbon trading and offsetting
- Animal Health**  
News, analysis, product market size and share, forecasting  
Preventives, vaccines, pharmaceuticals, services, equipment and technology  
Nutrition, food and additives  
Investment and M&A developments  
Policy and regulation

Crop Science / Trends in the Global Seed Market / February 2025

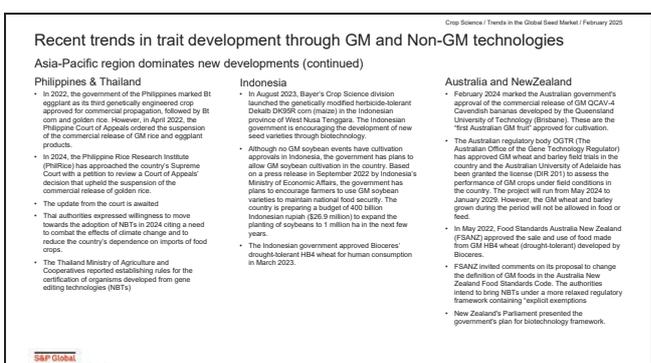
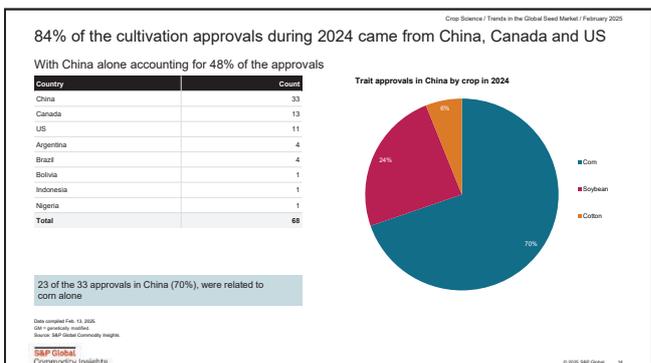
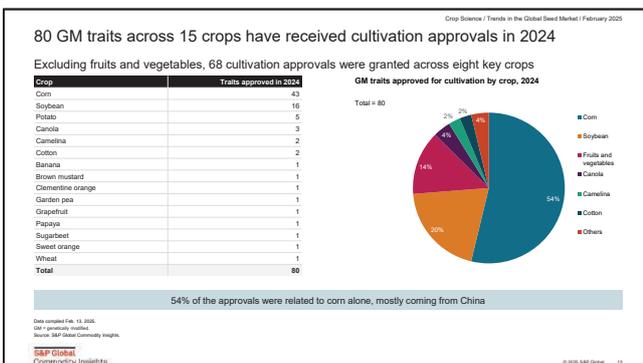
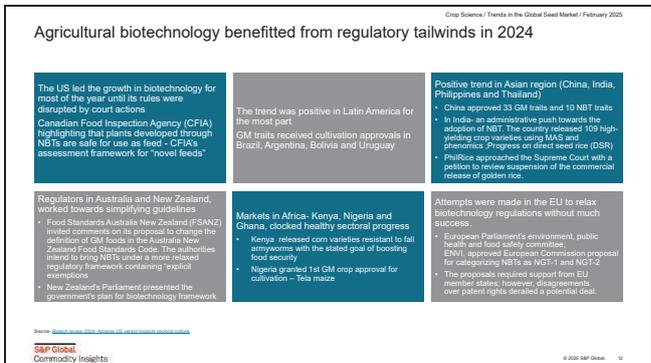
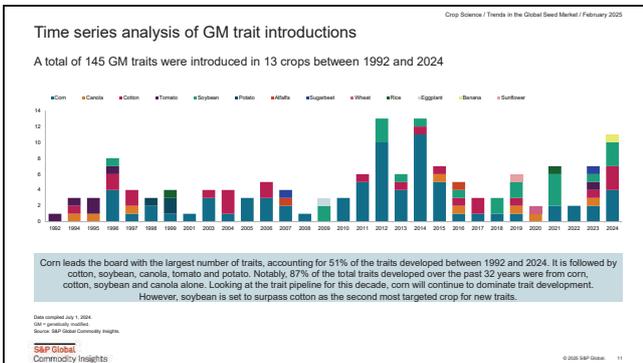
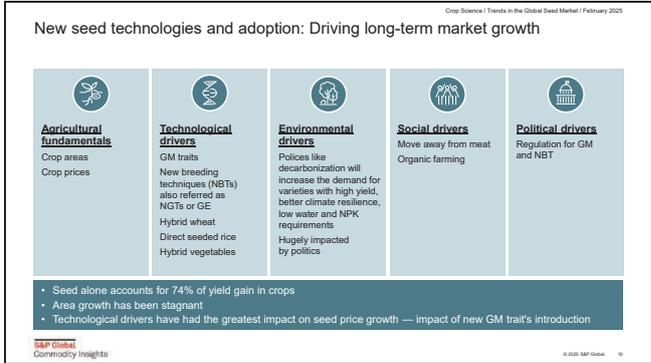
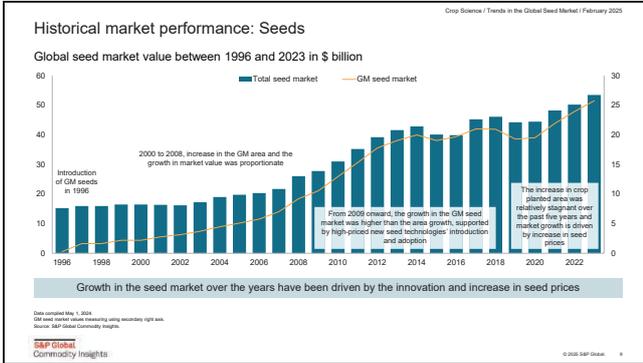
## Agriculture: Global Expertise for a Global Agricultural Value Chain

245+ analysts, journalists and consultants across 21 countries

**Our Experts**

- Fertilizers
- Crop Science
- Animal Health
- Agriculture and Food
- Biofuels and Bioenergy
- Food and Agricultural Policy
- Sustainability in Agriculture

**Our global coverage**



### Updates on Chinese approvals

Crop Science / Trends in the Global Seed Market / February 2025

2022-2024

Year	Action	Details
2022	Steps taken	<ul style="list-style-type: none"> <li>Ministry of Agriculture and Rural Affairs (MARA), announced amendment to make the GMO variety registration easier by making biosafety evaluation based on "events" rather than "crop variety and event"</li> <li>Published National Registration Standards for GM soybean and corn varieties (Trial)</li> </ul>
2023	First GM crop batch	<ul style="list-style-type: none"> <li>11 variety registration list for 37 GM corn varieties and 14 GM soybean varieties published and approved</li> <li>MARA granted 26 seed production and operation licenses to 24 enterprises for 26 GM corn and 15 GM soybean varieties</li> </ul>
2024	Second GM crop batch	<ul style="list-style-type: none"> <li>27 GM corn and 3 GM soybean varieties was published and approved</li> <li>Additional 13 seed production and operation licenses to 13 enterprises for 19 GM corn varieties given from the second list</li> </ul>
2023-24	Varieties registered	<ul style="list-style-type: none"> <li>81 GM corn and soybean varieties registered (64 GM corn + 17 GM soybean)</li> </ul>
2023-24	Varieties granted licenses	<ul style="list-style-type: none"> <li>64 varieties received operation and production licenses (54 GM corn + 10 GM soybean)</li> </ul>
2023-24	Enterprises involved	<ul style="list-style-type: none"> <li>37 enterprises received production and operation licenses for 64 GM corn and soybean varieties</li> </ul>
2023-24	GM corn events	<ul style="list-style-type: none"> <li>7 events: D2N936, ND207, D2N36011, B111 + GA21, B111 + MR162 + GA21, D2N8858, Ruffing 125.</li> <li>Six out of seven events been issued biosafety certificates with nationwide cultivation approvals, except Ruffing 125</li> </ul>
2023-24	GM soybean events	<ul style="list-style-type: none"> <li>2 events: D2N826A, Zhongshuang 9106.</li> <li>Both events have been issued biosafety certificates with national cultivation approvals</li> </ul>

Source: S&P Global Commodity Insights

### China's GM corn licenses cover all corn-growing provinces

Crop Science / Trends in the Global Seed Market / February 2025

List of Chinese provinces with production and operation licenses for GM corn and soybean

Province	Region	Major crop production	Varietal approvals
Beijing	North China	Corn	Corn and Soybean
Hebei	North China	Corn	Corn
Shanxi	North China	Corn	Corn
Inner Mongolia	North China	Corn and Soybean	Corn
Liaoning	Northeast China	Corn and Soybean	Corn
Jilin	Northeast China	Corn and Soybean	Corn
Heilongjiang	Northeast China	Corn and Soybean	Corn
Shandong	East China	Corn	Corn
Henan	Central China	Corn	Corn
Hubei	Central China	Corn	Corn
Anhui	East China	Corn	Corn
Gansu	Northeast China	Corn	Corn
Sichuan	Southeast China	Corn	Corn
Yunnan	Southwest China	Corn	Corn
Hainan	South China	Minor production (not major)	Corn and Soybean

- China has issued GM corn licenses to all corn-growing provinces, while only Beijing and Hainan have soybean licenses
- Beijing and Hainan, though not major soybean producers, are vital for GM crop research due to their advanced facilities for GM research, testing and trials. Hainan could be a testing ground for tropical short duration winter varieties
- A total of 54 corn varieties and 10 soybean varieties are licensed, highlighting greater advancements in corn

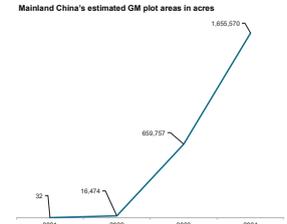
Source: S&P Global Commodity Insights

### Mainland China's GM pilot areas

Crop Science / Trends in the Global Seed Market / February 2025

We have 2024 updated data

Mainland China's estimated GM pilot areas in acres



2021

- Launched a pilot project for the commercialization of GM corn and soybeans
- Carried out in scientific research and experimental fields

2022

- Expanded the pilot project to farmer fields in Inner Mongolia and Yunnan

2023

- Expanded the pilot project to 20 counties in 5 provinces including Hebei, Inner Mongolia, Jilin, Sichuan and Yunnan
- Arranged GM seed production in Gansu

2024

- GM areas expected to further expand with addition of new provinces. Nonofficial sources have projected 1.65 million acres of area under GM Corn in China

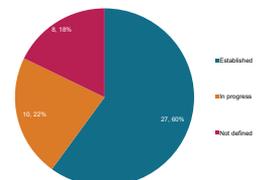
Source: S&P Global Commodity Insights

### New breeding techniques (NBT) regulatory framework

Crop Science / Trends in the Global Seed Market / February 2025

Trend analysis

NBT regulatory framework development by country



Established	In progress	Not defined
<ul style="list-style-type: none"> <li>US, Canada, Norway, England, Japan, Ecuador</li> <li>Philippines, India, Kenya, Nigeria, Ghana, Bangladesh</li> <li>Malawi, Australia, New Zealand, Argentina</li> <li>Brazil, Colombia, Chile, El Salvador, Costa Rica, Uruguay</li> <li>Honduras, Guatemala, El Salvador, Costa Rica, Uruguay</li> </ul>	<ul style="list-style-type: none"> <li>Mexico, Turkey, South Africa, Cuba, Ukraine, Bolivia, Peru</li> <li>Manland China, EU, Switzerland, Pakistan, Singapore, Taiwan, Russia, Indonesia</li> </ul>	<ul style="list-style-type: none"> <li>Egypt</li> </ul>

- Expanded our coverage from 31 countries in 2023 to 45 countries in 2024
- Trends is same, countries with established framework is the largest category
- Countries in process of developing the framework for NBTs have increased from five to ten during 2024

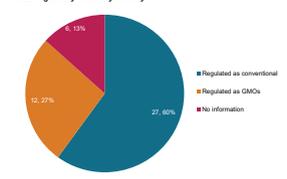
Source: S&P Global Commodity Insights

### NBT regulatory status by country

Crop Science / Trends in the Global Seed Market / February 2025

Trend analysis

NBT regulatory status by country



Regulated as conventional	Regulated as GMOs	No information
<ul style="list-style-type: none"> <li>US, Canada, England, Japan, Argentina, Bangladesh, Switzerland</li> <li>Philippines, India, Kenya, Nigeria, Singapore</li> <li>Ghana, Malawi, Australia, Israel, Burkina Faso</li> <li>Brazil, Colombia, Chile, Paraguay, Ecuador</li> <li>Honduras, Guatemala, El Salvador, Costa Rica, Indonesia</li> </ul>	<ul style="list-style-type: none"> <li>Mexico, South Africa, Turkey, New Zealand, Cuba, Ukraine, Bolivia, Peru</li> <li>Manland China, EU, Switzerland, Pakistan, Singapore, Taiwan, Russia, Indonesia</li> </ul>	<ul style="list-style-type: none"> <li>Egypt</li> </ul>

27 countries — NBTs are regulated as conventional, and all countries align on the definition of not having any transgene. However, there is still some non-harmonization in the terminology used such as cisgenesis, SON1, SON2, etc.

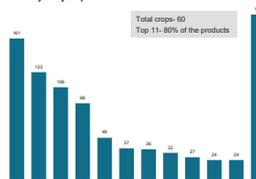
Source: S&P Global Commodity Insights

### NBT product analysis by crop and country

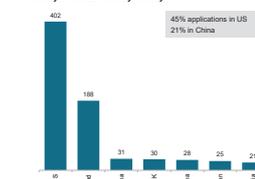
Crop Science / Trends in the Global Seed Market / February 2025

Trend analysis

NBT analysis by crops



Analysis of NBT traits by country



Total crops: 60  
Top 11: 80% of the products

45% applications in US  
21% in China

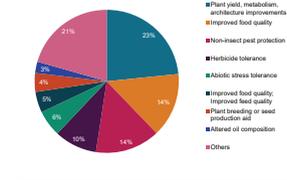
Source: S&P Global Commodity Insights

### NBT product analysis by crop category and trait type

Crop Science / Trends in the Global Seed Market / February 2025

70% of the products in NBT category are related to grains and oilseeds

NBT trait analysis



NBT traits analysis for grains and oilseeds

Trait	Count
Abiotic stress tolerance	38
Improved food quality/Improved feed quality	38
Improved food quality	40
Non-insect pest protection	50
Herbicide tolerance	75
Plant yield, metabolism, architecture	79
Improved food quality	157

NBT traits analysis for fruits and vegetables

Trait	Count
Plant breeding or seed	10
Storage performance	13
Improved food quality/Storage	15
Abiotic stress tolerance	15
Plant yield, metabolism,	52
Non-insect pest protection	55
Improved food quality	80

- In grains and oilseeds 50% of the products are related to top 3 categories
- 70% of the products in fruits and vegetables belongs to top 3 categories

Source: S&P Global Commodity Insights

### NBT product updates for leading countries/regions

Crop Science / Trends in the Global Seed Market / February 2025

Products are either commercialized or approved for near commercialization

Country	Commercialized products	Products in pipeline
US	<ul style="list-style-type: none"> <li>Calry's (2019, Cibus) soybean producing oleic acid rich oil (Now out of market since 2021); Consoletus™ greens (2023); Parvise plants; Non-browning lettuce (2023); GreenVenus</li> </ul>	<ol style="list-style-type: none"> <li>Three NBT soybean (two high proteins and one HT) from Benson Hills expected between 2024 and 2025</li> <li>Non-browning lettuce (2024; Tropis Biosciences)</li> <li>GLUtolerant-camelina (2025; Yield 10)</li> <li>Non-browning Arundo (2023; GreenVenus)</li> <li>Corviva Agriscience's gene-edited disease-resistant corn deregulated in 2024; commercialization awaited</li> <li>P-18 soybean (increased oleic acid content) from C-Bioscience (Beijing) has received USDA approval</li> <li>Parvise's improved quality berries (Blackberry and Raspberry)</li> <li>Nation-biochicken bioactive by Bayer and C-FLAS</li> <li>Many other companies have also received USDA approvals for gene-edited crops viz., CoverCres (Pentecosts for improved food quality); Reddfields (Corteva for improved yield); Andora (Pioneer and Soybean for improved protein content); Biohours (herbicide tolerant soybean); GDM seeds (improved drought stress tolerant soybean); GreenVenus (Fast growing lettuce); Tordian (Pioneer for increased oleic acid content); Inat Agriculture (Soybean and corn for increased yield and seed numbers); Phytomil Labs (Tomato for altered pedicel structure); Soil culture Solutions (Change tolerant to non-insect pests)</li> </ol>
Canada	<ul style="list-style-type: none"> <li>Consoletus™ greens with reduced bitterness (2023; Parvise plants)</li> </ul>	<ol style="list-style-type: none"> <li>CLB-1 canola-ODM (2020; BASF) — Approved; Waxy corn (2020; Corteva Agriscience) — Approved; commercialization awaited</li> <li>Obay has initiated potential developments for following NBT traits, and its target regions includes US, Canada and EU               <ol style="list-style-type: none"> <li>Pod shatter reduction (PSR) trait in canola to be launched in USA and Canada (2025 onwards); EU (2027 onwards)</li> <li>Herbicide tolerance (HT) trait in canola to be launched in USA, Canada and EU (2028 onwards); but first in USA</li> <li>Soletrinita resistance in canola to be launched in USA, Canada and EU (2028 onwards), but first in USA</li> <li>Herbicide tolerance HT1 (HT1) trait in rice to be launched in USA and Latin America, 2025 onwards</li> <li>Soletrinita resistance in soybean to be launched in USA and Brazil, 2025 onwards</li> <li>Herbicide tolerance HT2 trait in soybean to be launched in USA and Brazil, 2025 onwards</li> </ol> </li> </ol>

Source: S&P Global Commodity Insights

### NBT product updates for leading countries/regions

Products are either commercialized or approved for near commercialization

Country	Commercialized products	Products in pipeline
Japan	Sickian Rouge high GABA tomato sold since 2021	Amylopectin rich waxy corn (2023, Cereza AgriScience) — Approved: improved food quality of potatoes with reduction in steroidal glycoalkaloids; Rice with increased tolerance to stress and improved food quality
Philippines	None	Reduced-browning banana (2024, Tropic Biosciences); Sickian Rouge high GABA tomato (2024, Sanatex Seed) — Approved: commercialization awaited
China (mainland)	None	Ten biosafety approvals have been given in the years 2023 and 2024; two corn varieties for increased yield trait, two wheat varieties resistance to powdery mildew and ALS-inhibiting herbicides, five soybean varieties for improved traits of yield, quality and physiology and one rice variety for altered starch composition mainly amylose content Cibus has conducted field trials on pod shatter resistance canola Phytoform Labs has ongoing field trials for dwarf and high-yielding tomato plants and the market launch is expected in 2025
UK	None	Viaams Instituut voor Biotechnologie (VIB) is conducting regulated field trials for producing gene-edited corn with reduced lignin content with improved digestibility and its simultaneous application in paper and pulp industry
Belgium	None	Non-browning potatoes (2018) — Approved
Argentina	None	

• BioHorus, an Argentine gene-editing company, is actively developing non-GMO herbicide-resistant traits (PPD, HPPD, ALS, ACCase and Auxins) in crops including rice, soybean, sorghum and cotton. The company is collaborating with Cereza for developing herbicide-resistant cotton varieties, Santa Rosa Semillas, Grupo Don Muiro, and ACA (Asociación de Cooperativas Argentinas) for enhancing herbicide resistance in soybean, and Tolar for creating herbicide-resistant sorghum

• BioHorus is aiming to launch its rice and sorghum traits by 2026 and soybean and cotton by 2027. As per the company, many of their products are desegregated

Source: S&P Global Commodity Insights

### Gene-edited events approved for cultivation/processing in China

Crop type	Variety/Event	Trait	Developer	Genes modulated	Issue date	Expiry date
Corn	17MAC19-13	Improved yield traits	Shandong Shunfeng Biotechnology Ltd.	Bt2	May 7, 2024	May 6, 2029
Wheat	ML0-KNRP	Resistance to powdery mildew/fungal infection	Suzhou Qihc Biotechnology Co. Ltd., Chinese Academy of Sciences	TaMLD-A1, TaMLD-B1, TaMLD-C1, TaMLD-D1	May 7, 2024	May 6, 2029
Soybean	AE15-16-1	Increased oleic acid content and quality traits	Shandong Shunfeng Biotechnology Co. Ltd.	GmFAZ2-1A, GmFAZ2-1B	April 21, 2023	April 20, 2028
Soybean	25T93-1	Improved physiological traits	Shandong Biotech Biotechnology Co. Ltd.	GmELF3a	January 2, 2024	January 1, 2029
Soybean	P18	Improved quality trait	Suzhou Qihc Biotech Co. Ltd.	GmFAZ2-1A, GmFAZ2-1B	January 2, 2024	January 1, 2029
Soybean	QH4112	High yield	Suzhou Qihc Biotech Co. Ltd., Beijing Qihc Biotech Co. Ltd.	GmLn	December 25, 2024	December 24, 2029
Soybean	ED015YF7	Improved physiological traits	China Seed Group Co. Ltd.	GmE1, GmE1L5	December 25, 2024	December 24, 2029
Corn	KN-NL4-2	High yield	Waim Biotech (Hainan) Co. Ltd.	ZmNL4	December 25, 2024	December 24, 2029
Rice	118-9-15	Altered starch composition mainly amylose content	Suzhou Qihc Biotech Co. Ltd., Beijing Qihc Biotech Co. Ltd.	Wx	December 25, 2024	December 24, 2029
Wheat	TALS-4	Tolerance to ALS-inhibiting herbicides	Suzhou Qihc Biotech Co. Ltd.	TaALS	December 25, 2024	December 24, 2029

• NBT trials in China have been approved for soybean, corn, rice and wheat in 2024

• China passed its first food security law in 2024, and is the reason for push in the NBT trials as well explains why they bought Syngenta

• China's dominance in PMP applications has grown and it accounts for 52.7% of the global total. The global PMP applications grew from 14000 in 2009 to 29000 in 2023

Source: S&P Global Commodity Insights

### Analysis of GM traits in the pipeline from 2024 to 2030

Leading players have a strong pipeline, committing to introduce 26 traits in key crops

**Upcoming GM traits by crop**

**Upcoming GM traits by company**

**Upcoming GM traits by application category**

Analysis of 26 traits pipeline between 2024 and 2030. Launch year is missing for 16 traits and 18 approved

Source: S&P Global Commodity Insights

### Other technologies- Direct seeded rice

Adoption of DSR will positively impact rice seed prices and associated herbicides sales in the region

**Direct seeded rice- technology introduction**

- DSR is gaining attention globally as a more sustainable alternative to traditional rice transplanting, primarily due to its efficiency in water use, reduced emissions, reduced labor requirements, and suitability for mechanization
- DSR is common in the US and South America, but productivity challenges limit its adoption in Asia, where more than 80% of global rice is produced and consumed
- Leading seed companies involved in the development and promotion of DSR technologies in Asia includes Bayer Crop Science, BASF, Syngenta, East-West Seed, Mahyoo and Advanta Seeds
- Bayer, BASF and Corteva are working in collaboration with IRR
- Bayer, BASF, Corteva and Syngenta, also focused on the development and offering of herbicide system
- Savannah Seeds, an India-based subsidiary of RiceTec and Mahyoo formed a JV to introduce non-GMO HT rice varieties in India

**DSR-Recent updates**

- Bayer, Shell, and GenZero Collaboration (2023): Partnered to promote sustainable rice farming to reduce methane emissions and improve water efficiency, targeting 25,000 hectares in India by 2023-24.
- Mahyoo and Advanta involved in new DSR product launches.
- Syngenta and FMC launched leflurolym, herbicide tailored for DSR systems.
- BASF has successful products in American markets (Clearfield and Provisia Rice Systems). The company is working in collaboration with IRR (International Rice Research Institute) to develop DSR technologies and test rice varieties suitable for Asian environments.
- Bayer's breeding programs introduced climate-resilient hybrids optimized for DSR, coupled with digital tools like FarmRise to support agronomic decisions.
- It has claimed to reach around 18,700 hectares of DSR rice in India in 2024 and aim to reach 1,000,000 hectares in India by 2030.
- In 2024, Bayer signed a MoU with the Philippine Department of Agriculture – Bureau of Agricultural Research (DA-BAR) focusing on sustainability and new farming systems such as DSR.

Source: S&P Global Commodity Insights

### Summary

- The seed industry is an R&D-driven sector with a solid trait pipeline and innovation expected from both GM and non-GM technologies in the coming decade.
- GM traits and non-GM traits from technologies such as direct-seeded rice and hybrid wheat will be the key market drivers.
- Adoption of GM in new geographies, such as China, may significantly impact the market.
- GM traits are predominantly input traits, focusing mainly on industrial crops, whereas NBTs are more evenly distributed among input, agronomic, and processor/consumer traits, bringing a diverse variety of crops, including food crops.
- The impact of NBTs on seeds is likely to be less than that of GM traits, as their benefits are more marginal and further downstream, making it challenging to compete with established traits and chemistries in corn, soybean, cotton, and canola.
- However, NBTs could drive innovation in the fruits and vegetable category and in food crops like rice and wheat, where GM technology has faced several rejections.
- The impact of NBTs is not anticipated within this timeframe as it requires harmonization of regulations for successful adoption.
- The lack of a cohesive regulatory framework is delaying the significant influence of NBTs on the market, and their regulations will remain subject to political pressures and legal challenges, as highlighted by the recent US court ruling that vacated the SECURE Rule, reinstating stricter oversight.

Source: S&P Global Commodity Insights

### Global seed market outlook from 2024 to 2034

**Seed Market Performance in \$ billion**

Without GM commercialization in China, we expect the global market to grow at +1.2% per annum. GM adoption in China and hybrid wheat might change the scenario. With GM commercialization in China, we expect the global market to grow at +2.5% per annum.

Source: S&P Global Commodity Insights

### Questions?

Source: Getty.com

Source: S&P Global Commodity Insights

### Contact us

Primary contact(s)

Bharti Malhotra  
bharti.malhotra@sppglobal.com

Pratima Sharma  
pratima.sharma@sppglobal.com

Contact us

Americas +1 800 597 1344  
Asia-Pacific +60 4 296 1125  
Europe, Middle East, Africa +44 (0) 203 367 0681

[www.sppglobal.com/en/enterprise/about/contact-us.html](http://www.sppglobal.com/en/enterprise/about/contact-us.html)  
[www.sppglobal.com](http://www.sppglobal.com)

Source: S&P Global Commodity Insights

Dr. Tanushri Kaul, Group Leader, Nutritional Improvement of Crops, ICGEB

**Precision Breeding via CRISPR-Cas-mediated Genome-Editing**

**REVOLUTIONIZING SUSTAINABLE AGRICULTURE:**  
Leveraging Genomics and CRISPR/Cas9-Based Genome Editing Technology to Re-Design Crops

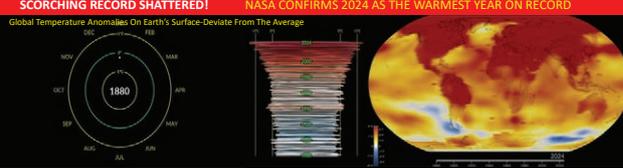


**Dr. Tanushri Kaul**  
Group Leader  
Nutritional Improvement of Crops Group  
International Centre for Genetic Engineering and Biotechnology (ICGEB)  
New Delhi, India



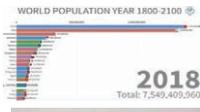
**SCORCHING RECORD SHATTERED! NASA CONFIRMS 2024 AS THE WARMEST YEAR ON RECORD**

Global Temperature Anomalies On Earth's Surface-Deviate From The Average



- Global temperatures in 2024 were 2.30 degrees Fahrenheit (1.28 degrees Celsius) above the agency's 20th-century baseline (1951-1980), which tops the record set in 2023. The new record comes after 15 consecutive months (June 2023 through August 2024) of monthly temperature records — an unprecedented HEAT STREAK! NASA scientists further estimate Earth in 2024 was about 2.65 degrees Fahrenheit (1.47 degrees Celsius) warmer than the mid-19th-century average (1850-1900).
- The Paris Agreement on climate change sets forth efforts to remain below 1.5 degrees Celsius over the long term. To put that in perspective, temperatures during the warm periods on Earth three million years ago — when sea levels were dozens of feet higher than today — were only around 3 degrees Celsius warmer than pre-industrial levels, said Gavin Schmidt, director of NASA's Goddard Institute for Space Studies (GISS) in New York. Hence, we are halfway to PLEISTOCENE level warmth in just 150 years.
- The warming trend of recent decades is driven by heat-trapping carbon dioxide, methane, and other greenhouse gases. In 2022 and 2023, Earth saw record increases in carbon dioxide emissions from fossil fuels, according to a recent international analysis. The concentration of carbon dioxide in the atmosphere has increased from pre-industrial levels in the 18th century of approximately 278 parts per million to about 420 parts per million today.

FOOD, FEED, AND FUEL



**2018**  
Total: 7,548,409,960

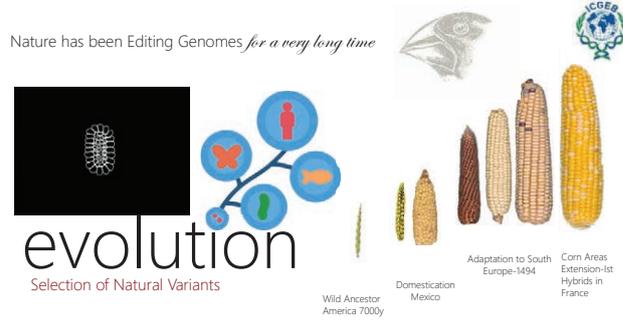
**NUTRITIONAL IMPROVEMENT OF CROPS**

**Tanushri Kaul**  
Group Leader  
tanushri@icgeb.res.in  
<https://www.icgeb.org/nutritional-improvement-of-crops/>



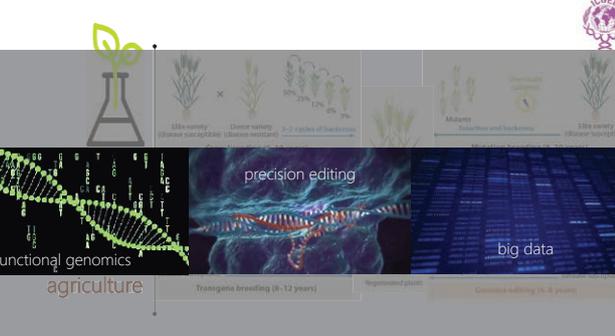
Nature has been Editing Genomes for a very long time

**evolution**  
Selection of Natural Variants



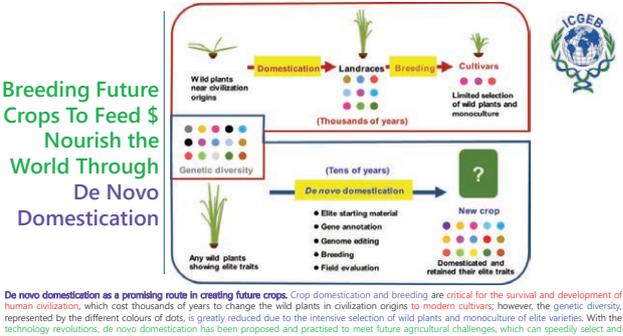
Wild Ancestor America 7000y  
Domestication Mexico  
Adaptation to South Europe-1494  
Corn Areas Extension-1st Hybrids in France

functional genomics, precision editing, big data, agriculture



Transgene breeding (8-12 years), CRISPR/Cas9 (1-4 years)

**Breeding Future Crops To Feed & Nourish the World Through De Novo Domestication**



Wild plants near civilization origins → Domestication → Landraces → Breeding → Cultivars (Thousands of years)

Genetic diversity → De novo domestication → New crop (Tens of years)

- Elite starting material
- Gene annotation
- Genome editing
- Breeding
- Field evaluation

Domesticated and retained their elite traits

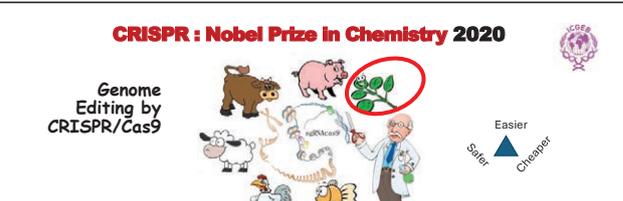
De novo domestication as a promising route in creating future crops. Crop domestication and breeding are critical for the survival and development of human civilization, which cost thousands of years to change the wild plants in civilization origins to modern cultivars; however, the genetic diversity, represented by the different colours of dots, is greatly reduced due to the intensive selection of wild plants and monoculture of elite varieties. With the technology revolutions, de novo domestication has been proposed and practised to meet future agricultural challenges, which can speedily select and domesticate elite wild plants while retaining the genetic diversity and the associated elite traits.



- Intensive farming, especially monoculture, is damaging the very soil it needs to grow healthy crops
- As soil quality decreases, so do the nutritional value of the crops that are produced.
- Hence, more use of Synthetic Fertilizers, Pesticides etc. that destroy organic Matter-Microbes
- Diversification of Diets is Crucial To Protect Top Soil Degradation And Human Health.
- Inclusion of Diverse Underutilized Nutrient-Rich Food Crops into Mainstream Commercial Markets for Consumer Health is The Key. (Rice bean, Amaranthus, Moringa, Buckwheat, MILLETS, Barley, Quinoa)

**CRISPR : Nobel Prize In Chemistry 2020**

Genome Editing by CRISPR/Cas9



Easier, Safer, Cheaper

- Humankind is on the verge of Genetic Revolution that holds great promise and potential in the areas of human health- somatic GE, gene therapy-cancer immunotherapy, infectious diseases, diagnostic tools, livestock- animal models, environment and agriculture.
- Alter the way food is grown, medicine is produced, animals are modified.
- Innovation in strategies to produce plastics, biofuels, chemicals etc.

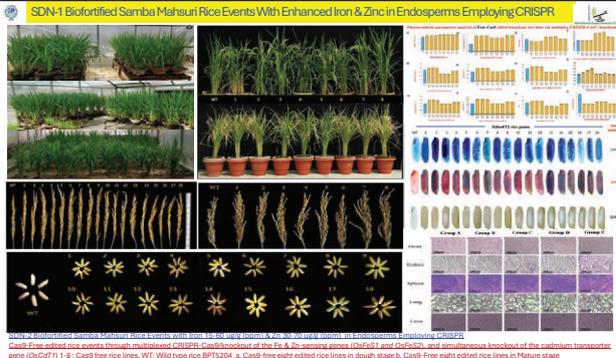
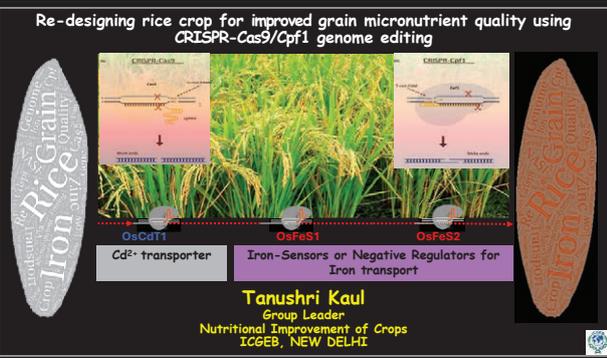
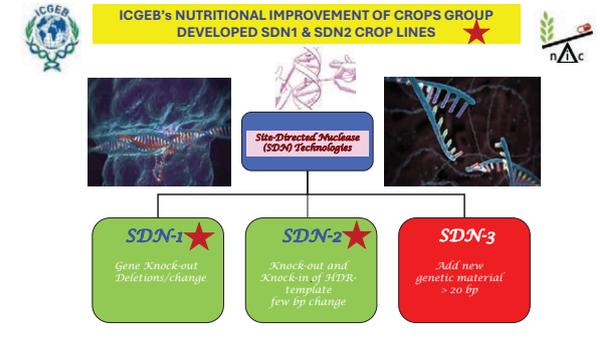
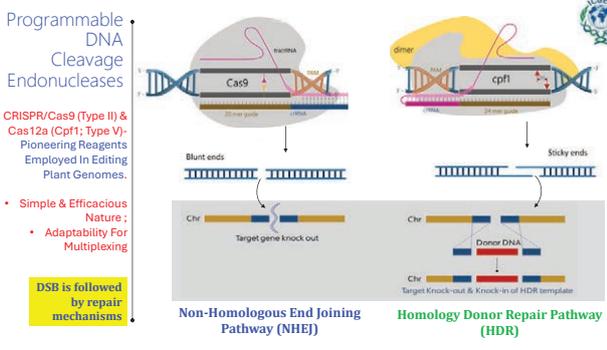
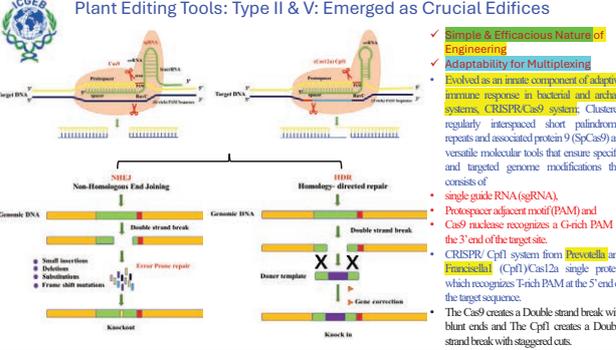
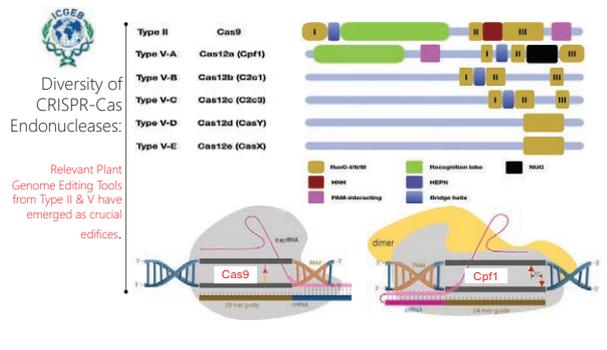
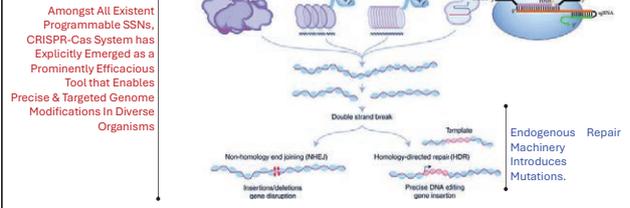
Ready-to-use set of precise surgical tools poised to salvage our food supply from climate change, weeds, poor nutrient levels and pathogens.

### THE CRISPR MENAGERIE

- Control the Genetic Composition of Species that Co-inhabit Earth
- Display facts about Nature & Genetic similarities that bind us
- Plants that stand climate change
- Plants that are resistant to Diseases resistance
- MLO gene mutation led to powdery mildew resistance in BARLEY, WHEAT
- SWEET GENES mutations led to Bacterial blight resistance in RICE
- HUANGLONGBING or Yellow Dragon Disease-Resistance in SWEET ORANGES
  - Affecting Asia, California, Texas & Florida
- SOIL-FUNGUS (*Fusarium oxysporum*) Resistance in Cavendish-BANANAS (Soo-Kim, S Korea)
- Natural Resistance to Herbicides in CORN, SOYBEAN, POTATO
- Mosquitoes that are unable to transmit Malaria
- Cows that No Longer Grow Horns, Goats with more muscle-meat-hair
- Ultra-muscular dogs that make fearsome partners for Police & Army.
- Creating Micropigs, Swines-No bigger than large cats that may be sold as pets.
- De-Extinction Ventures- Dodo, Mammoths, Winged Lizards (pterosaur), Unicorn... Geneticists using CRISPR wish to resurrect extinct beasts, someday!
- Studying relationships with modern-day species? Beth Shapiro, Univ Of California, Santa Cruz
- Study of Unique Features: Regeneration potential of limbs in Mexican salamanders, butterfly wing patterns, ageing in kill fish, yeast that infects human tissues, pigs as donors for human organs, ...?? Applications on our own species has greatest promise & peril



### Programmable DNA Cleavage Endonucleases





### Development of Transgene-Free Glyphosate-Resistant SDN-2 Rice

Tanushri Kaut  
Group Leader  
Nutritional Improvement of Crops Group  
ICGEB, Aruna Asat Ali Marg  
New Delhi-110067 INDIA

### Glyphosate: Non-Selective Broad Spectrum Systemic Herbicide

Introducing mutations in glyphosate binding sites in OsEPSPS gene by using CRISPR/Cas9

Glyphosate Resistant Rice Plants With Enhanced Yield

### CRISPR/Cas9-Based Genome Editing of Native EPSPS Employing Knock-out and Knock-in of Homology Donor Repair Template

Precise Sequence Modification of EPSPS genes by introducing three mutations in the target site amino acids.

### Cas9-Free SDN-2 Samba Mahsuri Rice Events With Enhanced Glyphosate Resistance

Quantification of Essential Aromatic Amino Acids (Tyr, Trp, Phe)

Quantification of Shikimate

### CRISPR-Cas9-Based EDITING OF PEP Target Site of Native EPSP Synthase gene in Maize

**CRISPR/CAS9-MEDIATED HOMOLGY DONOR REPAIR BASE EDITING SYSTEM TO CONFER HERBICIDE RESISTANCE**

Weed infestation poses a global threat to crop yield. To address this, CRISPR/Cas9-mediated HDR was used to knock-out a conserved region of the native *ZmEPSPS* gene and knock-in a modified fragment with triple amino acid substitutions (CAIIP). The edited maize lines exhibited superior glyphosate resistance, transgene-free inheritance, and enhanced aromatic amino acid content, with agronomic performance comparable to wild-type plants, offering a sustainable solution for improved crop resilience.

- Our group developed EPSPS edited maize lines tolerant to non-selective herbicide glyphosate.
- Technology is being extrapolated to other crops that face weed constraint- tomato, soybean & chickpea

Maize EPSPS gene Edited LINES Treated With 4ml Glyphosate

### Developing double herbicide tolerant pigeonpea for improved weed management employing two-pronged approach: haplotype mining in native germplasm and CRISPR/Cas9 mediated genome editing

Pigeonpea (*Cajanus cajan* L.) is a major legume crop in India and an important source of protein and food for both humans and animals. Weed infestation is one of the crucial biotic stress factors contributing to yield loss in pigeonpea. To overcome the weeds infestation, selective post-emergence herbicides have been used. One of the most widely used herbicides in agriculture today is glyphosate (post-emergence herbicides). Its mode of action encompasses inhibition of 5-enolpyruvylshikimate-3-phosphatase synthase (EPSPS), an enzyme involved in the biosynthesis of aromatic amino acids (Tyr, Trp, Phe). Besides glyphosate, ALS (Acetolactate synthase) inhibiting herbicides are widely used around the world. When we spray plants with these herbicides, plants cannot biosynthesize essential branched-chain amino acids due to the inhibition of ALS.

Introducing mutations in EPSPS binding sites in CcEPSPS gene by using CRISPR/Cas9

Introducing mutations in Sulfonylurea binding sites in CcALS gene by using CRISPR/Cas9

### CRISPR/Cas9-Based Genome Editing of Native EPSPS Employing Knock-out and Knock-in of Homology Donor Repair Template

Precise Sequence Modification of EPSPS genes by introducing three mutations in the target site amino acids.

### CRISPR/Cas9-Based Genome Editing of Native ALS Employing Knock-out and Knock-in of Homology Donor Repair Template

Precise Sequence Modification of ALS gene by introducing one, two or three mutations in the target site amino acids.

### Combating Aggressive Weeds in Pigeonpea (*Cajanus cajan* L.) through CRISPR-Based Genome Editing

Weed infestation severely limits pigeonpea productivity. To address this, the *GEPF5* gene was precisely edited at positions 182G to A, 1837A to L and 1879A to S using CRISPR-Cas9-mediated HDR, reducing glyphosate binding affinity. The edited plants exhibited stable inheritance, enhanced glyphosate resistance, and maintained superior photosynthetic efficiency and agronomic performance post-herbicide application, offering a sustainable and efficient weed management solution.

Photosynthetic parameters (Fv/Fm, Fv/Fm-1, Fv/Fm-2, Fv/Fm-3) for Control, Pigeonpea, and Weed lines under 3mL Glyphosate treatment.

### Advancing Herbicide Resistance in Soybean (*Glycine max* L.) through CRISPR/Cas9 Genome Editing

Weed infestation poses a significant challenge to soybean production, leading to severe yield losses. To tackle this issue, CRISPR/Cas9 genome editing technology was used to develop herbicide-resistant soybean lines by targeting key genes involved in herbicide sensitivity, *GmEPF5* and *GmALS5*. Sequencing of T<sub>1</sub> plants revealed successful mutations in *GmEPF5*, including G18A/T18G and G18A/T18G, and while two crucial edits, *GmALS5*, were identified in *GmALS5*. Cas9 integration and mutation-specific primer analysis validated the incorporation of these edits, with sequencing confirming site-specific modifications. These promising lines will undergo further screening and agronomic evaluation to establish robust, herbicide-resistant soybean varieties capable of sustaining productivity under aggressive weed pressures.

In vitro expression of multiple chimeric dsRNA constructs in different soybean lines (Gm, BL, and LAF). Survival percentage of T<sub>1</sub> plants under different herbicide treatments (Control, Roundup, LAF, and LAF+Roundup).

### CRISPR/Cas9-Mediated Genome Editing for Enhanced Fibre Quality and Agronomic Traits in Cotton

Cotton production faces challenges in simultaneously improving fibre quality and yield due to its complex genome. Through CRISPR/Cas9-based genome editing, a key negative regulator of fibre development was precisely knocked out, achieving a 100% mutation efficiency. Molecular analysis validated the successful edits. The edited plants demonstrated a significant twofold increase in fibre length, a 25-30% yield enhancement, and improved plant morphology. Early flowering was also observed, contributing to shorter cultivation periods. These advancements provide a promising approach for developing early-maturing, high-yielding, and high-quality Upland cotton cultivars, supporting sustainable cotton production and improved market competitiveness.

Fibre length (mm) and Fibre strength (g/tex) for Control, C1-6, C3-2, C1-4, and C3-7 Cotton Genome Edited Lines.

### CRISPR/Cas9-Mediated Development of Hypo-Allergenic & Hyper-Lycopene Tomatoes

Tomato's allergenic properties affect 12-14% of consumers, posing health risks and impacting food security. To address this issue, CRISPR/Cas9 genome editing was employed to precisely knockout a key allergen-regulating factor, achieving a 100% mutation rate and complete gene disruption. The edited lines exhibited significantly reduced allergenicity and improved nutritional safety. Enhanced stress adaptation was also observed in these modified plants. This breakthrough promotes healthier tomato consumption, reduces health risks for sensitive consumers, and contributes to sustainable agriculture. The innovation aligns with efforts to tackle food security challenges and improve consumer health.

CRISPR Validation and Gene Specific PCR validation. Below are images of tomatoes and a gel electrophoresis image.

### Genome-Edited DDSR-Herbicide Resistant & Fe-Zn Enriched Samba Mahsuri: Climate Smart, Water-Wise Dry-Direct Seeded Rice for Sustainable & Profitable Rice Production: Exploring the Paradigm Shift from TPR to DDSR

**Dr. Tanushri Kaul**  
Group Leader  
Nutrition & Crop Improvement Group

### Water-Guzzling Puddled Transplanted Rice (CT-TPR) & Global Warming Potential

- The demand for rice is on the rise. Projections by the world researchers anticipate crop production needs to increase by 100-110% in the next 30 years in order to meet global demand in the face of ever-increasing population.
- To achieve this challenge in a sustainable way, we have to produce this extra rice more efficiently with less labour, water, energy, and agro-chemicals to reduce the environmental footprint of rice production.
- In traditional rice cultivation methods, 40-50% of the world's irrigation water is applied for rice production. Presently irrigated agriculture accounts for 70% and 90% of total freshwater withdrawal, globally and in Asia, respectively. Per capita water availability reduced by 34-76%.
- Rice is a major freshwater user and consumes about 1000 times of Freshwater to produce ONE kg of Paddy Rice.
- Increasing water scarcity due to climate change and competition from urbanization is making this traditional method of rice production unsustainable in the long term.
- Combined with other factors like increasing population, shortage of labour and decreasing arable land, new ideas and innovations in rice cultivation are critically needed to meet rising demand and ensure food and nutritional security.
- Rice along with wheat forms the bedrock of Indian food security and to meet the country's stated goal of ensuring food for all, farmers will have to produce more rice from lesser land, which necessitates present and future investments in R&D for more rice development.

### Dry DSR-Need of the Hour: PROS & CONS Associated With Dry Direct-seeded Rice (DDSR).

DDSR system has various advantages over the transplanted and Wet-DSR systems such as:

- Reduced Water Usage, ZT, DZT
- Reduced Methane Emissions, N<sub>2</sub>O, CH<sub>4</sub>, CO<sub>2</sub> = 60:39:1 Rice-based CT-TPR.
- Compatible with Mechanization,
- Less Labour Requirement
- Shorter Crop Duration-Early maturity
- Better Soil Structure-No Hard Pan
- Successing crops grown after DDSR showed better yield than TPR.

At the same time, several challenges that have to be addressed to make DDSR a regular practice:

- Weed Rivalry,
- Micronutrient deficiencies: Fe, Zn, P, N (NH<sub>4</sub>)<sup>+</sup>
- Susceptibility To Diseases: BLB, Blast, Brown Spot
- Soil-borne-Pathogens-RKN-nematodes, Pathogenic fungus
- Lodging Susceptibility- Harvesting is difficult.
- Early Seedling Vigour – Seed Establishment, Growth Performance.

### Key Aspects of DDSR

- Water Conservation:** DDSR requires less water compared to traditional flooded rice cultivation methods, as it can be grown under aerobic conditions. This can help in conserving water, especially in regions facing water scarcity.
- Labor and Cost Savings:** DDSR eliminates the need for labor-intensive activities like raising nursery beds, transplanting seedlings, and maintaining flooded conditions. This can result in significant cost savings for farmers.
- Reduced Methane Emissions:** Unlike flooded rice cultivation, DDSR reduces methane emissions from paddies, which contributes to greenhouse gas reduction efforts. Trade-off between Methane and Nitrous Oxide is a problem in devising GHG mitigation strategies in rice. Crucial Soil redox potential for release of N<sub>2</sub>O is -250mV
- Weed Management & Nutritional Deficiencies:** DDSR requires effective weed management strategies, such as the use of herbicides, mechanical weeding, or crop rotation, to control weeds since the flooded conditions that suppress weeds in transplanted rice are not present. Nutrient dynamics also needs a boost as mobility & solubility is affected in aerobic conditions.
- Grain Yield Potential:** Properly managed DDSR can achieve comparable or even higher yields than traditional transplanted rice, especially in favorable conditions.



### Common Weeds of DDSR

**Common Weeds:** *Paspalum disticum*, *Digitaria setigera*, *Echinochloa glabrescens*, *Echinochloa crus-galli*, *Fimbristylis millettii*, *Oryza sativa*, *Cyperus difformis*, *Echinochloa colona*, *Paspalum disticum*, *Sphenoclea zeylanica*.

There is a Drastic Change in Composition and Diversity of Weed Flora with a SHIFT from CI-PTR to DDSR within 4-6 seasons of DDSR Cropping in India and Malaysia & Vietnam.

Emergence of weeds like Weedy-Rice (*O. sativa F. spontanea*) is a serious concern in DDSR causing yield loss between 15%-100%.

Milling Quality gets impaired if Weedy Rice gets mixed with rice seeds during harvesting.

### Weed Management

**Potential yield loss (%)**

Method	Yield Loss (%)
Manual	48.2
Mechanical	30.3
Chemical (Roundup spraying)	43.4
Other	62.5
Other	33.6
Other	42.3
Other	52.8
Other	56.5
Other	53
Other	41.1

**Global yield loss (%)**

Method	Yield Loss (%)
Manual	48.2
Mechanical	46.2
Chemical (Roundup spraying)	61.5
Other	21.4
Other	31
Other	38.19
Other	12.8
Other	34.4
Other	24
Other	47

The standard rate of foliar Roundup spraying is 0.75 lb a eiga/acre.

The current total global grain production is ~2.1 billion metric tons. Assuming an overall yield loss of 10% due to weeds (www.fao.org/3/cb944a/b94a.pdf), the total loss in grain production is ~200 million metric tons. If this loss can be reduced by half, grain production would increase by 100 million metric tons, which could serve in reducing hunger worldwide.

### Annual Economic Losses Due To Weeds In India.

**Economic losses (USD in million)**

Crop	Loss (USD million)
Rice	4420
Soybean	3376
Wheat	1559
Maize	720
Groundnut	257
Mustard	75
Chickpea	283
Green gram	104
Black gram	161
Other	50
Other	276
Other	49

**Economic losses (in crore)**

Crop	Loss (in crore)
Rice	28000
Soybean	22000
Wheat	10000
Maize	4500
Groundnut	1600
Mustard	450
Chickpea	1700
Green gram	650
Black gram	1000
Other	300
Other	1700
Other	300

India loses agricultural produce worth over \$11 billion; wherein Rice exhibited the maximum loss of \$4.4 billion.

### Glyphosate Status in India

Glyphosate based herbicides are registered and approved in India for weed control in tea gardens and their non-crop areas. However, **glyphosate is used for weed control in more than 20 crop fields (16 of them are food crops)** as well as non-crop areas.

Statistical data on pesticides in India shows that **glyphosate stands at the second position in production and consumption among herbicides**, following 2,4-D. The data for production and consumption shows a huge difference and little information is available on its export.

Though **seven glyphosate formulations are approved in India**, only **three are reported to be employed by farmers**. Glyphosate 41% SL is the widely used one, followed by Glyphosate 71%SG. A formulation, comprising of a combination of Oxyfluorfen 2.5% + Glyphosate (Isopropylamine salt) 41% SC is also reported.

An Indian Council of Agricultural Research's report reveals that **two formulations of glyphosate, 41% SL and 71% SG are widely used in at least 22 Indian states for a number of cereals, pulses, oilseeds, fruits, vegetables, fibre crops, etc.** About 52 brands of four glyphosate formulations have been reported (Choudhary et al. 2016).

Data source: Pesticide Action Network India (PAN India), PAN Asia Pacific, (PANAP) - State of Glyphosate Use in India

### Glyphosate Status in India

Glyphosate is registered for use in India under the provisions of Insecticide Act, 1968 (CIBRC)

In India, seven formulations of glyphosate [Glyphosate 41% SL, 20.2% SL, 5%SL; Glyphosate ammonium salt 71% SG, 5% SL(FI), 20% SL; Glyphosate Isopropyl amine salt (IPA) 41% SL] are registered under Insecticide Act 1968, for commercial use (<http://ppqs.gov.in/divisions/cib-rc/registered-products> as on 01-06-2023, cited on 05-07-2023).

Source: <https://ppqs.gov.in/divisions/cib-rc/registered-products>

### India- State Wise Glyphosate Consumption In Rice Field

State	Volume (t or kL)	Value (₹ in crore)
Jammu & Kashmir and Himachal Pradesh	10.10	2.45
Haryana	7.89	3.94
Punjab	58.60	14.21
Assam and North-East states	5.81	1.41
Gujarat	5.81	1.41
Odisha	2.32	0.56
Karnataka and Goa	3.11	0.75
Andhra Pradesh	15.01	3.64
Kerala	0.35	0.08
Tamil Nadu	7.92	1.92

\*- Ton : kL - kilolitre

Data Source: ICAR - Directorate of Weed Research; Herbicide Use in Indian Agriculture

### ICGEB's NUTRITIONAL IMPROVEMENT OF CROPS GROUP DEVELOPED SDN1 & SDN2 CROP LINES

**Site-Directed Nuclease (SDN) Technologies**

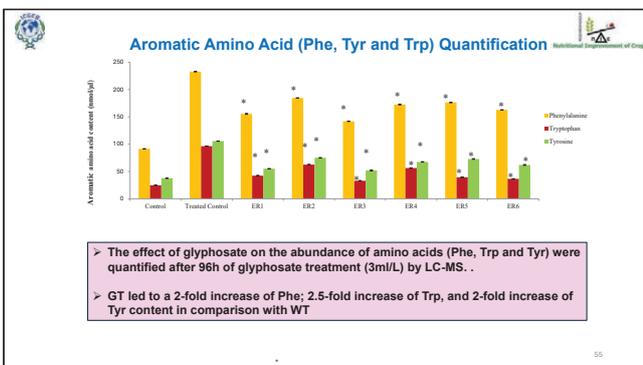
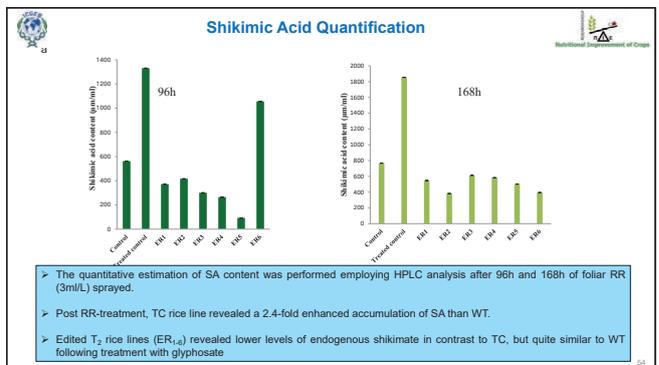
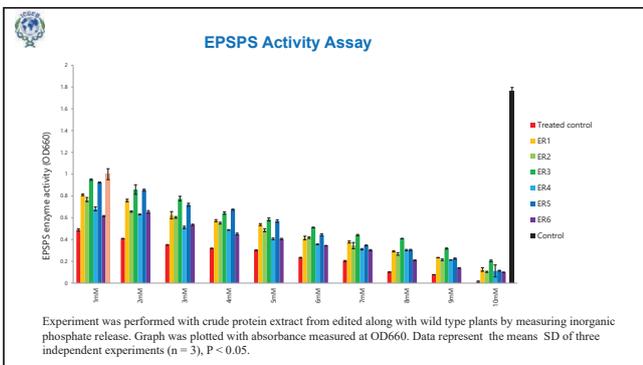
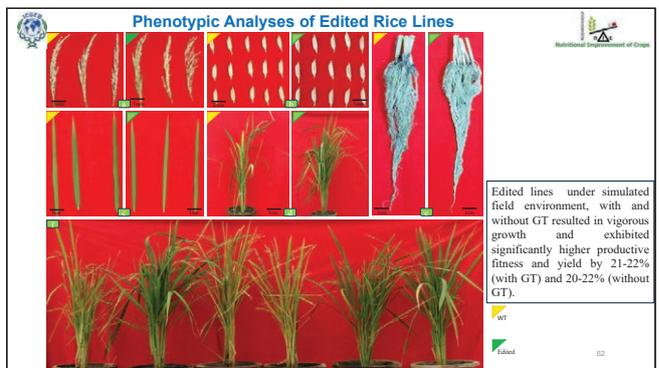
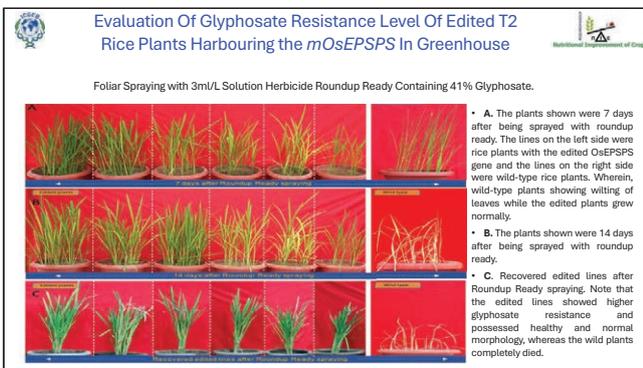
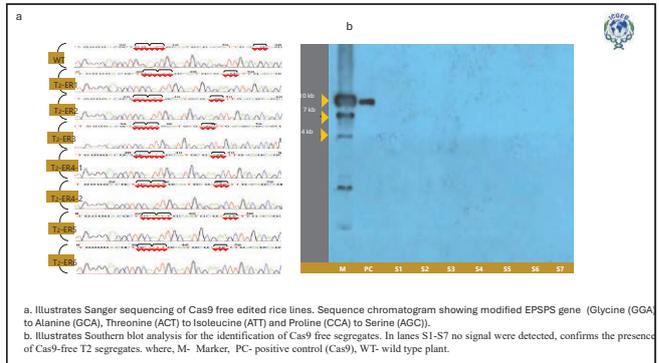
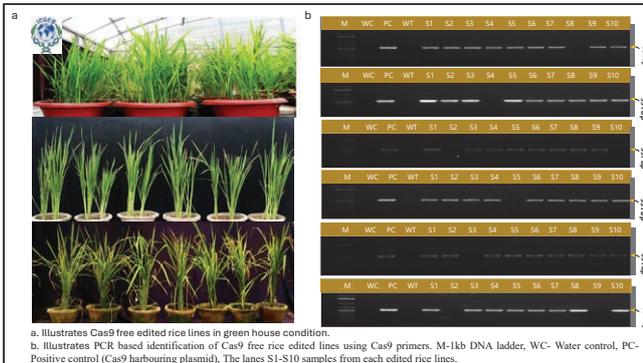
- SDN-1:** Gene Knock-out Deletions/change
- SDN-2:** Knockout and Knock-in of HDR template few bp change
- SDN-3:** Add new genetic material > 20 bp

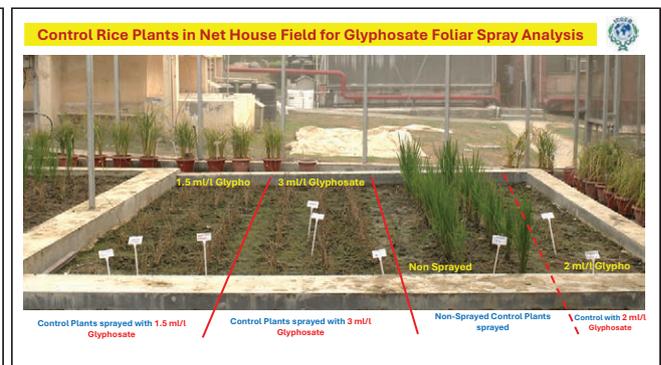
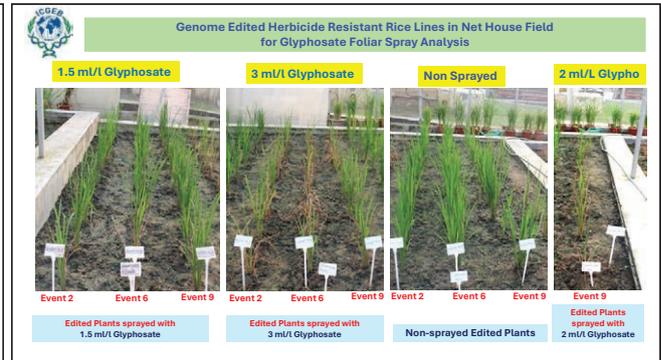
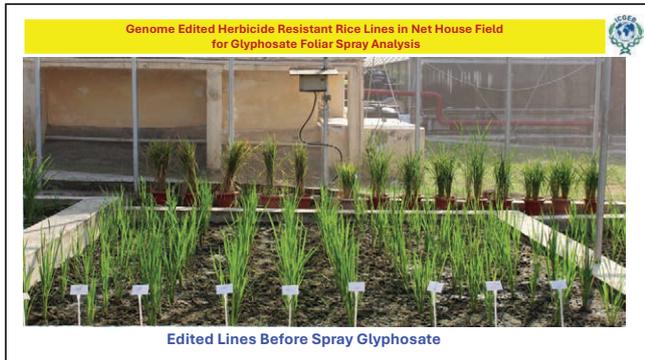
### Development of Transgene-Free Glyphosate-Resistant SDN-2 Rice

**Development of Transgene-Free Glyphosate-Resistant SDN-2 Rice**

Tanushri Kaul  
Group Leader  
Nutritional Improvement of Crops Group  
ICGEB, Aruna Asaf Ali Marg  
New Delhi-110067 INDIA







Re-designing rice crop for improved grain micronutrient quality using CRISPR-Cas9/Cpf1 genome editing

Traditional Rice Grain Iron Quality vs. Edited Rice Grain Iron Quality

OsCdT1 Cd<sup>2+</sup> transporter

OsFeS1 Iron-Sensors or Negative Regulators for Iron transport

OsFeS2 Iron-Sensors or Negative Regulators for Iron transport

**Tanushri Kaul**  
Group Leader  
Nutritional Improvement of Crops  
ICGEB, NEW DELHI

More than 2 billion people are affected by iron-zinc deficiency worldwide, in developed & developing nations.

Anaemia as a public health problem by country: Preschool-age children

- In developing countries every second pregnant woman and about 40% of preschool children are estimated to be anaemic.
- In many developing countries, iron deficiency anaemia is aggravated by worm infections, malaria, and other infectious diseases such as HIV and tuberculosis.
- Major health consequences impaired physical & cognitive development, increased risk of morbidity in children & reduced work productivity in adults.

✓ Globally, IDA-ADE affects 43-50% children as well as 38% pregnant and 29% non-pregnant women.  
✓ Anaemia contributes to 20% of all maternal deaths.

Current Nutritional Status (Fe/Zn) & Cd Toxicity

- Nachimuthu et al 2014 Ind J Sci Technol, Collection of 192 rice genotypes (brown rice) of diverse origin to assess variability in iron & zinc revealed that Rice germplasm Fe content ranges from 6.6 µg/g to 16.7 µg/g and Zn 7.1 µg/g to 32.4 µg/g with mean value of iron as 10.1 µg/g and zinc as 15.4 µg/g
- Anuradha et al. 2012 J Phytol 4:19-25, Analysed 126 accessions of brown rice genotypes Fe content 6.2 to 71.6 ppm and Zn content 26.2 to 67.3 ppm.
- Presently, Iron Content in Polished Rice Endosperms of popular varieties grown in field: 2-4 µg/g DW of Iron / 2-4 ppm Fe (Daily req: Iron is 16-28 mg/Day & Zn is 10-12 mg/Day)
- In order to provide 30% to 40% of dietary estimated average requirement (EAR) of iron & zinc, ppm that should be present in polished rice grain endosperms is Iron (15 µg/g Dry Weight) & Zinc (28 µg/g Dry Weight).
- More than 40% of dietary intake of cadmium is via rice leading to major health issue, especially in Asia. Higher Health Index (HI) values of rice consuming adults (1,561) and children (1,360) suggest adverse health effects in the near future. [Cd in Indian soils at the East Coast range from 0.02 to 0.6 µg/g-1 (Toxic levels 0.2 mg/kg)]

- Rice grain quality is crucial economic trait for consumers as it's one of the staple food crops, worldwide. Low levels of iron & zinc in rice grains cause nutritional deficiency related disorders, predominantly anaemia, especially in pregnant women and kids (< 5y) that rely on cereal-based diets. Iron and zinc also act as cofactors for plant growth and development. Plants have excogitated intricate regulatory mechanisms for metal ion accretion and transport as well as averting their hyper-accumulation, conjointly termed as metal ion homeostasis.
- Recognition of neoteric iron regulons/sensors in rice Zinc-finger proteins (OsFeS1, OsFeS2) that bind iron and zinc, exhibit an innate ubiquitination activity and act as negative regulators of iron accumulation in rice grains.
- More than 40% of dietary intake of cadmium is via rice leading to major health issue, especially in Asia. Higher Health Index (HI) values of rice consuming adults (1,561) and children (1,360) suggest their adverse health effects in the near future. Rice grains accumulate Cd via xylem to phloem transport. Regulation of transporters modulating Cd transport can alter the level of Cd deposition in grains. OsCdT1 has been shown to be involved in xylem to phloem Cd<sup>2+</sup> transport to grains & KD lines show low Cd and high Fe in grains.
- We proposed to knockout (KO) these 3 genes simultaneously in the rice genome by multiplex CRISPR-Cas9/Cpf1-based genome editing to develop rice lines with improved micronutrient quality i.e., high Fe, and low Cd-contents in grains of desired rice varieties.

Background

Mitico-analysis

Hypothesis



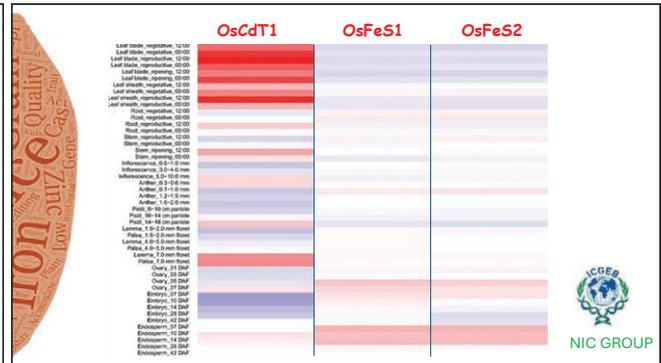
### PROOF OF CONCEPT

**Oryza sativa**

## Quantification of Ion level in a single cell can be predicted by Machine Learning

Inspiration of Algorithm has been adopted from Daniel C et al., 2018

NIC GROUP



### Constructing MODELS TO QUANTIFY IRON LEVELS in RICE Grains

To achieve the quantifications of Iron and Zinc Level, we have taken following features:

- Gene Sequence data
- Synonymous and Non Synonymous mutational data
- Gene Expression profiles
- Protein interactome profiles
- Enzyme kinetics profiles
- Metabolite (Both Small molecule and Ions) quantification profiles
- Descriptors profiles of each metabolites

Gene of interest for this proposal to knock out: **FeS1, FeS2, CdT1**

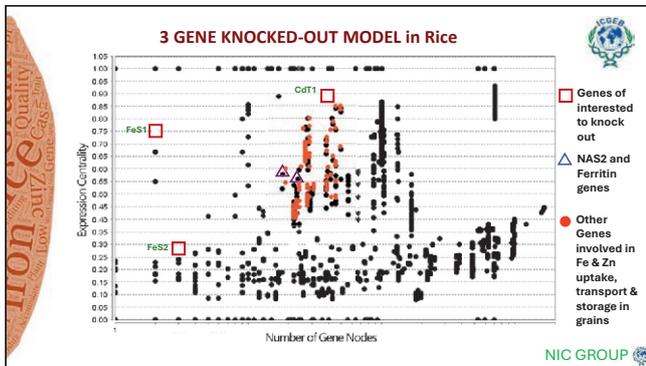
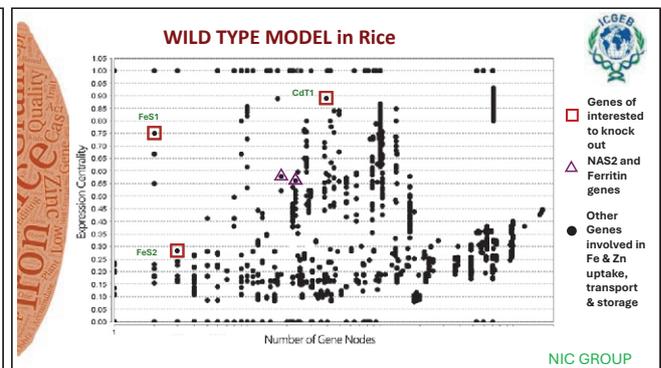
Total Network

Number of Edge is number of Genes involved  
Number of Node is cumulative cut off of total features involved

Number of features is total data available in the Biological database and NIC processed data

Genes and its node naturally have been selected as less neighbourhood centrality (kNN). So influence of network after knocking out is less and found only 18 genes are connected to the function. The analysis further was performed to check 27 gene regularities.

NIC GROUP



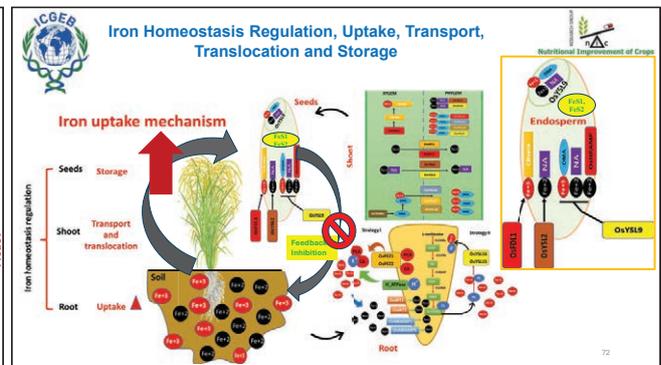
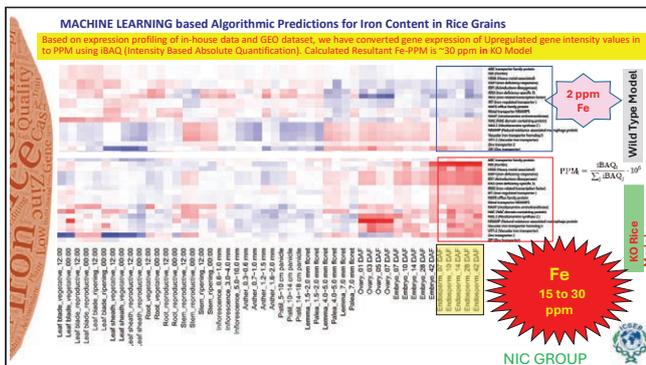
Ranking Matrix have been organised to compute all the multi-formatted data in to unidimensional plot as cut off value (0 to 1).

We have used Diffusion Matrix to combine all data and ranked all gene regulations. We kept Gene as the centrality point to insist its regulatory factors as upregulation or down regulations.

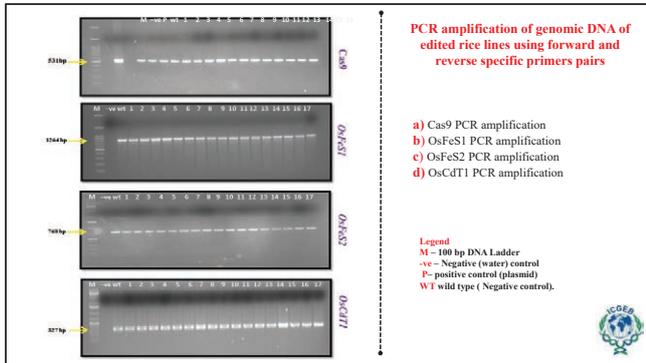
List of Genes	Ranking of Cumulative cut-off - Model	Ranking of Cumulative cut-off - Knocked gene model	Ranking Distance	Remarks
ABC transporter family protein	10227	9426	803	Upregulated
Fe (Ferritin)	7356	521	2064	Upregulated
HMA (Heavy metal-associated)	17650	9039	4611	Upregulated
IDF1 (Iron deficiency responsive)	16453	2719	13734	Upregulated
IDA1 (Acidoblastic dependent)	12174	10665	1229	Upregulated
IDS3 (Iron deficiency-specific 3)	11388	1366	10023	Upregulated
IRI2 (Iron-related transcription factor)	13658	4785	8873	Upregulated
IRT (Iron regulated transporter)	13112	3269	9863	Upregulated
MATE efflux family protein	18326	4327	13999	Upregulated
Natural transporter, NtMATE	8951	2243	6708	Upregulated
NARF (Nucleoside diphosphate reductase)	9500	6521	6159	Upregulated
NAC (NAC domain-containing protein)	6684	854	5830	Upregulated
NAS2 (Nicotianamine synthase 2)	13354	1250	10004	Upregulated
NRAMP (Natural resistance-associated macrophage protein)	5241	1712	3529	Upregulated
Vacuolar iron transporter homolog 5	14819	4947	11872	Upregulated
YPT1-2 (Yuscular iron transporter)	8709	3353	5450	Upregulated
Zinc transporter 2	11022	2513	8510	Upregulated
ZnT (Zinc transporter)	6505	1365	5450	Upregulated

Legend: ● Biological database and ● NIC processed data

NIC GROUP







Mutations identified within the target site of *OsFeS1* generated through CRISPR/Cas9 mediated genome editing

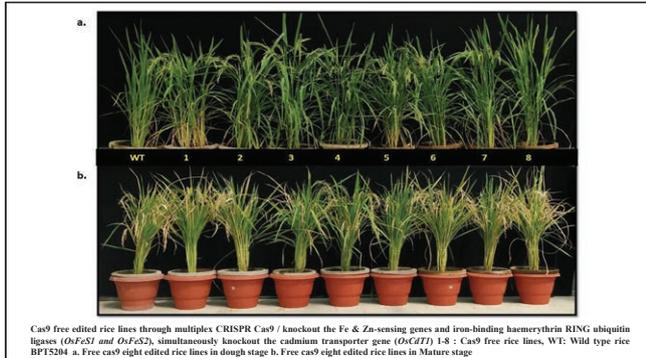
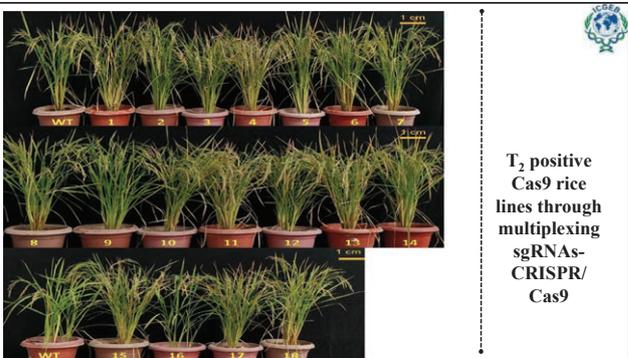
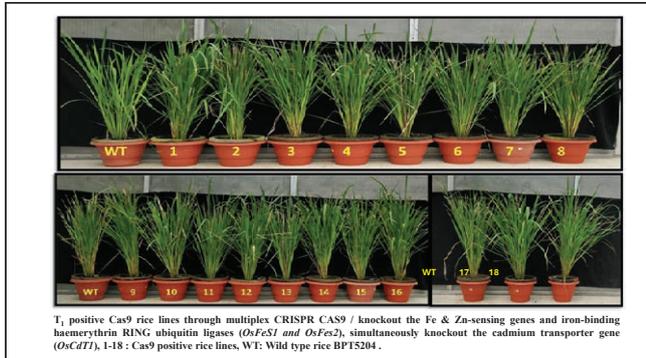
No.	Gene	gRNA sequence		PAM sequence		1 bp	Insertion	Deletion	Transversion	Transition
		gRNA sequence	PAM	CGG	CGG					
WT	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
641	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
642	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
643	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
644	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
645	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
646	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
647	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
648	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
649	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
650	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
651	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
652	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
653	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
654	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
655	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
656	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
657	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
658	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
659	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								
660	CTT0A099- <i>ACTC9C-AT-C-C-T-G-TAC-A</i>	-----G-999CCATCAACCA								

Mutations identified within the target site of *OsFeS2* generated through CRISPR/Cas9 mediated genome editing

No.	Gene	gRNA sequence		PAM sequence		1 bp	Insertion	Deletion	Transversion	Transition
		gRNA sequence	PAM	AGG	AGG					
WT	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
641	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
642	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
643	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
644	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
645	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
646	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
647	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
648	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
649	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
650	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
651	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
652	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
653	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
654	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
655	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
656	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
657	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
658	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
659	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
660	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									

Mutations identified within the target site of *OsCdT1* generated through CRISPR/Cas9 mediated genome editing

No.	Gene	gRNA sequence		PAM sequence		1 bp	Insertion	Deletion	Transversion	Transition
		gRNA sequence	PAM	CGG	CGG					
WT	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
641	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
642	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
643	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
644	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
645	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
646	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
647	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
648	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
649	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
650	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
651	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
652	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
653	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
654	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
655	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
656	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
657	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
658	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
659	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									
660	CGAGGCAGCAAGGTCGGA-G-TGGAGCGCGCCGAGAGGGA									



Mutations identified within the target sites of *OsFeS1*, *OsFeS2* and *OsCdT1* generated through CRISPR/Cas9 mediated genome editing in T<sub>2</sub> Cas9-free edited rice lines generation

No.	Gene	gRNA sequence		PAM sequence		1 bp	Insertion	Deletion	Transversion	Transition
		gRNA sequence	PAM	CGG	CGG					
WT	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
641	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
642	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
643	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
644	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
645	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
646	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
647	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
648	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
649	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
650	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
651	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
652	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
653	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
654	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
655	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
656	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
657	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
658	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
659	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									
660	AGAGGCCTTCAAATGCGGAA-CAAAGTTAGATTTTA									

## Genotype Confirmation

Determination of genotype at the *Osfes1*, *Osfes2* and *Oscdt1* genes locus after CRISPR/Cas9 editing

The CRISPR/Cas9 system used to generate insertions or deletions (indels) in cells that can result in *Osfes1*, *Osfes2* and *Oscdt1* genes knockouts.

There are two copies of any given gene, and indels can be generated in either one or both alleles.

Aim of work:

After gene editing to determine edited plants have mutations in;

- One allele (monoallelic)
- Both alleles (biallelic)
- None of alleles (wild type)

The protocol involves:

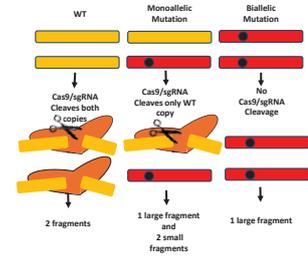
- Amplification of the target site
- **in vitro cleavage with Cas9**
- The sgRNA used for the original CRISPR/Cas9 gene editing experiment

Detection:

If indels are present at the target site, the original sgRNA/Cas9 complex will be unable to cleave the site, whereas wild-type alleles will be recognized and cleaved

## Principle of Genotype Confirmation:

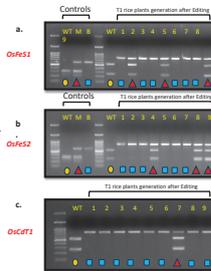
- If indels are present at the target site (black circle), the original Cas9-sgRNA complex will be unable to cleave the site;



- In contrast, wild-type alleles (yellow) will be recognized and cleaved.

- The three different cleavage patterns can be distinguished by agarose gel electrophoresis

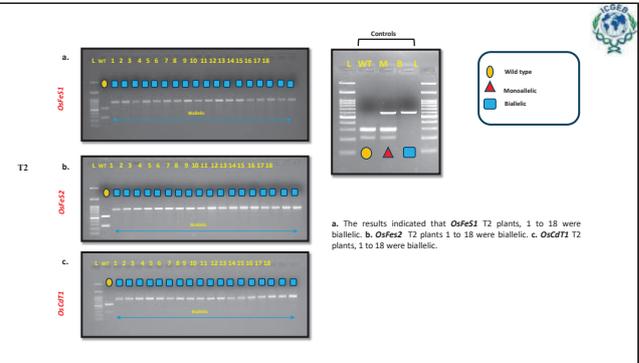
Determination of genotype at the *Osfes1*, *Osfes2* and *Oscdt1* locus after CRISPR/Cas9 editing



In this experiment, edited Rice lines were treated with Cas9 and a sgRNA targeting the *Osfes1*, *Osfes2* and *Oscdt1* genes. The Guide-IT Genotype Confirmation Kit was used to determine the genotype at the *Osfes1*, *Osfes2* and *Oscdt1* target site. Wild-type (WT), monoallelic (M), and biallelic (B), control reactions were included in the analysis.

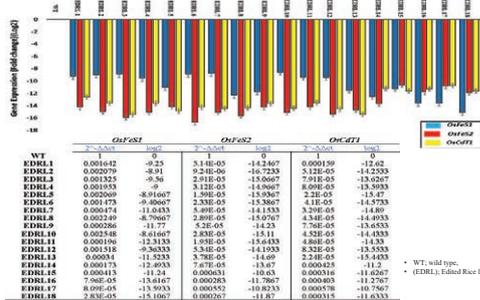


a. The results indicated that *Osfes1* T1 plants, 1, 3, 4, 6, 7 and 8 were biallelic; and plants 2, 5 and 9 were monoallelic. b. *Osfes2* T1 plants, 1, 2, 3, 5, 6 and 7 were biallelic; and plants 4, 8 and 9 were monoallelic. c. *Oscdt1* T1 plants, 1, 2, 3, 4, 5, 6, 8 and 9 were biallelic; and plant 7 was monoallelic.

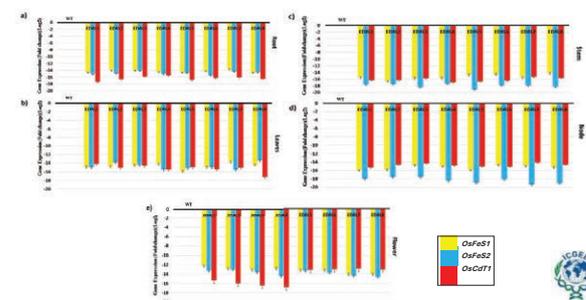


a. The results indicated that *Osfes1* T2 plants, 1 to 18 were biallelic. b. *Osfes2* T2 plants 1 to 18 were biallelic. c. *Oscdt1* T2 plants, 1 to 18 were biallelic.

Expression analysis of T2 edited knockout lines through multiplex CRISPR/Cas9/knockout the Fe & Zn-sensing genes and iron-binding haemerythrin RING ubiquitin ligases (*Osfes1* and *Osfes2*), simultaneously knockout the cadmium transporter gene (*Oscdt1*) through fold change (log2) and 2<sup>-ΔΔCt</sup> method

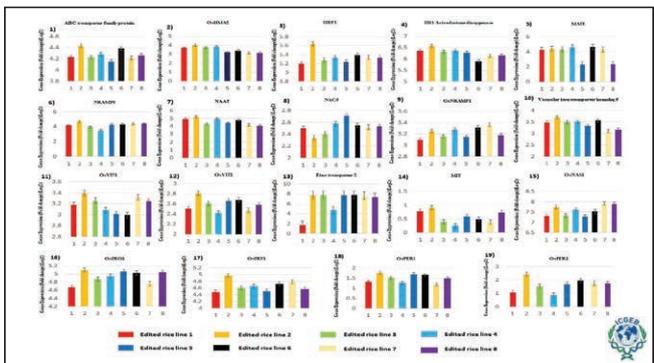


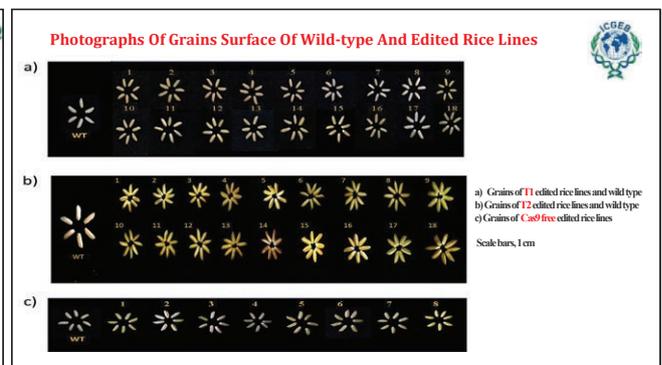
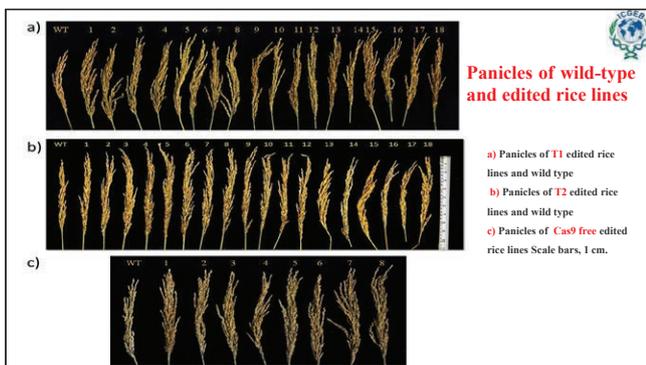
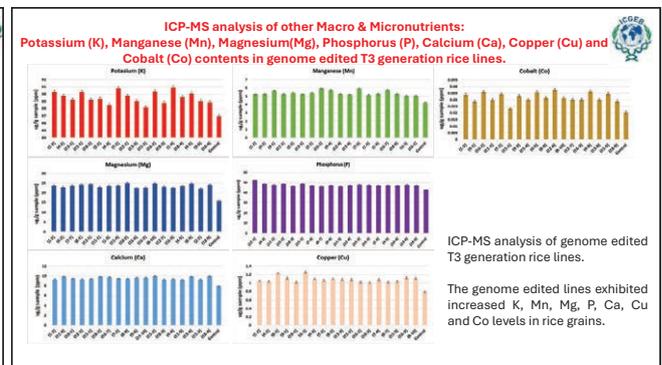
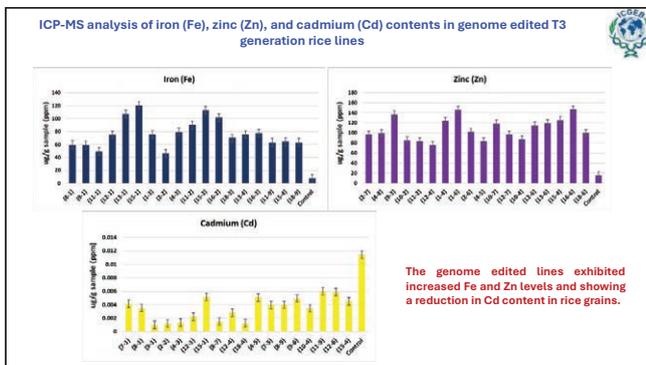
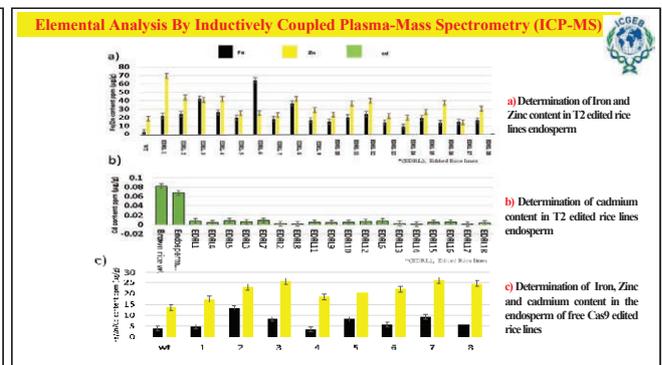
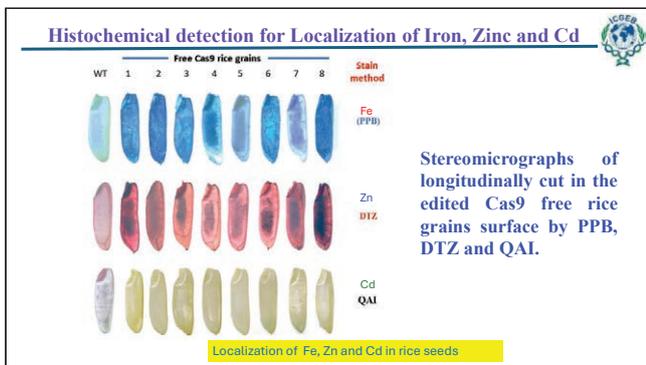
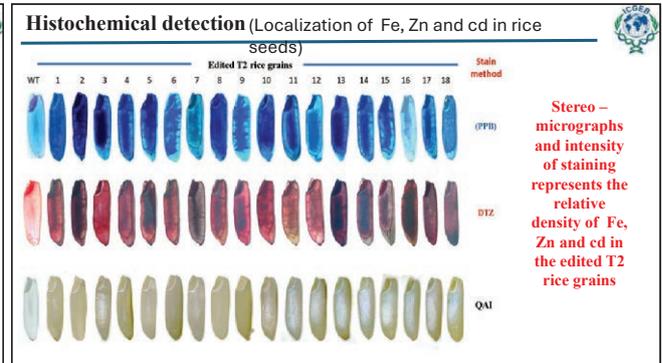
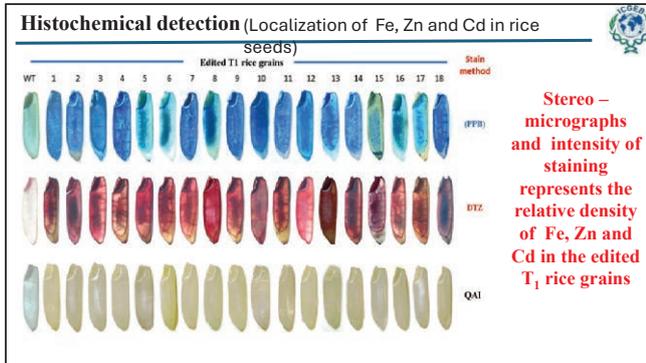
Expression analysis of edited knockout Cas9 free rice lines through multiplex CRISPR/Cas9 a) Fold change of *Osfes1*, *Osfes2* and *Oscdt1* in edited rice lines in roots b) Flag leave c) stem d) node e) flower



## Expression Analysis Of Differentially Expressed Genes For High Zinc And Iron In Polished Rice Edited Knockout Lines Through Multiplex CRISPR Cas9

- ABC transporter superfamily ABCG subgroup member 4.
- Heavy metal ATPase 2.
- Iron Deficiency-responsive Element-binding Factor 1.
- submergence-induced protein2,(acido-reductone dioxygenase) 1.
- Multi antimicrobial extrusion protein.
- Natural resistance associated macrophage protein 5.
- Nicotianamine aminotransferase 1.
- NAC domain-containing protein 5.
- BACTERIOCIDIC EFFECT 1, homologues of mammalian Nramp1 gene, Natural resistance associated macrophage protein 1.
- Vacuolar Iron Transporter/Nodulin-like family.
- Vacuolar Iron Transporter 1.
- Vacuolar Iron Transporter 2.
- Zinc-regulated transporter 2.
- mitochondrial Fe transporter.
- Nicotianamine synthase 1.
- Iron-related transcription factor 2.
- Iron regulated transporter 1.
- Ferritin 1.
- Ferritin 2.





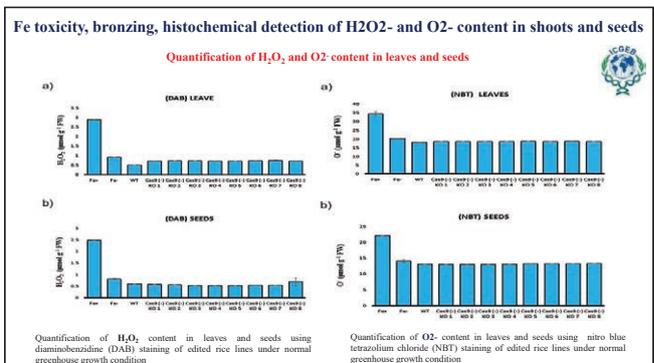
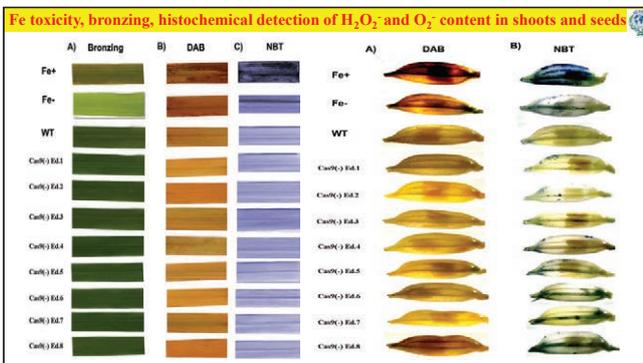
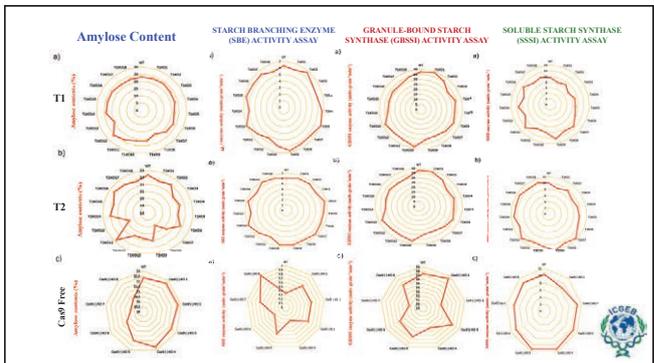
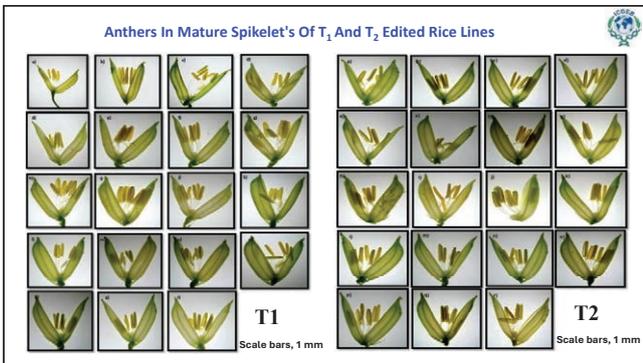
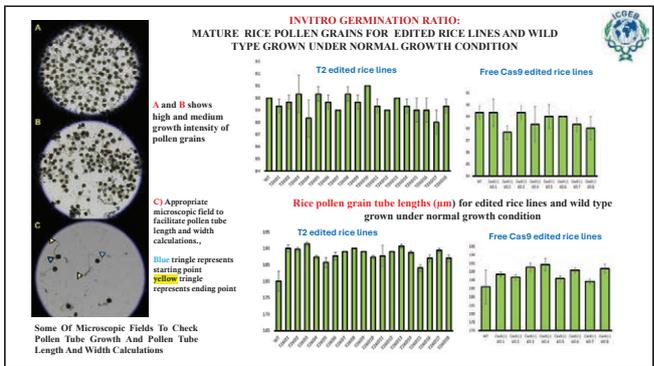
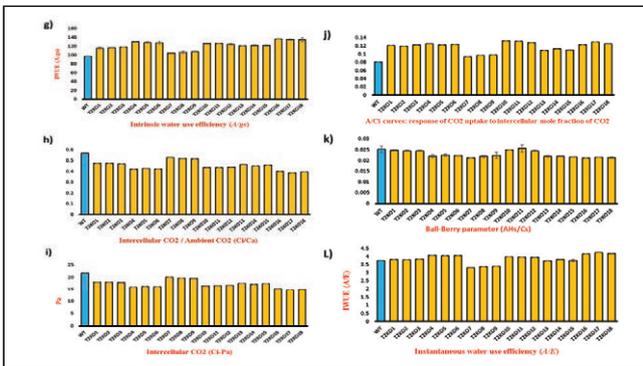
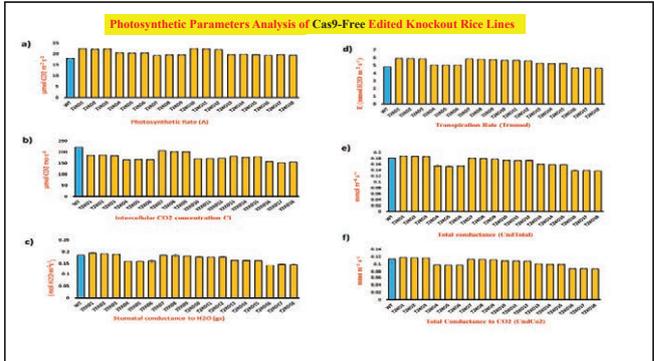
### Photosynthetic parameters analysis

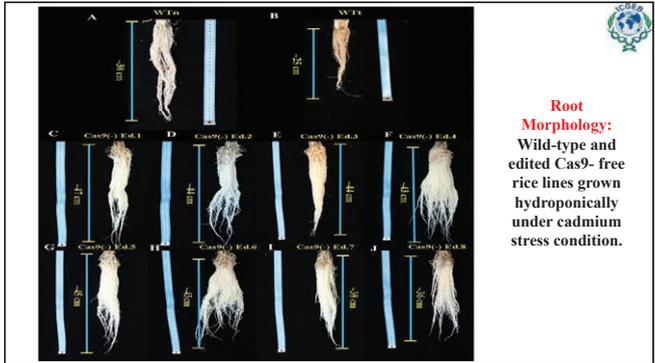
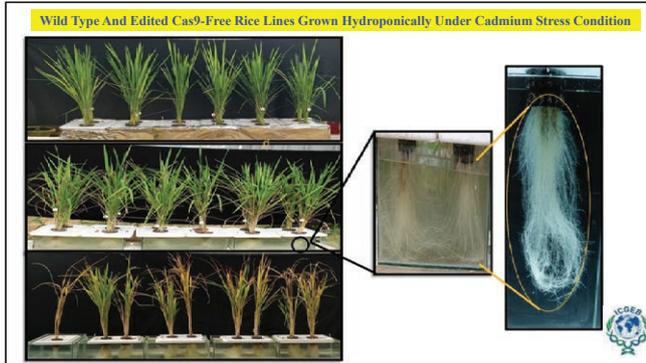
(Infra-red gas analyser Li-COR, 6400-40)

Leaf gas exchange analysis using Infra-red Gas Analyzer (IRGA)

Photosynthetic parameters :

a) Photosynthetic Rate (A)  $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$  b) Intercellular  $\text{CO}_2$  concentration (Ci)  $(\mu\text{mol CO}_2 \text{ mol}^{-1})$  c) Stomatal conductance to  $\text{H}_2\text{O}$  (gs)  $(\text{mol H}_2\text{O m}^{-2} \text{ s}^{-1})$  d) Transpiration Rate (Tmmol) E  $(\text{mmol H}_2\text{O m}^{-2} \text{ s}^{-1})$  e) Total conductance (CndTotal)  $(\text{mmol m}^{-2} \text{ s}^{-1})$  f) Total Conductance to  $\text{CO}_2$  (CndCO2)  $(\text{mmol m}^{-2} \text{ s}^{-1})$  g) Intrinsic water use efficiency IWUE (A/gs) h) Intercellular  $\text{CO}_2$  / Ambient  $\text{CO}_2$  (Ci/Ca) i) Intercellular  $\text{CO}_2$  (Ci-Pa) j) A/Ci curves: response of  $\text{CO}_2$  uptake to intercellular mole fraction of  $\text{CO}_2$  k) Ball-Berry parameter (AHS/Cs) l) Instantaneous water use efficiency IWUE (A/E) were measured and plotted as bar graphs. Data shown is mean  $\pm$  standard deviation; n=3.





Dr. Uma Maheshwar Singh, Scientist- Innovative Breeding SARC, IRRI

**Speed Breeding: A game changer for global food security**

Uma Maheshwar Singh, PhD  
Scientist, IRRI South Asia Regional Centre, Varanasi

**Traditional Breeding vs Speed Breeding**

Traditional Breeding: Crossing and inbreeding (3-7 years), Testing for desired traits (4-5 years), Seed prod<sup>n</sup> Release (1-3 years). Total: 8-15 years.

Speed Breeding: Crossing and inbreeding (1-2 years), Testing for desired traits (4-5 years), Seed prod<sup>n</sup> Release (1-3 years). Total: 6-10 years.

Speed breeding uses controlled conditions and has the potential to double the rate of genetic gain.

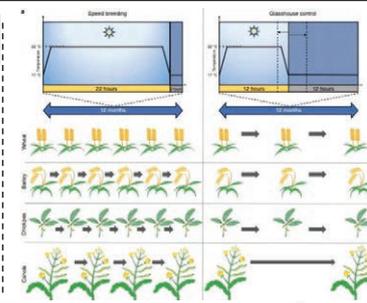
### Origin of concept: Growing Plants in Space

- The Advanced Plant Habitat (APH), like Veggie, is a growth chamber on station for plant research using controlled microgravity, gases, full spectrums LEDs, temperature, humidity, hormones, fertilizers
- Plants grow in space for both aesthetic and practical reasons by advancing multiple generations in year
- Veggie has successfully grown a variety of plants, including three types of lettuce, Chinese cabbage, mizuna mustard, red Russian kale and zinnia flowers.
- Identification of plant acclimatization to extra terrestrial environments



### Speed breeding in long-day plants

- Prolonging photoperiod beyond natural lighting
- Utilizing glasshouses for the process
- Extending photoperiod (16 to 24 hrs) accelerates flowering in long-day plants
- Employing LED lights for extending photoperiod
- Variations in day and night temperatures
- In some crops recently speed breeding protocol updated with vernalization treatments for seed germination as well as flowering



Watson et al., 2018; Ghosh et al., 2018



### Defined ranges of controlled parameters aligned with rice physiology



- Full spectrum LED lights
- Photosynthetically active radiation (PAR) and far-red light -400 nm to 735nm
- Light intensity up to 1000 μmol
- Temperature 18 °C to 42°C
- CO<sub>2</sub> (300 PPM to 1200 PPM)
- Relative humidity 60% to 95%
- Hydroponics and fertigation
- Research Lab and Briefing zone

How speed breeding can contribute to other programs activities

- Crop breeding could be configured for the optimization and rapid growth of different crops
- Screening process can help establish protocols for the rapid screening of biotic and abiotic stresses
- Gene editing can hasten the process of growth and development of transgenic plants
- Genomics selection produces the need for field testing required in conventional breeding
- Research combining innovative approaches with speed breeding can accelerate research



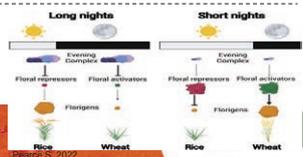
### Differences between short- and long-day plants

#### Short day plants

- Require short day light period (usually 8-10 hours) and continuous dark period (14-16 hrs) for subsequent flowering
- Dark period is critical and must be continuous
- Inhibition of flowering with intermediate light occurs at the middle of critical dark
- Prolongation of continuous dark period (Short day) initiates early flowering in SDP
- Ex. Rice, Soybeans

#### Long day plants

- Require long day light period (usually 14-16 hours) in 24 hours cycle for subsequent flowering
- Extended light period stimulates flowering in long day plants
- Ex. Pea, Barley, Lettuce, Wheat

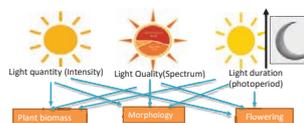
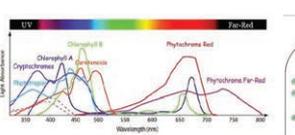


Debnath S, 2022

### 1. Light fundamentals for plants

Turning photons into food

PAR & Far-red light- photosynthesis and signalling. (Taiz and Zeiger, 2015)

#### Blue Light

- Facilitates stretching and compact vegetative growth
- Increases production of anthocyanins and flavonoids
- Enhances coloration of dark or colored varieties

#### Green Light

- Facilitates healthy development of leaves
- Increases light penetration area
- Increases photosynthesis at lower canopy layers
- Facilitates overall inspection of plants

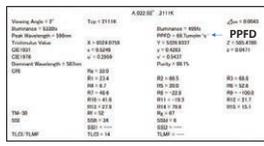
#### Red Light

- Most efficient wavelength for photosynthesis
- Stimulates biomass accumulation
- Stimulates stem and root development
- Increases seed germination
- Facilitates uniform plant development in dense canopy
- Regulates flower development...

#### Far Red Light

- Promotes extension growth of stems
- Stimulates stem and root expansion
- Increases seed germination
- Facilitates uniform plant development in dense canopy
- Regulates flower development...

### Measuring light intensity and spectrum: spectrometer C-7000: portable spectrometer



Sunlight, PPFD: 462 μmol/m<sup>2</sup>/s<sup>1</sup>

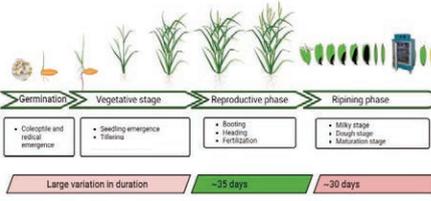
Multiplication Chamber-1, PPFD: 458 μmol/m<sup>2</sup>/s<sup>1</sup>




### Targeted growth stages of rice for speed breeding

3 growth stages in rice

- Vegetative stage (30-90 days)
  - A. Basic Vegetative phase
  - B. Photoperiod sensitive phase
- Reproductive stage (30-35 days)
- Ripening phase (30-45 days)



Varietal classification like early, medium and late is dependent on variation in vegetative stage (30-90 days)



### Protocol standardization at Speed-breeding using diverse groups of rice

Protocol optimization stages

Selection of different groups of rice

- Vegetative: CO-51, IR 64
- Reproductive: Sarjoo-52, DRR Dhan 44, NDR 359
- Maturation: Swarna Samba, Mahsuri, Pusa Basmati 1121
- Germination (Immature seeds): Kalanamak, Betagomblin, Black rice, Gedongpietan

Soil mixture: 3(Soil):1(FYM)

Pot Size: 200ml

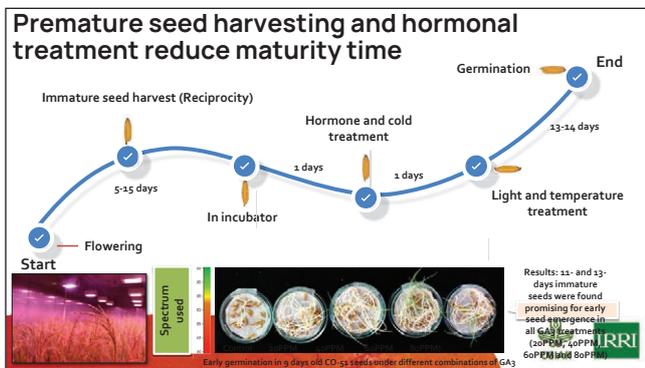
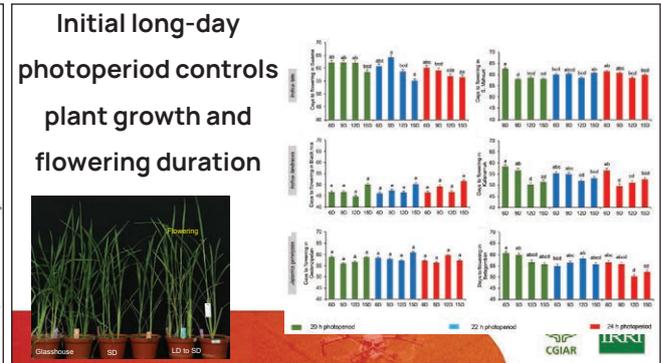
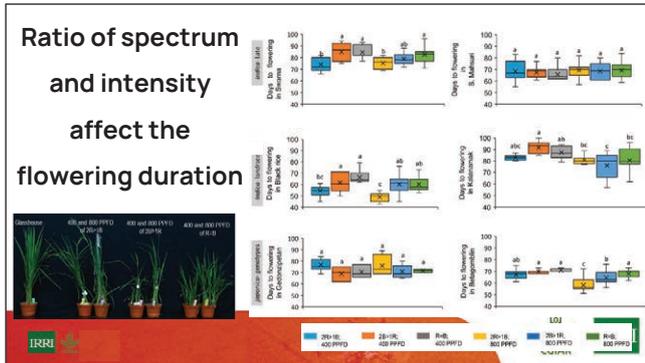
Nutrient Spray (as required): NPK: 2gm/L

Micronutrient: 2gm/L

o-P-K: 2gm/L: before pre-booting

Iron & Boron: Before anthesis

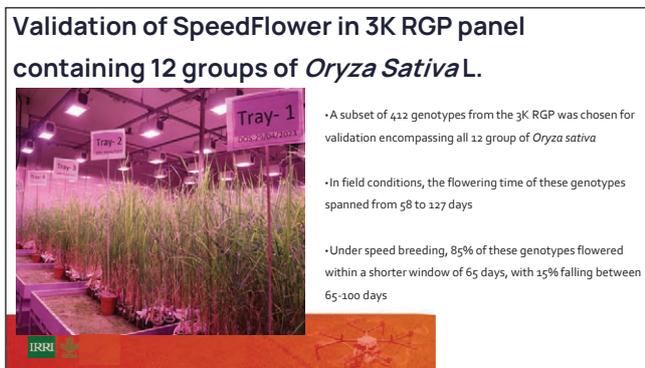




### SpeedFlower advances 4-5 generations of rice per year

Genotypes	Subspecies	Duration	DFF in field*	Generation time in field*	DTF in SBF*	Early flowering*	Maturation time in SBF*	Generation reduction*	Generations per year*
CO-51	Early	87.6	122.6	55.2	31.8	15.0	70.2	42.5	5.2
IR 64		84.6	119.6	55.9	28.1	15.0	70.9	40.4	5.1
DRR Dhan 44	Medium	93.6	128.6	53.0	46.0	15.0	68.0	45.9	5.4
Sarjoo-52	Indica	93.6	128.6	54.6	38.4	15.0	69.6	45.7	5.2
Swarna	Late	114.0	149.6	56.5	57.5	15.0	71.5	52.6	5.1
Swarna Mansuri		114.0	149.6	59.9	54.1	15.0	74.9	49.8	4.9
Black rice (Late)		108.0	143.6	51.6	56.4	15.0	66.6	53.4	5.5
Kalamnask		130.0	165.6	52.6	77.4	15.0	67.6	59.6	5.4
Chokkizipatan	Javanica	84.0	119.6	57.8	36.7	15.0	72.3	39.2	5.0
Beragambir	Medium	91.6	126.6	52.4	38.6	15.0	67.4	46.5	5.4

DFF: days to fifty percent flowering; DTF: days to flowering; SBF: SB facility.  
 \*One generation time; \*Early flowering in speed breeding as compared to field; \*Percentage reduction in one generation time under SB as compared to field; \*generation per year in speed breeding.



### Response of F1s/F2s/F3/BC1F1 in Speed Breeding

Sr. No	Cross combination	Stage	DFF in SpeedBreed	Female	DFF in field	Male	DTF in field
1	Tulsi manjiri x RP-BIO-226	BC3F1	74	Tulsi manjiri	140	RP-BIO-226	110
2	Naveen x Gheew bora-8	F1	69	Naveen	90	Gheew bora-8	115
3	Sarjoo-52 x CN-1035-61	F1	70	Sarjoo-52	97	CN-1035-61	105
4	Ranjeet Sub 1 x DHANE BURWA	F1	70	Ranjeet Sub 1	125	DHANE BURWA	101
5	Swarna x KALAI	F1	71	Swarna	114	KALAI	94
6	DRR Dhan 44 x CHAO KHIE	F1	71	DRR Dhan 44	97	CHAO KHIE	89
7	Swarna x Mansuri	F1	71	Swarna	114	Mansuri	103

Segregating materials (F<sub>2</sub>, F<sub>3</sub>) tend to flower in small windows despite of having significant differences between the parental lines, which will be useful to harvest mapping populations in less time compared to the field conditions

### Updates on Speed Breeding protocols across various crops

Long day plants			
Crop types	Methods	Generations per year	Growth conditions
Oat	Speed breeding	1 generation- 51 days	22h photoperiod
Canola	Speed breeding	6 generations	22h day/2h night and 16h day and 8h night
Chickpea	Speed breeding	6-7	22h day/2h night and 16h day and 8h night
Barley	Speed breeding	6 generations	22h day/2h night and 16h day and 8h night
Duram wheat	Speed breeding	6 generations	22h day/2h night and 16h day and 8h night
Spring wheat	Speed breeding	6 generations	22h day/2h night and 16h day and 8h night
Wheat & barley	Speed ver. + SB	Up to 5 generations	22h day/2h night at 10 °C
Pea	Speed breeding	6 generations	22h day/22°C day & 17°C night
Canola	Speed breeding	4 generations	22h day/2h night and 16h day and 8h night
Chickpea	RGA	7 generation	Extended photoperiod & immature seed

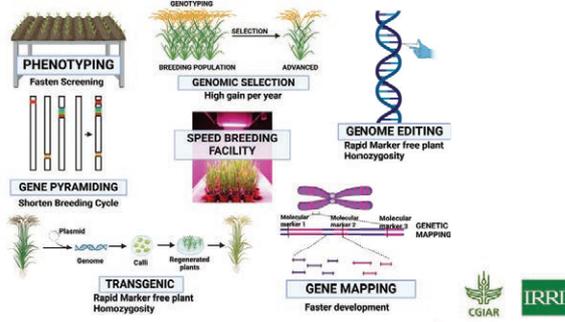
Short day plants			
Crop types	Generation advancement method	Generations per year	Growth conditions
Rice	Biotron speed-breeding technique	70 days for flowering, 10 days embryo rescue	Extended photoperiod, temperature & Embryo Rescue
Rice	Biotron speed-breeding technique	4 generations	Elevated CO <sub>2</sub> , tiller removal and embryo rescue
Rice	Speed breeding	4-5 generations	Spectrum, light intensity, photoperiod, early germination experiment
Soybean	Speed breeding	~5 generations	Photoperiod, light spectrum, intensity
Amaranthus	Speed breeding	4-5 generations	Photoperiod, light spectrum, intensity
Hemp	Speed breeding	5-6	Initial 15 days continuous light and then 10 h seeds
Pepper	Speed breeding	3	Spectrum ratios and extended photoperiod
Pigeonpea	Speed breeding	2-4 generations	Spectrum, light intensity, photoperiod, temperature

Day neutral plants			
Crop types	Generation advancement method	Generations per year	Growth conditions
Tomato	Biotron speed-breeding technique	3-4 generations	Extended photoperiod, temperature & Embryo Rescue



Speed breeding coupled with other breeding methodologies



Conclusion & Way Forward

- Speed breeding is a promising technology with **high turnover**, **reduced manpower needs**, and **lower fertilizer and pest management** inputs.
- Key benefits include rapid generation cycles, accelerated breeding, and **breeding with speed of climate change**.
- Challenges include maintaining **uniform growth conditions**, high **electricity consumption**, and **technical complexity** requiring trained personnel.
- Different crops require **specific growth protocols**, necessitating optimization for each species.
- Future focus should be on developing **energy-efficient systems**, reducing costs, and enhancing scalability.
- Strengthening **collaborations, investments, and training** will ensure wider adoption and long-term impact on global food security.



Acknowledgement



IRRI SA & SARC  
Vikas K. Singh  
Pallavi Sinha

Pramod G Kabade  
Shilpi Dixit  
Lokesh Malviya  
Sandhya Upadhyay  
Shamshad Alam  
Sonali Vijay Habde  
Namrata Patil  
Swati Tyagi  
Anoop Kishor Gurjar

Project coordinator  
Arvind Kumar

ISARC director  
Sudhanshu Singh

IRRI HQ  
Hans Bhardwaj  
Sankalp Bhosle  
Colleagues @ IRRI HQ

Special Thanks  
Team NARES





# Technical Session - II

Dr. Sunil Archak, Principal Scientist, NBPGR, New Delhi

**Digital Sequence Information**  
Technology, Policy & Regulation

Sunil Archak  
ICAR-National Bureau of Plant Genetic Resources  
New Delhi

## 1 DSI and plant breeding

- What is DSI?
- Do we use DSI in plant breeding?
- Will DSI be significant in future?



**DNA**  
Genetic material → Physical material → Information

Physical material      Sequence

**Modern breeding methods use DNA typing or DNA modification**

Source: Petra Jorusch, vice-secretary general of the German Plant Breeders' Association BDP

**Early generation marker assisted selection**      **Marker-assisted breeding**

**Plant breeders have been using DSI**

Modified from Plants 2024, 13(19), 2676; <https://doi.org/10.3390/plants13192676>

**DSI is an integral part of basic plant research**

**Plant Breeding And CRISPR Plants Global Market Report 2025**

Year	Market Size (in USD billion)
2024	\$13.56 billion
2025	\$15.59 billion
2026	
2027	
2028	
2029	\$26.65 billion

CAGR 14.3%

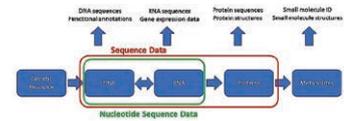
## 2 DSI: Scope and accessibility

- How is DSI defined?
- What all are covered in DSI?
- Where are DSI located?
- Are DSI available free?

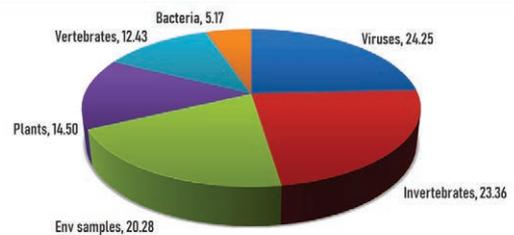


• DSI refers to the digital biological data in various international negotiations around sharing benefits from the uses of genetic resources.

- Alternative name is Genetic Sequence Data (GSD)
- No technical definition; only a legal placeholder



## GRFA sequences are not insignificant (%)

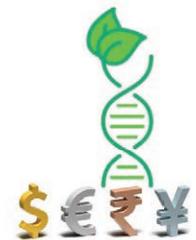


**IBDC**  
INDIAN BIOLOGICAL DATA CENTRE  
Regional Centre for Biotechnology (RCB), Faridkot - 121 001, INDIA  
Phone: 0129-2848674  
Email: support@ibdc.rcb.res.in  
Website: https://ibdc.rcb.res.in/

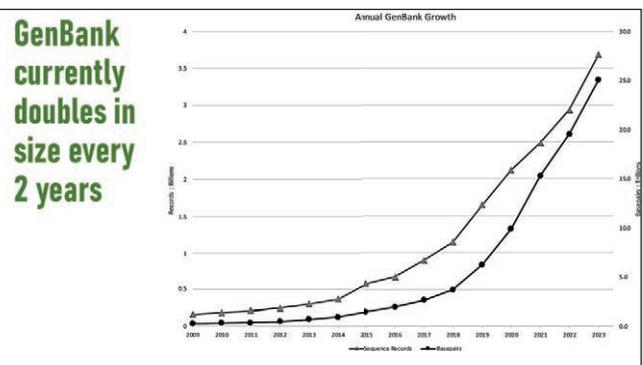
**INDA** Indian Nucleotide Data Archive  
**INDA-CA** Indian Nucleotide Data Archive  
**ICPD** Indian Crop Phenome Database  
**IMDA** Indian Metabolome Data Archive

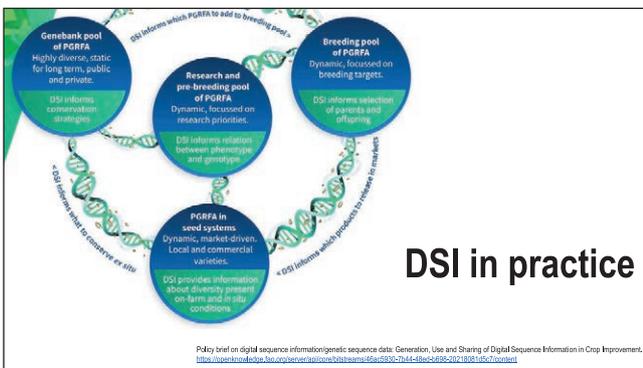
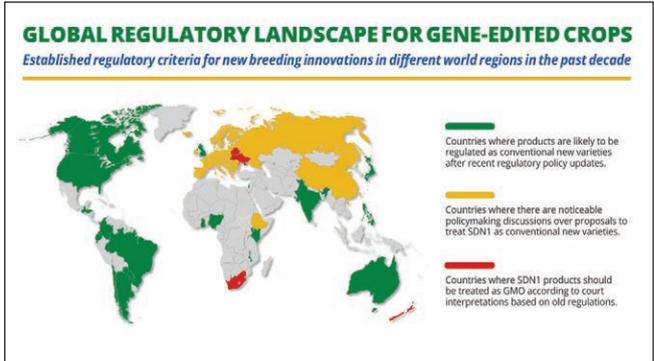
## 3 DSI in limelight

- Why so much attention to DSI?
- Are advances in technology matched with policy?
- DSI in breeding methods only?



- Explosive growth of DSI
- Open access availability of DSI
- Gene edited crops





### 4 DSI: Policy and governance

- Global interdependence
- Negotiation of DSI-ABS
- Status of DSI regulation (or not)

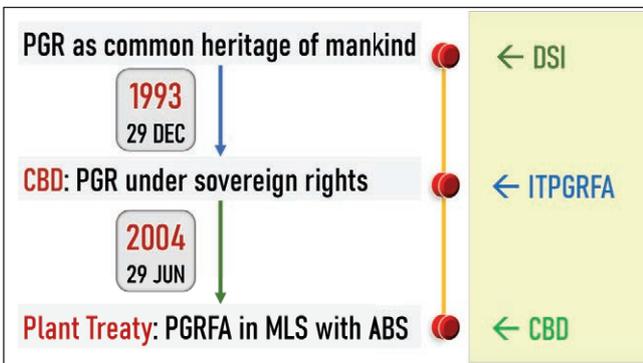
### Global PGR interdependence

- Globally, foreign crops make up 69% of country food supplies and farm production
- R&D requiring CWR are critically dependent

### PGRFA governance

“Aims at guaranteeing food security through the conservation, exchange and sustainable use of the world's PGRFA, as well as the fair and equitable benefit sharing arising from its use”

- Include DSI in principle
- Establish the process



### DSI and benefit sharing

**When?**

- Trigger point?

**How**

- Monetary benefits: user-based payments
- Non-monetary benefits:
  - DSI themselves
  - Technology
  - Capacity development

### Developments in global forums

**CBD** → DSI-ABS fund → **Cali Fund** → 1% profits or 0.1% revenue (if assets > 20 mUSD or sales > 50 mUSD or profit > 5 mUSD) by commercial users of DSI

**WHO:** Legally binding instrument on **pandemic prevention, preparedness and response** by the Intergovernmental Negotiating Body (INB) and the proposed instrument **pathogen access and benefit-sharing system (PABS)**

**ITPGRFA:** Working Group on EMLS preparing a new payment structure that subsumes DSI profits into seed sales

### Consensus on DSI-ABS

- Access not to trigger benefit sharing
- Cost of process shouldn't overshoot benefits
- Circumvent tracking-tracing requirement

### Formulate domestic policy on access to DSI and consequent benefit sharing

ITPGRFA and CBD can only set the framework and guide; domestic legislation needed for governance

<b>CBD</b>	<b>ITPGRFA</b>
MLS for benefit sharing	Enhancement process

NBA formulating the rules 2024

India should come out of "provider attitude" while developing policies and adopt "user attitude" by developing infra and HRD



### Acknowledgements

- ICAR-NBPGR
- Colleagues in national and international negotiations



**Mrs. Ruchika Gupta**, DDG, Ministry of Statistics & Programme Implementation



## Agri Stack

Building the Digital Infrastructure for the Agriculture Sector

Digital Public Infrastructure and Digital Public Goods have become powerful levers to deliver citizen services

- DPCs as powerful enablers for setting up Systems/DPIs
- DPIs are acting as foundational levers that enable solutions
- Such as...



Unique Identity System



Open APIs & Digital Public Goods



Realtime Payment Infrastructure

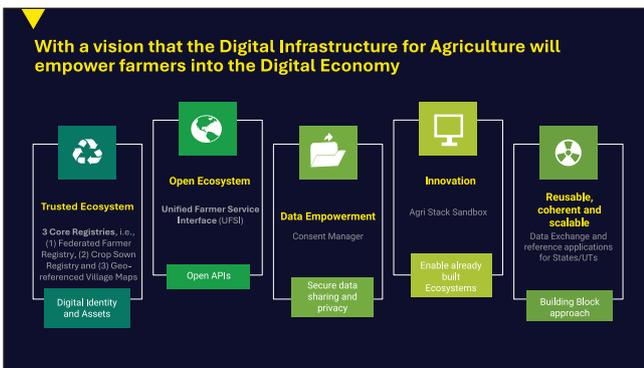
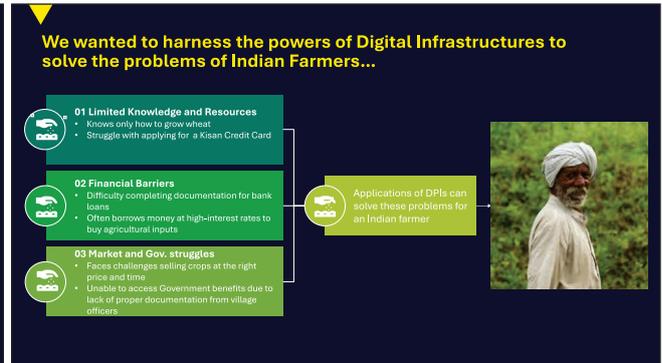
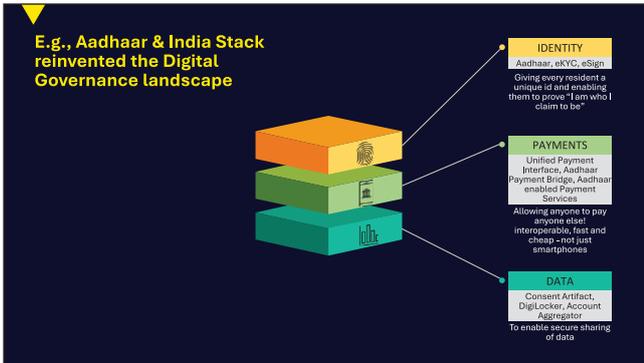


Digital Health Infrastructure



Network for Open, Fair Digital Commerce

- And many more **sector-focused** and **sector-agnostic** DPIs changing the Indian Digital Landscape

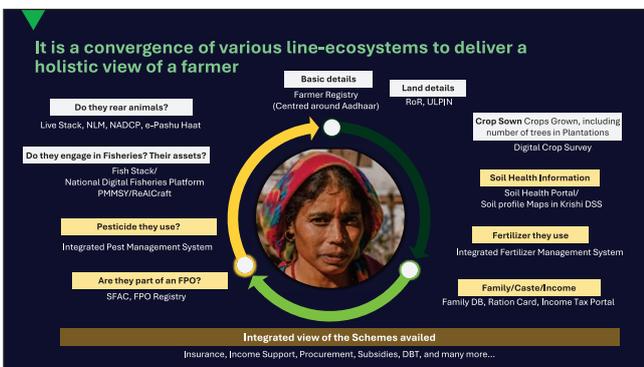


### It is a shift of thinking in the way we build IT systems

Databases – Old way of doing things	Registries – building for the future
<ul style="list-style-type: none"> <li>Focus on simply storing and managing data</li> <li>Basic structuring of records</li> <li>Not necessarily truthful data, maybe stored in multiple system, making it difficult to assess which one is current and updated</li> </ul>	<ul style="list-style-type: none"> <li>Trustful data – built through strict entry and exit process</li> <li>Are compliant with standards/schemas</li> <li>Single-source-of-truth</li> <li>As this is validated data, can be used as Digitally Verifiable Credentials for the ecosystem</li> </ul>

### Its approach is similar to what was done in Aadhaar

Sr. No.	Agri Stack	AADHAAR
1	Database of <b>Farmers</b> in India	Database of <b>Residents</b> of India
2	Unique <b>Farmer ID</b> to each Farmer	Unique <b>Aadhaar no.</b> to each Resident
3	1. <b>Agriculture land holding (plot) of Farmer</b> 2. <b>GPS coordinates of each plot of Farmer</b> 3. <b>Crops grown on each plot</b> Plus linkages to: Govt. Benefits availed by farmers	Contains <b>demographic information</b> i.e. Address, Gender, Date of Birth, Address
4	<b>Unified Farmer Service Interface (UFSI)</b> – API/Service layer to provide data to others (= similar to Unified Payments Interface – UPI, a payments API by National Payments Corporation of India)	<b>Aadhaar APIs/Services</b> for sharing data to other parties
5	Regulations under Agri Stack to control data sharing	Regulations to control misuse of data
6	Agri Stack Regulator	UIDAI as Regulator



### Powered by Key initiatives such as

### Farmers' Registry

- Registry of Landholding Farmers
- Linked to Aadhaar and Land Records and Geo-referenced Village Maps
- Built using Farmer's Consent
- Automatically updates if mutations in Land Records

### and Digital Crop Survey

- Survey of all agriculture plots, every season by surveyor
- With photographs and geo-tags as proofs
- Validated using geo-fencing from Geo-referenced Village Maps
- Enabling accurate Crop recording in the country



### And Supporting Registries that will enable data standardization in the Digital Agriculture Ecosystem



**Crop and Seed**

This Ecosystem consist of:

- ✓ Crop
- ✓ Seed
- ✓ Seed Dealers
- ✓ Seed Testing Laboratories



**Pesticide**

This Ecosystem consist of:

- ✓ Pest/Diseases
- ✓ Pesticide
- ✓ Pesticide Products
- ✓ Pesticide Dealers
- ✓ Pesticides
- ✓ Manufacturers
- ✓ Pesticide Testing Laboratories



**Fertilizer**

This Ecosystem consist of:

- ✓ National Fertilizers
- ✓ Fertilizers Raw Material
- ✓ Fertilizers
- ✓ Manufactures
- ✓ Fertilizers Plants
- ✓ Fertilizers
- ✓ Wholesalers / Retailers



**Financial**

This Ecosystem consist of:

- ✓ Banks
- ✓ NBFC
- ✓ Scale of Finance



**Farmer Support**

This Ecosystem consist of:

- ✓ Krishi Vigyan Kendras
- ✓ Common Service Centres
- ✓ FPOs
- ✓ FPOs

### Enabling open access to key ecosystem players via

### Key ecosystem players and their roles in Agri Stack ecosystem

**Unified Farmer Service Interface**

**Central Government**

- Maintain Aggregated data for Deduplication and Policy Making

**State Government**

- Data Fiduciaries of Core Registries, i.e., Farmer Registry, Crop Sown Registry and Geo-referenced Village Maps

**Farmers**

- Data Principles enabled by Consent Manager

Use-cases

- Data Users in line with DPDP Act 2023

### Empowering farmers with Digitally verifiable credentials

**Quick verification**

**Improved access to Digital Economy**

**Improvement in "Ease of Living" for Rural areas**



### To build Farmer-centric solutions and services

1. Farmers would now get KCC loans in less than 30 minutes without submitting any documents

2. Farmers get MSP / PMFBY registration without any documents in less than 5 minutes after they reaches the registration counter

3. No fake registration any more possible under these two schemes any more

4. Farmers will be able to get their crop insurance claims quickly due to electronic verification

5. Would get NDRF/SDRF benefits sitting at his home - no need of application

6. Suo moto inclusion of farmers under PM Kisan - no need of application

7. Farmers will get advisory services as per their Crops, Lands, Soil condition and Weather condition

### And enable better governance

**Enable**

- Enable the Government to take data-based decisions from national to farm level

**Stop**

- Prevent the misuse of government schemes (e.g., PM Kisan - Non-landholding farmers, PMFBY - Fake insurances)

**Identify**

- Identify eligible farmers who are not getting benefits

**Ensure**

- Ensure equitable distribution of benefits

**Speed up**

- Speed up benefits delivery process (e.g., MSP)

**Support**

- Support disaster response measures (e.g., Identify farmers affected by rain, drought)

**Provide**

- Provide aggregate data to Government for better scheme planning, budgeting and implementation

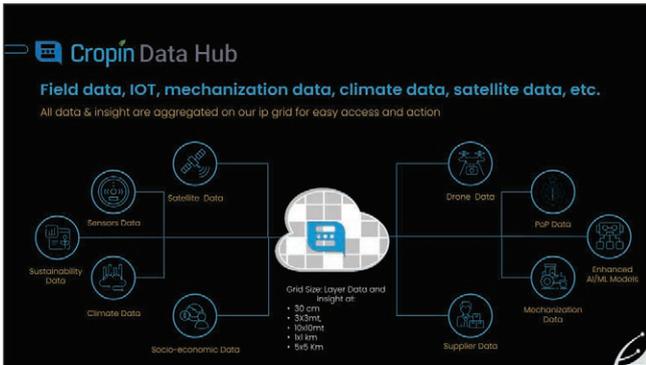
**Identify**

- Identify areas for intervention requirements (e.g., Identify farmers growing crops without drip irrigation facilities)

**Provide**

- Provide data to Agri-techs to develop innovative solutions and services





### CROPIN INTELLIGENCE

## In-Season Crop Monitoring & Intelligence with Actionable Insights at farm or supply chain

**Models O/P & insight in real world**

- Yield Prediction, Disease Prediction and Crop Progression Prediction, Harvest window for better quality, Climate Smart insight and its impact etc.

**Regenerative Ag Model**

- Tillage
- Cover crop
- Deforestation detection & monitoring
- Carbon Stock/Biomass

### Cropin Sage

## DISCOVER THE FUTURE POTENTIAL YIELD IN THE CLIMATE CHANGED WORLD

- Cropin Sage provides country-scale insights into the Food, Agriculture, and Beverage (FAB) supply chains by analyzing historical trends and real-time data.
- It helps businesses understand past supply chain behaviors, assess current risks, and forecast future production.
- The platform predicts the impact of changing climate conditions on crop supply chains for the next season.
- Cropin Sage enables proactive decision-making, allowing companies to optimize strategies and stay ahead of potential disruptions.

### Gen AI Based querying system to unlock insight

## Upcoming Season Yield Potential with Actionable Insights at Farm or supply chain level

- Ascertain suitability of growing grapes/strawberries, in a region to aid expansion strategy and manage long term supply risk
- Diversify sourcing origins from highly exposed geographies.

## THAILAND TECHNOLOGY EXCELLENCE AWARDS 2023

## Cultivate exceptional outcomes for seed production

### USE CASES For Breeding & Trialing

- 01** Reduce time-to-commercialization of new varieties  
Optimize breeding programs by predicting trials likely to succeed under various environmental conditions using Cropin's crop knowledge graph, accelerated identification of new promising seed varieties with Cropin Cloud's AI-powered genomic performance metrics in real-time, and automate data collection. thereby reduce the breeding cycle time-speed up commercialization.
- 02** Ensure process compliance  
Cropin Cloud digitizes trial processes, ensuring adherence to regulatory standards, with task tracking, audit trails, and digital records, compliance becomes easier to achieve and monitor.
- 03** Optimize cost of seed trading with efficient resource management  
Leverage Cropin Cloud's weather, water usage, satellite data and insights to monitor irrigation remotely & minimize manual intervention. Trading insights reduce labor & resource use, optimizing costs across multiple trials/batches.
- 04** Ensure climate resilient seed suitability map  
Shift the decision-making from reactive (based on past performance) to proactive (based on future resilience) with Cropin's advanced AI analytics. The predictive map powered by Cropin Sage forecasts the best regions for a seed variety considering future climate risks like heat tolerance, drought resilience, etc., enabling you to focus on varieties with the highest potential.

### For Seed Multiplication

- 01** Estimate yield accurately  
AI-powered predictive models analyze historical and real-time data to provide accurate variety & location-wise yield forecasts, helping you align seed production with sales strategies.
- 02** Better revenue & reduce costs  
Cropin Cloud's critical processes of seed production & avoids overstocking or understocking (achieved by forecasting future climate, variety, & farm performance variables). It suggests optimal resource use, reduces input costs, & boosts yields & profitability.
- 03** Farmer advisory for personalized seed  
Cropin Sage leverages geo-data-driven insights to deliver hyper-personalized farmer-focused seed variety recommendations based on soil type, weather, and past risk. This approach of less higher seed adoption while reducing input costs for farmers. It improves farmer's trust by aligning seed suitability with specific farmer needs, ultimately improving customer satisfaction and driving sales.
- 04** Ensure PGP adherence and quality assurance  
Ensure adherence to best practices by providing real-time alerts, reminders & checklists to better support seed quality & compliance, through the platform. Share Cropin Cloud to track crop health and growth stages via remote monitoring and ensure quality standards are met throughout the production process.
- 05** Mitigate in-season production risks  
Cropin Cloud's risk assessment tools analyze weather patterns, disease outbreaks, & other risks, arming you with proactive recommendations to minimize production disruptions.
- 06** Streamline end-to-end supply chain operations by integrating farm-level data with factory process management systems, enabling seamless data flow and real-time visibility.
- 07** Expand & diversify confidently  
Cropin Cloud's regional performance insights and trend analysis can help you identify new regions for expansion or crop diversification based on futuristic assessments of a accelerated region or operation.
- 08** Forecast demand, avoid overstock or stockouts, & enable precise production scheduling with the platform's predictive analytics capabilities.



**For Seed Sales & Marketing**

**01** Manage demo farms  
Set up **digitally managed demo farms** to showcase seed performance comparatives to stakeholders with remote sensing & provide real-time data to inform sales and marketing decisions.

**02** Seamlessly connect to all stakeholders  
Connect with growers, distributors, and retailers through **unified ecosystem** in the platform. Improve product visibility & reduce storage demand generation across the value chain.

**03** Optimize product placement  
Get **granular insights into regional performance** to optimize seed placement in markets where they are likely to perform better. Thus, the platform will help you reduce product waste & maximize sales.

**For All Departments**

**01** Adopt an intuitive solution easily  
Cropin Cloud's **easy-to-use interface** can be automated in local languages to enable easy global adoption while accounting for regional nuances & practices.

**02** Combat climate change  
Improve **climate-smart agriculture** by adopting farming practices to weather vagaries. Reduce climate change impacts & maximize farmer livelihoods, yield outputs, & other outcomes.

**03** Trace seed generations  
The platform's **multi-generation traceability capabilities** ensure transparency across the supply chain. Trace products across generations, enhance operational efficiency & profitability.

**04** Reduce carbon footprint  
Cropin Cloud supports **carbon sequestration tracking**, helping you to manage carbon credits while promoting low-carbon agricultural practices.

**05** Grow sustainably  
Monitor sustainable practices. Use minimum tillage, use of cover crops & defoliation prevention through **satellite imagery & AI analytics**.

**Still wondering if Cropin Cloud is the right fit for your seed business?**

**EAST WEST SEED**



See what East West Seed (EWS) has to say about our partnership.

East West Seed (EWS) adopted Cropin Cloud to achieve 100% production visibility - from sowing to harvest.

The platform's remote monitoring & data collection capabilities provided EWS with visibility to seed varieties & field ops. EWS enabled production accuracy with inputs traceability & output predictability through historical data, satellite & weather data, AI/ML, & big data. The multilingual secure support system further helped in farmer engagement & improved collaboration.

We were looking for a real-time monitoring & a mobile tool that we could use to monitor the activity of our seed production farms.

There was no software that did this. So we worked with Cropin to do it.

Michel Devarrevaere  
VP Production & Projects,  
EWS

21.6K+	14.2K+	35+	400+
hectares outbred	farmers registered	crops covered	varieties covered

**FEATURED SEED PARTNERS**

East West Seed	Mahindra HZPC	Suba Seeds Co.
Bejo Seeds	Savannah	BASF
Sayaji Seeds	Bioseed	C.P. Group
		Hytech
		BASF
		Syngenta
		ITC
		KWS

**Don't just survive in the competitive seed market; Thrive**

Get the Cropin advantage & watch your bottom line soar.



**Cropin**

**Thank You**

Safeguard the Future of Food with the World's First Intelligent Agriculture Cloud

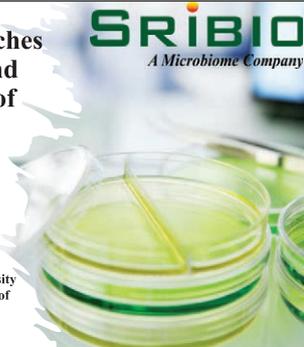
# Technical Session - III

Dr. K. R. K. Reddy, President BIPA and MD SRIBIO

**Microbiome-Based Approaches for Enabling Seed, Plant, and Soil Health for Realization of Potential of Plant Varieties**

**Dr. KRK REDDY**  
Sri BioAesthetics  
Hyderabad

Strategies and approaches for harnessing genetic diversity and agronomic innovations for improving profitability of farmers: 13<sup>th</sup> Indian Seed Congress, New Delhi, Feb 23-25, 2025



**HARNESSING THE POWER OF MICROBIOMES IN AGRICULTURE**

Understanding the functional potential of the plant microbiome has led to innovative agricultural practices, such as microbiome-based biofertilizers, biostimulants and biopesticides, which harness the power of beneficial microorganisms to enhance crop yields while reducing the dependency on chemical inputs



SRIBIO

**MICROBIOMES**

The set of genomes of the microorganisms in a particular habitat

OR

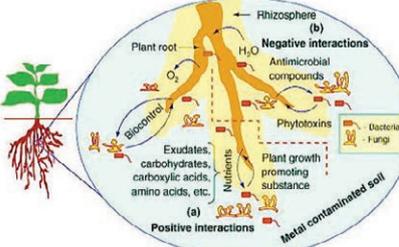
The set of microorganisms of a particular habitat

MICROBIOME IS A SECOND GENOME OR AN EXTENDED GENOME OF THE PLANTS/ANIMALS



SRIBIO

**RHIZOSPHERE MICROBIOME**

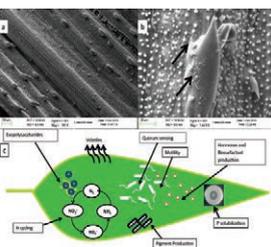


The narrow region of soil that is directly influenced by root secretions and associated soil microorganisms known as the rhizosphere microbiome. It takes care of all the important functions of plant growth and health.

SRIBIO

**PHYLLOSOPHERE MICROBIOME**

The leaf surface or total above-ground surfaces as a site for the establishment of various microorganisms including bacteria, yeasts, protozoa, and fungi (epiphytes)

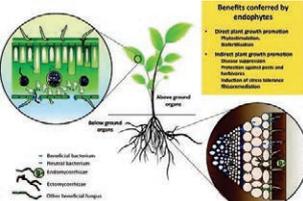


THE LEAF SURFACE AS A MICROBIAL HABITAT

SRIBIO

**ENDOSPHERE MICROBIOME**

Endophytes are microorganisms (bacteria or fungi or actinomycetes) that dwell within robust plant tissues by having a symbiotic association.



Benefits conferred by endophytes

- Direct plant growth promotion (Photosynthesis)
- Indirect plant growth promotion (Nutrient absorption, Hormonal signal transduction, Reduction of stress tolerance, Microsymbiosis)

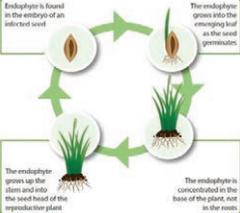
They produce a wide range of compounds useful for plants for their growth, protection and sustainability. They protect plants from herbivory by producing certain compounds which will prevent animals from further grazing on the same plant and sometimes act as biocontrol agents.

SRIBIO

**SEED MICROBIOME**

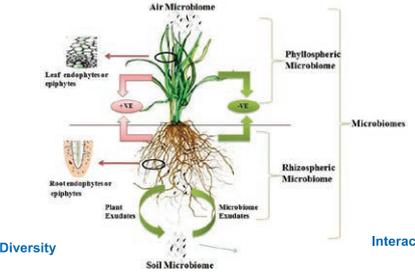
The seed microbiome is recognized as a vital component of plant health and productivity

- Seeds carry associated microbes that originate from their parent and the environment, thereby increasing the microbial diversity in a new environment
- Seeds, enriched with beneficial microbes, hold the promise of improved crop yields, enhanced stress tolerance, and reduced environmental impact, paving the way for a greener and more productive future in agriculture.



SRIBIO

**PLANT MICROBIOME COMPOSITION**



SRIBIO



## PLANT/CROP MICROBIOMES

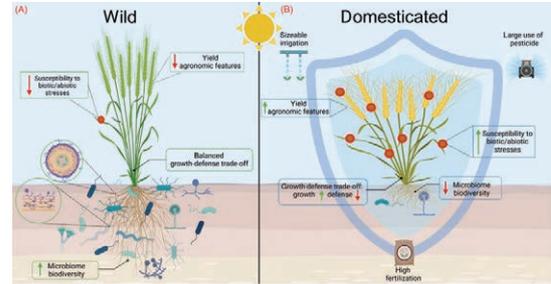
Complex interactions and crosstalk between plants and their associated microbiota, collectively known as the plant microbiome

**Culturable and non-culturable**  
**Culture dependent-culture independent**



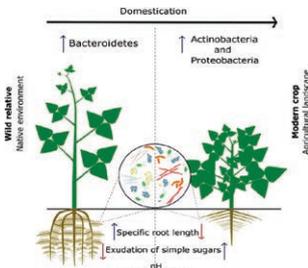
SRI BIO

## Microbiomes-wild and domesticated



Thanks to Plant SRI BIO

## DOMESTICATION-MICROBIOME MODIFICATION



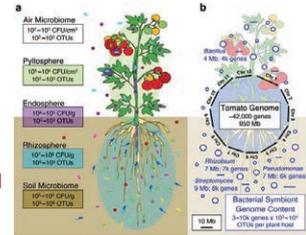
SRI BIO

## The plant microbiome expands the genetic potential of plants

- Plant genetics identifies heritable microbes in rhizosphere
- Crops to recruit top-performing microbes is key to the future of sustainable agriculture

Microorganisms that form the plant microbiome

- originate from the surrounding soil or air (horizontal transmission)
- inherited from the parent generation through seeds (vertical transmission).



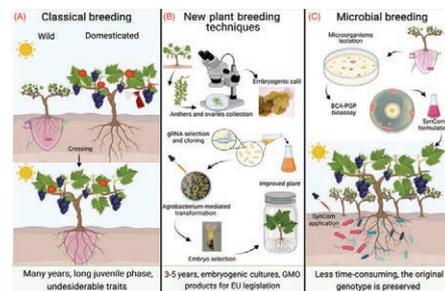
SRI BIO

## MICROBIOME-BASED APPROACHES IN BREEDING PROGRAMS TO ENHANCE THE POTENTIAL OF VARIETIES OR HYBRIDS

Integrating **microbiome-based approaches** into **plant breeding programs** can significantly improve the resilience, productivity, and sustainability of new varieties or hybrids.

SRI BIO

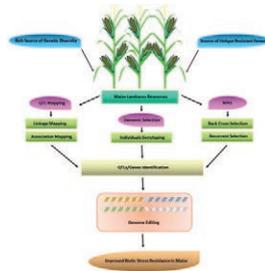
## Microbiome Breeding



SRI BIO

## Microbiome-Assisted Selection (MAS) in Breeding

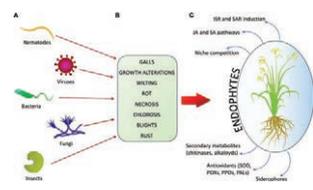
- Traditional breeding selects for desirable plant traits, MAS selects plants with beneficial microbial communities.
- Plants with favorable microbiomes can enhance nutrient uptake, stress tolerance, and disease resistance.
- Genotyping and metagenomic sequencing identify microbiome-associated traits in elite breeding lines.
- Case study:** Breeding maize varieties that recruit beneficial nitrogen-fixing bacteria from the soil.



SRI BIO

## ENDOPHYTE-DRIVEN BREEDING

- Endophytic microbes (inside plant tissues) enhance growth and stress tolerance.
- Selecting plants with a high diversity of beneficial endophytes can improve drought resistance, disease resistance, and nutrient use efficiency.
- Endophytic microbial inoculation can be integrated into hybrid development.
- Case study:** Wheat varieties with fungal endophytes that improve phosphorus solubilization and drought tolerance.



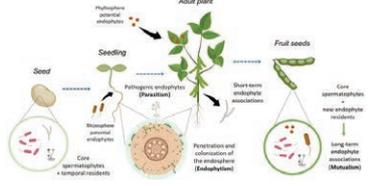
SRI BIO

### Endophytes and Their Role in Induced Systemic Resistance: Nurturing Plant Health from Within

Endophytes – partners inside plants

#### Induced Systemic Resistance (ISR)

- Mechanisms of ISR Activation
- Benefits of ISR
- Advantages of ISR
- Reduced reliance on chemical pesticides and enhanced plant fitness
- Endophytes as elicitors
- Resistance against pathogens
- Enhancing crop quality

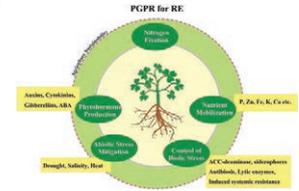


SRIPIO A Microbiome Centre

### RHIZOSPHERE ENGINEERING FOR ENHANCED NUTRIENT UPTAKE

- Plants with **strong root microbiome interactions** can access nutrients more efficiently.
- Selection of varieties that **support mycorrhizal fungi** or **phosphate-solubilizing bacteria** ensures better nutrient availability.
- Root exudates influence the microbiome—**selecting for beneficial root traits** can optimize soil microbial interactions.

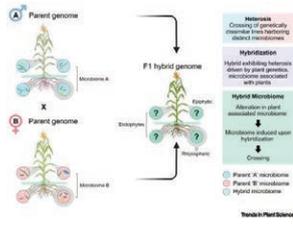
**Case study:** Breeding soybean varieties with root exudates that attract **nitrogen-fixing bacteria (Bradyrhizobium spp.)**.



SRIPIO A Microbiome Centre

### MICROBIOME-GUIDED HYBRID VIGOR (HETEROSIS)

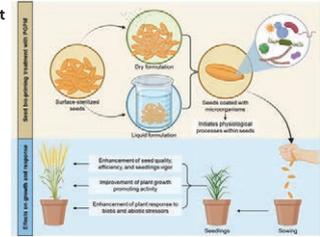
- Microbiomes play a key role in heterosis (hybrid vigor).
- **Evaluating hybrid varieties with favorable microbial associations ensures better adaptability and performance.**
- Microbial profiling of parental lines helps select the best hybrid combinations with beneficial microbiome inheritance.
- **Case study:** Hybrid rice with enhanced plant growth-promoting rhizobacteria (PGRP) interactions for yield improvement.



SRIPIO A Microbiome Centre

### BIOPRIMING AND SEED MICROBIOME OPTIMIZATION

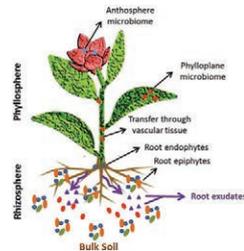
- Seeds harbor microbial communities that influence early plant development.
- **Microbiome-enriched seed coatings or seed biopriming can ensure better germination and resilience.**
- Selection of breeding lines with strong seed-associated microbiomes enhances stress tolerance in progeny.
- **Case study:** Tomato varieties with seed coatings containing *Bacillus subtilis* for early growth promotion and disease resistance.



SRIPIO A Microbiome Centre

### STRESS-RESILIENT MICROBIOME SELECTION

- Drought, salinity, and temperature stress influence microbiome composition.
- **Screening plant varieties under stress conditions and selecting for varieties that maintain beneficial microbial associations can improve resilience.**
- Developing microbial inoculants specific to climate-adaptive crops ensures sustainable yield stability.
- **Case study:** Sorghum varieties with heat-tolerant rhizosphere microbes for better survival in arid regions.



SRIPIO A Microbiome Centre

### DISEASE-SUPPRESSIVE MICROBIOME SELECTION

- Some plant varieties naturally recruit disease-suppressive microbes from the soil.
- **Breeding programs can integrate microbiome-based disease resistance traits, reducing the need for chemical pesticides.**
- Beneficial microbes can outcompete pathogens through antagonism, antibiosis, or induced systemic resistance (ISR).
- **Case study:** Cucumber varieties selected for rhizosphere microbes suppressing *Fusarium wilt*.



SRIPIO A Microbiome Centre

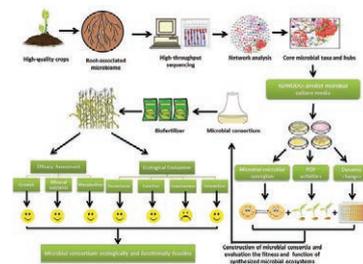
### GENETIC-MICROBIOME INTERACTION STUDIES

- Advanced multi-omics approaches (metagenomics, transcriptomics, metabolomics) reveal plant-microbiome interactions at the molecular level.
- Understanding how plant genes influence microbiome recruitment helps in breeding microbiome-compatible varieties.
- CRISPR and gene-editing techniques could be used to enhance root-microbiome interactions for better crop performance.
- **Case study:** Genomic studies on wheat varieties with enhanced mycorrhizal colonization genes for improved phosphorus uptake.

**M genes**  
The plant microbiota can complement host functioning, leading to improved growth and health under unfavorable conditions. Microbiome engineering could therefore become a transformative technique for crop production. Microbiome genes provide valuable targets for shaping plant-associated microbial communities.

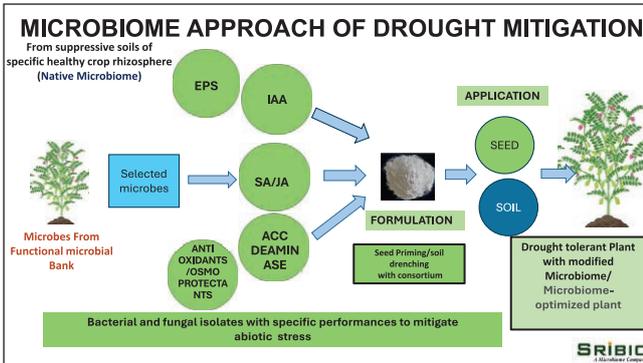
SRIPIO A Microbiome Centre

### CONSTRUCTION OF SYNTHETIC MICROBIAL CONSORTIA (SMC)



PAVING THE WAY FROM THE LAB TO THE FIELD: USING SYNTHETIC MICROBIAL CONSORTIA TO PRODUCE HIGH-QUALITY CROPS

SRIPIO A Microbiome Centre



### INTEGRATION OF MICROBIOME-BASED APPROACHES INTO BREEDING PROGRAMS

Step 1-Selecting varieties with **beneficial microbial associations**  
 Step 2-Engineering rhizosphere and endophytic microbiomes for **stress resilience**  
 Step 3-Utilizing **microbiome-assisted selection (MAS)** for better **nutrient uptake and disease resistance**  
 Step 4-Leveraging **biopriming, seed microbiome optimization, and genetic-microbiome studies** for sustainable crop improvement

**Harnessing microbiomes in plant breeding can move toward a next-generation, eco-friendly agriculture that enhances yield, resilience, and sustainability.**

**SRIBIO**  
A Microbiome Company

### MICROBIOMES HELP IN

<h4>SEED HEALTH</h4> <p>Endophytic and rhizospheric microbes influence seed germination and vigor. <b>Beneficial microbes help in seed priming, enhancing resistance to stress.</b> Bio-priming with microbial inoculants promotes early seedling establishment</p>	<h4>SOIL HEALTH</h4> <p>Microbial communities break down organic matter and improve soil fertility. <b>Maintain soil biodiversity and suppress harmful pathogens.</b> Biofertilizers and biostimulants improve nutrient availability.</p>	<h4>PLANT HEALTH</h4> <p>Plant growth-promoting rhizobacteria (PGPR) and fungi (PGPF) stimulate plant immunity. <b>Suppression of plant pathogens through microbial competition and antibiosis.</b> Enhances nutrient uptake efficiency (e.g., nitrogen-fixing bacteria, mycorrhizal fungi).</p>
---	---	--

**SRIBIO**  
A Microbiome Company

### MICROBIOME-BASED DELIVERY SYSTEMS

- **Biofertilizers** – Nitrogen-fixing bacteria, phosphate solubilizers.
- **Biostimulants**- Abiotic stress mitigating microbes
- **Biopesticides** – Microbes for controlling plant diseases and pests.
- **Soil Amendments** – Organic matter additions to boost microbial diversity.
- **Seed and Foliar Microbial Inoculants** – Beneficial microbes applied to seeds and leaves.

**SRIBIO**  
A Microbiome Company

### MICROBIOMES IN CROP IMPROVEMENT: CHALLENGES AND FUTURE PERSPECTIVES

Variability in microbiome responses due to environmental conditions.  
**Need for region/crop-specific microbial consortia.**  
 Advances in microbiome research and biotechnology can improve applications.  
The plant microbiome consists of beneficial microbes that interact with seeds, plants, and soil.  
These microbes enhance plant health, improve soil fertility, and increase crop resilience  
Utilizing microbiome-based approaches can unlock the full genetic potential of plant varieties.

**SRIBIO**  
A Microbiome Company

### MICROBIOMES THE FUTURE

The genetic makeup of plant influences the composition and function of the microbial communities (microbiome) living on and around it, impacting traits like growth, stress tolerance, and nutrient uptake, essentially exploring how a plant's genes actively shape its microbiome and vice versa; this field is crucial for understanding plant health and developing strategies for improved crop yields in agriculture.

**SRIBIO**  
A Microbiome Company

### MICROBIOME ASSISTED AGRICULTURE

Advances in technology allow for the precise application of microbial inoculants tailored to specific crops and soil conditions. This targeted approach maximizes the benefits of microbial interventions and minimizes chemical applications

**SRIBIO**  
A Microbiome Company



Mr. G. V. Ramana Rao, CTO, Ganga Kaveri Seeds

 **INDIAN SEED CONGRESS**  
NEW DELHI, FEB 22-25, 2016  
EMERGING TECHNOLOGIES - PROPPELLING SEED REVOLUTION

**SEED PRODUCTION INNOVATIONS for a RESILIENT INDIAN SEED INDUSTRY**




GV Ramana Rao, Chief Technology Officer,  
Ganga Kaveri Seeds Pvt Ltd, Hyderabad

## Contents

- Introduction
- Innovations in Seed Production
- Soil Health
- Seed Sowing
- Nutrient management
- Smart Farming technologies including Smart Pest Control
- Climate Change
- Seed Production Technology & Cultivar Traits
- Post Harvest Care
- Conclusion

## Introduction

- High yielding variety (HYV) seeds are one of the key elements of the **Green Revolution**.
- The Demand and availability of Quality Seeds in India is steadily increasing
- India's agricultural production has seen a significant growth and evolved from a Food-Scarce to a Food-Exporting Nation
- Seed production has become more Challenging due to Socio-economic and Climate Changes.
- Seed Production Innovations are therefore essential for Resilient Indian Seed Industry to overcome these Challenges

## Introduction

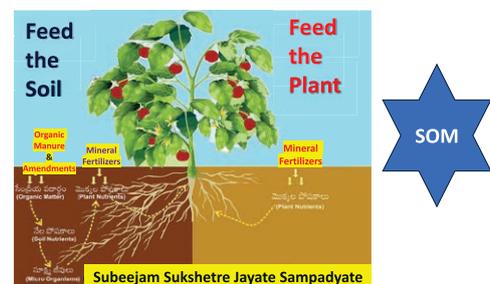
The main objective of Seed Production is to **Provide Required Quality Seed** to the Farmers **@Right Time** and **@ Optimum Price**.

## Key Success Factors

- **Quality** : Seed Quality should meet Indian Minimum Seed Standards and Farmers' Expectations
- **Availability** : Right Product @ Right Time
- **Cost** : Optimization of Production Cost by achieving higher Seed Production Yields

**Producing Quality Seeds means Quality Yields**

## Soil Health



The Picture shown on this slide is for explaining the Concept only Original Concept: UC Davis Global Soil Health Portal

## Organic & Bio-Amendments



Schematic overview of benefits effect of plant interaction with microorganisms in the rhizosphere zone; Source: <https://www.mdpi.com/2076-2607/12/3/558>

## Soil Health-Summary

- Sufficient Organic Matter is a must for Healthy Soil
- Crop Rotation
- Cover Crops
- Reduce Pesticide Use
- Provide Habitat for Beneficial Organisms
- Balanced Nutrition

### Seed Sowing

- Shortage of labour has been reported during the Peak Sowing Season
- Mechanized Planters suitable for Medium and small Seed Production Farms
- Helps in maintaining Optimum Population



5 Teeth Seed Drill

### Nutrient Management

#### Soil testing

- Regularly test soil or growth medium to ensure optimal plant health and yield- **Develop Right Nutrient Mix & Doses**
- Regular application of all **essential nutrients** based on **crop's nutritional needs**, growth stage and other environmental conditions-**AI powered Digital Tools**
- **Right balance of macro- and micro-nutrients**
- The fertilizer dose depends on the soil fertility-C:N:P Ratio etc.,
- **Foliar Sprays/ Fertigation of Water Soluble & Nano Fertilizers** will increase efficiency due to the direct delivery of
  - Essential nutrients to plants
  - Decreased environmental impacts through reduced doses of fertilizers

### SMART FARMING TECHNOLOGIES



Source: Revolutionizing Indian Agriculture by Drone Destination (Posted in LinkedIn-December 6, 2023)

### Smart Farming technologies

- **Digital Monitoring**
  - Use of drones and IoT devices to monitor Field conditions and Seed Development.
- **Data-Driven Decisions**
  - AI and Machine Learning for predicting optimal planting and harvesting times.
- **Precision Farming**
  - Use of Greenhouses and Net houses to ensure optimal growth and isolation; Soil less Farming-**Especially for high Value Crops**

### Digital tools used in sustainable agriculture

- **Farm management software**
- **Weather apps**
- **Satellite imagery**
- **Sensor networks**
- **Drone technology**

### Geographical Information System



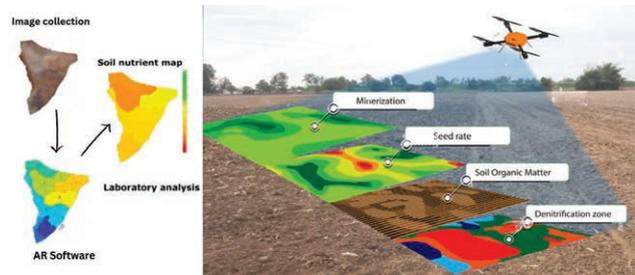
Source: Revolutionizing Indian Agriculture by Drone Destination (Posted in LinkedIn-December 6, 2023)

### Precision Spraying



Source: Revolutionizing Indian Agriculture by Drone Destination (Posted in LinkedIn-December 6, 2023)

### Soil Surveillance



Source: Revolutionizing Indian Agriculture by Drone Destination (Posted in LinkedIn-December 6, 2023)

### STREAMLINING INSURANCE PROCESS-GEOLOCATION



Source: Revolutionizing Indian Agriculture by Drone Destination (Posted in LinkedIn-December 6, 2023)

### Drone Seeding



Source: Revolutionizing Indian Agriculture by Drone Destination (Posted in LinkedIn-December 6, 2023)

### FERTIGATION



**Drone Spray**      **Foliar Spray**

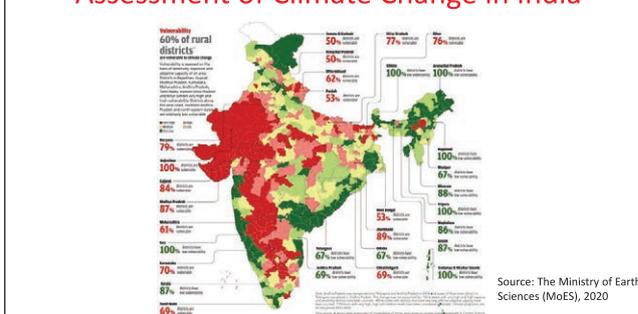
**Broadcasting**      **Right blend of Various Solutions**      **Placement**

### Smart Pest Control

- Smart pest control is the integration of data-driven decision-making through the use of sensors, drones, and artificial intelligence (AI).
- Combines biological, physical, and chemical controls to protect seed crops.
- To use environment friendly new molecules for preservation of beneficial organisms.
- Good Coverage of pesticide application through Drones along with wettable Agents.

### CLIMATE CHANGE is Real and Must be Acknowledged

### Assessment of Climate Change in India

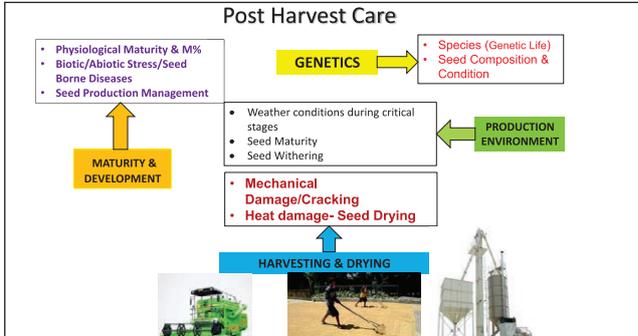


Source: The Ministry of Earth Sciences (MoES), 2020

### Seed Production Technologies & Cultivar Traits

- Need for adapting Climate-Resilient Seed Production Technologies
- To use Inbreds/Parents/Cultivars that thrive in advent climate
- Selection of Suitable Parents for Hybrid Seed Production
  - Photo-insensitive
  - Flag Leaf Angle
  - Zero Staggering
- New Breeding & Seed technologies for sustainable Seed Production
  - Gynoecious Cucurbits, TGMS in Rice, CMS in Corn et al
- Alternative pollination strategies are required in the advent of Climate Change
- **SYSTEMATIC SEED PRODUCTION RESEARCH IS VERY MUCH NEEDED**

### Post Harvest Care



- **GENETICS**
  - Species (Genetic Life)
  - Seed Composition & Condition
- **MATURITY & DEVELOPMENT**
  - Physiological Maturity & M%
  - Biotic/Abiotic Stress/Seed Borne Diseases
  - Seed Production Management
- **PRODUCTION ENVIRONMENT**
  - Weather conditions during critical stages
  - Seed Maturity
  - Seed Withering
- **HARVESTING & DRYING**
  - Mechanical Damage/Cracking
  - Heat damage- Seed Drying

### Conclusion

Key Aspects	Present Practices	Seed Production Innovations
Soil Health	Selection of Suitable Land Thorough land Preparation	Selection of Suitable Soil Minimum Soil Disturbance
	FYM and Fertilizers	Organic/Biological Amendments- Mycorrhizal fungi, FYM/Compost, Oil Cake(Press Cake), Beneficial Microbes, Bio-Stimulants etc.,
Seed Sowing	Manual Sowing	Mechanized Planters suitable for small Seed Production Farms
	Normal Population	High Density Population
Nutrition Management	Periodical applications of NPK Fertilizers & Micronutrients	Regular application of all essential nutrients; Small doses of Water Soluble & Nano Fertilizers based on crop condition and requirement; Foliar Sprays; Fertigation
	Traditional methods of Irrigation	Micro irrigation; Fertigation

Contd....

### Conclusion

Key Aspects	Present Practices	Seed Production Innovations
Smart Pest Control	Pesticide Application	Smart Pest Control with Prophylactic measures
Smart Farming Technologies	Intensive Agriculture	Smart Farming Technologies
Climate Change-Cultivar Traits	Hybrid Vigor & Hybrid Yield	Climate-Resilient Cultivars, Same day sowing of Both the Parents; Seed Parent Yield;
Seed Production Technology	OPVs; Hybridization through CMS; Detasseling; Emasculation & Pollination	New Technologies like TGMS in Rice; CMS in Corn; GMS in Cotton; Gynoeocious cultivars in Cucurbits; Farm Mechanization to match Seed Production requirements; SPR is the Key
Post Harvest Care	Threshing, Drying & Storage	Need for Mechanization with reliable machines to suit small land holdings

**Thank You for Your Kind Attention**

[ramana.rao@jangakaveri.in](mailto:ramana.rao@jangakaveri.in)  
[edvramanarao@gmail.com](mailto:edvramanarao@gmail.com)  
 +91-98499-89745; +91-96665-84500

**Dr. Rabi N. Sahoo**, Program Leader, Principal Scientist, Division of Agricultural Physics, ICAR-IARI

### Embracing Sensing and AI for Precision Agriculture

**Rabi N Sahoo**  
 Indian Agricultural Research Institute  
 (Indian Council of Agricultural Research)  
 New Delhi-110 012, India  
[rabi.sahoo@icar.gov.in](mailto:rabi.sahoo@icar.gov.in)  
<https://NePPA.iari.res.in>

### Innovations bringing Transformation in Agriculture

ICAR-Indian Agricultural Research Institute, New Delhi

### Creating a sustainable food future by 2050

**How do we feed 1.67 (India) / 9.7 (World) billion people without using more land & resources while lowering emissions?**

ICAR-Indian Agricultural Research Institute, New Delhi

### Possible Strategy for Enhanced Productivity

Crop production further increase is possible through either improving the yield potential or by reducing yield losses due to biotic/abiotic stresses

- Development of SMART CROPS through phenomics for high yield potential
- Precision Farming with increased accuracy, precision and throughput at all levels with reduced cost, labour through automation, remote sensing, data analytics

ICAR-Indian Agricultural Research Institute, New Delhi

### Precision Agriculture : A smart farming approach to agriculture

- ✓ Capturing and Managing the Variabilities
- ✓ Remote and In-Field Sensing
- ✓ Capturing soil variabilities (fertility)
- ✓ Monitoring crop health (Biotic and Abiotic Stress)
- ✓ Quality and grading in-season and post harvest
- ✓ UAV / Robotics / IoTs
- ✓ Data Analytics : ML/DL/AI
- ✓ Modeling crop response to variable environment (soil, weather and management)
- ✓ DSS/SDSS for Site Specific Management for optimal crop production system
- ✓ Variable Rate Application
- Making it possible in real or near real time
- Communication innovation/Service Science
- Efficient knowledge transfer to farmers and good user interface (exploring Mobile Network – best alternate for knowledge link)

Smart Farming

ICAR-Indian Agricultural Research Institute

### Innovations led Transformations in Agricultural Research in India

Gene revolution 2020-30s

1960-70s Green revolution

1<sup>st</sup> air borne image of coconut plantations, Kerala, India

B/W print of Ektachrome Color Film 1969 NASA-ISRO-IARI 2015 AVIRIS-NG Hyperspectral Remote Sensing

Phenomics Centre @IARI

### AgTech growth to come from beyond farm management systems

Farming technologies adoption and willingness to adopt

% respondents currently adopting or willing to adopt over the next 2 years

Q: What is your level of adoption regarding the following trends? % respondents currently adopting or willing to adopt over next 2 years (n=5,474)

Region	Currently using or willing to adopt	Currently using	Planning to use within the next 2 years
Europe	62%	35%	26%
North America	61%	47%	28%
South America	50%	31%	23%
Asia	9%	3%	4%
Global	39%	25%	18%

Breakdown of current usage or willingness to adopt over the next 2 years

Adoption of Precision Agriculture Technologies

Global 18, North America 28, South America 27, Europe 21

Source :https://globalfarmerinsights2022.mckinsey.com/#themes

ICAR-Indian Agricultural Research Institute, New Delhi

### ICAR- Network Program on Precision Agriculture (NePPA)

Soil Health, Crop Health, Decision Support System, VRTs/Robotics, Post Harvest quality, Precision Dairy, Precision Fishery, Scaling Up

Developing ICT based Technologies for Accelerated Profitable and Sustainable Indian Agricultural System through Precise Use of Inputs

Phenomics Centre @IARI

### Sensing and Data Analytics (Intelligent Sensing)

- Monitoring and Management Crop Health:
  - Biotic : Pest & Disease
  - Abiotic : Water, Nutrient and heat
- Monitoring crop growth, yield and damage assessment
- High throughput field phenotyping for designing new plant type/variety/precision agriculture
- Monitoring Soil Fertility and Management

SMART CROPS

Smart Farming

ICAR-Indian Agricultural Research Institute, New Delhi

### Sensing from Laboratory to Field scale

In-situ data, UAV, Earth Observing Satellite

Point, Several Sq. m, low Sq. Km, hundreds of Sq. Km

Limitations, Advantages, Limitations, Advantages, Limitations, Advantages

ICAR-Indian Agricultural Research Institute, New Delhi

### Sensors and Sensing Technologies for Crop and Soil Health Monitoring @ IARI

Thermal Sensor, LiDAR, MultiSpectral Sensor, Imaging spectrometer, Hyperspectral lab, Phenomics Centre

ICAR-Indian Agricultural Research Institute, New Delhi

### High throughput Phenotyping for Precision Agriculture

Controlled Environment, Natural Field

Plant to the Camera, Camera to the plant

Mobile platforms, Phenomobile

Imaging Sensors

- Visual - RGB (400-700nm)
- NIR (Near Infra red) - 900-1700nm
- VNIR, Hyperspectral (600-1000nm)
- SWIR, Hyperspectral (1000-2500nm)
- Chlorophyll Fluorescence (Photosynthetic efficiency)
- Infrared (IR) Thermal (8-16 µm)
- Spectroradiometer

Nanjai Deshmukh Plant Phenomics Centre 70+ Million Images till date

ICAR-Indian Agricultural Research Institute, New Delhi

### Multimodal Sensing : for 360° info of the Farm

ICAR-Indian Agricultural Research Institute, New Delhi

### Sensing and Big Data Analytics

- Univariate Approach
  - Spectral Indices and sensitive bands
- Multivariate Approach
  - Partial Least Squares Regression (PLSR)
  - Multiple Linear Regression (MLR)
  - Multivariate Adaptive Regression Spline (MARS)
- Machine Learning
  - Support Vector Machine (SVM)
  - Random Forest (RF)
  - Artificial Neural Network (ANN)
- AI - Deep Learning- Gen. AI, Foundational Model etc
- Physical Process based Modelling : Radiative Transfer

ICAR-Indian Agricultural Research Institute, New Delhi

### Remote Sensing of Soil Fertility from Lab to Field Scale

ICAR-Indian Agricultural Research Institute, New Delhi

### Soil Organic Carbon Map from Air borne Sensors (AVIRIS-NG)

(in collaboration with ISRO and ICAR Institutes)

ICAR-Indian Agricultural Research Institute, New Delhi

### Sensing and AI for optimizing Soil Sampling and Digital Soil Fertility Mapping

A Case Study of Odisha

Samples # 6 lakhs To 3000

Digital Soil Map of Soil OC of 6 Districts of Odisha

	R	Deviation	MAE	RMSE
Calibration	0.93	0.09	0.07	0.02
Hyperparameter	0.89	0.10	0.09	0.03
CV	0.96	0.07	0.05	0.02
Independent Validation	0.87	0.12	0.09	0.03
RMSE	0.03	0.08	0.02	0.01
Independent Validation	0.90	0.08	0.06	0.01

(in collaboration with ICAR-National Bureau of Soil Survey & Land Use Planning)

ICAR-Indian Agricultural Research Institute, New Delhi

### Remote Sensing of Soil Fertility : In situ to Satellite for SSNM

Earth Intelligence for All

Soil Fertility based Site Specific Fertilizer Recommendation

Use Mendly Mobile App

Advisory for Fertilizer

(in collaboration with ICAR-NBSSLU, IISS)

ICAR-Indian Agricultural Research Institute, New Delhi

### Near Real Time Crop Health Monitoring for Site Specific Management from experimental plot to Large Farmers' field Scale in Rice and Wheat

with ICAR-National Rice Research Institute & Indian Institute of Wheat and Barley

Pusa N-Manager

ICAR-Indian Agricultural Research Institute

### Computer Vision for Plant Phenomics and Smart Agriculture

Wheat Phenomics : 2024

Sample Size: 150 Genotypes x 3 Treatments x 2 Replications = 900 samples

Environment: Pot Experiment in NDPPC

Genotypes: 150 Diverse Genotypes

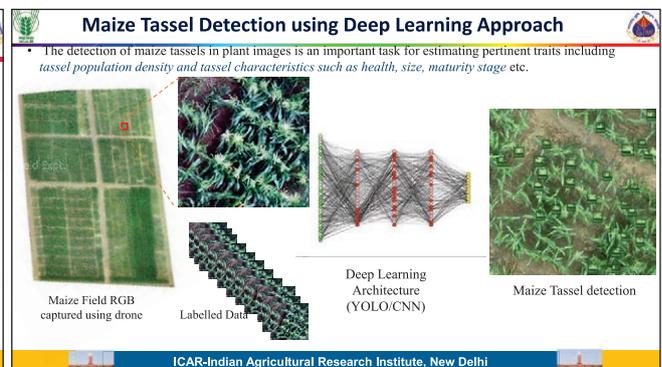
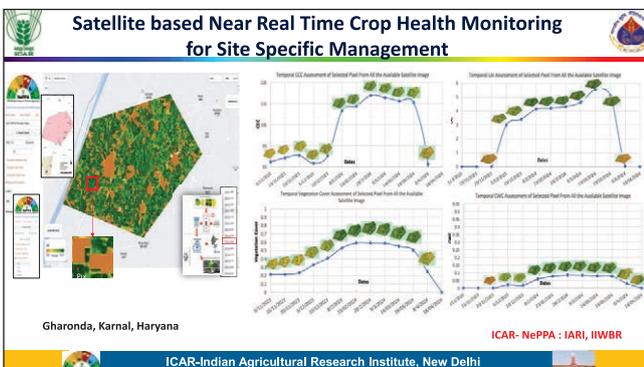
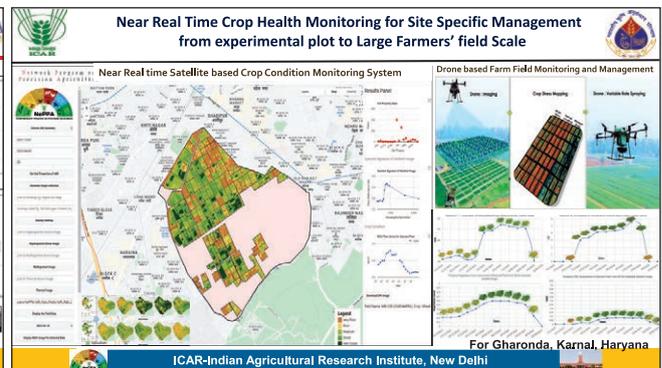
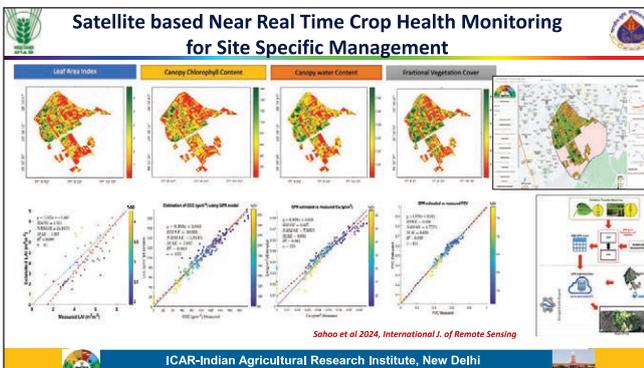
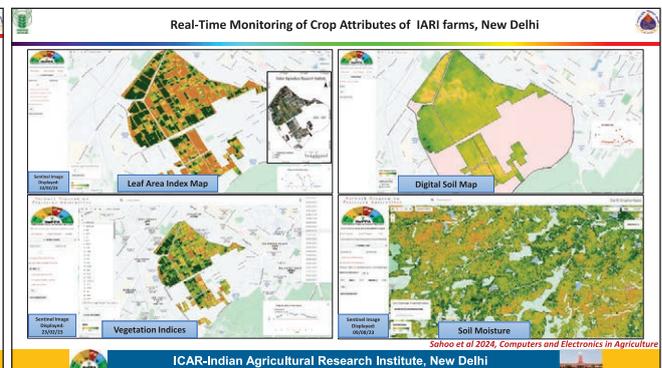
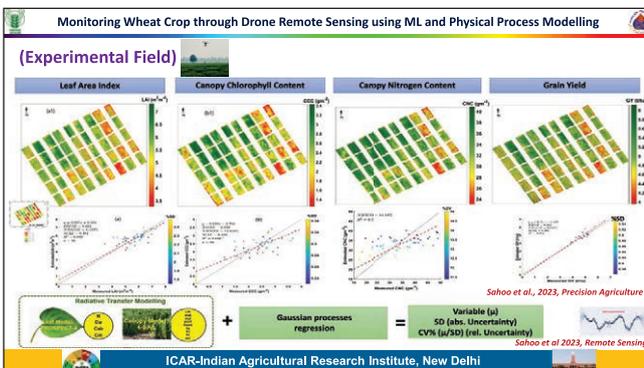
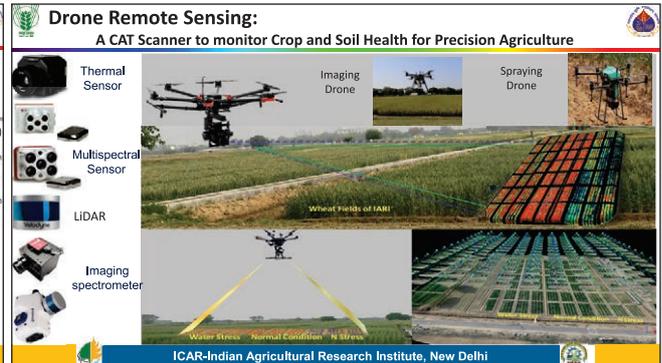
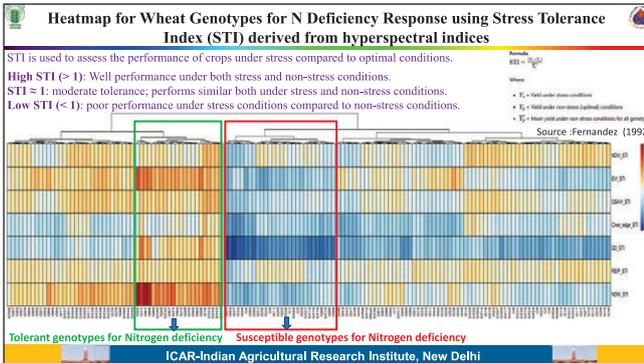
Treatments:
 

- Control (RDFs full)
- Nitrogen Deficiency (RDFs-Nitrogen)
- Drought Stress (Withholding Irrigation at Heading)

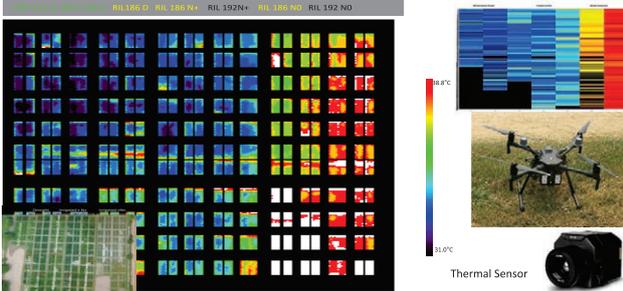
Sensors Used:
 

- NDPPC Imaging
- Manual Imaging
- RGB
- Multispectral
- Thermal
- NIR
- TIR
- RGB
- Spectroradiometer

ICAR-Indian Agricultural Research Institute, New Delhi



### Capturing water deficit stress through Drone based thermal imaging



Thermal Sensor

ICAR-Indian Agricultural Research Institute, New Delhi

### Satellite and Drone based Crop Nutrient Monitoring and Management



Soil Available Nitrogen, Image derived crop growth indicators, Plant Nitrogen Content

Multimodal imaging, edge computing on Drone

5G Captive Environment

Site specific input application

Imaging and Site specific Input application from ground robots

ICAR-Indian Agricultural Research Institute, New Delhi

### Development Low cost Sensor and IoT Enabled Automated Irrigation Management System



Transplanted rice with Alternate wetting and drying schedule

IoT enabled irrigation water management systems

Controller, Irrrometer

Implementation

NRC Banana

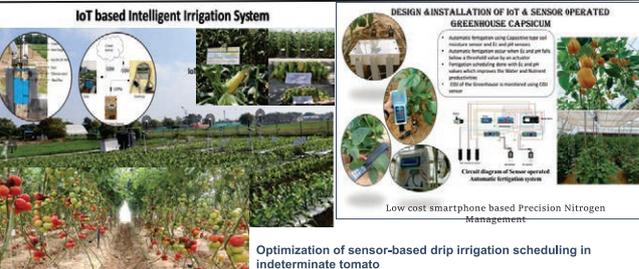
Direct Seeded Rice (DSR)

IIVR, Varanasi

ICAR- NePPA : IIWM, IARI, CIAE, NRCB

ICAR-Indian Agricultural Research Institute, New Delhi

### Development of IoT Enabled Automated Irrigation Management System and Fertigation in Green House



IoT based Intelligent Irrigation System

DESIGN & INSTALLATION OF IOT & SENSOR OPERATED GREENHOUSE CAPSICUM

Low cost smartphone based Precision Nitrogen Management

Optimization of sensor-based drip irrigation scheduling in indeterminate tomato

ICAR- NePPA : IARI, CIAE, IIVR

ICAR-Indian Agricultural Research Institute, New Delhi

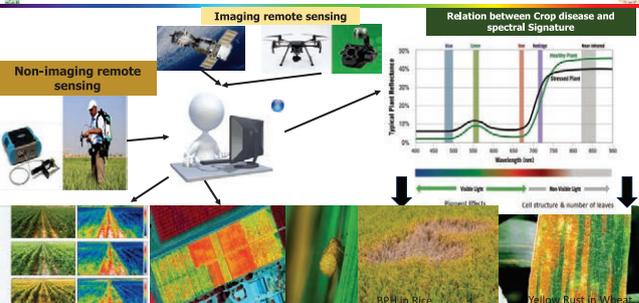
### AI based intelligent irrigation system for field crops

- 7-10% water saving was found as compared to 100% Etc with drip irrigation.
- Whether data is used in conjunction soil moisture to actuate the pump for irrigation.
- IoT based sensors lack accuracy as compared to normal ones.
- Resolution of whether data (0.25° × 0.25°) limits the accuracy of the system.



ICAR-Indian Agricultural Research Institute, New Delhi

### Remote sensing- based approach for Crop Health monitoring



Imaging remote sensing

Non-imaging remote sensing

Relation between Crop disease and spectral Signature

Wavelength (nm)

Visible Light, Near Visible Light, Near Infrared

Cell structure & number of leaves

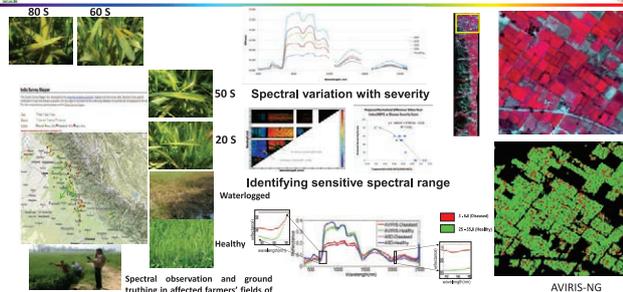
Waterlogging (rice)

BPH in Rice

Yellow Rust in Wheat

ICAR-Indian Agricultural Research Institute, New Delhi

### Monitoring of Wheat Yellow Rust through Hyperspectral Remote Sensing



80 S, 60 S, 50 S, 20 S

Spectral variation with severity

Identifying sensitive spectral range

Waterlogged

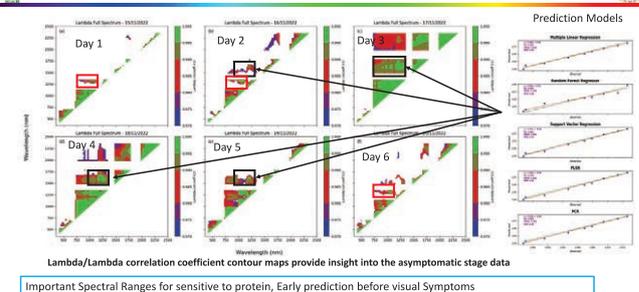
Healthy

Spectral observation and ground truthing in affected farmers' fields of Yamuna Nagar, Haryana

AVIRIS-NG ISRO-SAC

ICAR-Indian Agricultural Research Institute, New Delhi

### Sensing Asymptomatic Pathway Rice Blast through Spectroscopy



Day 1, Day 2, Day 3, Day 4, Day 5, Day 6

Prediction Models

Lambda/Lambda correlation coefficient contour maps provide insight into the asymptomatic stage data

Important Spectral Ranges for sensitive to protein, Early prediction before visual Symptoms

- X 980 nm and Y 1064 nm, X 1064 nm and Y is 1300 nm X 1750 nm and Y 2250 nm,

ICAR-Indian Agricultural Research Institute, New Delhi

### Deep Learning Techniques Based Rice Blast Disease Identification using RGB image

#### U-Net Architecture

Accuracy of 97.8 %

ICAR-Indian Agricultural Research Institute, New Delhi

### Assessing biotic stress (BPH of rice and wheat aphids) through sensors

ICAR-Indian Agricultural Research Institute, New Delhi

### Variable-Rate Technology (VRT) for different Input Applications

#### VRT ROBOT

#### VRT Drone for Spraying

#### Sensor based VRT

ICAR-NePPA : CIAE, IARI

ICAR-Indian Agricultural Research Institute, New Delhi

### Sensor-based variable-rate nutrient applicator

- Can improve crop yields by up to 5–8% compared to conventional methods.
- Savings in the fertilizer of up to 16 to 24%, with some indirect benefits such as reduced soil degradation and salinization.
- Sensors are not sensitive enough to increase the number of classifications.
- Overall savings is not more than 2000/- per hectare

ICAR-CIAE

ICAR-Indian Agricultural Research Institute, New Delhi

### Un-manned paddy transplanter

- A multi-functional remote-controlled system to ride-on-rice transplanter.
- The system comprises a remote-controlled on/off system, steering, direction, speed, brake, transplanting function and emergency stop using a programmed electronic control unit (ECU).
- The field capacity, field efficiency and fuel consumption was 0.24 ha/h, 71 % and 3.1 L/ha.
- The limitation of remote control can be overcome with a GPS.

ICAR-CIAE

ICAR-Indian Agricultural Research Institute, New Delhi

### Camera-assisted hydraulically operated pneumatic fruit picking system

- Plucking of citrus has been attempted by pneumatic as well as robotic arm.
- Plucked fruits have a punctured skin as the pedicle is removed with a part of it.
- Genetic engineering interventions can rescue the situation for successful operation.

ICAR-CIAE

ICAR-Indian Agricultural Research Institute, New Delhi

### Automatic fruit grader

- The capacity of the machine is 1700 fruits/h.
- The machine has a custom lightweight CNN model "SortNet" for vision-based classification of citrus fruits.
- Environmental parameters affect the sensors and microcontroller performances.

ICAR-CIAE

ICAR-Indian Agricultural Research Institute, New Delhi

### Electronic sensing system for onion, potato & tomato

- Lower life of MOS sensor.
- Detect only group of compounds and not the individual compound.
- Needs multiple sensors as an array leads complexity in the system.
- Poor repeatability among the different lots due to diversity in biological commodities.
- Incorrect results due to accumulated VOC's when used in fixed system.

ICAR-CIAE

ICAR-Indian Agricultural Research Institute, New Delhi

### Smart Urban Agriculture

#### Hydroponics Farming

- 98% water efficient
- 96% fertigation efficient
- Season-neutral
- Green house ready
- Indoor farming compliant
- AI, IoT and sensor operated

### Smart Hydroponic Model

Multiple layer Vertical Hydroponic Model

108 Plants Capacity

With and without LED Light

Fertigation Tank: 100 liter

Total Energy Requirement 250 Watt

### Precision Aquaculture

IoT based Aqua system Quality Monitoring (Dissolved Oxygen, Salinity, pH, NH<sub>3</sub> and TDS and Temperature Profile)

Smart Hatchery System for Sustainable Catfish Seed Production

Smart Hatchery

IoT based Automatic Fish Feeding Devices

Water sampling in river Ganga

Automatic tracking & counting

Disease detection

Low cost sensor with computer vision

Sensor based drum filter

### Drone and Sensor based Monitoring of Fish and Water Quality for Precision Aquaculture

DO sensor in fish tank

FISH V6 underwater drone

IoT based Dissolved Oxygen (DO) Management System (IDOMS)

Cloud computing

Aerator 'on' when DO < 5 mg/l

Continuous DO recording with aerator status

Pond quality monitoring from drone

Drone based Water Sampling in river Ganga

Fish monitoring

Cage net monitoring

Date	Time	Temperature (°C)	pH	DO (mg/l)	Salinity (ppt)	TDS (ppm)
2023/03/24	08:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	09:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	10:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	11:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	12:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	13:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	14:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	15:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	16:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	17:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	18:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	19:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	20:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	21:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	22:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	23:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	00:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	01:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	02:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	03:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	04:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	05:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	06:00	27.00	7.50	3.00	0.00	0.00
2023/03/24	07:00	27.00	7.50	3.00	0.00	0.00

### Precision Livestock Farming

#### Early Sub-clinical Mastitis Detection

Images of IRT temperature (°C) of feet of healthy, sub-clinical and sub-clinical affected with sub-clinical degree of lameness.

Healthy Sub-clinical Clinical

#### Lameness Detection

#### Parturition time Detection

Tail raising, -2h

Tail raising, -3h

Relaxation of sacro-sciatic ligament, -4h

Vaginal discharge, -4h

#### Diagrammatic representation of data flow of pedometer

#### Estrus Detection

Heat to animal

Heat start monitoring date

Heat display on laptop

### 5G Private Network : leveraging to Crop Field for Smart Farming

ITU-DoT-FAO delegations during March 2024

NIB on Drone in IARI Farm

LAB PRODUCTS at IITD AIC

5G-NIB COTS Hardware

IARI : one of the 5G Use Labs of India with support from DoT

W4S-Lab-IITD

ICAR-Indian Agricultural Research Institute, New Delhi

### Initiatives for Future Agriculture

Inspired from nature

IoD for Smart Agriculture

IoDs : Internet of Drones (using 5G Captive Network)

SWARM DRONE TECHNOLOGY for different civilian use

ICAR-Indian Agricultural Research Institute

### Internet of Drones using 5G : IARI for Next Generation Farming

Big Data Analytics Lab

Cloud computing

Edge Computing

Drone with NIB

Drone with AI

Imaging Drones with sensors

Spraying Drone

Cows having monitoring devices

Paid with Fish and Sensors

ICAR-Indian Agricultural Research Institute, New Delhi

Sahoo et al, 2024

### IoT, 5G and AI enabled Edge Computing- a step towards Digital Farming @ IARI

Real-time Dashboard

Data Accumulation

Data Transmission

Data Storage, Processing and Analytics

On Cloud

EDGE computing

ICAR-Indian Agricultural Research Institute, New Delhi

### Kisan-SARATHI

System of Agri-Information Resources Auto-transmission and Technology Hub Interface

Empowering Agriculture Community

**Empowering Farmers**

- Personalized Advisory
- Live interaction in local language with domain expert.
- Anywhere, Any time Access on past advisories
- Facility to register through Toll Free and Mobile App

**Empowering Institutions**

- Dashboard and MIS for monitoring and Evaluation
- Click to Call facility-on mobile, conferencing, recording.
- Access to Knowledge and Farmers Database- Know Your Farmer (KYF)
- Push emergency messages at any level.
- Feedback mechanism

**Connected with**

- 731 KVKs
- 3000+ Agricultural Experts
- 113 ICAR Institutes
- 76 Agricultural Universities

Coverage : All India  
Language: All National Languages

SMS: Bulk, Groups, Personal  
IVRS: 14 Languages

### KISAN SARATHI

System of Agri-Information Resources Auto-transmission and Technology Hub Interface

Number of Registered Farmers

2.56+ Crores, till January 2025

Level	Without Kisan Sarathi	With Kisan Sarathi
Districts	10%	90%
Blocks	12%	88%
Villages	45%	55%

ICAR-Indian Agricultural Research Institute, New Delhi

### 5G enabled Smart Village : to start from home, IARI

- Multi-Disciplinary Collaborative Research Translation (IARI & IIT Delhi)
- Globally competitive & 'Ahead of State-of-art' Commercially deployable Solutions for Smart Farming
- R&D Cost & Timeline optimization is to be powered by:
  - Research Translation exercise in Academia-Industry Collaboration
- Easy to implement at Pilot scale involving knowledge experts from all domains
- Parallely to start any of the 10 villages proposed keeping in view proximity
- Finally to implement in cluster of villages for viable business proposition

Total Area Coverage: 500 ha

ICAR-Indian Agricultural Research Institute, New Delhi

### Scaling the Precision Agriculture in India : Challenges

- Average farm size (70 % less than 1ha), and heterogeneous in cropping, agri-ecosystem, and management practices
- Poor yield and limited access to resources - financial services, credit (or lenders), support expertise,
- Poor infrastructure
- Low use of farm technologies and best farming techniques
- Decrease of soil fertility due to over fertilization and increase in pesticide use
- Post harvest loss
- Frequent natural calamities

ICAR-Indian Agricultural Research Institute, New Delhi

### Best practices for inclusiveness and scaling of farmer centric digital innovations

- Institutional support** for and with the new innovation agenda
- Public and private partnership** for collective measures to bridge the gap between farming community and technological interventions, mobilizing **vital agro-services** to Indian agriculture services
- Digital empowerment** of Network of Common Service Centres (CSC) and extension services network in the form of Krishi Vigyan Kendras (KVKs)
- Demonstration** of new innovations for digital agriculture through CSC, KVKs and FPOs large scale community level acceptance and adoption.
- Capacity building and hand holding** for new innovations in smart farming

ICAR-Indian Agricultural Research Institute, New Delhi

### Way Forward

#### Farmer Centric Digital Innovations

- More investments into Research on Digital Inclusion, Responsible-Generative AI and Quantum computing
- Standard Spectral Library for Indian Soils
- Low Cost Sensor Technology for Soil and Water management
- Digital and Data Innovations for enhanced last-mile adoption of agricultural technologies
- Precision Monitoring of Agricultural ecosystem using Remote sensing, IoT Sensors, Drones
- Public-Private-Partnerships for scaling
- Policy matter- Digital Agriculture Strategy

ICAR-Indian Agricultural Research Institute, New Delhi

**NePPA**  
ICAR-Network Program on Precision Agriculture

**THANK YOU**

<https://NePPA.iari.res.in> [rabi.sahoo@icar.gov.in](mailto:rabi.sahoo@icar.gov.in)

**Acknowledgement**  
My students, research fellows and fellow colleagues associated with

# Technical Session - IV

Dr. Gyan Prakash Mishra, Head, Division of Seed Science and Technology, IARI

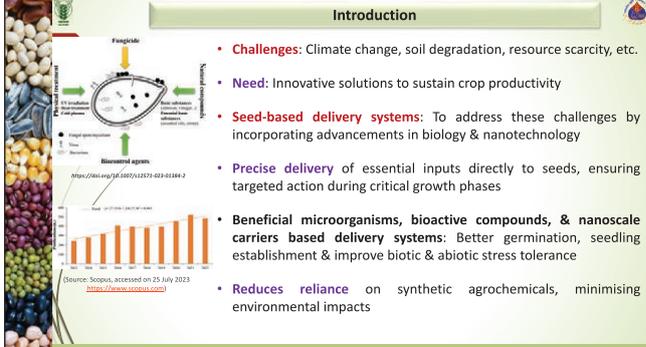
### Seed-Based Delivery Systems Using Biologicals and Nanotechnologies for Improved Stress Tolerance and Crop Productivity



**Dr Gyan Prakash Mishra**  
Head, Division of Seed Science and Technology  
Indian Agricultural Research Institute, New Delhi-110012  
Email: gyan.gene@gmail.com

13<sup>th</sup> ISC-2025

### Introduction



- Challenges:** Climate change, soil degradation, resource scarcity, etc.
- Need:** Innovative solutions to sustain crop productivity
- Seed-based delivery systems:** To address these challenges by incorporating advancements in biology & nanotechnology
- Precise delivery** of essential inputs directly to seeds, ensuring targeted action during critical growth phases
- Beneficial microorganisms, bioactive compounds, & nanoscale carriers based delivery systems:** Better germination, seedling establishment & improve biotic & abiotic stress tolerance
- Reduces reliance** on synthetic agrochemicals, minimising environmental impacts

13<sup>th</sup> ISC-2025

### 1. Biologicals in Seed-Based Delivery Systems

**Biologicals:** Products derived from natural sources viz. microorganisms, plant extracts, or naturally occurring compounds

(i) **Beneficial Microorganisms:**

- Rhizobia,** mycorrhiza, & endophytic bacteria- Enhance N-fixation, nutrient uptake, & stress resilience
- PGPRs-** improve plant hormone (auxins, cytokinins) & tolerance to abiotic stresses
- Biocontrol agents-** protect seeds from pathogens through competitive exclusion & induced systemic resistance

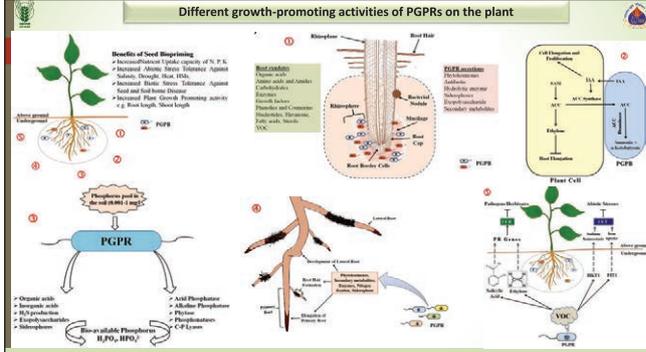
(ii) **Biostimulants:** Humic substances, seaweed extracts, & amino acids enhance germination rates, root growth, & stress tolerance

(iii) **Metabolite Based Enhancements:** Phenolics & flavonoids activate antioxidant pathways, enhancing seedling resilience & mitigating oxidative stress

*Seed treatment: Improves seed performance & crop resilience*

13<sup>th</sup> ISC-2025

### Different growth-promoting activities of PGPRs on the plant



13<sup>th</sup> ISC-2025

### Advantages of Seed coatings with biologicals

(i) **Stress Tolerance:** Microbial inoculants help plants withstand abiotic stresses

- Rhizobium-** Symbiotic relationship with legume (atmospheric N into ammonia)
- Azospirillum-** Promotes **root development** (IAA)
- Trichoderma-** Synthesis of **antifungal compounds**, that suppress harmful pathogens

(ii) **Nutrient Efficiency:**

- Biofertilizers** in seed coat- Significantly improve nutrient use efficiency
- PSB** produce organic acids (Citric & Lactic acid)- Dissolve insoluble phosphate into accessible forms
- Mycorrhizal fungi:** Extend the effective root surface area through hyphal networks, allows plants to access P & vital micronutrients
- Increase P uptake (up to 30%) & provide boost to early seedling & overall plant development

13<sup>th</sup> ISC-2025

### Advantages of Seed coatings with biologicals

(iii) **Disease Suppression:** Seed coating with *Bacillus subtilis* & *Pseudomonas fluorescens* protects plants from soil-borne pathogens

- P. fluorescens** produce **siderophores** which bind Fe (in soil), making it unavailable to pathogens & starves harmful pathogens
- B. subtilis** synthesizes various **antifungal metabolites** (lipopeptides & antibiotics) which suppress diseases (root rot & damping-off)
- Also enhance seedling vigour & overall plant health

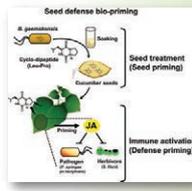
(iv) **Plant Growth Promotion:** Biostimulants activate metabolic pathways in seeds & promote synthesis of enzymes, hormones, & bioactive molecules

- Seaweed extracts** (cytokinins, auxins, gibberellins), stimulate robust root growth & enhance nutrient absorption
- Amino acids:** Building blocks for proteins & signalling molecules, improve photosynthetic efficiency & stress response

13<sup>th</sup> ISC-2025

### Challenges: Biologicals in Seed-Based Delivery Systems

- Ensuring** long-term **survival** & **activity** of microbial inoculants under field conditions
- Optimization:** **Compatibility** between seeds, microbial strains, & environmental conditions
- Standardized guidelines** (production & application) for large-scale adoption
- Scalability** for large agricultural systems



**Biopriming has immense potential for the sustainable development of agriculture by enhancing stress tolerance**

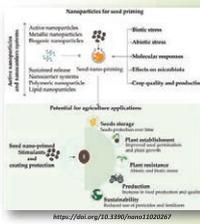
13<sup>th</sup> ISC-2025

### 2. Nanotechnologies in Seed-Based Delivery Systems

- Seed nanoprimering:** Enhances stress tolerance & productivity
- Activates physiological & molecular mechanisms (abiotic & biotic stress tolerance)
- Nanoscale delivery** of nutrients, agrochemicals, or biological agents **improves efficiency**

(i) **Nanoparticles (NPs)**

- Nanofertilizers:** Slow & targeted nutrient delivery (Zn, Fe), enhance seedling vigor by ensured nutrient availability
- Nano-pesticides & -herbicides:** Protection against early-stage pests & weeds
- Stress-protective NPs:** Engineered NPs (Si, Titanium dioxide), enhance antioxidant activity, reduce oxidative damage, & improve drought tolerance



13<sup>th</sup> ISC-2025



### Synergistic Approaches: Combining Biologicals & Nanotechnology

- (i) Microbial-Nano Hybrids**
  - Integrating microorganisms with nanoparticles (better efficiency)
  - Bioinoculants with Si NPs: Improved seed germination & stress tolerance (drought/salinity)
- (ii) Seed Priming**
  - Nano-priming with biochar-loaded NPs or nanoclay composites: Enhanced abiotic stress tolerance
- (iii) Multi-functional Coatings**
  - Seed coatings with both biologicals & nanomaterials for protection & growth stimulation (nutrient supply, pathogen resistance, & abiotic stress mitigation)

https://doi.org/10.1016/j.seeds.2022.100091  
13<sup>th</sup> ISC-2025

### Advantages of Seed-Based Delivery Systems

- (i) Precision and Sustainability**
  - Reduced input waste & environmental contamination (localized & efficient delivery of agro-inputs)
  - Minimal application of synthetic agrochemicals for eco-friendly farming
- (ii) Enhanced Stress Tolerance**
  - Promotes seedling survival & growth under abiotic stresses
  - Induced stress-related gene expression & antioxidant pathways to protect seedlings from oxidative damage
- (iii) Improved Crop Productivity**
  - Boosts germination rates, seedling uniformity, & ESV
  - Enhanced nutrient use efficiency, photosynthetic performance, & plant health

13<sup>th</sup> ISC-2025

### Challenges and Future Directions

- Optimization of **compatibility** of biologicals with nanoparticles & seed coatings
- Regulatory challenges** & public perception of nanotechnology pose barriers in its adoption
- Stability & efficacy** of nanoformulations & biologicals during storage & application
- Multi-functional coatings** for specific crops & environmental conditions
- Integration with IoT & AI: Enhanced stress management
- Biodegradable & renewable** nanomaterials are eco-friendly solutions
- Genetic engineering for biologicals for improved resilience to environmental stress & compatibility with nanocarriers

13<sup>th</sup> ISC-2025

### Conclusions

- Enhanced Crop Productivity & Resilience:** Seed-based delivery systems (biologicals & nanomaterials) improve plant growth & stress tolerance
- Precision & Sustainability:** Enable efficient, environment-friendly solutions to climate change & resource limitations
- Collaboration & Innovation Needed:** Need interdisciplinary research, collaboration among scientists, policymakers, industry, & farmers
- Scaling for Global Impact:** Widespread adoption for achieving long-term food security & sustainable farming

13<sup>th</sup> ISC-2025

### SpeedySeed Viability Kit- A Non destructive & quick option to find the seed viability

- Aged seeds, reduced mitochondrial activity, thus the respiration rate
- CO<sub>2</sub> is captured in an **Indicator solution**, which change the colour in response
- Wheat, paddy, maize, soybean, lentil, Mungbean, cucumber, bottle gourd

CO<sub>2</sub> evolution by old & fresh seeds in maize

Variety/line (Maize)	Standard germination test	SpeedySeed Viability Kit™
Agra 2024	100%	95%
Maize (lot 2)	63.15%	60%
Maize (lot 3)	21.05%	18%
Maize (lot 4)	0%	10%
ICM1 242.4	36%	39%
HKI-163	84.7%	85.3%

Patent filed  
Licensed: Varmes Supply Chain Pvt. Ltd (14 Feb 2025)  
13<sup>th</sup> ISC-2025

### Thank You

13<sup>th</sup> ISC-2025

Mr. Pradeep Korishetter, Deputy Director, TSSOCA

### 13<sup>th</sup> Indian Seed Congress

*"Emerging Technologies: Propelling Seed Revolution"*  
February 24-25, 2025, New Delhi

#### Innovative Approaches in Seed Quality Assurance for Globally Competitive Indian seed industry

**Dr. K. Keshavulu**  
President, ISTA  
Director, Telangana State Seed & Organic Certification Authority, Hyderabad, India

13<sup>th</sup> Indian Seed Congress  
February 24-25, 2025, New Delhi

### Seed Industry Overview

- Global seed market is valued about \$70 billion
- Major players such as the US, Netherlands, China, and France leading in seed exports
- India – 5<sup>th</sup> largest and the fastest-growing seed market in the world.
- Estimated value is about 5.0 billion USD in 2024
- India's seed exports: 0.18 Bn USD (2020-21) – Vegetable seeds, Corn, Cotton, Rice, Sorghum
- India's global share in the seed trade is about 2%, with a ranking of 26th globally.

13<sup>th</sup> Indian Seed Congress  
February 24-25, 2025, New Delhi

### Competitive Seed Industry: Factors

13<sup>th</sup> Indian Seed Congress  
February 24-25, 2025, New Delhi

- Research & Innovations
- Enabling Policies / Regulations
- Infrastructure Availability
- Production costs – Farmers Skills
- Logistics & Communications
- Intellectual Property Protection
- Globalisation, Acquisitions and Mergers
- **Seed Quality Assurance**  
*Access to High Quality Seed !!!!*



### Seed Quality Assurance: Importance

13<sup>th</sup> Indian Seed Congress  
February 24-25, 2025, New Delhi

- High-quality seed: pre-requisite for higher crop productivity & good returns
- Seed sector strengthening: adherence to policies that guarantee quality standards and regulatory features
- Regulatory framework: to oversee the interests of governments, seed producers, and farmers
- Appropriate Quality Assurance framework promotes;
  - Competitive seed markets
  - Ensure quality seed access to farmers
  - Lowers trade barriers
  - Promotes seed sector growth and innovations



**Quality Assurance is fundamental for Seed Industry's reputation and evolution**

**It is insurance against crop failure**

### Seed Quality Assurance: Components

13<sup>th</sup> Indian Seed Congress  
February 24-25, 2025, New Delhi

- Seed certification schemes based on varietal identity and varietal purity (National, OECD, AOSCA)
- Seed quality testing (ISTA & AOSA)
- Phytosanitary measures (IPPC, WTO-SPS & NPPO)



### Global Seed Quality Assurance Framework

13<sup>th</sup> Indian Seed Congress  
February 24-25, 2025, New Delhi



**Seed Certification Schemes** (OECD, AOSCA)

**Rules for Seed Sampling & Testing** (International Seed Federation, International Union for Pure and Applied Chemistry, International Union of Pure and Applied Chemistry)

**Phytosanitary measures** (IPPC)

**Plant Variety Protection** (UPOV)

**Quality Declared Seeds** (FAO)

*National laws of the respective countries also plays a greater role*

### Innovations in seed quality assurance: Need !!!

13<sup>th</sup> Indian Seed Congress  
February 24-25, 2025, New Delhi

For improving the quality seed supply system

- Enhanced transparency, accountability & accuracy
- Reduced overall cost of labour-intensive methods
- Faster / quick quality assessment for timely placement of seeds in the market
- Farmers access to improved varieties

*New and innovative technologies have been devised by several researchers /organisations for seed quality assurance around the globe*

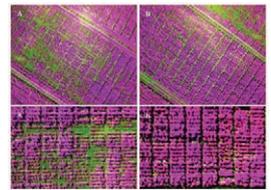


### Innovations in Seed Certification

13<sup>th</sup> Indian Seed Congress  
February 24-25, 2025, New Delhi

Drones for field inspections:

- Based on the differential characters of seed crop, off types, diseased plants, weed plants etc.
- Possible to measure plant health, identify crop species, field counts etc.
- Has already been used in precision breeding techniques
- Needs further research .....!!!!

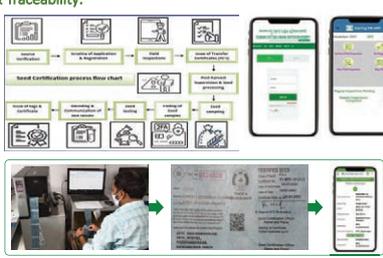



### Innovations in Seed Certification (Contd.)

13<sup>th</sup> Indian Seed Congress  
February 24-25, 2025, New Delhi

Digitalization of Seed Certification & Traceability:

- Transparency, accountability & timely services
- Avoids paper works and saves time
- Real time data on seed certification process
- Easy monitoring-Real time
- Improved genuineness in seed production



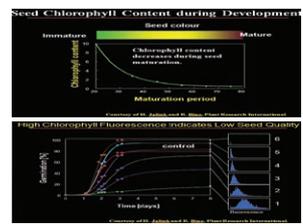
### Seed Maturity Determination

13<sup>th</sup> Indian Seed Congress  
February 24-25, 2025, New Delhi

Chlorophyll fluorescence (CF):

- It is one of the promising technologies for assessing seed maturity
- Chlorophyll is present in seeds during their early development
- Chlorophyll declines with increasing seed maturity and quality
- Seed quality can be determined by relationship between chlorophyll content and seed quality quickly and non-destructively
- Decision on right time of harvesting

**Seed Chlorophyll Content during Development**



Seed chlorophyll content is a good indicator of maturity and seed quality. High chlorophyll fluorescence indicates low seed quality.

*(Source: H. Jalink and R. Bino, 1999, Plant Research International)*



### Advances in Phytosanitary / Seed Health Testing

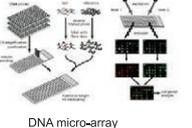
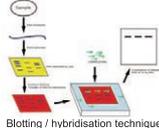
13<sup>th</sup> Indian Seed Congress  
February 24-25, 2025, New Delhi

- Essential test for seed trade across the borders
- Quarantine or economic importance
- It is a routine test in many of the EU and other developed countries
- Draft seed bill also emphasise on the importance of seed health




**Advanced techniques**

- NASH (Nucleic Acid Sequence or Spot Hybridization) technique
- ELISA & PCR based detection assays
- DNA Chip (Microarray) technology

DNA micro-array      Blotting / hybridisation technique

### Conclusion...

13<sup>th</sup> Indian Seed Congress  
February 24-25, 2025, New Delhi

- India's seed export share is currently underrepresented compared to its vast potential.
- Adopting modern seed quality assurance techniques, increasing R&D investments, and enhancing export infrastructure will foster India's growth in the global seed trade.
- Innovation, global collaborations, and adherence to international standards will empower India's seed industry to achieve global competitiveness in the export market.
- Focusing on innovative approaches like digitalization, AI, blockchain, and validation of advance testing protocols, will drive India's position as a global seed leader.
- Need to promote innovations in seed quality assurance for enhanced transparency, accountability and timely placement of seeds in the market.
- Some of these are well established and renewed for application, others are still in their infancy and waiting for more detailed research and validation.

**Dr. Dilip K. Srivastava**, Deputy Commissioner (QC), Seeds Division, DA&FW,

## Seed Traceability in India

### Leveraging the SATHI Portal for Transparency and Quality Assurance

## Vision

*"To build a Digital Ecosystem for effective monitoring of the seed production & distribution chain and to provide complete traceability of the seeds from point of origin till sale"*

## Introduction

The GoI has decided to launch Seed Traceability portal for effective monitoring, efficiency and transparency in seed production and distribution chain.

It aims to provide a quality assurance system through end to end traceability.

It was officially launched by the Honorable Minister of Agriculture, on April 19, 2023.

### OBJECTIVE

- Effective monitoring, efficiency and transparency in seed production and distribution chain.
- Ensure quality assurance system and to track the spurious seed in Seed Production Chain.
- Validate several important criteria such as origin of the seed, stages in production, conformance to quality standards such as genetic purity, germination rate etc.
- To ensure better quality of seed should reach farmer, thus increasing his income.

### What is SATHI?

Seed Authentication, Traceability & Holistic Inventory

### Developed By

National Informatics Centre (NIC), Ministry of Electronics and Information Technology, Government of India

### Phases & Parts of SATHI Portal

#### Phase-I

- Part-I: Nucleus to Breeder Seed Lifting Module
- Part-II: Conversion of Breeder Seed to Foundation and Certified Seed Module

#### Phase-II

- Part-IV: Seed Inventory Module



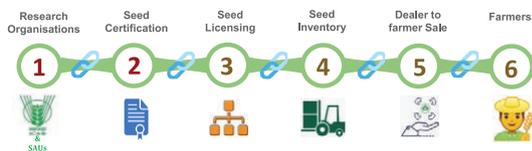
**BENEFITS**

- End to end visibility of seeds throughout their lifecycle.
- Identification of a seed source, variety and quality by backward linkage (traceability) till its origin.
- Automation of manual processes of indent submission, allocation, allotment, lifting etc. for breeder seeds.
- Real time monitoring of demand, allocation and supply of breeder seeds.
- Automation of seed certification system involving registration, inspection, testing, certificate issuance.

**BENEFITS**

- Monitoring of seed inventory and sale to farmers.
- Automated registration of seed dealers, application renewal and license issuance.
- Dashboard based monitoring and MIS for complete track of all activities in seed lifecycle.
- Reduced paper work, easy and effective inspection by use of Mobile based application.

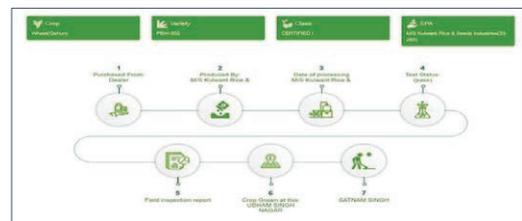
**Integrated Six Verticals of Seed Chain**



**HOW TRACEABILITY HAPPENS**



<https://seedtrace.gov.in/tracetag?tagNo=C3321-000001>



**PHASE-I: NUCLEUS TO BREEDER SEED PRODCUTION MODULE**

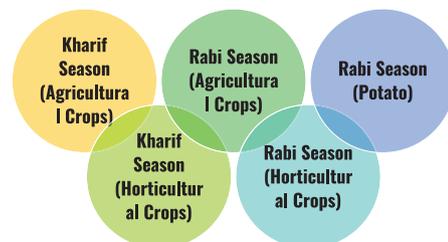
**OBJECTIVE**

- To digitalize the entire Nucleus to Breeder Seed Production chain of National Agriculture Research System (NARS) system under ICAR.

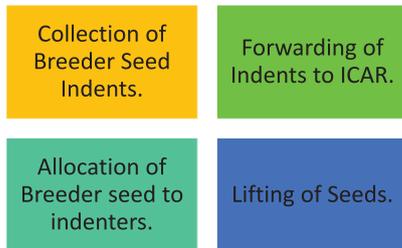
**PROCESS OF SUBMISSION OF BREEDER SEED INDENTS**

- Seed Division DA&FW as a routine used to take Breeder Seed Indent of different crops (in both Kharif and Rabi seasons) from Department of Agriculture States/UTs, National Level Seed Producing Agencies & NSAI

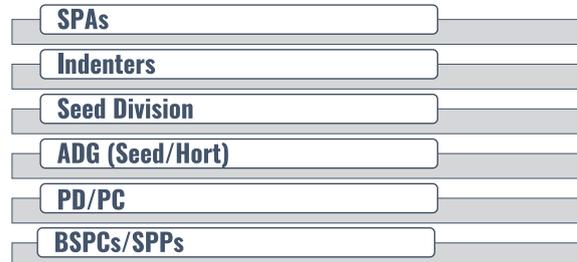
**FREQUENCY OF INDENTS IN A YEAR**



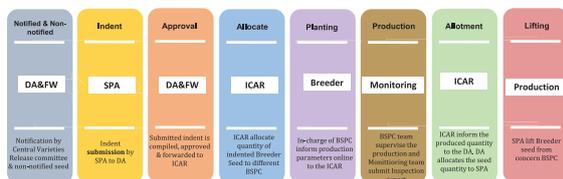
### Breeder Seed System



### Stakeholders in N to B Module of SATHI



### PROCESS FLOW



### STAKEHOLDER STATISTICS

S. No.	Name	Status
1	Indenters	43
2	Nodal Officers	02
3	PD/PCs	23
4	BSPCs	350
5	STLs	185
6	SPPs	369

### PROGRESS SO FAR

10 PD/PCS OF KHARIF CROPS (PADDY, SOYBEAN, KHARIF PULSES, JUTE, MESTA, SUNHEMP, GROUNDNUT, SESAME, NIGER, FORAGE CROPS, ONION, GARLIC AND VEGETABLE CROPS) HAVE STARTED WORKING ON THE SATHI PORTAL FOR KHARIF-2025 INDENTS.

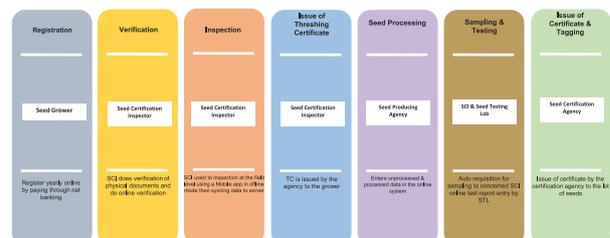
REST 13 PD/PCS OF RABI CROPS (WHEAT, BARLEY, RABI PULSES, RAPESEED, MUSTARD, LINSEED, POTATO AND SPICES) WILL START WORKING FROM RABI 2025-26 INDENTS.

### PHASE-I: BREEDER To FOUNDATION & FOUNDATION To CERTIFIED OR SEED CERTIFICATION AGENCY MODULE

### OBJECTIVE

- To digitalize the entire seed production chain from Breeder to Foundation & Foundation to Certified seed under the supervision of State Seed Certification Agencies.

### PROCESS FLOW



### STATUS OF ONBOARDING OF SSCAs

Before Kharif-2024	In Kharif-2024	Rabi 2024-25	Onboarding Pending
<ul style="list-style-type: none"> <li>Assam, Chhattisgarh, Punjab, Maharashtra, Karnataka, West Bengal, Rajasthan, Odisha, Jammu, Kashmir &amp; Uttarakhand (11).</li> </ul>	<ul style="list-style-type: none"> <li>Bihar, Haryana, Sikkim, Jharkhand, Himachal Pradesh &amp; Madhya Pradesh (06).</li> </ul>	<ul style="list-style-type: none"> <li>Andhra Pradesh, Kerala, Puducherry, Tripura &amp; Uttar Pradesh (05).</li> </ul>	<ul style="list-style-type: none"> <li>Delhi, Gujarat, Telangana &amp; Tamil Nadu (04).</li> </ul>

### PHASE-II: SEED INVENTORY MODULE

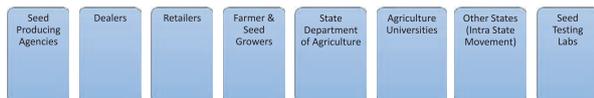
#### OBJECTIVE

- To digitalize the entire seed movement from Seed Producing Agency, Distributors, Dealers/Retailers to Farmers.

#### FUNCTIONALITY

- Record movement of Seed Bag in distribution network.
- Provide real-time inventory.
- Monitoring & Enforcement.

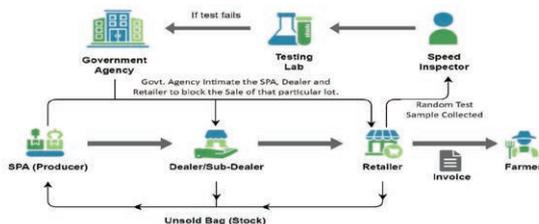
#### STAKE HOLDERS



#### OUTPUT

- Authorised Seed Distribution Network
- Trace & Track of Seed Bag Movement (Traceability)
- Info on Seed Availability from Micro to Macro Level (Holistic Inventory)

#### PROCESS FLOW



#### Seed Inventory Module: Status

Kharif-2024	Rabi 2024-25	Kharif-2025	Rabi 2025-26
<ul style="list-style-type: none"> <li>Maharashtra (01)</li> </ul>	<ul style="list-style-type: none"> <li>Assam, Chhattisgarh, Punjab, Maharashtra, Karnataka, West Bengal, Rajasthan, Odisha, Jammu &amp; Kashmir and Uttarakhand (10)</li> </ul>	<ul style="list-style-type: none"> <li>Bihar, Haryana, Sikkim, Jharkhand, Himachal Pradesh and Madhya Pradesh (06)</li> </ul>	<ul style="list-style-type: none"> <li>Andhra Pradesh, Kerala, Puducherry, Tripura and Uttar Pradesh (05)</li> </ul>



### OTHER PERIPHERAL MODULES OF SATHI

- CENTRAL SEED TESTING LAB (5% SAMPLE SENDING AND TESTING MODULE).
- DASHBOARD DEVELOPMENT FOR NATIONAL LEVEL SEED PRODUCING AGENCIES.
- SEED HUBS INTEGRATION AND MONITORING DASHBOARD.
- INTEGRATION WITH KRISHI MAPPER AND OTHER PORTALS.

### OTHER PERIPHERAL MODULES OF SATHI

- INTEGRATION OF SEEDNET ON SATHI.
- TL SEED MODULE FOR NOTIFIED SEED.
- TL SEED MODULE FOR RESEARCH MATERIAL SEED.
- CVRC VARIETY PROPOSAL SUBMISSION MODULE.

### Issues & Challenges

Complete on-boarding of all State Seed Certification agencies by Rabi 2024-25.

More proactive approach for utilization of "Seed Inventory Module" by State Agriculture Departments.

Complete digitalization of Nucleus to Breeder Seed Module under the preview of ICAR.

To ensure uniformity in different types of reports and tags being issued by ICAR system across the country.

To ensure that breeder seed reaching in the seed chain whether through indenting system or through direct procurement should be from SATHI portal only.

Formation of a National Seed Grid for complete integration of each and every state to ensure-

- Interstate movement of seed,
- To carry out interstate seed certification activity.
- To bring seed inventory in states where no Seed Certification Agency is there but seed is being sold over there.

# THANKS



# Session-wise Key Observations





Day 1: 24-02-2025

## Technical Session I

### Innovations & Next Generation Technologies for Crop Improvement

#### Presentation on “Trends in the Global Seed Market: Role of Technological Innovations as a Key Influencing Factor, Strategies and a Decadal Outlook”

**Dr. Bharti Malhotra**, Research Manager- Analysis Lead, Crop Science, Agribusiness, S&P Global

#### Highlights of the presentation

- The global seed market has been significantly shaped by technological innovations, which have been crucial in driving industry trends and strategies.
- The seed industry is heavily research and development (R&D) driven, with around 15% of seed companies sales allocated to R&D. Technological innovations are pivotal in enhancing seed performance and addressing the challenges faced by the agricultural sector.
- The successful launch of new traits and improved seed varieties is a key driver of seed pricing dynamics, as they can significantly impact market demand. A total of 137 GM traits were introduced in 12 crops between 1992 and 2024.
- The global regulatory framework for New Plant Breeding Techniques (NBTs) is still underdeveloped and requires harmonization for successful adoption, delaying their significant influence on the market.

#### Presentation on “Precision Breeding through CRISPR-Cas mediated Genome Editing”

**Dr. Tanushri Kaul**, Group Leader, Nutritional Improvement of Crops, ICGEB

#### Highlights of the presentation

- By 2050, the world population is expected to reach 9.6 billion, doubling global crop demand. With climate change, shrinking arable land, and water shortages, innovative crop breeding technologies are crucial to boosting productivity and ensuring sustainable agriculture.

- CRISPR/Cas 9 genome editing was used to enhance iron (Fe) and zinc (Zn) levels (15-120 ppm and 28-150 ppm) in rice while reducing cadmium (Cd) accumulation (<0.01 ppm). This breakthrough improves nutritional security and offers a safe, cost-effective solution to combat malnutrition and toxic metal contamination globally.
- CRISPR-based genome editing combats aggressive weeds in Pigeon-pea (*Cajanus cajan* L.) and herbicide resistance in Maize (*Zea mays* L.)
- CRISPR/Cas 9 editing in cotton has led to improving fibre quality, doubling fibre length, enhancing plant morphology and increasing yield by 25-30%.
- There are greater possibilities for utilizing CRISPR-Cas-based genome editing to enhance traits like herbicide tolerance, biofortification, and other quality attributes.
- Invest in new-generation technologies to tackle challenges posed by climate change and rapid population growth.

## Presentation on “Speed Breeding: A game changer for global food security”

**Dr. Uma Maheshwar Singh**, Scientist- Innovative Breeding SARC, IRRI

### Highlights of the presentation

- Speed breeding is a promising technology with high turnover, reduced manpower needs, and lower fertilizer and pest management inputs.
- Key benefits include rapid generation cycles, accelerated breeding, and breeding with speed of climate change.
- Challenges in Speed Breeding include maintaining uniform growth conditions, high electricity consumption, and technical complexity requiring trained personnel.
- Different crops require specific growth protocols, necessitating optimization for each species.
- Future focus should be on developing energy-efficient systems, reducing costs, and enhancing scalability.
- Strengthening collaborations, investments, and training will ensure wider adoption and long-term impact on global food security.
- Prioritize speed breeding programs to accelerate the development of new crop varieties.
- Supplement speed breeding with mapping studies to identify key traits for improved crops.

Conduct research to optimize speed breeding components for different crop species to maximize efficiency.

Day 1: 24-02-2025

## Technical Session II

### Digital and Data-Driven Technologies/applications for seed industry

#### Presentation on “Digital Sequence Information: Technology, Policy & Regulation”

**Dr. Sunil Archak**, Principal Scientist, NBPGR, New Delhi

#### Highlights of the presentation

- DSI on genetic resources refers to the genetic sequence data (GSD) that describes the order of nucleotides in DNA or RNA in genetic material.
- DSI is a collective common resource for use in R&D, for sustainable agriculture and development, is becoming increasingly important.
- Plant breeding and CRISPR-based plant breeding utilizing DSI is estimated to be a \$29 billion industry by 2029.
- Currently, DSI databases are freely available but may become chargeable in the future.
- India is developing its own DSI system, named the Indian Biological Centre, to reduce dependency on foreign databases.
- Indian seed industries should make their opinion on the use of DSI for profit-sharing.

#### Presentation on “Development of Agri Stack: Building Blocks for a future digital paradigm”

**Mrs. Ruchika Gupta**, DDG, Ministry of Statistics & Programme Implementation

#### Highlights of the presentation

- Agri Stack DPI is designed to enhance entire agricultural value chain by improving governance, service delivery, and inclusivity.
- Agri-stack will help farmers by providing solutions, especially farmers having limited knowledge, financial Barriers, Market & Government Struggles.
- Agri Stack’s vision extends beyond land owning farmers to include animal

husbandry, fisheries, tenant farmers, and forest land rights holders in the next phase of the Farmer Registry rollout.

- The digital transformation of agriculture through Agri Stack harnesses emerging technologies to empower citizens, promote sustainability and create equitable access to opportunities.
- With its inclusive approach and emphasis on scalability, Agri Stack can revolutionize agriculture, enhance livelihood and drive national growth.

## **Presentation on “AI based Predictive analytics and crop simulation modeling for precision agronomy for realizing Genetic gains”**

**Mr. Aditya Shah**, Global Director – Strategic Partnerships, CropIn

### **Highlights of the presentation**

- Innovation in digital transformation is essential to address challenges in seed production, while promoting sustainable and responsible growth.
- AI-powered predictive models analyze historical and real-time data to provide accurate variety & location-wise yield forecasts, helping the industry to align seed production with sales strategies.
- CropIn Sage leverages data-driven insights, to deliver hyper-personalized farmer-focused seed variety recommendations based on soil type, weather, and pest risk. This approach drives higher seed adoption while reducing input costs for farmers. It improves farmer’s trust by aligning seed solutions with specific farmer needs, ultimately improving customer satisfaction and driving sales
- CropIn Cloud supports carbon sequestration tracking, helping the seed industry to manage carbon credits while promoting low-carbon agricultural practices

Day 1: 24-02-2025

## Technical Session III

### Strategies and Approaches for harnessing genetic diversity and agronomic innovations for improving profitability of farmers

#### Presentation on “Microbiome based approaches for enabling seed, plant and soil health for realization of potential of Plant varieties.”

**Dr. K. R. K. Reddy**, President BIPA and MD SRIBIO

#### Highlights of the presentation

- Harnessing microbiome-based approaches can significantly improve seed vigor, plant health, and soil fertility, thereby unlocking the full potential of plant varieties.
- Advances in technology allow for the precise application of microbial inoculants tailored to specific crops and soil conditions. This targeted approach maximizes the benefits of microbial interventions and minimizes chemical applications
- Advancements in metagenomics, AI-driven microbial selection, and precision agriculture will drive the future of microbiome applications in sustainable farming.
- Integrating microbiome-based strategies into modern agriculture is key to unlocking the genetic potential of plant varieties.
- Continued research and technological innovations will further optimize microbiome applications, ensuring long-term agricultural sustainability and food security.

#### Presentation on “Seed production innovations for a resilient Indian seed industry”

**Mr. G. V. Ramana Rao**, CTO, Ganga Kaveri Seeds

#### Highlights of the presentation

- Seed production is a complex process facing challenges in the areas of soil health, nutrient and water management, pest outbreaks, labor shortages,

climate change, production technology, and post-harvest care, requiring innovations and effective management.

- Post-harvest care in hybrid seed production is crucial as it directly impacts the quality and viability of the seeds, ensuring genetic purity and high germination rates.
- Labor shortages during peak seed production require solutions like small-farm machinery, optimized schedules, and smart farming technologies for better efficiency.
- The combination of established, time-tested agricultural practices with innovative technologies and methods is essential for resilient seed production.

## Presentation on “Precision Farming to Improve Input use in Agriculture.”

**Dr. Rabi N. Sahoo**, Program Leader, Principal Scientist, Division of Agricultural Physics, ICAR-IARI

### Highlights of the Presentation

- Use of genomics and precision technologies such as high-throughput phenotyping and imaging tools need to be promoted to optimize agricultural productivity.
- There is a need for increased investments in research focused on digital inclusion, responsible use of generative AI, and quantum computing in agriculture.
- Developing and implementing a Standard Spectral Library for Indian Soils is important to support accurate soil analysis and management.
- Adoption of low-cost sensor technologies may be encouraged for efficient soil and water resource management.
- We may foster digital and data-driven innovations to improve last-mile delivery and adoption of agricultural technologies by farmers.
- Precision monitoring of the agricultural ecosystem using remote sensing, IoT sensors, and drones for real-time insights may be strengthened.
- Facilitating public-private partnerships (PPPs) may help in scaling up precision agriculture initiatives across regions.
- There is a need to formulate and implement a comprehensive Digital Agriculture Strategy to guide the transformation of the seed sector through technology interventions.

Day 2: 25-03-2025

## Technical Session IV

### Innovations in Seed Health Management and Traceability

**Presentation on “Seed based delivery systems using Biologicals and Nano technologies for improved stress tolerance and crop productivity”**

**Dr. Gyan Prakash Mishra**, Head, Division of Seed Science and Technology, IARI

#### Highlights of the presentation

- R & D for optimization of compatibility of biologicals with nanoparticles & seed coatings is the need of the hour.
- Stability & efficacy of nano formulations & biologicals during storage and application is important for achieving their full impact.
- Development of crop- specific multi-functional coatings for different environmental conditions may be taken up for customized applications.
- Formulation of regulatory guidelines and standards as well as creating awareness among public will help in large scale adoption of nanotechnology for seed quality enhancement
- Use of biodegradable and renewable nanomaterials will provide a cost-effective and environmentally sustainable option.
- Genetic engineering techniques may be adopted for biologicals to achieve improved resilience to environmental stress & compatibility with nanocarriers.
- Bio- safety issues in the use of nano technologies pertaining to potential toxicity of nanomaterials to the environment & human health need to be studied.



## **Presentation on “Innovative approaches towards seed quality certification for promoting exports for a Globally competitive Indian Seed Industry”**

**Mr. Pradeep Korishetter**, Deputy Director, TSSOCA

### **Highlights of the presentation**

- There is a need for enhancing seed exports through creation of competitive environment and building robust seed industry based on credibility and trust in global market for India. In this regard, adopting modern seed quality assurance techniques, increasing R&D investments, and enhancing export infrastructure is the need of our will foster India’s growth in the global seed trade.
- Innovation, global collaborations, and adherence to international standards are required to empower the Indian seed industry and achieve global competitiveness in the export market.
- Focus on innovative approaches and validation of advanced seed testing protocols will drive India’s position as a global seed leader.
- We need to promote innovations in seed quality assurance for enhanced transparency, accountability and timely placement of seeds in the market.

## **Presentation on “Seed Traceability in India: Leveraging the SATHI Portal for Transparency and Quality Assurance”**

**Dr. Dilip K. Srivastava**, Deputy Commissioner (QC), Seeds Division, DA&FW, MoA&FW

### **Highlights of the presentation**

- TL seed need to be brought within the ambit of SATHI Portal to ensure end to end traceability of TL seed.
- Strengthening of seed testing laboratories (STLs) is urgently needed, especially with respect to seed health testing facilities to ensure supply of quality seed to the farmers.
- Complete digitalization of Nucleus to Breeder Seed Module under the preview of ICAR will provide greater transparency in the seed sector.
- It is targeted to complete the on-boarding of all the State Seed Certification agencies by Rabi 2024-25.
- Formation of a National Seed Grid for complete integration of all states across the country will help in ensuring the availability of quality seeds across the country.

Day 2: 25-02-2025

## Technical Session V

### Shaping the Future: Policy, IP and Emerging Technologies for a Seed Revolution in India

#### Presentation on “Policy and Systems for IPR Governance relevant to Indian Seed Industry”

**Dr. D. K. Agarwal**, RG, PPV&FRA

#### Highlights of the presentation

- PPV&FR Act is a sui-generis IPR system for Plant variety protection gives Plant Breeder Rights (PBRs), which also recognizes the Farmers Rights for protection of the farmers in India who sow, save and resow the seeds.
- The PPV&FR Authority is an IP recognizing body and can sustain with a greater number of IP application filings to give protection the breeder’s efforts.
- The protocols for DUS and VCU testing is being further worked out for putting in place an integrated model to reduce the time for processing applications for PPV&FRA registrations.
- New DUS Guidelines under the PPV&FR Act may be required to help in the protection of IPR in case of new technologies for the development of plant varieties/hybrids.

#### Presentation on “Strengthening In House R&D set up of Seed Companies for DSIR Recognition”

**Dr. Deepika Rohatgi**, Scientist-E, DSIR

#### Highlights of the presentation

- DSIR is the nodal Department of Government of India for granting recognition/ registration to the In-house R&D centres established by industry in the country.
- The in-house R&D recognition of industry by DSIR is a primary requirement

for the industry to avail fiscal incentives under specified sections of 35 (2AB) of the IT Act, 1961.

- The in-house R&D centres of industry applying for recognition to DSIR are expected to be engaged in innovative research & development activities related to the line of business of the firm, such as, development of new technologies, design & engineering, process/product/design improvements, developing new methods of analysis & testing; research for increased efficiency in use of resources, such as, capital equipment, materials & energy; pollution control, effluent treatment ; recycling of waste products or any other areas of research.
- DSIR supports the Indian seed industry by promoting technology development, demonstration, and commercialization, while establishing regulatory benchmarks such as minimum R&D farm size, germplasm sourcing and evaluation guidelines, and certified/truthfully labelled seed development protocols with third-party validation from agencies like ICAR, SAUs, or KVKs.
- The seed industry must enhance its R&D infrastructure with defined priorities and a strategic roadmap, adopt standardized evaluation metrics and advanced testing systems, and align with best practices to leverage government support, foster innovation, and achieve competitive positioning alongside other key sectors.

Day 2: 25-02-2025

## Technical Session VI

### PANEL DISCUSSION – Navigating Challenges and Leveraging Opportunities in Seed Technology through Policy Reforms

**Coordinator: Dr. Sanjay Kumar**, Director, ICAR-NISST, Mau

#### Panelists:

**Dr. M. Prabhakar Rao**, Chairman & Managing Director, Nuziveedu Seeds Ltd

**Mr. Kuldeep Singh**, CMD, HIL (India) Ltd

**Mr. Satish Kagliwal**, Managing Director, Nath Bio-Genes Pvt. Ltd

**Mr. Ajai Rana**, CEO and Managing Director, Savannah Seeds Pvt Ltd

**Dr. Manish Patel**, Executive Director, INCOTEC

**Mr. Rajvir Rathi**, Director Public Affairs, Science and Sustainability (South Asia) & Lead – Traits Licensing Business, Bayer CropScience

#### Highlights of the Penal Discussion

- Indian seed industry has made good progress in supplying good quality seeds to farmers at reasonable price. The self-sufficiency of country in agriculture sector is made possible mainly due to availability of good quality seeds of hybrids and high yielding varieties to the farmers on affordable prices, which are comparatively lower than our neighboring countries.
- The private sector is doing substantive business not only in hybrids of many crops but also has a bigger role in OP varieties of crops like cereals, coarse cereals, oilseed and pulses.
- There is no difference in the quality of TL seeds and certified seeds as both have the same quality standards as prescribed in IMSCS prescribed by the Government of India. Therefore, state government should not put any ban on sell of TL seeds by private seed companies as observed in case of some states like Odisha, Bihar, Rajasthan etc.
- GM traits should be developed and released in many crops to enhance productivity, break yield barrier, and improve quality attributes. Bt cotton, Ht cotton, Bt brinjal etc. are good examples for crop improvements
- In order to have ease of seed business on pan India basis “one nation one license system” should be developed and implemented under seed legislative framework. The work initiated by DAFW in this direction should be speed up.

- Cotton seed prices fixed by DAFW under Cotton Seed Price (Control) Order 2015 have been constant and stable for last so many years making it non remunerative to produce and market Bt cotton seed by cotton seed producing companies. It should be increased for the year 25-26 to improve availability of cotton seed and to remove difficulties of seed companies in making available quality cotton seeds. Increasing Bt Cotton seed price will also eliminate fake and spurious cotton seed producers from the market who are operating due to shortage of quality Bt cotton seed as due to non-remunerative price of Bt cotton seed many good seed companies have reduced their Bt cotton seed production plan.
- HDPS cotton cultivation and seed production should be encouraged to improve cotton production and productivity.
- SATHI portal of DAFW for seed traceability should be encouraged and expanded to cover TL seed also. It should also protect business privacy of private seed companies.
- Allocation of Breeder seed against the indents of private seed companies should be increased so that maximum quantity of quality seed reaches to the farmers through their dealer network, which is spread in the remotest part of the country.
- Seed Revalidation standards and procedures given in IMSCS should be amended, considering the latest developments in seed technology, which is a long pending demand of seed companies.
- Private seed companies R&D facility should be recognized and included in AICRIP variety testing and evaluation system.
- Seed export from India is very less as compared to global market, though, it has tremendous potential. Establishment of bodies like Seed Export Promotion Council may help in augmenting seed exports from India.
- PRA protocols for potential Latin American and African countries may be developed for a fast and uninterrupted processing export and import of seeds with respect to these countries.
- Greater investments in seed quality enhancement technology should be made by seed companies, and the government may support this for providing high quality seeds to farmers.
- For last many years NSAI is representing to Ministry of Finance to make rule-based Income tax provision for seed companies on the lines of Income tax on tea, coffee and rubber crop producers. DAFW may take up this issue with Ministry of finance and get it resolved.
- GST on seed inputs may be exempted to boost growth of seed industry.

# Key Recommendations of Indian Seed Congress 2025





## Technical Session I: Innovations & Next Generation Technologies for Crop Improvement

**Chair – Dr. P. L. Gautam**, Chancellor, Dr RPCAU, Pusa, Bihar

**Co- Chair- Dr. Venkata Subbarao, Kolli**, Partner – Agvaya LLP

### Key Speakers:

**Dr. Bharti Malhotra**, Research Manager- Analysis Lead, Crop Science, Agribusiness, S&P Global

**Dr. Tanushri Kaul**, Group Leader, Nutritional Improvement of Crops, ICGEB

**Dr Uma Maheshwar Singh**, Scientist- Innovative Breeding SARC, IIRI

- Implement policy interventions that facilitate the safe and responsible adoption of genetically modified (GM) technologies in India's food production systems. This includes streamlining regulatory approvals, building public trust through transparent communication, and ensuring science-based decision-making processes.
- Support and incentivize the adoption of direct-seeded rice (DSR) methods among farmers to significantly reduce water consumption in rice cultivation. This could involve investment in farmer training, provision of appropriate seed varieties, and development of mechanization suited for DSR practices.
- Promote the use of CRISPR-Cas-based genome editing technologies to develop crops with enhanced traits such as herbicide tolerance, biofortification (nutritional enhancement), and improved grain quality. Establish clear regulatory frameworks to encourage innovations while ensuring biosafety.
- Foster strong partnerships between private sector companies and public research institutions to accelerate the development and dissemination of cutting-edge agricultural technologies. Collaborative efforts should focus on research, technology transfer, and large-scale deployment of innovations to farmers.
- Prioritize and invest in speed breeding programs to shorten the crop breeding cycle and rapidly develop new varieties that meet emerging challenges such as climate change, evolving pest profiles, and market demands.



- Enhance the use of high-throughput phenotyping technologies to efficiently and accurately assess biotic stresses like diseases in crops. This will support faster identification of resilient varieties and more effective management strategies in breeding programs.

## Technical Session II: Digital and Data-Driven Technologies/ applications for seed industry

**Chair- Mr. Siraj Hussain**, Former Secretary (Agriculture), MoA&FW, GOI

**Co- Chair- Dr. A. K. Singh**, Vice Chancellor, CSAU&T, Kanpur

### Key Speakers:

**Dr. Sunil Archak**, Principal Scientist, NBPGR

**Mrs. Ruchika Gupta**, DDG, Ministry of Statistics & Programme Implementation

**Mr. Aditya Shah**, Global Director – Strategic, Partnerships, CropIn

- Promote the development and utilization of the Agri-Stack platform to provide comprehensive solutions for farmers, particularly those facing challenges such as limited knowledge, financial constraints, and difficulties in accessing markets and government support systems.
- Accelerate regulatory clearances for genomics and precision agriculture technologies to facilitate ease of doing business and encourage greater innovation and investment in the agricultural sector.

## Technical Session III: Strategies and Approaches for harnessing genetic diversity and agronomic innovations for improving profitability of farmers

**Chair- Dr. T. Mohapatra**, Chairperson, PPV&FRA

**Co- Chair- Mr. Rajvir Rathi**, Director Public Affairs, Science and Sustainability (South Asia) & Lead – Traits Licensing Business, Bayer CropScience

### Key Speakers:

**Dr. K. R. K. Reddy**, President BIPA and MD SRIBIO

**Mr. G. V. Ramana Rao**, CTO, Ganga Kaveri Seeds

**Dr. Rabi N. Sahoo**, Program Leader, Principal Scientist, Division of Agricultural Physics, ICAR-IARI

- Promote the integration of microbiome-based approaches in modern agriculture to unlock the full genetic potential of plant varieties, enhancing crop productivity and resilience
- Support ongoing research and technological advancements to further optimize the use of microbiomes, ensuring long-term agricultural sustainability, improved soil health, and global food security.
- Promote the integration of traditional practices with modern technologies to strengthen and ensure resilience in seed production systems.
- Promote the use of genomics, precision technologies, high-throughput phenotyping, and digital tools like remote sensing, IoT sensors, and drones to optimize agricultural productivity, improve resource management, and foster real-time monitoring of the agricultural ecosystem.
- Focus on increasing investment in R&D for digital inclusion, generative AI, and quantum computing in agriculture. Support low-cost sensor adoption and foster public-private partnerships to scale precision agriculture and develop a comprehensive Digital Agriculture Strategy.

## Technical Session IV: Innovations in seed health management and traceability

**Chair- Mr. Ashish Bahuguna**, Former Secretary (Agriculture), MoA&FW, GOI

**Co- Chair- Dr. D. K. Yadava**, DDG (Crop Science), ICAR

### Key Speakers:

**Dr. Gyan Prakash Mishra**, Head, Division of SS&T, IARI

**Mr. Pradeep Korishetter**, Deputy Director, TSSOCA

**Dr. Dilip K. Srivastava**, DC(QC), Seeds Division, DA&FW, MoA&FW

- Focus on R&D in the area of optimizing the compatibility of biologicals with nanoparticles, ensuring stability, efficacy, and environmental sustainability of nano-formulations, and developing crop-specific coatings for diverse conditions.

- Develop regulatory standards for nanotechnology in seed quality enhancement, promote public awareness for large-scale adoption, and address bio-safety concerns regarding the potential toxicity of nanomaterials.
- Enhance seed exports by adopting modern quality assurance techniques, increasing R&D investments, improving infrastructure, and fostering global collaborations to meet international standards and boost India's position in the global seed market.
- Focus on innovative seed testing protocols, ensuring transparency, accountability, and timely market placement to position India as a global leader in the seed industry.
- The government should integrate TL seed into the SATHI Portal for end-to-end traceability and strengthen seed testing laboratories (STLs) to ensure quality assurance.
- Government may create a National Seed Grid for seamless inter-state integration to ensure a consistent supply of quality seeds to farmers.

## Technical Session V: Shaping the Future: Policy, IP and Emerging Technologies for a Seed Revolution in India

**Chair- Mr. Sanjay Agarwal**, ADG, ICRISAT and Ex. Secretary, DA&FW, Govt of India

### Key Speakers:

**Dr. D. K. Agarwal**, Registrar General, PPV&FRA

**Dr. Deepika Rohatgi**, Scientist-E, DSIR

- New DUS Guidelines under the PPV&FR Act may be required to help in the protection of IPR in case of new technologies for the development of plant varieties/hybrids.
- The PPV&FR Authority should adopt more proactive approaches to incentivize the seed industry for encouraging them to participate in filing applications.

- Implement confidence-building measures to foster trust and encourage active engagement of stakeholders in the registration process. These actions are imperative to streamline the PPV&FR registration process and promote the growth of the seed industry.
- Strengthen the Indian seed industry by enhancing R&D infrastructure, adopting standardized evaluation metrics, and aligning with best practices.
- Support technology development, demonstration, and commercialization, while establishing regulatory benchmarks for R&D farm size, germplasm sourcing, and certified seed protocols with third-party validation from ICAR, SAUs, or KVKs.
- Develop special guidelines to strengthen the in-house R&D capabilities of seed companies, encouraging innovation and boosting productivity.

## Technical Session VI: PANEL DISCUSSION – Navigating Challenges and Leveraging Opportunities in Seed Technology through Policy Reforms

**Chair: Mr. Ajeet Kumar Sahu**, Joint Secretary (Seeds), DAFW, MoAFW, Government of India

**Coordinator: Dr. Sanjay Kumar**, Director, ICAR-NISST, Mau

### Panelists:

**Dr. M. Prabhakar Rao**, Chairman & Managing Director, Nuziveedu Seeds Ltd

**Mr. Kuldeep Singh**, CMD, HIL (India) Ltd

**Mr. Satish Kagliwal**, Managing Director, Nath Bio-Genes Pvt. Ltd

**Mr. Ajai Rana**, CEO and Managing Director, Savannah Seeds Pvt Ltd

**Dr. Manish Patel**, Executive Director, INCOTEC

**Mr. Rajvir Rathi**, Director Public Affairs, Science and Sustainability (South Asia) & Lead – Traits Licensing Business, Bayer CropScience

- There is no difference in the quality of TL seeds and Certified seeds as both have the compliance to the same quality standards as prescribed by the

Government of India in the IMSCS. Therefore, state governments should not put any ban on the sale of TL seeds by private seed companies as observed in case of some states like Odisha, Bihar, Rajasthan etc.

- GM traits should be developed and released in many crops to enhance productivity, break yield barrier, and improve quality attributes. Bt cotton, Ht cotton, Bt brinjal etc. are good examples crop improvements through GM technology.
- In order to have ease of doing seed business on pan India basis “**One Nation One Licence system**” should be developed and implemented under seed legislative framework. The work initiated by DAFW in this direction should be speeded up.
- The trend of cotton seed prices fixed by DAFW under Cotton Seed Price (Control) Order 2015 has been mostly linear or with very nominal increase for so many years making it non remunerative to produce and market Bt cotton seed by cotton seed producing companies . It should be increased reasonably to make it remunerative for the seed companies to improve availability of cotton seed and to remove difficulties of seed companies in making available quality cotton seeds. Increasing Bt Cotton seed price will also eliminate fake and spurious cotton seed producers from the market who are operating due to shortage of quality Bt cotton seed as due to non-remunerative price of Bt cotton seed many good seed companies have cut down their Bt cotton seed production plan.
- HDPS cotton cultivation and seed production should be encouraged to improve cotton production and productivity.
- SATHI portal of DAFW for seed traceability should be encouraged and expanded to cover TL seed also. It should also protect business privacy of private seed companies.
- Allocation of Breeder seed against the indents of private seed companies should be increased so that maximum quantity of quality seed reaches to the farmers through their dealer network which is spread in the remotest part of the country.
- Seed Revalidation standards and procedures given in IMSCS should be

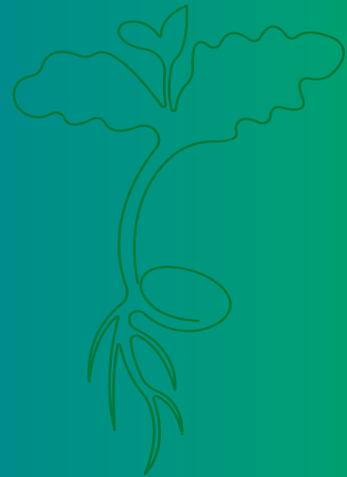


amended which is a long pending demand of seed companies.

- Private seed companies R&D facility should be recognized and included in the AICRIP variety testing and evaluation system.
- Seed export from India is very less as compared to global market, though, it has tremendous potential. Establishment of bodies like Seed Export Promotion Council may help in augmenting seed exports from India.
- PRA protocols for potential Latin American and African countries may be developed for a fast and uninterrupted processing export and import of seeds with respect to these countries.
- Greater investment in seed quality enhancement technology should be made by seed companies, and the government may support this for providing high quality seeds to farmers.
- Income tax provision for seed companies on the lines of Income tax on tea, coffee and rubber crop producers. DAFW may take up this issue with Ministry of finance and get it resolved.
- GST on seed inputs may be exempted to boost growth of seed industry.



# List of Delegates







S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
1	Mr Aakula Ganesh	Proprietor	AN Laxmi Seeds	Nizamabad	AP/ Telangana	India	9885274124	anlaxmiseds41@gmail.com
2	Mr Yanamadala Ravi Chandra	Director	Aadhyaa Seeds Pvt. Ltd.	Bengaluru	TELANGANA - Karnataka	India	9642395999	aadhyaaaseeds@gmail.com
3	Mr MNR BAIG	DIRECTOR	Aasma Seeds India Pvt. Ltd.	Gurgaon	Haryana	India	9513366900	mnrbaig@aaasmaseeds.in
4	Mr Abishiek Senthilnathan	Executive Director	Acsen Agriscience Pvt. Ltd.	Gurgaon	Haryana	India	9650594332	ajay.dayal@acsen.in
5	Mr Ajay Dayal	VP-Seed Health & Farmer Services	Acsen Agriscience Pvt. Ltd.	Gurgaon	Haryana	India	9650594332	ajay.dayal@acsen.in
6	Mr N Narsa Reddy	Director	Adithya Agritech	Nizamabad	AP/ Telangana	India	8500100900	adithyaagritech@gmail.com
7	Mr Sudhir Chandra Nath	Business Director	Advance Chemical Industries Ltd.	Dhaka	Bangladesh	Bangladesh	0170-8467579	sudhir.nath@aci-bd.com
8	Dr KV Subbarao	Consultant	Ag Vaya LLP	Mumbai	Maharashtra	India	9989083312	subbarao.kv@agvaya.com
9	Mr Pravin Chandra Dravid	Consultant	Agri Business Consultant	Pune	Maharashtra	India	9766617103	pravin_dravid@hotmail.com
10	Mr Vikrant kandhway	VP-Institutional Business	Agribazaar	Noida	UP	India	9082851820	vikram.kandhway@agribazaar.com
11	Mr Deepak Choudhary	Head-AgriHumani	Agribazaar	Noida	UP	India	7506925142	deepak.choudhary@agribazaar.com
12	Mr J S Jadhav		Agricall Crop Life Pvt. Ltd.	Dhrangadhra	Gujarat	India	97123995945	agricallcroplife@gmail.com
13	Mr ABDULFATTAH	Owner	Agricultural Corner for seeds	Seiwan	Lebanon	Seiwan	967112927117	alzoobery2001@yahoo.com
14	Mr Souheib Hajjar	CEO	agrimedica		Lebanon	Lebanon	96170095310	souheib.hajjar@agrimedica.com
15	Mr Mihar Shah	CEO	Agriown Farmtech Pvt. Ltd.	Visakhapatnam	AP/ Telangana	India	9824762150	mihar.shah@agriown.com
16	Mr Wouter Van Stuyvesant Meijen	Director	Agro Business Solutions	Hyderabad	AP/ Telangana	India	9966230006	wsm@agrosolutions.nl,
17	Mr Rachamalla Praveen Reddy	Senior Business Cinsultant	Agro Business Solutions	Hyderabad	AP/ Telangana	India	9966230006	pr@agrosolutions.nl,
18	Mr AAYUSH MARODIA	Director	Agrotech Seeds	Kolkata	West Bengal	India	9831048211	aayush@panseeds.in
19	Mr Anshuman Marodia	Director	Agrotech Seeds	Kolkata	West Bengal	India	9830388985	anshuman@panseeds.in
20	Mr RAVIRAJ JAMDADE	Manager - Institutional Sales (Bulk, Export & Ecom)	Agrotech Seeds	Kolkata	West Bengal	India	9403079133	aayush@panseeds.in
21	Mr Pratap Maji	Purchase Manager	Agrotech Seeds	Kolkata	West Bengal	India	9433976396	pratap@panseed.in
22	Mr Chetan Rao	Managing Director	Akaaya Seeds India Pvt. Ltd.	Rewari	Haryana	India	9871115541	chetan@akaayaaseeds.com
23	Mr Deep Makadia	Managing Director	Akshay Seed Tech Company	Junagadh	Gujarat	India	9033378525	info@akshayseed.com



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
24	Mr Sanjay Kapoor	Director	Ambala Agro Machineries Pvt. Ltd.	Ambala	Haryana	India	9896238366	ambala_2004@yahoo.co.in,
25	Mr Saurabh Kapoor	Director	Ambala Agro Machineries Pvt. Ltd.	Ambala	Haryana	India	9996010753	saurabhkapoor.ambala@gmail.com,
26	Mr Marta Pesquera	Sales Manager	Amphasys AG	Root D4	Switzerland	Switzerland	41415419123	marta.pesquera@amphasys.com
27	Mr Markus Bernasconi	Head of Sales	Amphasys AG	Root D4	Switzerland	Switzerland	(+49) 41415419123	marta.pesquera@amphasys.com
28	Dr L K Pandey	Managing Director	Ananya Seeds Pvt. Ltd.	Delhi	Delhi	India	9811159584	lkpande@gmail.com
29	Mr Vaibhav Ravi Kashikar	Executive Director	Ankur Seeds Pvt. Ltd.	Nagpur	Maharashtra	India	9822201123	vrkashikar@ankurseeds.com,
30	Mr DAVIDE FOSCHI	SALES MANAGER	ANSEME SPA	CESENA (FC) ITALY		Italy	393387000000	anseme@anseme.it
31	Mr Rahul Pagar	Special Invitee	APSA					
32	Mr A Santosh Reddy	Managing Director	Armoor Hybrid Seeds	Armoor	AP/ Telangana	India	9848034163	armoorthybridseeds@yahoo.com
33	Mr A Anil Reddy	Director	Armoor Hybrid Seeds	Armoor	AP/ Telangana	India	7989276135	armoorthybridseeds@yahoo.com
34	Mr Mahesh Yadav	V.P. Marketing (Veg)	Arya Hybrid Seeds Ltd.	Aurangabad	Maharashtra	India	7721840999	m.yadav@ajeetseed.co.in
35	Mr Surendra Deshmukh	G.M. - R&D (Veg)	Arya Hybrid Seeds Ltd.	Aurangabad	Maharashtra	India	9921882699	surendra.deshmukh@ajeetseed.co.in
36	Mr J A Earanna	Managing Partner	Ashoka Farm Aids	Bengaluru	Karnataka	India	9341956265	earanna@ashokaseeds.com,
37	Mr Nitin Earanna	Managing Partner	Ashoka Farm Aids	Bengaluru	Karnataka	India	9341956265	nitinearanna@ashokaseeds.com
38	Mr JI HOON SHIN	MANAGING DIRECTOR	ASIA SEED INDIA PVT. LTD.	Bengaluru	Karnataka	India	9731446539	in@asiaseed.co.kr
39	Mr SUYOUNG EOM	DIRECTOR-INTERNATIONAL SALES & MARKETING	ASIA SEED INDIA PVT. LTD.	Bengaluru	Karnataka	India	1033263744	in@asiaseed.co.kr
40	Mr VEERABHADRAIAH T N	MANAGER-BUSINESS DEVELOPMENT	ASIA SEED INDIA PVT. LTD.	Bengaluru	Karnataka	India	9945822155	in@asiaseed.co.kr
41	Mr Saurav Gope	Partner	Astha Agri Genetics	Tufanganj	West Bengal	India	9830012412	admin@asthaagri.com
42	Mr Ashish A. Patel	Managing Director	Avani Seeds Pvt Ltd	Ahmedabad	Gujarat	India	9824069347	ashish@avaniseeds.com
43	Mr Donakanti Srikanth	Proprietor	Ayodhya Hybrid Seeds	Nizamabad	AP/ Telangana	India	6302416213	ayodhyahybridseeds@gmail.com
44	Mr Baddam Ravi	Proprietor	Baddam Agri Sciences	Hyderabad	AP/ Telangana	India	9441538453	srrhs2012@gmail.com
45	Dr Pentela Balaji	CEO & Managing Director	Balaji Seeds Crop-Sciences Pvt. Ltd.	Hyderabad	AP/ Telangana	India	8186015678	balajiseedsindia@gmail.com
46	Mr Sudipta Ghosh	Director	Bankim Prosad Ghosh Seeds Pvt. Ltd.	Howrah	West Bengal	India	9433020062	seedsbankim@gmail.com
47	Mr Uttam Mondal		Basudha Seeds	Murshidabad	West Bengal	India	7076732185	basudhaseeds1@gmail.com,



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
48	Mr Arjun Chowdhuri	Lead -Industry Affairs	Bayer Crop Sciences Ltd.	Gurgaon	Haryana	India		arjun.chowdhuri@bayer.com
49	Mr Ajeet Chahal		Bayer Crop Sciences Ltd.	Gurgaon	Haryana	India	7032226832	ajit.chahal@bayer.com
50	Mr Syama Sankar Patra		Bengal Hybrid Seeds	Bankura	West Bengal	India	9475687243	lotus.bengalhybrid@gmail.com
51	Mr Pathik Nandi		Bengal Hybrid Seeds	Bankura	West Bengal	India	9475687243	lotus.bengalhybrid@gmail.com
52	Mr B.K. Tripathi	CEO	BHALSAR SEEDS INDIA PVT LTD	Bangalore	Karnataka	India	9980948621	info.blr@bhalsarseeds.com, bktripathi@bhalsarseeds.com
53	Mr Deepak Dogra	Director	Bharat Agro Overseas (India)	Delhi	Delhi	India	9810048747	deepakdogra_64@yahoo.com,
54	Dr Asish Ghosh	Executive R&D	Bharat Nursery Pvt. Ltd.	Kolkata	West Bengal	India	9830031229	asish@bharatnursery.in
55	Dr Arijit Ghosh		Bharat Nursery Pvt. Ltd.	Kolkata	West Bengal	India	9830310100	arijit@bharatnursery.in
56	Mr Himanshu Taneja	Director	Bharat Seeds Corporation	Delhi	Delhi	India	9810054840	sunnytaneja62@gmail.com
57	Mr M Srinibas Rao	Managing Partner	Bhulaxmi Seeds	Bargarh	Odisha	India	9437198381	bhulaxmiseeds17.2009@rediff-mail.com,
58	Mr. Sagar Lahoti	Director	Bhumitantra Agri Business Pvt. Ltd.	Bengaluru	Karnataka	India	9867106106	sagar.lahoti@bhumitantra.com
59	Mr Akshay	Director	Bhumitantra Agribusiness Pvt. Ltd.	Satara	Maharashtra	India	9594755289	akshay@bhumitantra.com
60	Mr Walter William Scaringella	Owner	Biolegumi Italia SRL	ANDRIA (ITALY)	Italy	Italy	393398333821	walter@biolegumitalia.it
61	Mr Sukhwinder Singh	Sales Manager Asia	Biolegumi Italia SRL	ANDRIA (ITALY)	Italy	Italy	9945467780	sohi@biolegumitalia.it
62	Mr Abhijit Dudhane		Carpel Agri Genetics Pvt. Ltd.					
63	Mr Suryabhan Chavan		Carpel Agri Genetics Pvt. Ltd.					
64	Mr Darren Driscoll	Head of Business Dev. Asia Pacific	Centor India Agri Pvt. Ltd.	Secunderabad	AP/ Telangana	India	61-4487258266	ddriscoll@centoroceania.com
65	Mr Biraja Prasad Mohapatra	Head of Regional Asia	Centor India Agri Pvt. Ltd.	Secunderabad	AP/ Telangana	India	9439204075	biraja@centorindia.com
66	Dr Sibotosh Dash	National Sales Manager	Centor India Agri Pvt. Ltd.	Secunderabad	AP/ Telangana	India	9618555388	sibotosh@centorindia.com
67	Ms Rekula Venkat Reddy	Assistant Sales Manager South	Centor India Agri Pvt. Ltd.	Secunderabad	AP/ Telangana	India	9652195999	venkat@centorindia.com
68	Mr Kshitija N P Priyadarshini	Marketing Executive	Centor India Agri Pvt. Ltd.	Secunderabad	AP/ Telangana	India	9849975533	kshitija@centorindia.com
69	Dr Gajendra Babu	Founder	Chloropy Technologies India Pvt. Ltd.	Hyderabad	AP/ Telangana	India	7893447711	gajendra@chloropy.com



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
70	Mr Rajat Sabharwal	SALES MANAGER	CIMBRIA Heid GMBH	Austria	Austria	Austria	9560453082	rajat.sabharwal@agcocorp.com
71	Mr Michael Petzmann	Cluster Lead - Greater Asia	CIMBRIA Heid GMBH	Austria	Austria	Austria	(43) 6648250610	michael.petzmann@agcocorp.com,
72	Mr Alberto Zaccaria	Area Sales Manager	CIMBRIA Heid GMBH	Austria	Austria	Austria	+39 0542361423	alberto.zaccaria@agcocorp.com
73	Mr Nishant Kumar Singh		Cisco Agricommodities Pvt. Ltd.	Hajipur	Bihar	India	8207777777	punjabseeds2010@gmail.com
74	Mr Devender Kumar		Cisco Agricommodities Pvt. Ltd.	Hajipur	Bihar	India	8207777777	punjabseeds2010@gmail.com
75	Mr Vignan Nalam	Managing Director	CLEARBIZ SOFTWARE SOLUTIONS PRIVATE LIMITED	Adilabad	AP/ Telangana	India	900000137	vignan@clearbiz.ai
76	Mr Sachin Loddha	CFO	Comienzo Agri Science Ltd. (Vachan Seeds)	Raipur	Chhattisgar	India	8275233044	srathi@conienzoagri.com
77	Mr Pankaj Bhila Pagar	Product Dev. Manager	Comienzo Agri Science Ltd. (Vachan Seeds)	Raipur	Chhattisgar	India	8275233044	srathi@conienzoagri.com
78	Mr Pompili Fabrizio		Consorzio Sativa Societa Cooperativa Agricola	Italy	Italy	Italy		pompili@sativa.it
79	Mr Yaganti Venkateswarlu	MD	Comtech Seeds Private Limited	Secunderabad	AP/ Telangana	India	8978955678	
80	Mr N.ANEEL KUMAR REDDY	ASSISTANT GENERAL MANAGER	Coromandel International Limited	Secunderabad	AP/ Telangana	India	9000303193	kumarna@coromandel.muru-gappa.com
81	Mr S.YASHASWI	MANAGER	Coromandel International Limited	Secunderabad	AP/ Telangana	India	9154797695	kumarna@coromandel.muru-gappa.com
82	Mr Kapil Tripathi	Director	Cosmosagri Genetics Pvt. Ltd.	Lucknow	UP	India	9793789999	cosmoagri@seeds@gmail.com
83	Mr Manjul Anand	General Manager	Crystal Crop Protection Limited	Delhi	Delhi	India	7799150009	manjul.anand@crystalcrop.com
84	Mr Arpan Uppal	Director	Crystal Crop Sciences Ltd.	Delhi	Delhi	India	999232585	arpan@crystalseeds.in
85	Mr Nitish Tayal	Owner	Cy Agro Organic	Hisar	Haryana	India	9996109696	admin@cyagro.com
86	Dr Avinash Kumar Singh	General Manager Seeds	Dayal Seeds (P) Ltd.	Meerut	Uttar Pradesh	India	9792201615	avanesh.kumar@dayalgroup.com,
87	Mr Sai Murali Raj		Dayal Seeds (P) Ltd.	Meerut	Uttar Pradesh	India	9792201615	avanesh.kumar@dayalgroup.com,
88	Mr Rajesh Tripathi		DCM Shriram Ltd	Gurgaon	Haryana	India	9815219872	rajeshtripathi@dcmshriram.com
89	Mr Kailash Joshi		DCM Shriram Ltd	Gurgaon	Haryana	India	9815219872	rajeshtripathi@dcmshriram.com
90	Mr Sunil Kumar		DCM Shriram Ltd	Gurgaon	Haryana	India	9815219872	rajeshtripathi@dcmshriram.com
91	Ms Apporva		DCM Shriram Ltd	Gurgaon	Haryana	India	9815219872	rajeshtripathi@dcmshriram.com
92	Mr Vivek Srivastava		DCM Shriram Ltd	Gurgaon	Haryana	India	9815219872	rajeshtripathi@dcmshriram.com



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
93	Mr V Narasimhan		DCM Shriram Ltd	Gurgaon	Haryana	India	9815219872	rajeshtripathi@dcmshriram.com
94	Mr Vishal Kakkar		DCM Shriram Ltd	Gurgaon	Haryana	India	9815219872	rajeshtripathi@dcmshriram.com
95	Mr Ashok Kumar Jha		Delta Agrigenetics Pvt. Ltd.	Secunderabad	AP/ Telangana	India	8886001202	ashok.jha@deltaseeds.in
96	Mr P V RAVI KUMAR	CMD	Dhana Crop Science Limited	Hyderabad	AP/ Telangana	India	9912088588	vrrpolsani@gmail.com
97	Mr P V RAMA RAO	CEO	Dhana Crop Science Limited	Hyderabad	AP/ Telangana	India	9849009748	
98	Mr Prajwal	Partner	Diamond Hybrid Seeds	Bengaluru	Karnataka	India	9108100451	
99	Mr Himanshu Bhadana	Proprietor	Divine Agro Seeds	New Delhi	Delhi	India	9413619140	divineagroseedsgmail.com
100	Mr Geetha Madhuri P	Managing Director	Dufloora Agri Products Pvt. Ltd.	Hyderabad	AP/ Telangana	India	9632129039	director@duflora.com
101	Mr Srinivasan S	CEO	Dufloora Agri Products Pvt. Ltd.	Manoharabad	AP/ Telangana	India	9632169966	srinivasan@duflora.com
102	Mr Karan Mahajan	Partner	Durga Seed Farm (Regd)	Chandigarh	Punjab	India	9815300454	durgaseedfarm@gmail.com
103	Mr P Vishwanath Aithal	Business Dev. Manager	East West Seeds India Pvt. Ltd.	Bengaluru	Karnataka	India	9112270452	vishwanath.aithal@eastwest-seed.com
104	Mr Ketan Mehta	Director	ECOSENSE Labs (I) Pvt. Ltd.	Mumbai	Maharashtra	India	9820028696	info@ecocosense.com
105	Dr B. Siva Prasad		ECOSENSE Labs (I) Pvt. Ltd.	Mumbai	Maharashtra	India	9820028696	info@ecocosense.com
106	Mr Harshit Jain	Manager Operation	Eight Brothers Sales Pvt. Ltd.	Jaipur	Rajasthan	India	7665544003	harshitjain@oswaisoap.com
107	Mr Dhruv K Jain	CEO	Eight Brothers Sales Pvt. Ltd.	Jaipur	Rajasthan	India	9275242424	dhruvjain@oswaisoap.com
108	Mr Karan Chugh	Owner	Eknaam Printers & Packers	Delhi	Delhi	India	9899776887	eknaam.printers@gmail.com
109	Mr Shahsi Chugh	Owner	Eknaam Printers & Packers	Delhi	Delhi	India	9810677318	eknaam.printers@gmail.com
110	Mr G K Santhi	Technical Head	Eknaam Printers & Packers	Chennai	Tamilnadu	India	7010769036	mizpah.eknaam@gmail.com
111	Mr L Srinivasa Rao	Chairmen Managing Director	Eldorado Agritech Pvt. Ltd.	Hyderabad	AP/ Telangana	India	8008801951	
112	Mr L Mallikharjuna Rao	Director	Eldorado Agritech Pvt. Ltd.	Hyderabad	AP/ Telangana	India	8008801954	lmr@srikargroup.com
113	Dr Arvind Kapoor		Eldorado Agritech Pvt. Ltd.	Hyderabad	AP/ Telangana	India		
114	Mr Kishor T.Veer	Managing Director	Elloira Natural Seeds Pvt. Ltd.	Chh.Sambhajinagar	Maharashtra	India	9158425271	elloraseed@gmail.com



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
115	Mr Deshpande Y D	Head QA	Ellora Natural Seeds Pvt. Ltd.	Chh.Sambhajanagar	Maharashtra	India	8010775278	elloraqualitycontrol@gmail.com
116	Mr Akshay Mallapuram	Director-Growth& Innovation	Elvatoz Agritech	Bengarulu	Karnataka	India	9848826183	akshaymallapuram@elvatozagritech.com
117	Mr Saurabh Kumar	Director-Business Development	Elvatoz Agritech	Bengarulu	Karnataka	India	9540724158	saurabhkumar@elvatozagritech.com
118	Mr Bhaskar Venkataramasetty	Co-Founder & Director	Elvetoz Agritech	Bengaluru	Kartanaka	India	9845080036	bhaskarvsetty@elvatozagritech.com
119	Ms Sushma Prasanna		Elvetoz Agritech	Bengaluru	Kartanaka	India	9845080036	bhaskarvsetty@elvatozagritech.com
120	Mr V Nagarajan		Evergreen Hitech Seeds		Tamilnadu	India		
121	Mr Paras B Sutariya	Director Export	Farm Semillas Production Company	Ankleshwar	Gujarat	India	7227877915	info@farmsemillas.com
122	Mr Arhaan Khan	Associate Director	Farm Tech	Bilaspur	Chattisgarh	India	9201962616	Farmotechfed@gmail.com
123	Mr Vallabh Dogra	Director Production	Farmson Biotech Pvt. Ltd.	Ankleshwar	Gujarat	India	9574088803	info@farmsonbiotech.com
124	Mr Raghavan Sampath Kumar	Executive Director	Federation of Seed Industry of India	New Delhi	Delhi	India		ed@fsii.in
125	Mr G. Prabhakar Babu	CEO & Director	Foragen Seeds Pvt. Ltd.	Hyderabad	AP/ Telangana	India	9000002334	prabhakar@foragenseeds.com
126	Mr K. Anil Kumar Reddy	MD	Foragen Seeds Pvt. Ltd.	Hyderabad	AP/ Telangana	India	9448754286	prabhakar@foragenseeds.com
127	Mr Amit Dutta	Associate Director	Frost & Sullivan Private Ltd.	Mumbai	Maharashtra	India	9811703520	amit.dutta@frost.com
128	Mr Rahul Gupta		G T Packers	Bethinda	Punjab	India	9872227127	guptatraders7127@gmail.com
129	Mr Gaddam Tirupathi	Proprietor	Ganga Devi Seeds	Hyderabad	AP/ Telangana	India	9573555150	tgaddam1@gmail.com
130	Mr Akansh Chugh	Director	Ganga Seeds Pvt Ltd	Delhi	Delhi	India	9873925200	gangaseeds135@gmail.com
131	Mr Yogesh C Patel	Managing Director	Gangamani Bio Agritech Seeds Co.	Vadodara	Gujarat	India	9824059902	gangamanibioagritech@gmail.com
132	Mr Robilichan Singha Mahapatra		Gangamani Pvt. Ltd.	Bankura	West Bengal	India	9732266750	gangaseed@gmail.com
133	Mr Pankaj Taneja	Director	Garnier Seeds India Pvt. Ltd.	Delhi	Delhi	India	9871677777	ptaneja@garnierseeds.com
134	Mr Lakkaram Poshetty	Managing Director	Gayathri Seeds Corporation	Nizamabad	AP/ Telangana	India	9848887283	gayathriseedscorporation@gmail.com
135	Mr Basa Sagar	Production Director	Gayathri Seeds Corporation	Nizamabad	AP/ Telangana	India	8897431213	sagarbas9111@gmail.com
136	Mr L Praneeth Kumar	Marketing Manager	Gayathri Seeds Corporation	Nizamabad	AP/ Telangana	India		



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
137	Mr Shankar Lal Agarwal	Director	Genetic Pure Seeds Pvt. Ltd.	Bengaluru	Karnataka	India	9448086093	rtshankarlal@gmail.com
138	Mr Deepak Kantilal Shastri	Director	Genetic Pure Seeds Pvt. Ltd.	Bengaluru	Karnataka	India	9845262287	dkshastri@gmail.com
139	Ms Shraddha Dongare	Sr.Manager- Corporate Sales	Geolife Agritech India Pvt Ltd	Mumbai	Maharashtra	India	7028162269	shraddha@geolife.com
140	Mr Mayur Tapadiya	Director	Geolife Agritech India Pvt Ltd	Mumbai	Maharashtra	India	9960792206	mayur.geolife@gmail.com
141	Mr Bhaailal Patel	Managing Director	GG Agri Genetics	Vadodara	Gujarat	India	9925204877	gg.agribaroda@gmail.com
142	Mr S.U.Baig	Chairman	Global Agritech Seeds	Aurangabad	Maharashtra	India	9372549443	baig@globalagritecseeds.in,
143	Dr Kirtibhai Shamalbhai Patel	Director (CMD)	Goldking Biogene Pvt. Ltd.	Ahmedabad	Gujarat	India	9825988532	admin@goldkingbiogene.in,
144	Dr Preeti Sawairan	Dy. Director of Agri-Seed-IQC)Commissioner of Maharashtra	Govt. of Mah. Commissionerate of Agriculture	Pune	Maharashtra	India		ddaseed@gmail.com
145	Mr Kaushlesh Joshi		Grainpro India Postharvest Technology	Noida	UP	India	9910665844	mithu.jangra@grainpro.com
146	Mr Kamlesh Sharma		Green Agrevolution Pvt. Ltd.	Gurgaon	Haryana	India	9873993713	akash.malhotra@agrevolution.in
147	Mr Amrendra Singh	Co-Founder	Green Agrevolution Pvt. Ltd.	Gurgaon	Haryana	India	9801339080	amrendra@agrevolution.in
148	Mr Shyam Sunder Singh	Co-Founder	Green Agrevolution Pvt. Ltd.	Gurgaon	Haryana	India	9920845530	shyam@agrevolution.in
149	Mr Akash Malhotra	AVP-Marketing	Green Agrevolution Pvt. Ltd.	Gurgaon	Haryana	India	9873993713	aakash.malhotra@agrevolution.in
150	Mr Ajeet Mulay	Managing Director	Green Gold Seeds Pvt. Ltd.	Aurangabad	Maharashtra	India	9822011111	md@greengoldseeds.co.in
151	Mr Anugu Gangaram Reddy	Director	Green Vision Agritech	Nizamabad	AP/ Telangana	India	9848612392	greenvisionagritech@yahoo.com,
152	Mr Anugu Rahul Reddy	Director	Green Vision Agritech	Nizamabad	AP/ Telangana	India	8297222299	reddyrahul264@gmail.com
153	Mr R Madhusudhan Reddy	Director	GROWER HYBRID	Nizamabad	AP/ Telangana	India	9948826255	growerhybridseeds@gmail.com
154	Ms Syamala Gowri Ramisetty	Associate Scientist	Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/ Telangana	India	7702865626	associatescientist.syamala@gubbagroup.com
155	Mr Srikanth Sabbu	MLT Manager	Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/ Telangana	India	8977930626	mltmanager.srikanth@gubbagroup.com
156	Mr Narendra	Management Trinee	Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/ Telangana	India	7674970626	sales.narender@gubbagroup.com



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
157	Mr Sumeeth Reddy	CDAM	Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/ Telangana	India	7386114626	sales.sumeeth@gubbagroup.com
158	Mr Suraj Singh	CDAM	Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/ Telangana	India	8121555656	sales.suraj@gubbagroup.com
159	Mr Manoj Singh	CDAM	Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/ Telangana	India	8790591626	sales.manojsing@gubbagroup.com
160	Mr Sachchita Nand Patel	Management Trainee	Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/ Telangana	India	9030832626	sachchit.sales@gubbagroup.com
161	Mr Praneeth Thakur	Management Trainee	Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/ Telangana	India	7674943626	sales.praneeth@gubbagroup.com
162	Mr Manoj Krishna	CDM	Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/ Telangana	India	8977944626	cdm.manoj@gubbagroup.com
163	Mr Mohit	CDAM	Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/ Telangana	India	7674867626	sales.mohit@gubbagroup.com
164	Mr Gubba Kiran	CEO	Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/ Telangana	India	9849999624	kiran@gubbagroup.com
165	Mr Gubba Deepthi	COO	Gubba Cold Storage Pvt. Ltd.	Secunderabad	AP/ Telangana	India	9866199626	deepthi@gubbagroup.com
166	Mr Dhruvkumar Dilipbhai Patel	Plant Breeder	Gujarat Hybrid Seeds	Ahmedabad	Gujarat	India	9712380805	dhruv80805@gmail.com
167	Mr Ashok Kateshia	Executive Director	Gujarat Seed Industry Association	Gandhinagar	Gujarat	India	9427000375	gsipa2013@gmail.com
168	Mr S Mahalingam	CEO	Guru Agrotech	Panipat	Tamil Nadu	India	9629712567	
169	Mr Deepak Munjal		Guru Kripa Seeds	Panipat	Haryana	India	9896253132	brotherseeds71@gmail.com
170	Mr Sanket Jani	Business Development Exec.	Helicore info pvt ltd.	Ahmedabad	Gujarat	India	7600055570	sales@helicoreinfo.com
171	Mr Moinuddin Hassan Haroon	Managing Director	Hytech Seed India Pvt. Ltd.	Hyderabad	AP/ Telangana	India	8106089761	moinuddin.haroon@hytechseed.in,
172	Mr Ganesh Laxman Patel	Vice President Mkt & Sales	Hytech Seed India Pvt. Ltd.	Hyderabad	AP/ Telangana	India	96899914402	g.patel@hytechseed.in
173	Ms Kamini Kaushal	Research Scholar (Seed Science)	ICAR (IARI New Delhi)	New Delhi	Delhi	India	8757088960	kaushalkamani38@gmail.com
174	Dr Sandeep Lal	SST	ICAR Indian Agriculture Research Institute	New Delhi	Delhi	India		sandeepal@iari.res.in
175	Mr Ravi Shankar Pandey	CEO	IFSA Seeds Pvt Ltd	Sriganganagar	Rajasthan	India	9462594022	md@ifsaseeds.com
176	Mr Sukhmahender Pal	Managing Director	IFSA Seeds Pvt Ltd	Sriganganagar	Rajasthan	India	9414091929	
177	Mr Naveen Gulati		IKO Hybrid Seeds Pvt. Ltd.					
178	Mr Md.Abu Sayed	Sales Manager - Bangladesh	Image Crop Sciences Pvt.Ltd.,	Hyderabad	AP/ Telangana	India	00880 1717242949	info@imagecropsciences.com
179	Dr Manish Patel	Executive Director	Incotec India Pvt Ltd	Ahmedabad	Gujarat	India	9825046614	manish.patel@incotec.com



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
180	Mr Arshad Amir	Manager Corporate Sales & Director	Incotec India Pvt Ltd	Ahmedabad	Gujarat	India	9998244108	arshad.amir@incotec.com
181	Mr Pramod Jadhav	Manager Corporate Sales & Director	Incotec India Pvt Ltd	Ahmedabad	Gujarat	India	9610549629	pramod.jadhav@incotec.com
182	Mrs Madhavi M Vipradash	Managing Director	Indian Farm Forestry Development Co-operative Ltd.(IFFDC)	Gurgaon	Haryana	India	9971715741	madhavi@iffco.in
183	Dr B.R. Yadav	Senior Project Manager	Indian Farm Forestry Development Co-operative Ltd.(IFFDC)	Gurgaon	Haryana	India	9414808146	baluramayadav@iffdc.in
184	Mr K.S. Sandhu	Chief Project Manager	Indian Farm Forestry Development Co-operative Ltd.(IFFDC)	Gurgaon	Haryana	India	9417500958	karnailsinghsandhu@iffdc.in
185	Mr R.K.Dwivedi	Deputy Project Manager	Indian Farm Forestry Development Co-operative Ltd.(IFFDC)	Gurgaon	Haryana	India	9555666778	rkdwivedi@iffdc.in
186	Mr C.P. Yadav	Deputy Project Manager	Indian Farm Forestry Development Co-operative Ltd.(IFFDC)	Gurgaon	Haryana	India	7290071052	cpyadav@iffdc.in
187	Mr Ashish Kumar	State Coordinator	Indian Farm Forestry Development Co-operative Ltd.(IFFDC)	Gurgaon	Haryana	India	8295988417	ashishkumar@iffdc.in
188	Dr Prashant Goel	CEO	Indigo Seeds Pvt. Ltd.	Bengaluru	Karnataka	India	8218290063	director.rnd@indigoseeds.com
189	Dr Prashant Goel	CEO	Indigo Seeds Pvt. Ltd.	Bengaluru	Karnataka	India	8218290063	director.rnd@indigoseeds.com
190	Mr Mehul K Prajapati	Managing Partner	Indo Agri Genetics	Gandhinaagar	Gujarat	India	9825447908	mehules@yahoo.co.in
191	Mr S James William	Head SBU FC	Indo American Hybrid Seeds (India) Pvt. Ltd.	Bengaluru	Karnataka	India	9845491900	james@indamseeds.com,
192	Mr Sangappa B Nelge	Head International Business B2B & PD VEG. Crop	Indo American Hybrid Seeds (India) Pvt. Ltd.	Bengaluru	Karnataka	India	819742675	sangamesh@indamseeds.com
193	Mr Sridhar Hegde	Head SBU Vegetable Crops	Indo American Hybrid Seeds (India) Pvt. Ltd.	Bengaluru	Karnataka	India	9845491907	sridharhegde@indamseeds.com
194	Mr Ajj Abbasmulla	General Manager Sales Veg. Crop	Indo American Hybrid Seeds (India) Pvt. Ltd.	Bengaluru	Karnataka	India	9850117017	ajjj@indamseeds.com
195	Mr PULKIT JAIN	DIRECTOR	Insightgeeks Solutions Pvt. Ltd.	Noida	UP	India	9310402059	accounts@insightgeeks.in
196	Mr Pallavi Singh	BDE	Insightgeeks Solutions Pvt. Ltd.	Noida	UP	India		
197	Mr Linga Reddy Guttha	Senior Manager	International Rice Research Institute	New Delhi	Delhi	India	7893440077	L.r.gutha@irri.org
198	Mr Sambhav Garg	CEO	Inventive Seeds Pvt Ltd	Bengaluru	Karnataka	India	9406903706	sambhav@ispseeds.com
199	Mr Prashant Pachariwala	Director	Inventive Seeds Pvt Ltd	Bengaluru	Karnataka	India	9997995812	prashant.p@ispseeds.com



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
200	Dr Jaswant Singh	Director-Technical	Inventive Seeds Pvt Ltd	Bengaluru	Karnataka	India	8884050040	jsingh@ispseeds.com
201	Mr Veeranjanyulu Dronadula	Managing Director	Invicta Agritech India Pvt. Ltd.	Secunderabad	AP/ Telangana	India	97101531606	invicta.agri@gmail.com,
202	Mr Naveen Parasramani	Business Owner	Jai Devi Seed Store	Gwalior	Madhya Pradesh	India	9752542755	jaidevseedstore@gmail.com,
203	Mr Manish Parasramani	Owner	Jai Devi Seed Store	Gwalior	Madhya Pradesh	India	9753000000	jaidevseedstore@gmail.com,
204	Mr Siddhartha H S	Lead-Export and Emport	JK Agri Genetics	Hyderabad	AP/ Telangana	India	9972466038	siddharthahs@jkagri.com
205	Mr Rangaswami	Chief Manager-Commercial	JK Agri Genetics	Hyderabad	AP/ Telangana	India	7799339977	swami@jkagri.com
206	Mr Rahul D Gurjar	General Manager	Kalash Crop Seeds Sciences Pvt. Ltd.	Jalna	Maharashtra	India	9421743276	rahul@kalashseeds.co.in
207	Mr Narendra A Pande	Manager	Kalash Crop Seeds Sciences Pvt. Ltd.	Jalna	Maharashtra	India	9823567895	narendra.pande@kalashseeds.com
208	Mr Sameer S Agrawal	Managing Director	Kalash Crop Seeds Sciences Pvt. Ltd.	Jalna	Maharashtra	India	9422216889	rahul@kalashseeds.co.in
209	Mr Garrapally Ravinder	Managing Partner	Kanaka Durga Hybrid Seeds Co.	Nizamabad	AP/ Telangana	India	9010663666	kdhseeds@gmail.com
210	Mr Abhishek BM	Managing Director	Karnataka Seed Corporation	Bengaluru	Karnataka	India	9482952457	karnatakaseedscorporation@gmail.com,
211	Mr Ganesh Shinde	Legal Consultant	Karver & Co.	Aurangabad	Maharashtra	India	9960144742	contact@karver.co.in,
212	Mr Ganesh Shinde	Managing Partner	Karver and Company	Aurangabad	Maharashtra	India	9960144742	ynarale@tuv-austria.in
213	Mr Milan Shaw		Kiranbala Krushi Bhandar	Balasore	Odisha	India	9437404783	kiranseeds1@gmail.com
214	Mr Gaddam Vinod	Proprietor	Kisan Hybrid Seeds	Hyderabad	AP/ Telangana	India	9848088815	kisanhybridseeds3273@gmail.com
215	Mr Pawan Kumar Kansal	CMD	Kohinoor Seed Fields (India) Pvt. Ltd.	Delhi	Delhi	India	9582222891	pkk@kohinoorseeds.com
216	Mr Jatin Kansal	Director	Kohinoor Seed Fields (India) Pvt. Ltd.	Delhi	Delhi	India	9582222801	jatin@kohinoorseeds.com
217	Mr Sudhir Kansal	Director	Kohinoor Seed Fields (India) Pvt. Ltd.	Delhi	Delhi	India	9350888012	sudhir@kohinoorseeds.com
218	Mr Gajendra Kumar		Krishak Bharati Cooperative Limited	Noida	Uttar Pradesh	India	7991204036	gajendrakumar@kribcho.net
219	Mr Abhinay Birla	Director	krishimax agricultural service providers private limited	Indore	Madhya Pradesh	India	7987920846	abhinaybirla009@gmail.com
220	Mr Jitendra Singh	General Executive Manager	Krushisharang Agrilclinic Pvt Ltd	Junagdh	Gujarat	India	9131269309	jitendrasingh2271998@gmail.com



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
221	Mr Patoliya Hiren B	Managing Director	Krushisharang Agrilclinic Pvt Ltd	Junagadh	Gujarat	India		
222	Mr P Srinivasa Rao	Managing Director	Kurnool Seeds Pvt. Ltd.	Secunderabad	AP/ Telangana	India	9440292591	srivedas96@gmail.com
223	Mr Cesar Ruano Delgado	Head of Business Ventures, Business Unit Sugarbeet	KWS SAAT SE & Co.	Einbeck	Germany	Germany	151118855270	cesar.ruano@kws.com
224	Mr Elo West Larsen	Sr. Agronomist	KWS SAAT SE & Co.	Einbeck	Germany	Germany	9220441516	cesar.ruano@kws.com
225	Dr Parthasarathi Bhattacharya	Sr. Advisor - Technology	KWS SAAT SE & Co.	Einbeck	Germany	Germany	7799312121	cesar.ruano@kws.com
226	Mr Joydeep Bhattacharya	Sr. Advisor - Commercial	KWS SAAT SE & Co.	Einbeck	Germany	Germany	9830184530	cesar.ruano@kws.com
227	Mr Ayushman Mishra	Manager - Business Development	KWS SAAT SE & Co.	Einbeck	Germany	Germany	9958002420	cesar.ruano@kws.com
228	Mr ANTONIO LAROSA	Owner	LAROSA INTERNATIONAL SEEDS COMPANY	TRANI		ITALY	3.93E+11	antonio@larosainternational-seeds.com
229	Mr PRADIP KAKDE	SALES MANAGER ASIA	LAROSA INTERNATIONAL SEEDS COMPANY	TRANI		ITALY	3351213636	antonio@larosainternational-seeds.com
230	Dr Basavarajiah D	Head R&D	Laxmi Inputs (India) Private Limited	Bengaluru	Karnataka	India	9353901921	bc@laxmiinputs.in,
231	Mr E A Ezra	GM-Work	Littles Agrivet Private Limited	Chennai	Tamilnadu	India	8939828226	littles@littlesoriental.com
232	Mr Malli Mohith Sai	Market Research Associate	Littles Agrivet Private Limited	Chennai	Tamilnadu	India	9840366695	littles@littlesoriental.com
233	Mr Devarapalli Haribabu Reddy	General Manager Sales	Littles Agrivet Private Limited	Chennai	Tamilnadu	India	9182286528	littles@littlesoriental.com
234	Mr D Nitesh Kumar	Managing Director	Lorven Flex and Sack India Pvt. Ltd.	Hyderabad	AP/ Telangana	India	9885094071	cmd@lorvengroup.in,
235	Mr Lokesh Khemka	Proprietor	Luxmi Seeds Corporation	Sriganganagar	Rajasthan	India	9414210483	lokeskhemka806@gmail.com
236	Mr DINESHBHAI PATEL	CMD	Mahalaxmi Cropsience Pvt. Ltd.	Idar	Gujarat	India	9426027614	mahalaxmi212003@yahoo.co.in
237	Mr JATIN CHAUDHARY	Director Research	Mahalaxmi Cropsience Pvt. Ltd.	Idar	Gujarat	India	7069053011	mahalaxmi212003@yahoo.co.in
238	Mr Yogesh Kumbhejkar	Managing Director	Maharashtra State Seeds Corpn. Ltd.	Akola	Maharashtra	India	7588609600	homarketing@mahabeej.com
239	Mr Prakash Tatar	General Manager (Mktg)	Maharashtra State Seeds Corpn. Ltd.	Akola	Maharashtra	India	7588609670	homarketing@mahabeej.com
240	Mr Rakesh Kumar Jain	Managing Director	Malav Seeds Pvt. Ltd.	Indore	Madhya Pradesh	India	9827033215	info@malavseeds.com,
241	Mr Rajarshi Kundu	Managing Director	Mali Agritech Pvt. Ltd.	Ranaghat	West Bengal	India	9332182940	official@maliseeds.com,
242	Mr Pashapu Mahesh	Director	Mallanna Seeds Pvt. Ltd.	Hyderabad	AP/ Telangana	India	9848911991	mallanaseeds@gmail.com



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
243	Mr Meet Savaliya	Director	Mantavya Seeds Pvt. Ltd.	Gandhinagar	Gujarat	India	635438/3150	meetsavaliya7056@gmail.com
244	Mr Viral Kanani	Director	Mantavya Seeds Pvt. Ltd.	Gandhinagar	Gujarat	India	9898988062	viralkanani6414@gmail.com
245	Mr Ramesh Shankarlal Mor		Mayur Seeds Corporation	Pachora	Maharashtra	India	9422292337	
246	Mr Ramesh Shankarlal Mor		Mayur Seeds Corporation	Pachora	Maharashtra	India	9422292337	
247	Mr HARPREET SINGH GULATY	DIRECTOR	MEDHINI AGRITECH PRIVATE LIMITED	RAIPUR	Chhattisgarh	India	9179988090	harpreet.gulaty@medhini.in
248	Mr ASUTOSH PANDEY	DIRECTOR	MEDHINI AGRITECH PRIVATE LIMITED	RAIPUR	Chhattisgarh	India	9179988090	harpreet.gulaty@medhini.in
249	Mr ESHAN BANDIL	PLANT BREEDER	MEDHINI AGRITECH PRIVATE LIMITED	RAIPUR	Chhattisgarh	India	9179988090	harpreet.gulaty@medhini.in
250	Mr Mohammed Munaf	Partner	Meenakshi Agro Chemicals	Hyderabad	AP/ Telangana	India	9849982760	munaf@macagrochemicals.com
251	Dr Kirtan Y Patel	Director	Moti Seeds Pvt. Ltd.	Vijapur	Gujarat	India	9727920100	kirtan@motiseeds.com
252	Mr Pritesh Y Patel	Director	Moti Seeds Pvt. Ltd.	Vijapur	Gujarat	India	9925035763	pritesh6570@gmail.com
253	Mr Akhilesh Kushwaha	Director	MSN Agro Seeds Pvt. Ltd.	Delhi	Delhi	India	9910033672	akhishmaurya333@gmail.com
254	Mr Ankush Chugh	Director	MSN Agro Seeds Pvt. Ltd.	Delhi	Delhi	India	9910032973	ankush25200@hotmail.com
255	Mr Chalapathi Rao A	CEO	My Seeds Pvt. Ltd.	Secunderabad	AP/ Telangana	India	9440616449	myseedsindia@yahoo.com
256	Mr J Chandrashekhar		Nakasa Crop Science					
257	Mr Ganesh Trimbak Ladkat	Director	Namdeo Umaji Agritech (I) Pvt. Ltd.	Pune	Maharashtra	India	9822110432	ganesh@namdeoumaji.com
258	Mr Kachakayala Ranjith	Proprietor	Nandi Seeds Company	Nizamabad	AP/ Telangana	India	9492476823	ranjithkachakayala@gmail.com
259	Mr M Ravi Kumar	Director	Nandini Agri Sciences Pvt. Ltd.	Hyderabad	AP/ Telangana	India	9866234506	nandiniseeds@gmail.com
260	Mr Dwarka Gupta	Managing Director	Narmada Phosphate Limited	Bilaspur	Chhattisgarh	India	8827482739	npl.10095@yahoo.com
261	Dr Venkatesh Kulkarni	Director-R&D	Nath Biogene (India) Ltd.	Aurangabad	Maharashtra	India	7799315151	venkatesh.kulkarni@biogenes.in
262	Mr Satish Kagliwal	Managing Director	Nath Biogene India Ltd.	Aurangabad	Maharashtra	India	9325459999	mdes@biogenes.in,
263	Mr Mudassar Patel	Manager I.B.Development	Nath Biogene India Ltd.	Aurangabad	Maharashtra	India	9970992965	mudassar.patel@biogenes.in
264	Dr Jyoti Goel	Manager (mktg)	National Fertilizer Ltd.	Noida	Uttar Pradesh	India	9717908855	jjyotipande21@nfl.co.in



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
265	Mr R K Trivedi	Former ED NSAI	National Seed Association of India	New Delhi	Delhi	India	9818713591	r_k2001in@yahoo.com
266	Dr Keyur Shah	Director	Navkar Hybrid Seeds Pvt. Ltd.	Ahmedabad	Gujarat	India	9427605412	mail@navkarseeds.com
267	Mr Manish Patel	Managing Director	Neelkanth Agri Biogene	Ahmedabad	Gujarat	India	9925222757	neelkanthseeds@yahoo.co.in
268	Mr Hitesh Zakhaniya	Director	Nidhi Seeds	Rajkot	Gujarat	India		
269	Mr Narendra Matholiya	Managing Director	Nidhi Seeds	Rajkot	Gujarat	India		
270	Mr Amrut Matholiya	Executive Director	Nidhi Seeds	Rajkot	Gujarat	India		
271	Mr Nayan Khandhar	Plant Breeder	Nidhi Seeds	Rajkot	Gujarat	India		
272	Mr Jagdish Kachhadia	Director	Nidhi Seeds	Rajkot	Gujarat	India		
273	Mr Partha Sarathi Das	Manager Exim	Noble Seeds Pvt. Ltd.	Sonipat	Haryana	India	9350342520	exim@nobleseeds.org
274	Mr Lakshmi Narasimhaiah Medemahally	Manager Director	Noble Seeds Pvt. Ltd.	Sonipat	Haryana	India	9350042525	md@nobleseeds.org
275	Mr Sudhir Kumar		Noble Seeds Pvt. Ltd.	Sonipat	Haryana	India	7496969427	cmo@nobleseeds.org
276	Mr Sanket .S. Patil	Director	Novel Seeds Pvt Ltd	Jaigaon	Maharashtra	India	7507775336	
277	Mr Tushar.D. Deshmukh	Director	Novel Seeds Pvt Ltd	Jaigaon	Maharashtra	India	7507775337	tushar@novelseeds.com
278	Mr Jeetendra J. Solanki	Director	Novel Seeds Pvt Ltd	Jaigaon	Maharashtra	India	7507775338	disolanki@novelseeds.com
279	Mr Natha Pandit Raut	Chairman	Novogold Seeds Pvt. Ltd.	Pune	Maharashtra	India	9923200425	nath.raut@gmail.com,
280	Mr Vishnu B. Joshi	Director	Novogold Seeds Pvt. Ltd.	Pune	Maharashtra	India	8010499783	vishnu.joshi@novogoldseeds.com
281	Mr Shripad L. Patil	Director	Novogold Seeds Pvt. Ltd.	Pune	Maharashtra	India	9322029643	shripad.patil@novogoldseeds.com
282	Mr Buwasaheb G. Raut	Director	Novogold Seeds Pvt. Ltd.	Pune	Maharashtra	India	8999464693	bg.raut@novogoldseeds.com
283	Mr Shanmugam Sambanthan	Commercial Head - Agriculture	Novonesis	Bangalore	Karnataka	India	9663054922	SMBS@novozymes.com
284	Mr Rajeev Dwiwedi	Business Development Manager- BioAg	Novonesis	Bangalore	Karnataka	India	9513336722	RKUD@novozymes.com
285	Mr Jalendra Kumar	Technical Services Manager	Novonesis	Bangalore	Karnataka	India	9513336732	JKHG@novozymes.com
286	Mr Chinmay Sardeshpande	Technical Services Manager - Agronomy	Novonesis	Bangalore	Karnataka	India	9850893626	CSSD@novozymes.com
287	Mr Vinay G	Technical Sales Manager - BioAg	Novonesis	Bangalore	Karnataka	India	9008274218	VYG@novozymes.com
288	Ms Esther Vinita		Novonesis	Bangalore	Karnataka	India	7760961453	esvk@novonesis.com
289	Mr G Chaluvaraju	Head R&D APAC	Nunhems India Pvt. Ltd.	Bengaluru	Karnataka	India	9972904773	g.chaluvaraju@basf.com
290	Mr Mahendra S	Proprietor	Nutan Agri Exports	Ranebennur	Karnataka	India	7019984559	mahendra.nutanagri@gmail.com

S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
291	Mr K Venkat Rao	Chief Operating Officer	Nuziveedu Seeds Limited	Hyderabad	AP/ Telangana	India		venkatraok@nslindia.com
292	Mr K Praveen Kumar	Senior Vice-President	Nuziveedu Seeds Limited	Hyderabad	AP/ Telangana	India	9581412313	praveenk@aagindia.com,
293	Mr Sudhir Singh Bhadauria	Head Vegetable Seed Business	Nuziveedu Seeds Limited	Hyderabad	AP/ Telangana	India		sudhir.singh@nuziveeduseeds.com
294	Mr Paramjeet Singh Saluja	Head-Export & Institutional Sales	Nuziveedu Seeds Limited	Hyderabad	AP/ Telangana	India		paramjeet.saluja@nuziveedu-seeds.com
295	Mr Asseem Bhatnagar		Osaw Agro Industries	Ambala Cantt	Haryana	India	9416027005	marketing@agrosaw.com
296	Mr DINKAR KHURMA	VICE PRESIDENT	Osaw Agro Industries Pvt. Ltd.	Ambala Cantt	Haryana	India	9416027005	marketing@agrosaw.com
297	Mr MADHAV PUURI	DY. MANAGER MARKETING	Osaw Agro Industries Pvt. Ltd.	Ambala Cantt	Haryana	India	9416027005	marketing@agrosaw.com
298	Mr Anand Thakkar	Manager - Sales & Marketing	Pace Packaging Machines Pvt. Ltd.	Ahmedabad	Gujarat	India	9099055771	anand@pacepackaging.in
299	Mr Parth Panchal	Executive	Pace Packaging Machines Pvt. Ltd.	Ahmedabad	Gujarat	India		
300	Mr Anup Patel	Executive	Pace Packaging Machines Pvt. Ltd.	Ahmedabad	Gujarat	India		
301	Mr Akshay Pahuja	CEO	Pahuja Seeds	Delhi	Delhi	India	9811180250	pahujasales100@gmail.com,
302	Mr Yash Shah	Director	Paras Genetech Pvt. Ltd.	Ahmedabad	Gujarat	India	9898945789	yash@parasgenetech.com,
303	Mr Siddhartha Shankar Sen	Director	Parasmoni Organic & Agri Products Pvt. Ltd.	Bankura	West Bengal	India	9434590603	sidh_sen@rediffmail.com,
304	Mr Sudip Paramanik		Parasmoni Organic & Agri Products Pvt. Ltd.	Bankura	West Bengal	India	9434590603	sidh_sen@rediffmail.com,
305	Mr Mahendra Patel	Partner	Patel Seeds Corporation Ltd.	Delhi	Delhi	India	9711978097	patelseeds@yahoo.co.in
306	Mr Sachin Soni	Regional Sales Manager B2B	Peptech Biosciences Ltd.	Delhi	Delhi	India	9990181075	sachin@peptechbio.com
307	Mr Sangameswara Rao Bhagavatula	Director	PETKUS Technologies Gmbh	Gurgaon	Haryana	India	9818711044	sachin.bansal@petkus.com
308	Mr Sachin Bansal	Assistant Manager - Finance	PETKUS Technologies Gmbh	Gurgaon	Haryana	India	9560636173	sachin.bansal@petkus.com
309	Mr Sangameswara Rao Bhagavatula	Director	PETKUS Technologies Gmbh	Gurgaon	Haryana	India	9818711044	sachin.bansal@petkus.com
310	Mr Sachin Bansal	Assistant Manager - Finance	PETKUS Technologies Gmbh	Gurgaon	Haryana	India	9560636173	sachin.bansal@petkus.com
311	Dr Sadananda Ajanahalli		Patrika Biosystems	Hyderabad	AP/ Telangana	India	8897458982	phani@patrika.com
312	Mr Phani Gopal Varlagadda	Coo & Co-Founder	Patrika Biosystems Pvt. Ltd.	Hyderabad	AP/ Telangana	India	9573556999	info@patrika.com



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
313	Mr Madhawa Bandara	Manager Agriculture	Plenty Foods (Pvt) Ltd			Sri Lanka	767840505	madhawab.pf@cblk.com
314	Mr Sameera Senarathne	General Manager	Plenty Foods (Pvt) Ltd			Sri Lanka	763205341	sameera.sfc@cblk.com
315	Dr Bibhuti Bhushan Pattanaik		Prabhat Agri Biotech Limited	Hyderabad	AP/ Telangana	India	9818372724	pattanaik181@yahoo.com,
316	Mr Paras Ashtha		Pristine Information Services Pvt. Ltd.	Delhi	Delhi	India	9015329182	paras.ashtha@pristinebs.co.in,
317	Mr L Ramachandran	Director Marketing	Priya Seeds & Biotech	Hyderabad	AP/ Telangana	India	9443259438	priyaseeds2013@gmail.com
318	Mr Surinder Arora	Managing Director	Proline Seeds	New Delhi	Delhi	India	9810128119	surinder@proline-seeds.com
319	Mr Devu Phani Kumar	Managing Director	Provin Holiday N Gifts	Hyderabad	AP/ Telangana	India	9885435448	phani@provingroups.com
320	Mr Bhupinder Garg	Director	Punjab Seed Company	Gidderbaha	Punjab	India	9814425382	su_nnygarg@yahoo.com,
321	Mr Ashok Kumar	Director	Punjab Seed Company	Gidderbaha	Punjab	India	9814425382	pscgdb@gmail.com
322	Mr Vipul Kumar Patel		PVR Agrigenetics	Himmat Nagar	Gujarat	India	9913420375	pvrgrigenetics3@gmail.com,
323	Mr Rajib Das	Managing Director	R.D. Seeds	Nadia	West Bengal	India	8335807676	rdseeds@gmail.com
324	Mr Asham Anil Yadav	Managing Director	Raama Agro Tech India LLP	Hyderabad	AP/ Telangana	India	9948335057	yadava.anilyadava@gmail.com
325	Mr Rajesh Kumar Munjal	Chairman/MD	Rama Krishna Hybrid Seeds	Delhi	Delhi	India	9810079404	contact@rkhsgroup.com,
326	Mr Vinay Goyal	Head Marketing	Regal Woven Sack Pvt. Ltd.	Ghaziabad	UP	India	9958066811	Vinay.goel@regalsacks.com
327	Mr Vanka Raghavaiah	Partner	Reliance Automation Solutions	Hyderabad	AP/ Telangana	India		
328	Mr T Venkateswara Rao		Reliance Automation Solutions	Hyderabad	AP/ Telangana	India		
329	Mr Lakshay Taneja	Business Operations Head	Religio Hybrid Seeds	Delhi	Delhi	India	9999605473	lakshay.taneja@religio.com,
330	Ms Ine Sofie Kristiansen	Advisor	Royal Norwegian Embassy	New Delhi	Delhi	India		ine.sofie.kristiansen@mfa.no
331	Mr Lalit Gambhir		Royal Seeds	Delhi	Delhi	India	9811363639	seeds4royal@yahoo.co.in
332	Mr M. MAHESH KUMAR	MANAGING DIRECTOR	Royal Seeds Pvt. Ltd.	Hyderabad	AP/ Telangana	India	7997744222	royalseeds19@gmail.com
333	Mr ASHIL SINGHAL	DIRECTOR	S G Snack Food Pvt. Ltd.	HYDERABAD	AP/ Telangana	India	9655552294	sgsnackfood@gmail.com
334	Mr NITESH AGARWAL	DIRECTOR	S G Snack Food Pvt. Ltd.	HYDERABAD	AP/ Telangana	India	9655552294	sgsnackfood@gmail.com
335	Ms Pratima Sharma	Senior Research Analyst	S&P Global	Gurgaon	Haryana	India	8800916721	pratima.sharma@spglobal.com
336	Ms Bharti Malhotra	Analysis Lead, Crop Science	S&P Global		New York	USA	12018741915	bharti.malhotra@spglobal.com
337	Mr Vinay Mohite	New Business Manager	S&P Global Commodity Insights	Mumbai	Maharashtra	India	8657303042	vinay.mohite@spglobal.com



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
338	Mr Yogesh Singh Parihar	Export Manager	Safal Seeds & Biotech	Jalna	Maharashtra	India	8788954658	safalseeds@rediffmail.com
339	Mr Kamal Zunzunwala	Chairman	Safal Seeds & Biotech Limited	Jalna	Maharashtra	India	954515954	safalseeds@rediffmail.com
340	Mr Ramesh B Shiraguppi	Director Sr. GM SMPD	Sakata Seed India Pvt. Ltd.	Bengaluru	Karnataka	India	9845146911	rameshbs@sakata.in
341	Mr Ashish Rangappa Wankhede	Sr. Manager SMPD	Sakata Seed India Pvt. Ltd.	Bengaluru	Karnataka	India	9845146911	ashish.wankhede@sakata.co.in
342	Mr adnan	manager	Salar agricultural company		Jordan	Amman	71697575	info@agrisalar.com
343	Mr Bharat Talekar	Proprietor	Samruddhi Agritech	Karimnagar	AP/ Telangana	India	9949038773	tbharatbabu@gmail.com
344	Dr N B Gaddaginath	Managing Director	Sarpan Hybrid Seeds Co Pvt Ltd	Dhanwad	Karnataka	India	9848373377	nbg@sarpanseeds.com
345	Mr Sourabh N Gaddaginath	Head Asia Pacific	Sarpan Hybrid Seeds Co Pvt Ltd	Dhanwad	Karnataka	India	8884051713	sourabh@sarpanseeds.com
346	Mr Rahul Baravarkar	Zonal Manager	Sarpan Hybrid Seeds Co Pvt Ltd	Dhanwad	Karnataka	India	9823944090	rahul@sarpanseeds.com
347	Mr Dilipbhai Patel	Partner	Sarvoday Trading Company	Idar	Gujarat	India	9825096155	stcidar@yahoo.co.in,
348	Mr Subrata Das	Director	Sashyashree Agri Processing Pvt.Ltd.	Hooghly	West Bengal	India	8001926461	sashyashree@gmail.com
349	Mr Abhishek Patel	CEO	Sayaji Seeds LLP	Ahmedabad	Gujarat	India	7574843532	abp@sayajigroup.in
350	Mr Varun Mehta	Partner	Sayaji Seeds LLP	Ahmedabad	Gujarat	India	9998005858	vpm@sayajigroup.in
351	Mr Anil Kolte		Seed Association of MP	Indore	MP	India	9833361345	anil.kolte@eagleseeds.com
352	Dr Ashok Gupta		Seed Association of MP	Indore	MP	India	9833104933	ashok.gupta@eagleseeds.com
353	Mr Shridhar Dhanagara		Seed Association of MP	Indore	MP	India	9850092897	shridhar.dhanagara@eagleseeds.com
354	Mr Vijay Oswal	Executive Director	Seed Association of MP				7024130415	sampindia@gmail.com
355	Mr M Bhagawath Swaroop	Consultant	Seedsmen Association	Hyderabad	AP/ Telangana	India	9618611508	contact@seedsmen.in
356	Mr Hatem Sharabati	Managing Partner	Seven Seeds	The Netherlands		The Netherlands		h.sharabati@7seeds.nl
357	Mr Hatem Sharabati	Managing Partner	Seven Seeds	The Netherlands		Netherlands		h.sharabati@7seeds.nl
358	Mr Rajat Arya	Asst. Director	Shakti Vardhak Hybrid Seeds	Hisar	Haryana	India	9167019425	rajat@shaktivardhakhspl.com
359	Ms Sunaina	General Manager	Shakti Vardhak Hybrid Seeds	Hisar	Haryana	India	9167019425	sunaina@shaktivardhakhspl.com
360	Dr Dara Singh	Marketing (G.M.)	Shakti Vardhak Hybrid Seeds	Hisar	Haryana	India	9416061925	manager.marketing@shaktivardhakhspl.com



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
361	Mr Hinesh Taneja	Director	Shipra Vegetable & Grain Pvt. Ltd.	Delhi	Delhi	India	9810082852	shipraoerseas61@gmail.com,
362	Mr Satavirappa Rotti	Managing Director	Shivson Crop Science Pvt. Ltd.	Bengaluru	Karnataka	India	9561125268	sataveerr@yahoo.com
363	Mr Rameshbhai Dhulabhai Patel	Proprietor	Shree Ram Agrotech	Idar	Gujarat	India	9426032565	create_the_world@yahoo.com,
364	Mr SUDHEER AWASTHI	AVP PEA & BDA	Shriram Bioseed Genetics	Hyderabad	AP/ Telangana	India	9963700177	sudheer.awasthi@bioseed.com
365	Mr RUPESH KUMAR	HEAD INTERNATIONAL BUSINESS	Shriram Bioseed Genetics	Hyderabad	AP/ Telangana	India	7858095122	sudheer.awasthi@bioseed.com
366	Mr Atul Kumar Jain	Vice President & Head SCM	Shriram Bioseed Genetics	Hyderabad	AP/ Telangana	India	9703529709	atul.jain@bioseed.com
367	Mr YV Murali Krishna	Category Head	Shriram Bioseed Genetics	Hyderabad	AP/ Telangana	India	7738235275	muralikrishna.yvs@bioseed.com
368	Mr Aleti Bharath Reddy	Partner	Shuba Ganga Seeds	Hyderabad	AP/ Telangana	India	8096804996	shubagangaseeds@gmail.com
369	Mr T Naga Mohan Reddy	Managing Director	SMR Seeds Pvt. Ltd.		India	India	9490387440	nagamohanr5@gmail.com
370	Mr Shashank Bhushan Singh	Manager Agriculture	SNF India Pvt. Ltd.	Visakhapatnam	AP/ Telangana	India	8558871101	shashank@snf.com,
371	Mr Christophe Bellouard	Global Head Agriculture	SNF India Pvt. Ltd.	Visakhapatnam	AP/ Telangana	India	033-632254448	cbellouard@sbf.com
372	Mr Paul Hublart	Technical Sales Manager Agriculture	SNF India Pvt. Ltd.	Visakhapatnam	AP/ Telangana	India	33602160374	phublart@sbf.com
373	Mr Nagaraj BM	Partner	Solar Seeds	Bengaluru	Karnataka	India	9886100144	nagaraj@solarseeds.com
374	Mr KH RAKSHITH	Partner	Solar Seeds	Bengaluru	Karnataka	India	9663367046	rakshith@solarseeds.com
375	Mr K V Somani	Managing Director	Somani Kanak Seedz Pvt. Ltd.	Delhi	Delhi	India	9999499392	kamal.somani@somaniseedz.com
376	Dr Arjun Singh	Director	Somani Kanak Seedz Pvt. Ltd.	Delhi	Delhi	India	9466238197	arjun.singh@somaniseedz.com
377	Mr Abhishek Somani	Director	Somani Kanak Seedz Pvt. Ltd.	Delhi	Delhi	India	9811901987	abhishek.somani@somaniseedz.com
378	Mr Shehzad Choudary	Managing Director	Sonora Agro Seeds Corporation	Malerkotla	Punjab	India	9417507488	shehzaschoudary77@gmail.com; sonoraseeds@gmail.com
379	Mr Sri Ganga Reddy	Partner	Sri Ganga Hybrid Seeds Co.	Hyderabad	AP/ Telangana	India	9848154321	srigangaseeds@gmail.com
380	Mr V Soundarajan	CEO	Sri Krishna Seeds	Trichy	Tamilnadu	India	9445566573	srikrishnaseeds@gmail.com
381	Mr D Naveen Kumar	Partner	Sri Laxmi Seeds	Nizamabad	AP/ Telangana	India	9848206256	srilaxmi.seeds@gmail.com
382	Mr Kunta Ganga Reddy	Managing Director	Sri Nithya Bio Sciences Pvt. Ltd.	Hyderabad	AP/ Telangana	India	9848665544	srinthybio@gmail.com



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
383	Mr Chunduri Rambabu	Managing Director	Sri Rama Agri Genetics India Pvt. Ltd.	Kurnool	AP/ Telangana	India	9440024567	babu@sriramaseeds.com
384	Mr Naresh Babu	B2B and International Business Manager	Sri Rama Agri Genetics India Pvt. Ltd.	Kurnool	AP/ Telangana	India	8997855001	naresh@sriramaseeds.com
385	Mr Venkata Nagesh.W	Advisor	Sri Rama Agri Genetics India Pvt. Ltd.	Kurnool	AP/ Telangana	India	9903879909	wnagesh@sriramaseeds.com
386	Mr D Bajanna		Sri Rama Seeds Company	Nizamabad	AP/ Telangana	India	9440220213	
387	Mr Kosana Ramakoteswara Rao	Chairman and MD	Sri Sathya Agri Biotech Pvt. Ltd.	Hyderabad	AP/ Telangana	India	9848036039	krkraocmd@sathyaseeds.com
388	Mr Kosana Narendra Prasad	Chief Admin officer	Sri Sathya Agri Biotech Pvt. Ltd.	Hyderabad	AP/ Telangana	India	9948094079	narenkosana@sathyaseeds.com
389	Mr Ram Kosana	Executive Director	Sri Sathya Agri Biotech Pvt. Ltd.	Hyderabad	AP/ Telangana	India	9666278289	ramkosana@sathyaseeds.com
390	Mr RAJ KUMAR	MANAGER-ASIA & PACIFIC	SUBA SEEDS CO.	Longiano	Italy	Italy	9880090364	aryanraj01@gmail.com
391	Mr ALESSANDRO BRUNACCI	SALES MANAGER	SUBA SEEDS CO.	Longiano	Italy	Italy	9880090364	aryanraj01@gmail.com
392	Mr Maggidi Rajeshwar	Proprietor	Sun Hybrid Seeds	Hyderabad	AP/ Telangana	India	9848012201	sunseeds@gmail.com
393	Mr N Chandu	Director	Surya Seeds Ltd.	Guntur	AP/ Telangana	India	7680965251	narasangu.chandu@gmail.com
394	Mr George Gialamas	Managing Director	Suti PC	Psychiko	Athens	Greece	30-120-6729170	ggialamas@emkat.gr
395	Sri Pudraj N Patil	Director	Suvarna Hybrid Seeds Pvt. Ltd.	Bengaluru	Karnataka	India	9606134422	suvarnahys@gmail.com
396	Mr Narayan V Patil	Managing Director	Suvarna Hybrid Seeds Pvt. Ltd.	Bengaluru	Karnataka	India	9341231422	suvarnahys@gmail.com
397	Mr Dhruv Patel	Director	Swarnim Farms India Pvt. Ltd.	Ahmedabad	Gujarat	India	9148999096	info@swarnimfarms.com
398	Mr Akhilesh Kumar Trivedi	Director	Swarup Chemicals (P) Ltd.	Lucknow	Uttar Pradesh	India	9335201818	info@swarupchemicals.com,
399	Mr B N Singh		Swarup Chemicals (P) Ltd.	Lucknow	Uttar Pradesh	India		
400	Mr Sanjay Verma	General Manager	Swarup Chemicals (P) Ltd.	Lucknow	Uttar Pradesh	India	9820771812	info@swarupchemicals.com,
401	Mr Atik Khan	Strategic Alliances Manager	Syngenta India Pvt. Ltd.	Hyderabad	AP/ Telangana	India	9948311699	atik.khan@syngenta.com
402	Mr Kuldeep Sachdeva	Strategic Alliances Manager	Syngenta India Pvt. Ltd.	Hyderabad	AP/ Telangana	India	9948311699	atik.khan@syngenta.com
403	Mr Rizwan Rafeek		TAFF					
404	Mr Armaan Taneja		Taneja Hybrid Seeds (P) Ltd.		Delhi			



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
405	Mr Mr-SERCENK KILIC	CEO	TAREN ENGINEERING COTTON SEED DELINTING EQUIPMENT	Adana	Turkey	Turkey	+905348930010	
406	Mr FIRAT HINIS	SALES DIRECTOR	TAREN ENGINEERING COTTON SEED DELINTING EQUIPMENT	Adana	Turkey	Turkey	+905322301211	frat.hinis@taren.com.tr
407	Mr MOHAMMED ARMAN MOHI- UDDIN	ADVISOR	TAREN ENGINEERING COTTON SEED DELINTING EQUIPMENT	Adana	Turkey	Turkey	+905322936607	farazm72@hotmail.com
408	Mr SEBAHAT ULUSAN	GENERAL MANAGER	TAREN ENGINEERING COTTON SEED DELINTING EQUIPMENT	Adana	Turkey	Turkey	+905333261851	b.gormus@taren.com.tr
409	Mr Mohideen Imran J	Director	Testa Polymer Technology Pvt Ltd	Chennai	Tamilnadu	India	9841526669	info@testapolytech.com
410	Mr Naresh Kumar		The Hitron Herbal Seedcoat	Coimbatore	Tamilnadu	India	9493993701	
411	Mr Sree Harsha		The Hitron Herbal Seedcoat	Coimbatore	Tamilnadu	India		
412	Mr Arvind Dharmalingam	CEO	The Hitron Herbal Seedcoat	Coimbatore	Tamilnadu	India	9043001881	arvind@hitronhct.com,
413	Mr Aloor Ramesh	Proprietor	Thirumala Agri Tech	Hyderabad	AP/ Telangana	India	9849177775	rameshreddy.aloor@gmail.com
414	Mr Varun Gupta	Commercial Development Manager	Traitomic A/S	Copenhagen	Denmark	Denmark	4553708149	varun.gupta@carisberg.com
415	Mr Yash Narendra Narale	Technical Team Leader	TUV AUSTRIA INDIA PRIVATE LIMITED	Nagpur	Maharashtra	India	94047269*31	ynarale@tuv-austria.in
416	Mrs Sushmita Roy	Director	UACI Seeds and Biotech Pvt Ltd	Kolkata	West Bengal	India	9836000576	sushmita.roy@universallagri.net
417	Mr AMIT KADIAN	CEO	UJJAWAL SEEDS PVT LTD	SONIPAT	Haryana	India	9034238224	contact@ujjwalseeds.com
418	Mr Sairam Reddy Palicherla	Co-Founder	UrbanKisaan Farms Pvt Ltd	HYDERABAD	AP/ Telangana	India	9160880789	sai@urbankisaan.com
419	Mr Radhakanta Bagarti	Proprietor	Uttam Bihan Bhandar's	Bargarh	Odisha	India	9438258522 9937000000	uttambihanbhandarbh@gmail.com
420	Mr G N V Ramakrishna	Director	Varun Seeds & Agrotech (India) Pvt. Ltd.	Hyderabad	AP/ Telangana	India	8008121234	varunseeds411@gmail.com
421	Mr Vasanthapu Srinivas	Managing Director	Vasanth Agri Biotech Pvt. Ltd.	Hyderabad	AP/ Telangana	India	9000210022	vasanthseeds@gmail.com
422	Dr P Chandrasekhar	CEO & MD	Veda Seed Sciences (P) Ltd.	Guntur	AP/ Telangana	India	8179633999	ceo@vedaseeds.com, contact@vedaseeds.com,



S.No.	Delegate Name	Designation	Organisation	City	State	Country	Mobile	Email
423	Mr Raj Kumar Goyal	Managing Director	Verdesian Life Sciences, LLC	North Carolina		USA	9350640003	rk.goyal@vlsoci.com
424	Mr Akshay Khurana	General Manager Marketing	Verdesian Life Sciences, LLC	North Carolina		USA	7988216735	akshay.khurana@ulsci.com
425	Mr Sekhar Kumar	Scientist	Verdesian Life Sciences, LLC	North Carolina		USA	8708194119	sekhar.kumar@ulsci.com
426	Mr Reza Jivani	Managing Director	Vikas Crop Care	Mumbai	Maharashtra	India	9978782828	vikascropcare@gmail.com
427	Mr V. Subramanian	TNSA Member	Vinayaga Seeds	Villupuram	Tamilnadu	India	9842397377	vinayagarseeds@gmail.com
428	Mr K H Hulamani	GM Sales & Marketing	Vokkal Seeds Private Limited	Bengaluru	Karnataka	India	9845314840	info@vokkalseeds.com,
429	Mr Sudarshan M	Director	Vriksha Agro Sciences Pvt. Ltd.	Coimbatore	Tamil Nadu	India	9487572610	sudarshan@vrikshaagro.com
430	Mr Amol		Vriksha Agro Sciences Pvt. Ltd.	Coimbatore	Tamil Nadu	India	9487572610	sudarshan@vrikshaagro.com
431	Mr Manoj Kumar		Vriksha Agro Sciences Pvt. Ltd.	Coimbatore	Tamil Nadu	India		
432	Mr Nagerendra Reddy		Vriksha Agro Sciences Pvt. Ltd.	Coimbatore	Tamil Nadu	India		
433	Mr Devi Ram	Managing Director	Weldon Seeds Pvt. Ltd.	Sriganganagar	Rajasthan	India	9461675887	devmudgi75@gmail.com
434	Mr Santosh Sharma	Marketing Head	Weldon Seeds Pvt. Ltd.	Sriganganagar	Rajasthan	India	9461675887	ssantosh870@gmail.com
435	Mr Akash N Patel	Director	Western Agri Seeds Ltd.	Gandhinaagar	Gujarat	India	9825220218	info@westernagriseeds.com
436	Dr Jagadeesha Gouda	Director Research	Yaganti Agrotech Private Limited	Hyderabad	AP/ Telangana	India	9849948443	yagantiagrotech@gmail.com,
437	Mr Gaurav Kumar	Sales Manager	Yamato Scale India Pvt. Ltd.	Delhi	Delhi	India	9873098107	gaurav@yamatoscale.co.in,
438	Mr Koichi Yamaji	General Manager	Yamato Scale India Pvt. Ltd.	Delhi	Delhi	India	96677 04858	
439	Mr Moussa Kindrebeogo		Ynnege Industries					
440	Mr Sahil Gulati	Chief Executive Officer	Zenith Hybri Seeds Pvt. Ltd.	Delhi	Delhi	India	9582712222	sg@zenithhybridseeds.com
441	Mr Sahil Mehta	Chief Product Officer	Zenith Hybri Seeds Pvt. Ltd.	Delhi	Delhi	India	9810016128	sm@zenithhybridseeds.com

# Annexures





# Indian Seed Congress 2025

## CEO Conclave

23<sup>RD</sup> FEBRUARY 2025, HOTEL ANDAZ, AEROCITY, NEW DELHI

### Programme Schedule of the CEO Conclave

S. No.	Programme	Time
1	Registration	02:00 PM – 02:45 PM
2	Welcome of the Guest by the Convener NOC, ISC 2025	02:45 PM-02:50 PM
3	Address by President, NSAI	02:50 PM- 03:00 PM
4	<b>First Session</b> Theme: Mantras for Success Speaker: Mr. Pankaj Dubey, Founder & CEO, DSPIN Consulting Pvt Ltd	03:00 PM-04:15 PM
5	High Tea	04:15 PM-04:45 PM
6	<b>Second Session</b> Theme: Global Perspective of the Indian Seed Sector Speaker: Mr. Simon Wiebusch, President, Bayer South Asia and Vice Chairman, MD & CEO, Bayer CropScience Ltd (BCSL)	04:45 PM-06:00 PM
7	<b>Third Session</b> Theme: United in Rythm, Stronger in Action Group: Team Dhunn, Facilitator: Mr Dinesh Patole	06:00 PM- 07:15 PM
9	Vote of Thanks by Treasurer, NSAI	07:15 PM
10	Cocktail Dinner	07:30 PM onwards

# Indian Seed Congress 2025

EMERGING TECHNOLOGIES - PROPELLING SEED REVOLUTION

Day 1-Monday, 24<sup>th</sup> February, 2025

## Programme Schedule of the Technical Sessions

Time		Event	
9:00 AM-9:45 AM		Registration	
9:45 AM-10:00 AM		Inauguration of Exhibition by Chief Guest/Dignitaries	
10:00 AM-11:00 AM		Inaugural Session followed by Press Briefing	
11:00 AM-11:30 AM		Tea Break	
<b>Technical Session I: Innovations &amp; Next Generation Technologies for Crop Improvement</b> <b>Time: 11:30 AM – 12:50 PM</b> Chair – <b>Dr. P. L. Gautam</b> , Chancellor, Dr Rajendra Prasad Central Agricultural University, Pusa, Bihar Co- Chair- <b>Dr. Venkata Subbarao, Kolli</b> , Partner – Agvaya LLP Rapporteur: <b>Dr. Sneha Adhikari</b> , Scientist, Genetics and Plant Breeding, IARI, Pusa			
11:30 AM-11:40 AM		Opening Remarks by Chair/Co-chair	
SN	Duration	Topic	Speaker
1.	11:40 AM-12:00 Noon	Trends in the Global Seed Market: Role of Technological Innovations as a Key Influencing Factor, Strategies and a Decadal Outlook	<b>Dr. Bharti Malhotra</b> Research Manager- Analysis Lead, Crop Science, Agribusiness, S&P Global
2.	12:00 Noon-12:20 PM	Precision Breeding through CRISPR-Cas mediated Genome Editing	<b>Dr. Tanushri Kaul</b> Group Leader, Nutritional Improvement of Crops, ICGEB
3.	12:20 PM-12:40 PM	Speed Breeding: A game changer for global food security	<b>Dr. Uma Maheshwar Singh</b> Scientist- Innovative Breeding SARC, IIRI
12:40 PM- 12:50 PM		Q&A and Closing Remarks by Chair/Co-Chair	
<b>Lunch- 12:50 PM- 2:30 PM</b>			

### Technical Session II: Digital and Data-Driven Technologies/applications for seed industry

Time: 2:30 PM-3:50 PM

Chair- **Mr. Siraj Hussain**, Former Secretary (Agriculture), MoA&FW, GOI

Co- Chair- **Dr. A. K. Singh**, Vice Chancellor, CSAU&T, Kanpur

Rapporteur: **Dr. Manjeet Kumar**, Scientist, Genetics and Plant Breeding, IARI, Pusa

2:30 PM- 2:40 PM		Opening Remarks by Chair/Co-chair	
SN	Duration	Topic	Speaker
1.	2:40 PM-3:00 PM	Digital Sequence Information: Technology, Policy & Regulation	<b>Dr. Sunil Archak</b> Principal Scientist, NBPGR
2.	3:00 PM-3:20 PM	Development of Agri Stack: Building Blocks for a future digital paradigm	<b>Ms. Ruchika Gupta</b> DDG, Ministry of Statistics & Programme Implementation
3.	3:20 PM-3:40 PM	AI based Predictive analytics and crop simulation modeling for precision agronomy for realizing Genetic gains	<b>Mr. Aditya Shah</b> Global Director – Strategic, Partnerships, Cropln
3:40 PM-3:50 PM		Q&A and Closing Remarks by Chair/Co-Chair	
Technology Presentation-I			
3:50 PM-4:00 PM		Technology for Nutritional Enhancement of Seed - "Need of Hour"	<b>Mr. R. K. Goyal</b> Managing Director, Verdesian
Tea Break: 4:00 PM- 04:45 PM			

### Technical Session III: Strategies and Approaches for harnessing genetic diversity and agronomic innovations for improving profitability of farmers

Time: 4:45 PM-6:05 PM

Chair- **Dr. T. Mohapatra**, Chairperson, PPV&FRA

Co- Chair- **Mr. Rajvir Rathi**, Director Public Affairs, Science and Sustainability (South Asia) & Lead – Traits Licensing Business, Bayer CropScience

Rapporteur: **Mrs. OK Tara**, Head – IPR & Regulatory Affairs, , Nuziveedu Seeds Ltd

04:45 PM- 04:55 PM		Opening Remarks by Chair/Co-chair	
SN	Duration	Topic	Speaker
1.	4:55 PM-5:15 PM	Microbiome based approaches for enabling seed, plant and soil health for realization of potential of Plant varieties.	<b>Dr. K. R. K. Reddy</b> President BIPA and MD SRIBIO
2.	5:15 PM-5:35 PM	Seed production innovations for a resilient Indian seed industry	<b>Mr. G. V. Ramana Rao</b> CTO, Ganga Kaveri Seeds
3.	5:35 PM-5:55 PM	Precision Farming to Improve Input use in Agriculture.	<b>Dr. Rabi N. Sahoo</b> Program Leader, Principal Scientist, Division of Agricultural Physics, ICAR-IARI
5:55 PM-6:05 PM		Q&A and Closing Remarks by Chair/Co-Chair	
7:20 PM Onward		Cultural Program & Welcome Dinner	



## Day 2- Tuesday, 25<sup>th</sup> February, 2025

### Technical Session IV: Innovations in seed health management and traceability

9:30 AM – 10:50 AM

Chair- **Mr. Ashish Bahuguna**, Former Secretary (Agriculture), MoA&FW, GOI

Co- Chair- **Dr. D. K. Yadava**, DDG (Crop Science), ICAR

Rapporteur: **Dr. Sandeep Kumar Lal**, Principal Scientist, Division of Seed Science and Technology, IARI, New Delhi

<b>9:30 AM - 9:40 AM</b>		<b>Opening Remarks by Chair/Co-chair</b>	
SN	Duration	Topic	Speaker
1.	9:40 AM-10:00 AM	Seed based delivery systems using Biologicals and Nano technologies for improved stress tolerance and crop productivity	<b>Dr. Gyan Prakash Mishra</b> Head, Division of SS&T, IARI
2.	10:00 AM-10:20 AM	Innovative approaches towards seed quality certification for promoting exports for a Globally competitive Indian Seed Industry	<b>Mr. Pradeep Korishetter</b> Deputy Director, TSSOCA
3.	10:20 AM-10:40 AM	Seed Traceability in India: Leveraging the SATHI Portal for Transparency and Quality Assurance	<b>Dr. Dilip K. Srivastava</b> DC(QC), Seeds Division, DA&FW, MoA&FW
<b>10:40 AM-10:50 AM</b>		<b>Q&amp;A and Closing Remarks by Chair/Co-Chair</b>	
<b>Technology Presentation-II</b>			
<b>10:50 AM-11:00 PM</b>		Transformative Biological Seed Applied solutions – Driving crop productivity sustainably	<b>Dr. Jalendra</b> Technical Services Managers, Novonosis

**Tea Break: 10: 50 AM-11:45 AM**

### Technical Session V: Shaping the Future: Policy, IP and Emerging Technologies for a Seed Revolution in India

Time: 11:45 AM - 1:05 PM

Chair- **Mr. Sanjay Agarwal**, ADG, ICRISAT and Ex. Secretary, DA&FW, Govt of India

Rapporteur: **Mrs. OK Tara**, Head – IPR & Regulatory Affairs, Nuziveedu Seeds Ltd

<b>11:45 AM - 11:55 AM</b>		<b>Opening Remarks by Chair/Co-chair</b>	
SN	Duration	Topic	Speaker
1.	11:55 AM-12:15 PM	Policy and Systems for IPR Governance relevant to Indian Seed Industry	<b>Dr. D. K. Agarwal</b> RG, PPV&FRA
2.	12:15 PM-12:35 PM	Strengthening In House R&D set up of Seed Companies for DSIR Recognition	<b>Dr. Deepika Rohatgi</b> Scientist-E, DSIR
<b>12:35 PM- 12:45 PM</b>		<b>Q&amp;A and Closing Remarks by Chair/Co-Chair</b>	

**Lunch: 12:45 PM-2:45 PM**

**Technical Session VI: PANEL DISCUSSION – Navigating Challenges and Leveraging Opportunities in Seed Technology through Policy Reforms**

**Time: 2:45 PM-3:45 PM**

Chair: **Mr. Ajeet Kumar Sahu**, Joint Secretary (Seeds), DAFW, MoAFW, Government of India

Coordinator: **Dr. Sanjay Kumar**, Director, ICAR-NISST, Mau

Rapporteur: **Mr R K Trivedi**, Former Executive Director, NSAI

SN	Panelist
1.	<b>Dr. M. Prabhakar Rao</b> , Chairman & Managing Director, Nuziveedu Seeds Ltd
2.	<b>Mr. Kuldeep Singh</b> , CMD, HIL (India) Ltd
3.	<b>Mr. Satish Kagliwal</b> , Managing Director, Nath Bio-Genes Pvt. Ltd
4.	<b>Mr. Ajai Rana</b> , CEO and Managing Director, Savannah Seeds Pvt Ltd
5.	<b>Dr. Manish Patel</b> , Executive Director, INCOTEC
6.	<b>Mr. Rajvir Rathi</b> , Director Public Affairs, Science and Sustainability (South Asia ) & Lead – Traits Licensing Business, Bayer CropScience

**Tea Break: 3:45 PM-4:30 PM**

<b>4:30 PM- 6:00 PM</b>	<b>Valedictory Session and Award Ceremony</b>
<b>7:00 PM Onwards</b>	<b>Cultural Program &amp; Gala Dinner</b>







## **National Seed Association of India**

909, Surya Kiran Building,  
19 Kasturba Gandhi Marg, New Delhi - 110001 (INDIA)

Ph.: 011-43553241-43, Fax.: 011-43533248  
Email: [info@nsai.co.in](mailto:info@nsai.co.in) | Web: [www.nsai.co.in](http://www.nsai.co.in)